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THE EVOLUTION AND FUNCTION OF LIVING PURPOSIVE MATTER

BY

N. C. MACNAMARA, F.R.C.S.

AUTHOR OF
"HUMAN SPEECH, A STUDY IN THE PURPOSIVE ACTION OF LIVING MATTER" AND OF
"THE ORIGIN AND CHARACTER OF THE BRITISH PEOPLE," ETC.

WITH ILLUSTRATIONS

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PREFACE

In a previous volume of the *International Scientific Series* I described the fundamental properties of living protoplasm, and gave an outline of the development of the sense organs of the body and the functions performed by them, in their relation to those parts of the central nervous system by which we gain ideas concerning the external worlds, and are able to express our thoughts in intelligent speech.

The object of the following work is to endeavour to explain the evolution of, and functions performed by those elements of protoplasm which are essential for the manifestation of purposive, instinctive, and psychical phenomena. I believe that knowledge to be derived from the study of this subject, is capable of helping us to realise the importance of heredity in determining the personal character of individuals, and the influence which the environment exercises in modifying the innate qualities handed down to us by our progenitors.[1]

I hold the opinion that the protoplasm of even the simplest organism, such as that which constitutes

[1] With confidence we recommend those persons who are interested in this subject to study Mr and Mrs Whetham's able and interesting work, "The Family and the Nation."

the body of an amœba, in response to various stimuli, discharges a part of its potential energy which, through the action of certain of its constituent elements, is transformed into purposive movements, or work adapted to promote the well-being of the organism. Beyond this, there is evidence to prove that the living substance of an amœba retains impressions made upon it by appropriate stimuli, and that these impressions may be re-excited by similar, or it may be by other, stimuli than those which produced the original impression. So that the movements of these minute particles of protoplasm are not only purposive, but are to some extent guided by memory and experience.

In unicellular organisms the purposive elements appear to be equally diffused throughout the living substance of their bodies, but in all the higher classes of beings these elements have become differentiated, and constitute a part of the protoplasm of their ganglionic nerve cells. These cells send out amœboid-like processes in the form of nerve fibres which communicate with one another and form structures, the basis substance of which receives and retains impressions made upon it by appropriate stimuli, responding by the discharge of energy which becomes manifest in definite movements of the body.

I maintain that the purposive elements of protoplasm undergo evolution *pari passu* with those elements which constitute the structures and organs of the bodies of the ascending classes of animals, and trace the development of these elements through their various stages, showing that this specialised form of matter has come to occupy a definite part of the cerebrum, its functions being to elaborate the instinctive and emotional faculties displayed in the movements made by animals. I adduce evidence to prove that the psychic nervous substance of the brain has been developed from matter possessing instinctive functions. It is through the orderly working of such a system that mental phenomena are brought into operation.

In a well-balanced brain energy derived from psychic nervous matter, to a large extent, controls the action of those parts of the cerebral substance by means of which inherited, instinctive, and emotional processes are elaborated, nevertheless, in the majority of human beings these faculties exercise a paramount influence over their personal characters. In the first part of this volume I have given biological and anatomical evidence to demonstrate the nature of the living matter out of which the hereditary qualities possessed by individuals are elaborated. In the second part of this book the soundness of these conclusions are put to the test, by giving the outline of the leading characteristics displayed by a long line of individuals, who lived under conditions well adapted to show the power which their inherited qualities exercised on the actions of many succeeding generations, and on the destinies of the race to which they belonged. I thus emphasize the importance of heredity in determining individual character.

My sincere thanks are due to Mr R. H. Burne, M.A., F.Z.S., for the never failing and able assistance he has given me in preparing the first part of the following work, much of its contents being based on material contained in the Physiological Series of the Museum of the Royal College of Surgeons of England.

N. C. MACNAMARA.

CHORLEY WOOD,
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PART I

CHAPTER I

THE object of the following work is to establish the fact, that action excited in living protoplasm by various modes of energy, is transmuted by certain of its elements into movements adapted to promote the well-being of the organism. We term the elements constituting this kind of matter " purposive," and show they are sufficient to effect all the movements necessary to maintain the existence of the lower classes of living beings.[1] But as in the ascending orders of animals the structures entering into the formation of their bodies become more complicated, the purposive elements which direct their movements undergo a corresponding evolution, and become developed into matter possessing instinctive and finally psychical functions.

In our previous volume on " Human Speech," we gave an outline of the fundamental properties possessed by living protoplasm, its sources of potential energy, and its adaptation to the action of the environment, through means of which the eyes, ears, and other sensory organs, together with a nervous system had become developed. In order to illustrate the working of this system we referred to its power, in human beings, of elaborating and giving expression to intellectual processes in spoken language. Following on these lines in the present work

[1] *Purposive*—" a word to express the adaptation of means to an end, whether involving consciousness or not."—" Enc. Brit.," vol. xx. p. 73.

we apply the teaching of comparative biology to elucidate the origin and nature of hereditary instinctive matter, and to show that in the case of human beings it exercises a paramount influence on their personal characters and on the race to which they belong.

Throughout the following pages we employ the term individual or personal character to signify those hereditary instinctive and emotional processes which, as we conceive, form the substratum of our actions, and to a large extent rule our whole life.[1]

We hold that purposive matter consists of certain elements of living protoplasm which transmute specific modes of energy into action adapted to promote the well-being of the organism; the supply of energy necessary for this work is derived from the reaction of living matter to various forms of stimuli.

The agent or form of energy which excites living matter to action is known as a *stimulus*; movements or other work thus effected by living matter is described as a response or reaction to a stimulus.

For instance, the substance which forms the body of a unicellular being known as the Bacterium Photometricum, consists of a minute speck of protoplasm, from which a number of fibrils or cilia project outwards through the delicate cell wall of the organism; these form the motory

[1] Professor Villa states, that which determines our actions, rules our whole life, and represents consequently better than any other mental activity our personality, is what we call our "character." When the latter coincides with our ideas, the mental life is harmonious, and we have the illusion that it is they that regulate our actions, whereas we are really only obeying our nature. And of this we have an evident proof when there arises a discrepancy between our ideas and our character, for in that case it is always the character which conquers. The intelligence is a superadded element.—"Contemporary Psychology," p. 180.

structures of the cell, and by their lashing movements propel it through the water. As before explained, under favourable conditions the living matter forming the body of a being of this kind is charged with potential energy derived from chemical action and other sources.[1] If a Bacterium of this kind is kept in the dark it remains almost stationary, but directly the water in which it is floating is exposed to the stimulus of sunlight its cilia commence to work and the cell moves rapidly through the water; thus bringing the organism within reach of food. Movements of this kind, we hold, are purposive, being adapted to promote the well-being of the organism.

We shall endeavour to show that movements such as those above referred to result from energy acting on the living matter constituting the cilia of the organism: we call such energy purposive, and the form of matter from which it proceeds purposive elements. Our theory is, that in the case of a Bacterium Photometricum a portion of the potential energy of its protoplasm is discharged by the action of energy it receives in the form of sunlight; a part of the potential force thus released is transformed by the purposive elements of the cell, into energy which directs the action of its cilia as above described. The work thus performed by the purposive elements of a bacterium might be referred to as being analogous to that of the central nervous system of the higher classes of animals, in that these elements constitute the guiding apparatus of the motary substance of the organism.

For some years past it has been recognised as an established fact, that movements made by the simplest kinds of organisms were effected by the response of their

[1] "Human Speech," p. 28.

living substance to various forms of external stimuli. As far back as the year 1878 Professor Strasburger (and in 1879 Professor Stahl) employed the word Phototaxis to designate the position taken by an organism with reference to the direction of the incident rays of light. He refers to certain of the Desmids. This elongated cell attaches itself by one end, then swings itself over and attaches itself by the other end: each time this is repeated the organism moves the length of its body. This movement, Stahl observes, is due to a periodical reversal of position, such that, for a time, one end of the cell is directed towards the source of light, and then the body is swung over like a pendulum, so that the other end comes to be directed towards the source of light. When, however, the light is intense, these beings place their long axes perpendicularly to the direction of the incident rays. As already shown ("Human Speech," p. 51) the position of chlorophyll-corpuscles are influenced by light, they collect on the cell-wall which is perpendicular to the direction of the incident rays.

In the case of zoospores the intensity of the light to which they are exposed directs their movements either towards or from the source of light; but such movements depend on the sensitiveness of the living matter of the organism, and this will be largely influenced by its supply of potential energy due to the perfection or otherwise of its nutritive and metabolic processes. "Again, supposing that at a certain medium temperature zoospores move away from light of a given and considerable intensity; if now the temperature be raised several degrees, the zoospores will move towards the source of light, that is, at the higher temperature they are less sensitive to light." The sensitivity of these organisms is affected by the supply of free oxygen, and is also increased by their age, so that when young they move towards light, from which when they are older they move away.[1]

Professor Jacques Loeb holds that the movements of the higher animals like those of the simpler orders of beings, result from the response of their living substance to the direct action of light and other natural forces; he maintains that these beings have no power of directing or of resisting the action of these forces. The movements of both plants and animals, he states, depend, "first, upon the specific irritability of certain elements of the body-surface, and, secondly, upon the relation of symmetry of the body." Symmetrical elements at the surface of the body have the same irritability; unsymmetrical elements have a different irritability. Those nearer the oral pole possess an irritability greater than that of those near the aboral pole. These circumstances force an animal to place itself towards a source of stimulation in such a way that symmetrical points on the surface of the body are stimulated equally. In this way animals are led without will of their own either towards the source of the stimulus or away from it.[2]

[1] "Physiology of Plants," S. H. Vines, pp. 520, 525; also Fischer, "The Structure and Functions of Bacteria," p. 81.

[2] "Comparative Physiology of the Brain and Psychology," pp. 7, 181, by Professor J. Loeb, who is of opinion that the central nervous system is nothing more than a protoplasmic medium of communication between the skin and the muscles. Somewhat similar opinions have been promulgated by Dr Kronthal, his idea being that the conducting paths of fibrillæ constitute the only essential nervous mass, and that the remaining parts of the nerve cell—that is, the protoplasmic and chromatic masses, nucleus and nucleolus—belong to wandering cells, which bear the same relation to the neuro-fibrillæ that a drop of oil does to a number of threads at whose intersecting points the drop has become entangled.—*Brit. Med. Journ.*, May 29, 1909, p. 1303.

As an example, Professor Loeb refers to the movements of a moth in the presence of a lighted candle. He states that if a moth be struck by the light on one side, those muscles which turn the head towards the light become more active than those of the opposite side, and correspondingly the head of the animal is turned towards the source of light. As soon as the head of the animal has this position, and the median-plane comes into the direction of the rays of light, the symmetrical points of the surface of the body are struck by the rays of light at the same angle. The intensity of light is the same on both sides, and there is no more reason why the animal should turn to the right or left—away from the direction of the rays of light. Thus it is led to the source of light. Animals that move rapidly get into the flame before the heat of the flame has time to check them in their flight. Animals that move slowly are affected by the increasing heat as they approach the flame; the high temperature checks their progressive movement, and they walk or fly slowly about the flame. The more refractive rays are the most effective in animals, just as in plants, in producing these movements.

Dr G. Bohn is a strenuous advocate of Loeb's ideas, but is under the impression that the "tropisms," or the action of natural forces on irritable living matter, are not sufficient alone to insure the well-being and reproduction of unicellular or other organisms. He holds that action of this kind is insufficient in itself to insure the preservation of the life of the animal; he therefore supplements the action of tropisms by what he terms "sensibilité différentielle," that is, sensitiveness to changes in intensity, or the power organisms possess of responding to the action of different degrees of energy received from stimuli. It is through this form of sensibility, in Dr Bohn's opinion, that when an organism, under the stimulus of light, is attracted in a certain direction, and reaches a shaded spot, it rotates on itself and moves away from the shadow.[1]

Professor F. Darwin, in his address to the British Association (September 1908), when referring to the movements of plants, is disposed to adopt Professor H. S. Jenning's teaching on this subject, and states that we must take into consideration what he calls physiological conditions of the organism as distinguished from permanent anatomical conditions. External stimuli are supposed to act by altering this physiological state; that is, the organism is temporarily transformed into what, judged by its reactions, is practically a different creature. This may be illustrated by the behaviour of a unicellular being known as *Stentor*, one of the Infusoria (Jennings, "Behaviour of the Lower Organisms," p. 170, 1906). If a fine jet of water is directed against the disc of the creature, it contracts "like a flash" into its tube. In about half a minute it expands again and the

[1] We must refer the reader to Dr G. Bohn's work, "La Naissance de l'Intelligence," for the full meaning and the evidence on which he bases his ideas regarding "tropisms" and their relation to Differential Sensibility. He appears to hold with Professor Loeb that all biological processes could be explained on physico-chemical bases and that life is to be regarded as a chemical function. He describes how, working with the eggs of marine animals, he attempted to discover the physico-chemical nature of fecundation. He found that extracts of the male seed of homologous animals failed to fertilise the eggs, but that of a foreign species was capable of doing so. He further found that the process acts in two stages and each stage can be initiated chemically. First the sperm cell acts by partially dissolving the external layers of the egg, and, secondly, the process called formative stimulation proceeds by the penetration of a substance of high tonicity.

cilia resume their activity. Now we cause the current to act again upon the disc. This time the Stentor does not contract, which proves that the animal had been in some way changed by the first stimulus. This is a simple example of "physiological state." "When the Stentor was at rest, before it received the first current of water, it was in state 1, the stimulus changed state 1 into state 2, to which contraction is the reaction. When again stimulated it passed into state 3, which does not produce contraction. We cannot prove that the contraction which occurred when the Stentor was first stimulated was due to a change of states. But it is a fair deduction from the result of the whole experiment, for after the original reaction the creature is undoubtedly in a changed state since it no longer reacts in the same way to the repetition of the original stimulus. Jennings points out that as in the case of plants, spontaneous acts are brought about when the physiological state is changed by unknown causes, whereas in other cases we can point to an external agency by which the same result is effected." [1]

Professor Berthold compares the movements of amœbæ and of swarm-spores to the drops of oil in an emulsion, or to a piece of camphor floating in water, the movements always occurring towards the side of least surface-tension. But as Professor Ewart remarks, this statement is misleading. In the case of a piece of camphor floating on water the surface-tension is lowered unequally as the camphor dissolves irregularly. The fragment is drawn to the side where the surface-tension of the water is greater; for the surface-tension-

[1] Professor F. Darwin's Presidential Address to the British Association, 1908.

film moves in that direction and drags the camphor after it. In the particles of an emulsion, however, a diminution of the centrally-directed surface-tension pressure on one side, or an increase on the opposite face, causes the particle to move to the side of least surface-tension, and this movement will continue as long as the potential difference is maintained, and will cease as soon as equilibrium is reached.[1]

With reference to the movements made by protoplasm in response to the various forms of energy which act upon it, we must, as Professor B. Moore states, recognise the fact that the living cell receives its supply of energy from organic compounds capable of yielding energy in the process of oxidation in the cell, provided its protoplasm is in working order. He states, that the integrity of the living matter of the cell is just as completely dependent upon the presence of *ions* of certain simple organic salts in its substance and in the surrounding fluid, as upon the supply of energy it receives from the organic compounds of the cell.[2] In point of time the physiological activity

[1] "On the Physics and Physiology of Protoplasmic Streaming in Plants," by A. J. Ewart, p. 112.

[2] If a lump of common salt is dissolved in water, and bits of metal joined to a copper wire are dipped into the solution, an electric current is started. A solution of this kind is known as a conducting solution, and any substance which, when dissolved, produces a conducting solution is termed an electrolyte (to set free). It is held by most scientists that when an electrolyte is dissolved in water its molecules undergo to a greater or less extent dissociation or separation into electrically charged atoms, which Farady called *ions* (that which goes). These either positively or negatively charged atoms have an independent existence in the solution, and have their specific properties and reactions behaving, therefore, as independent molecules. When two electrodes (poles) are placed in a solution of an electrolyte and connected with a battery, the positively charged

of the cell is more rapidly destroyed by removing or altering the supply of inorganic ions, than it is by interfering with the supply of food stuff. The latter can to some extent be supplied by the combustible materials present in the cell; but when the inorganic ions forming a constitutional part of the living cell are altered, and the equilibrium between the protoplasm and ions thus destroyed, the cell activities immediately come to rest.[1] The ions form an intrinsic and indispensable part of the cell structure in the absence of which it can no longer utilise its food supply; it "is the ions which act."

Professor Moore refers to the influence which the ions have on the work performed by living muscles, as for instance on the muscular structure of the heart. If an animal's heart is isolated, and fluid containing a solution of food stuff be passed through it, the muscular structure will at once cease to act and the heart stops beating. If, however, a solution of common salt be used in the same way, the heart will continue to beat

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electrode attracts the negatively charged ions; and the negatively charged electrode attracts the positively charged ions. These atoms move in opposite directions through the solution, and give up their charges at the electrodes; it is their movement through the solution that constitutes the electric current in the solution. When a salt ionises a solution, the metal part forms the positive (cat-ions) and the acid part the negative (an-ions). In the case of acids hydrogen forms the positive, thus hydrochloric acid gives the positive, H ions, and the Cl the negative. It is, indeed, to the presence of the hydrogen ions that so-called acid properties are to be ascribed. In the case of alkalies, such as sodium hydroxide (NaoH), the negative ions are formed of the hydroxyl group.

[1] "Further Advances in Physiology." Edited by Leonard Hill. Article by Professor B. Moore, pp. 1, 2, "The Equilibrium of Colloid and Crystalloid in Living Cells."

for some time and then stops, the solution having gradually washed out the potassium salts from the muscular structure of the heart, it then ceases to act. If a definite small percentage of potassium and calcium salts are added to the solution of common salt, and the solution is passed through a freshly isolated heart, its muscular fibres will continue to work for hours and even days in a regular and automatic manner ; thus demonstrating that inorganic potassium and calcium ions are essential factors in promoting the action of the specialised living substance of muscle fibres.

These inorganic ions also possess a remarkable influence on other processes of living matter ; for instance, if the ova of the starfish are exposed to the action of hydrogen ions, that is, if they are placed in a proper acid solution, they undergo developmental changes, and produce a multitude of cells. The ova of chætopterus undergo developmental activities when placed in a solution containing potassium ions, *i.e.* the addition of any potassium salt causes the development of the egg ; but other salts, which do not yield potasssium ions are without any such influence.[1] Without ions or the bearers of electricity in the living substance of the cell, and in the fluid surrounding it, it cannot respond effectively to the action of the forces that play upon it. Our object is to endeavour to form ideas regarding the substance which directs movements thus excited into orderly and purposive action. The movements effected by the simplest kinds of beings are as well adapted for their needs as those of the higher classes of animals possessing an elaborate nervous system, and complicated structures and organs. The

[1] Findlay, p. 39.

physico-chemical forces which initiate the movements are the same in every form of living matter, but the materials acted on differ in each order of beings, that is, the structural arrangement and motion of the elements constituting the protoplasms of the various classes of beings has a special architecture of its own, and consequently definite action.

We fully appreciate the fact that the movements made by living protoplasm in response to the action of stimuli depend upon its elements being placed under favourable conditions, but we hold that the movements of even the simplest forms of plants and animals cannot be wholly interpreted in chemical and physical terms. On the other hand, we conceive that the movements of the living matter of organisms excited by external and internal stimuli, are directed by elements which form part of all living matter, each after its own order. We cannot place our fingers on these elements and separate them from the other constitutents of living protoplasm, and must, therefore, in studying their nature depend on the series of phenomena they produce in the various classes of animals.

That unicellular organisms possess inherent powers of directing their own movements in a purposive manner is an idea supported by some of the ablest and most accurate scientists of the present time. Thus Professor A. J. Ewart, when referring to the movements of organisms which possess definite locomotory organs, such as flagellæ or cilia, states there can be no doubt that they have "acquired the power of directing and controlling the natural forces for their own benefit." [1]

[1] "On the Physics and Physiology of Protoplasmic Straining in Plants," by A. J. Ewart, p. 112.

Professor W. B. Hardy, when discussing the nature of the movements made by an Amœba, observes "the tiny animal manifests discrimination, imperfect no doubt, but clearly recognisable. And the choice is beneficial, it contains an element of purpose."[1] Again, Professor Calkins, when discussing the movements of certain unicellular animals, remarks, "it appears the organism, as a whole, is endowed with a set of motor responses which might be identified as instinctive. Stimulation at one point induces a local response, but a reaction of the entire organism is poorly explained by the assumption of a machine-like organisation of the cell, or by the statement that these responses are merely the expression of chemical and physical forces."[2]

We may now proceed to give the evidence on which we base our ideas regarding purposive matter, and in the first place refer to movements habitually made by some of the simplest classes of organisms.

If we place a multitude of ciliated bacteria, in pure distilled water, into which only filtered air can pass, and thus prevent these beings obtaining any food, we find after a few days many of them disappear, others become languid and under the microscope appear shrivelled and transparent, they are in fact on the verge of starvation. If we then introduce into the fluid in which these bacteria have been kept some finely divided particles of organic and inorganic matter, we see some of the bacteria moving up to the particles of inorganic matter round which they hover for a brief space of time, and then reversing the action of their cilia they move

[1] "The Physical Basis of Life," by H. W. Hardy. *Science Progress*, October, 1906, p. 182.

[2] Professor Gary N. C. Calkins on the "Protozoa," p. 301.

away to another part of the field; if in their course they meet with an organic particle of matter they seem to imbibe nutriment from its substance, for after a time their protoplasmic contents contain granules of what we take to be food, and the organism at the same time becomes plump and active. This process of starving and feeding bacteria may be repeated over and over again, and under similar conditions the result is always the same.

If a number of bacteria are placed in water containing particles of carmine their protoplasmic bodies absorb this colouring matter, but after a short time extrude it; this process may be repeated for some five weeks; after which the bacteria cease to take up any more of the carmine particles. But if sepia is substituted for carmine these same bacteria will absorb it into their bodies for a time, and then, as in the case of carmine, discontinue to absorb the particles of sepia, which, like the carmine, are useless substances either for nutritive or other purposes of these beings.[1]

Not unfrequently we find a flagellum at the anterior and another proceeding from the posterior end of the cell; the former draws the being along at the same time that it rotates about its axis; while the latter exerts a directive and modifying influence on the movements of the Infusorian, serving also as an anchor, and sometimes as a spring, promoting a rapid jerking movement of leaps and bounds.

An *Amœba proteus* consists of a minute particle of nucleated protoplasm; when its outer surface is gently touched by the point of a glass rod, the living matter of the organism responds to the stimulus by pro-

[1] "La Naissance de l'Intelligence," par Dr G. Bohn, p. 103.

truding a portion of its substance in the form of a pseudopodium, by means of which it clings to the rod. But if the point of the rod is roughly pushed against the surface of the amœba the organism moves away as if to avoid injury.

Amœbæ ordinarily crawl, aided by their pseudopodia, over the surface of solid substances in search of food. If, then, one of these beings becomes isolated, at first it floats about in the water in an aimless manner; but after a time if it meets with no solid substance on which to anchor, the animal thrusts out a number of long slender pseudopodia; these processes of living matter spread out in all directions from the body until its substance becomes little more than a meeting point of the pseudopodia. So soon, however, as one of these feelers comes in contact with a solid body it attaches itself to it, the whole animal follows on, and resumes its normal method of locomotion.[1] Professor H. J. Jennings is disposed to think that amœbæ retain the effects of impressions made upon them by stimuli, and that these impressions may be brought into action by fresh stimuli; in other words, the living matter of these, the simplest forms of nucleated living beings possess what we call memory, and further, their actions are voluntary and prompted by what they remember. For instance, Mr Jennings on one occasion watched a large amœba seize a small one by one of its pseudopodia, which it then retracted and thus nearly enclosed its prey, but leaving an opening in its encircling embrace the small amœba escaped and moved away. The larger animal, however, reversed the course it had

[1] H. J. Jennings on "The Behaviour of Lower Organisms," p. 8. See also "The Animal Mind," by M. F. Washburn, p. 41.

been following, pursued, and again seized its prey; the small amœba again broke away and made good its escape. Referring to action of this kind Mr Jennings remarks that, in his opinion, "it is difficult to conceive each phase of action of the pursuer to be completely determined by simple present stimuli," but rather that to some extent the amœba's movements were governed by the experience it had acquired from former possession.[1]

The class of Protozoa known as the Paramœcia differ from the amœba in that they preserve a definite form. These animals are spindle-shaped, one extremity being pointed, the other is rounded and forms the anterior end, which in the movements of the animal through the water is always foremost. On the under surface of this unicellular being there is a groove passing from the anterior end backwards to a depression leading into the soft protoplasm of the body. The outer surface of the Paramœcium is covered with cilia arranged in definite rows; their attached ends pass through the outer delicate membrane which encloses this unicellular animal's body and enters its ectoplasmic layer, within which is the softer endoplasm with its large and small nuclei.[2]

The movements of these animals are effected by the action of their cilia, which also line the groove leading to the opening into the endoplasm and by their action direct a current of water containing nutrient matter into the body of the Paramœcium. The movements of a Paramœcium through the water, as seen under the

[1] Washburn on "Animal Mind," p. 46.

[2] "Heredity and Variation in the Simplest Organisms," by Professor H. S. Jennings, *American Naturalist*, June 1909.

field of a microscope, appear to be rapid; the animal darts about in all directions if unopposed, but if in its course it meets with an obstacle it reverses the action of its cilia and moves backwards, coming to a momentary halt. The Paramœcium then again reverses the action of its cilia, moving at an angle to its original course. So long as the animal is unable to pass the impediment it repeats these tactics, but when it has turned the flank of the obstacle it resumes its original passage onwards.[1]

In another Family of these unicellular organisms, we find a group which includes among its members the Didinium nasutum, and the Actinobolus radians. The former of these beings in form may be compared to a diminutive cask, rounded off at one end and terminating at the opposite extremity in an almost level surface from the middle of which rises a conical projection ending in an opening which leads into the endoplastic layer of the animal's body; the cortical layer of this projection contains a multitude of spindle-shaped structures (trichocysts), which the Didinium has the power to discharge, either for defensive or offensive purposes. The outer or cortical layer of the animal's body possesses two sets of cilia disposed in rows, which always act in unison during locomotion, and the direction which the animal gives them determines the course it follows. In the movement forward, all the cilia are directed towards the anterior part of the body, when it swims backwards their action is reversed.[2]

A Didinium moving through the water in search of food, when it comes within a certain distance of its

[1] Washburn on "Animal Mind," p. 46.

[2] "The Psychical Life of Micro-Organisms," by A. Binet, p. 50.

prey extrudes a number of its trichocysts, which are aimed at the being it desires to capture. These dart-like filaments penetrate and paralyse the prey, the Didinium extends its conical process which it fastens upon its victim, and then retracts and so draws its prey in to its body, where it is soon converted into nutrient matter. This unicellular animal appears to have its likes and dislikes as regards food, for it is said to prefer a Paramœcium for a meal, and rejects the Rotatoria which abound in the water Didiniæ inhabit.

The outer surface of an Actinobolus radians is covered with cilia; it also possesses a number of retractile processes or tentacles armed with trichocysts. When at rest the opening which leads into the interior of its body is directed downwards, and its tentacles are stretched out in all directions forming a number of protoplasmic filaments. Various kinds of small ciliates and flagellates may become entangled in these tentacles without injury to themselves or producing any reaction on the part of the animal. But if one of the Halteria happens to come within a short distance of an Actinobolus the latter discharges its trichocytes at its prey which it seizes, and aided by its retractile tentacles passes into its mouth.

Another of the Infusoria (Stentor ræselia), when attached by its stem to some solid substance and irritated by being roughly stroked with a glass rod, first tries to withdraw from injury by contracting its protoplasmic substance at the point irritated, and next reverses momentarily the direction in which its cilia are whirling. If these movements are not effective in getting rid of the cause of irritation the animal contracts its whole body substance upon its stem, and remains in this position for some time; should this movement not effect its purpose, the Stentor loosens hold of its anchorage and swims away from the cause of irritation.

If a Vorticella is placed in such a position as to be removed from all possible sources of irritation, its movements of contraction and expansion continue spontaneously, due to energy derived from chemical changes effected through the agency of its living matter, movements which closely resemble those made by the animal in response to mechanical stimuli. Many of the unicellular organisms do not possess either flagella, cilia, or other organs of locomotion, their movements being effected by processes of a mechanical, but none the less of a purposive nature. Thus the Radiolaria (Thalassicolla) responds to only two forms of external stimuli—vibration and heat.[1] Under the influence of wave-action a Thalassicolla sinks till a calm stratum is reached, and then after a time ascends to the surface. Towards small variations of temperature it remains inert, as also towards all conditions of illumination that have been tried; but a long-continued application of temperature above 30° C. or below 2° C. induces a descent from the surface of the sea water, and this is followed by the death of the animal. The onset of maturity is also correlated with a descent into deep water. Professor Gamble explains that the vertical movement of this animal is due to the formation and expulsion of fluid lodged in the spaces or vacuoles contained in its protoplasmic body. In

[1] "The Protozoa, Radiolaria," by Professor F. W. Gamble. "A Treatise on Zoology," edited by Sir Ray Lankester, pp. 96, 111, 115, part i. first fascicle.

calm weather, and through a considerable range of temperature, the interchange of fluid between the vacuole and the sea is gradual, and the slight wave-motion reinforces the calymena by acting as a stimulant. Thus the balance of loss and gain, and with it the surface position, are maintained. But the movements of larger waves, or extremes of temperature, cause contraction of the calymenal plasma. The pseudopodia are withdrawn, the vacuoles burst, and the animal descends until the calmer zone enables it to reform its calymena and recharge its vacuoles, upon which it ascends.[1]

It seems to us that the movements of unicellular beings such as those to which we have referred, taken as a whole, are but " poorly explained by the assumption of a machine-like organisation of the cell " (p. 13). The living substance of these cells exhibit well-defined fundamental processes including purposive action; it also possesses memory and the power of reproducing its like. And further, as we have shown, under the action of energy derived from its environment it undergoes molecular changes which, in the course of time, permanently modify its functions (" Human Speech," p. 71). As far back as the year 1874 Professor Huxley, in his address to the British Association, stated that there could be no doubt, that by continued repetition, stimuli came to be impressed on corresponding areas of living nervous matter, and that these impressions

[1] The calymena consists of a frothy mass of mucilaginous and vacuolated substance secreted by interstitial cytoplasm, which surrounds the centrally placed nucleus, embedded in a layer of cytoplasm. The calymena is thus a peculiar secretion specialised for contact with the outer world and also for performing functions such as those above indicated.

might be excited by various stimuli so as to reproduce movements which had resulted from the original impression. Action of this description, he argued, formed the basis substance of memory. We have now come to learn from Professor Jennings that the elements forming the basis substance of memory are not confined to the living matter of nerve-cells, but that they exist in the simplest forms of beings whose bodies are constituted of what we term undifferentiated protoplasm. We have, as an example of the existence of memorial impressions in an amœba, referred to the movements of one of these beings as described by Professor Jennings. This amœba left the course it had been following and turned back in pursuit of its prey. Having captured the small amœba, the presence of this foreign body acted as a stimulus to the protoplasm of the captor's body, which in consequence produced pseudopodias, and these processes of living matter displayed purposive action in that they surrounded and for a time secured the prey. As Mr Jennings states, the amœba's movements seem to have been governed by the experience it had acquired from former possession—that is, the present stimulus re-excited impressions previously received by the living matter of the organism. The response to this action became manifest in the purposive movements made of the living substance of the amœba; in other words, its living protoplasm, on being stimulated, brought past impressions into action.

This animal seems also to have evinced purposive action in that it changed the direction of the course it was following in order to capture its prey. Again, in the case of the Stentor ræselia, after effecting various movements calculated to protect itself from injury, it gave up further attempts of this kind, and deliberately detached itself from its base and moved away from the source of trouble. And so again, the movements and choice of food displayed by Actinobolus are attributable to a purposive or guiding apparatus which constitutes a part of the animal's body substance.

Mr G. J. Romanes, when discussing the subject of the "purposive determination on the part of unicellular organisms," states, "it is of course unquestionable that all the activities in question are highly suggestive of intelligence; but, to say the least, it is equally possible to suppose that all these activities may be due to special endowments which have been gradually conferred by natural selection on highly specialised, though wholly unintelligent cells, for the purpose of more and more efficiently discharging their special functions." [1]

Each species of unicellular being has a specific hereditary molecular structure, and a definite locomotory apparatus; so that if their living substance is in good working order, and they are placed in a like environment, their movements should be identical; but the individuals forming a crowd of any one species hustle and bustle about in all directions. Isolated beings are propelled here and there, by means of their celia, apparently in search of food, which if they cannot secure in one place, the action of their locomotory organs are reversed and the organism follows some other course.

The question is from what source is the energy derived which directs these movements. In the higher animals we know their movements are controlled by nervous energy derived from a specialised form of matter

[1] "The Open Court," July 11, 1889, p. 1718.

located in their central nervous system. The unicellular beings have no differentiated nervous or any other structures, but that is no reason why their living substance should not contain elements capable of transforming energy into action, tending to serve the needs of these simple forms of living beings in their struggle for existence. We have shown that out of what appears to be homogeneous living protoplasm germinal matter is developed under certain conditions of the environment. Doubtless, it is difficult to realise the existence in the living elements of a bacterium of purposive, guiding elements of matter; indeed, the complex nature of the forces at work in effecting the simplest biological processes are well-nigh unthinkable; and to grasp the idea of processes such as those entailed in purposive action, requires not only the full exercise of our thoughts but also of our powers of imagination. But processes of this kind seem quite possible when we are dealing with matter which, from a minute particle of its substance produces a thinking, speaking, being.

If, however, the combination and mutual action of certain elements of living matter constitute the basis substance out of which sensitivity, memory, and spontaneous purposive action are elaborated, it is reasonable to suppose that the protoplasm of plants, as well as that of unicellular animals, should manifest phenomena of a similar kind.

The sensitivity of plants to various modes of energy is such a well-established fact that it is unnecessary for us to dwell on this subject.

Professor S. Vines, in his Lectures on the Physiology of Plants, refers to the motility of their various structures in relation to what he terms phototaxis; a term which, as before stated, Strasburger has employed to describe the action produced by light on the movements of plants. Vines states that, in addition to the periodical

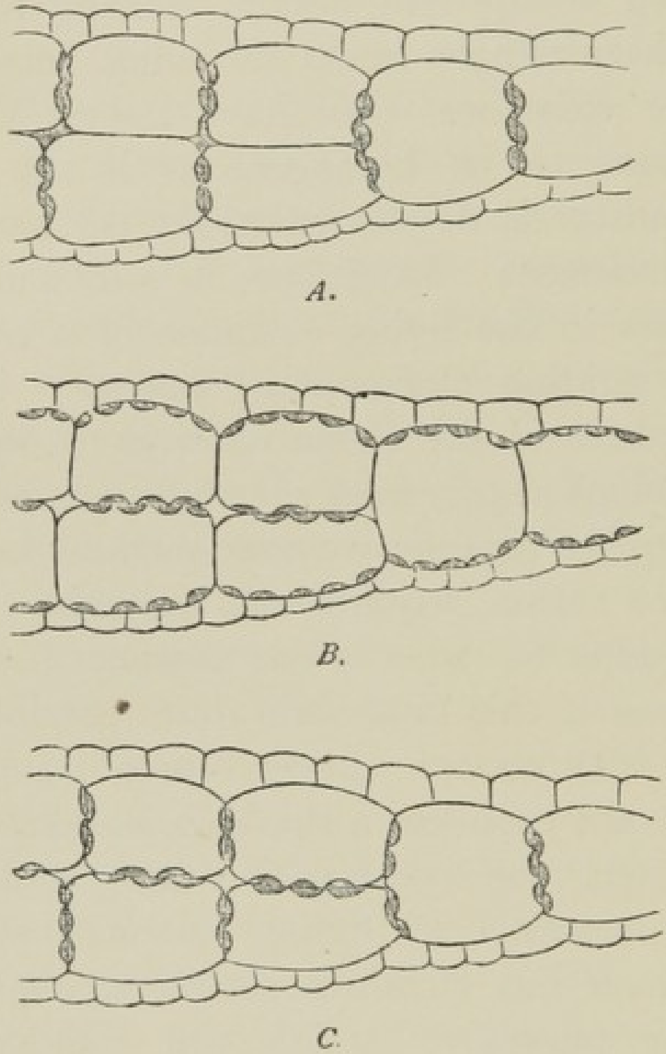

Fig. 1 (after Stahl).—Sections of the phylloid stem of Lemna trisulca *A*, Position of the chlorophyll-corpuscles when the stem is exposed to intense light. *B*, Position of the corpuscles in diffused daylight. *C*, Position of the corpuscles in darkness. ("Physiology of Plants," by S. H. Vines, p. 300.)

movements of plants, the changes in the position of chlorophyll bodies are the result of phototaxis, and he dwells on the influence which heat, chemical energy, and other forces exercise on the movements of plants (Fig. 1). He attributes this action to the transmutation of energy effected by the molecular structure of their living protoplasm.[1] The kind and degree of these movements depending on differences in the sensitivity possessed by their protoplasm, which in its turn depends on the store of potential energy it has acquired, and continues to gain, from the chemical energy it receives from the environment.[2] Professor Vines goes on to contrast these movements with those which, as he states, result from spontaneous action, and describes the living structures by means of which such movements become manifest, the transformation of energy by the living molecules of their protoplasm becoming apparent in the form of motility, heat, etc.[3] As an instance of such action reference is made to the scattering of pollen by Stylidium adnatum, and to the movements of the foliage leaves of Leguminosæ. Professor Vines adds that these "spontaneous movements," from constant repetition on the molecular structure of the protoplasm, mould it into such a form that its movements come to be habitual.[4] We have referred to the fact, that the living matter of the simplest forms of organisms naturally responds to specific modes of energy; much the same state of affairs is manifested by the protoplasm of plants. Thus the tentacles of the Drosera rotundifolia require to be touched several times before any movements occur, and they react better to the continued contact of small bodies than to coarser impacts. These tentacles, however, respond readily to chemical stimuli. The tentacles of Drosera become inflected much more rapidly when bodies placed on their leaves contain nitrogenous sub-

[1] Vines, p. 525.
[2] *Idem*, p. 525.
[3] *Idem*, pp. 536, 567.
[4] *Idem*, pp. 536, 567.

stances which can be absorbed by the plant, such as raw meat, fragments of insects, etc. (see p. 18). Ammonia gas is one of the most powerful chemical irritants; exposure to it induces movements in all irritable motile organs; on the other hand, the vapour of chloroform inhibits these movements, producing chemical changes in the molecular action of the living protoplasm, and so interfering with its supply of potential energy or working power.

The memory of plants consists essentially of the trace or record of a stimulus left on certain elements of its living protoplasm, a memorial impression, built up by modes of energy which for the time being may cease to act. Thus if a sleeping plant is placed in a dark room after it has gone to sleep at night, it will be found next day in the light position, and will assume the nocturnal position as evening comes on—we have, in fact, what seems to be a habit built into the living protoplasm by the alternative of night and day. The plant normally drops its leaves at the stimulus of darkness and raises them at the stimulus of light. But here we see the leaves rising and falling in the absence of the accustomed stimulus. Since this change of position is not due to external conditions, it must be the result of the internal conditions which habitually accompany the movements. This is the characteristic *par excellence* of habit, namely, a capacity, acquired by repetition, of reacting to a fraction of the original stimulus:[1] a process which becomes easier and more rapid by repetition, and in the higher organisms is recognised as the phenomena of memory, association, habit-formation, and learning.

[1] President's Address to the British Association, 1908.

Professor F. Darwin goes on to observe, "it is impossible to know whether or not plants are conscious; but it is consistent with the doctrine of continuity that in all living things there is something psychic, and if we accept this point of view we must believe that in plants there exists a faint copy of what we know as consciousness in ourselves."

We concur in this opinion, if we may be allowed to interpret the term "something psychic" to mean the inherent property possessed by the living matter of unicellular beings, of performing work directed by purposive elements—that is, by action adapted to control the movements of these organisms for their own benefit: matter which, as we have before remarked, like the nervous system of the higher animals, guides the action of their motory substance.

From the above facts we learn that the difference between the phenomena presented by the living matter of animals and of plants is one of degrees; their fundamental properties are identical, and among these we recognise memory-like and purposive qualities. The life cycle of plants do not require a high development of their purposive living elements, such as is necessary to ensure the existence of the various classes of animals. Plants take in from the soil and the atmosphere all that is necessary for their maintenance, growth, and reproduction, and have no need, therefore, for instinctive or intellectual processes to enable them to hold their own in the struggle for existence; their power of adaptation to their environment is, however, remarkable. Darwin, in his later years, freely admitted that the hereditary character of changes of structure and functions were effected not only in plants, but also in animals, as a result of the direct action of their environment. He wrote as follows to Professor Moritz Wagner:[1]—

"The greatest mistake I made was, I now think, that I did not attach sufficient weight to the direct influence of food, climate, etc., quite independently of natural selection. When I wrote my book, and for some years later, I could not find a good proof of the direct action [*i.e.* in producing definite variations] of the environment on the species. Such proofs are now plentiful." Leaves of a beech tree developed in the deep shade of the middle of the tree are so different in structure from leaves grown in full sunlight that they would unhesitatingly be described as belonging to different species. Professor Henslow has for the last forty years insisted on the fact that the origin of function and of structure in plants results from the inherent responsiveness of their living matter to the environment, and he has brought forward incontestable evidence to prove that structural changes thus induced in the course of time become hereditary characters.[2] Professor Henslow remarks, "I will here pause to repeat that my object in giving all the preceding details is not to propose any *theory* whatever, but to show on what facts the two conclusions are based, viz.: (1) that all structures arise by *direct adaptation* to response; and (2) that they may or may not be hereditary. The condition for the latter is solely a question of time in the number of generations which have been subjected to the same conditions of life."[3] The reader

[1] "Life and Letters," vol. iii. p. 159.

[2] "The Heredity of Acquired Characters," by the Rev. Professor G. Henslow, pp. 21, 49.

[3] *Idem*, pp. 22, 78.

is referred to this author's work on "Alpine and Arctic Plants," as well as to his book from which we have quoted, for the details concerning the evidence upon which he relies in making the above statement. The facts on which he bases his conclusions, so far as we can ascertain, are incontrovertible, and in our opinion are sufficient to establish the truth of his reasoning on this subject.

The evidence we have adduced in the preceding pages appears to us sufficient to prove the influence which various forms of stimuli or energy exercise on the simplest forms of living matter; and we may add, from long-continued and careful observation of the movements of these beings, we have arrived at the conviction that they are directed by purposive energy. The protoplasm of the simplest known forms of organism contains somatic and germinal, and we believe, purposive elements. The somatic elements carry on the work of nutrition, the repair of the substance of the organism, and the protection of its germinal substance; the latter perpetuates the species; and the purposive elements transmutes energy derived from the response of the living matter to various stimuli, into action tending to promote the well-being of the organism. The somatic elements become progressively developed under the influence of the environment and natural selection into complex structures. With this structural development there is a corresponding evolution of the purposive elements, first into matter having instinctive functions, and finally, in the mammalia, into psychical matter, a fact we shall endeavour to demonstrate in the following chapters of this work.

CHAPTER II

We have shown that the movements of unicellular organisms are attributable to the action of their living protoplasm when charged with potential energy, derived from physico-chemical processes. A portion of this energy is released in response to various stimuli received by the living matter from external and internal sources, and becomes manifest in purposive action tending to promote the well-being of the organism. Matter possessing these properties is capable of retaining impressions made upon it by repeated stimuli received from various sources, and these impressions may be re-excited and brought into play by the action of similar, or by other forms of stimuli to those which had produced the original impression. We have now to show that in animals purposive elements become evolved simultaneously with their increasing structural complexity arising out of their struggle for existence. It seems desirable, therefore, in the first place, to give a brief account of the development of the nervous system of various classes of animals, for it is in the living substance of their ganglionic nerve-cells that we find the clearest evidence of the action of purposive matter.

Sponges probably represent a divergent branch sprung from an ancestral stock, from which they, and other families of multicellular organisms were derived ;

but the sponges appear only to possess a limited range of evolutionary capacity. They constitute, however,

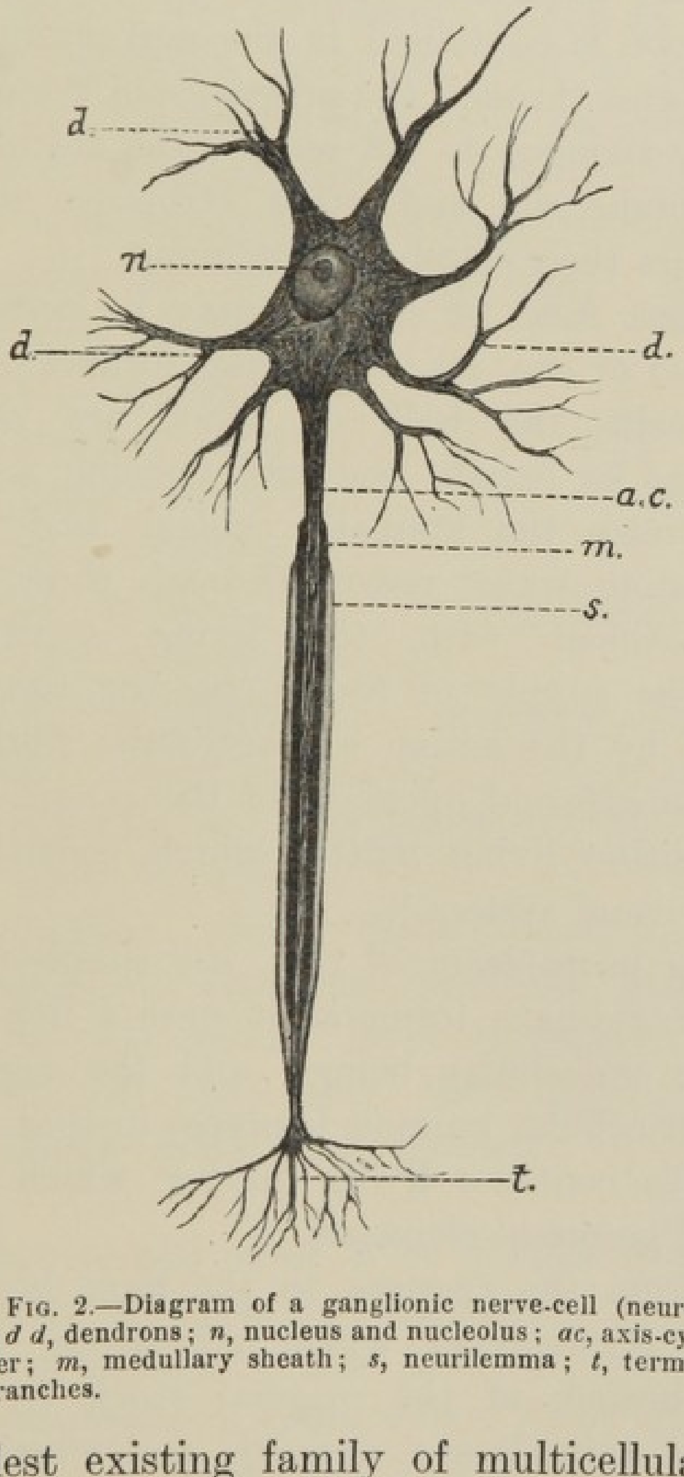

Fig. 2.—Diagram of a ganglionic nerve-cell (neuron). *d d d*, dendrons; *n*, nucleus and nucleolus; *ac*, axis-cylinder; *m*, medullary sheath; *s*, neurilemma; *t*, terminal branches.

the simplest existing family of multicellular animals, built up of cell-units which are less specialised than in other forms of multicellular beings, and therefore able to perform a variety of functions either simultaneously or at different times during their life cycle.

The sponges for the most part remain fixed to rocks or other solid materials beneath the surface of the sea; their food is contained in the surrounding water which percolates through the substance of the organism, consequently sponges do not require the aid of sensory organs or prehensile and other structure to enable them to secure their supply of nutriment.

The simplest form of sponges may be compared to a hollow vase or sac, its walls being formed of a mass of living cells, the bulk of which are perforated by a passage or canal, one end opening externally, the other into the animal's central body cavity. The surrounding water passes through these passages which are lined with the living substance of the cell. The supply of water entering these canals is regulated by the action of contractile fibrils which surround the external openings of the canals, and also by the sensitive living matter which constitutes the walls of the canal system.[1]

The living protoplasm of this, the simplest class of multicellular animals, forms as it were a link between that of the unicellular beings, and the next higher class of multicellular animals (Polyps) in that the outer layer of cells contains living matter, which produces somatic and germinal elements.

Passing from the sponges to the next higher class of animals (Cœlentera) which constitute the most important branch of the original stock from which multicellular animals are derived, and which include among its members such well-known beings as the

[1] "Human Speech," p. 103.

Polyps (Hydroids), and also Jelly-fishes (Medusoids). The small yellow or green polyps afford us an example of this order of animals; their bodies consist of an outer layer of cells (ectoderm), and of an inner layer (endoderm), between these we find a thin lamina (mesoglœa), which affords support to the soft structures of the animal's body substance. One end of the polyp terminates in an opening which communicates with the central cavity of the animal's body. Surrounding this opening a number of hollow arms or tentacles project outwards, forming free and movable members.

The living substance of some of the sensitive external layer of cells of the animal's body and tentacles, is prolonged from the attached surface of the cell into what is known as a muscle-cell. From these contractile muscle-cells protoplasmic processes pass to become connected with the middle layer (mesoglœa), and by their action on this layer they cause movements of the animal's body and tentacles to take place (Fig. 3).

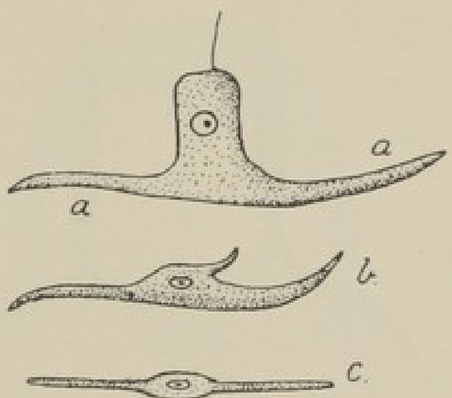

FIG. 3. — Tactile sensory-cell of Hydroid, its protoplasm being prolonged into contractile muscle- or motor-cell. (After Lendenfeld.)

From some of the outer layer of cells of the bodies and tentacles of polyps, upstanding protoplasmic filaments may be seen; these processes grow out from the living substance of these cells. From the opposite or deep surface of these cells processes of living matter pass into the subjacent structures and there develop into nerve-cells (Fig. 4). The nerve-cells send off branches which communicate with neighbouring muscle-cells, and also with fibrils passing from other nerve-cells.[1]

A stimulus or cause of excitation acting on the free outstanding filament of a system such as that referred to, is conducted to the living substance of the cell,

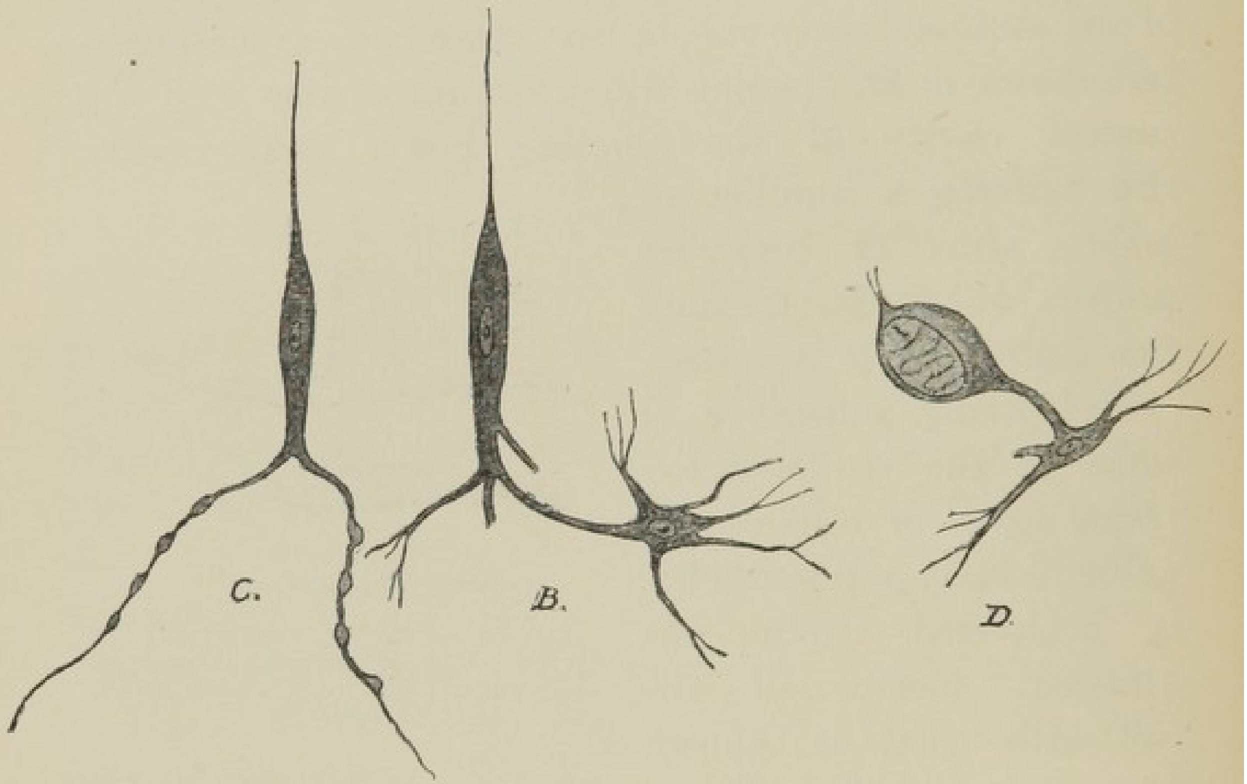

FIG. 4.—*B*, Sensory-cell connected with ganglionic nerve-cell. *C*, Protoplasmic fibre of a tactile sensory-cell forming nodular enlargements (nerve-cells ?). *D*, Cnidoblast connected with ganglionic nerve-cell by a protoplasmic fibre (Medusoid).

and by it is transformed into energy which passes to the purposive elements of subjacent nerve-cells, becom-

[1] The constant excitation of definite functions gradually effects certain structural modifications. Accordingly these paths of conduction become anatomically differentiated from their surroundings, and the nerves develop into independent anatomical tissue. In the protoplasmic structures of plants under the action of stimuli fibrillar strands may be produced, which represent the channels along which energy is more readily transmitted than through the general protoplasm.—"Introduction to Study of Physiological Psychology," by Dr T. Ziehen, p. 7; and Professor A. J. Ewart, "Streaming in Plants," p. 102.

ing manifest in movements effected by the animal's body and tentacles. The outstanding process has been compared to the trigger of a gun, which, by the action of external force, sets free a portion of the potential energy of the substance contained in the cartridge, and leads to the discharge of the bullet, by force comparable to that of the nervous energy which becomes manifest in the movements of a polyp's body and tentacles. It is to be noticed that the stimulus or energy acting on the protoplasmic trigger is derived from the environment, and that the purposive action comes into play and directs this force into appropriate movements.

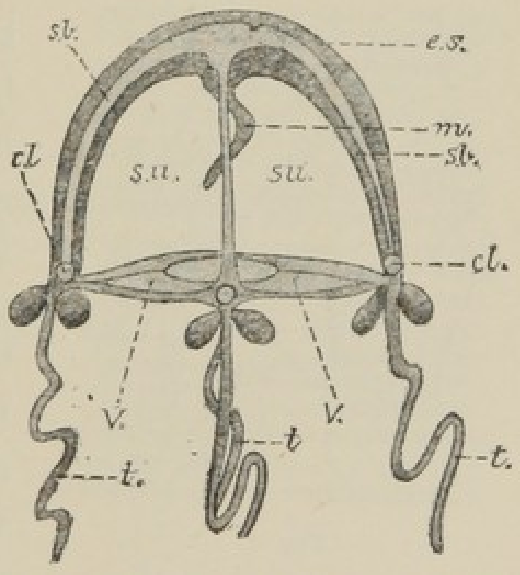

FIG. 5.—Diagram of a Medusoid (Sarsia). *m*, manubrium; *es*, external surface of bell; *sb*, subumbral surface; *v v*, velum; *su*, subumbral cavity; *cl*, curcular canal; *t t t*, tentacles. (After Lankester's "Treatise on Zoology," part ii. p. 17, The Hydromeduse.)

In addition to the free projecting tactile filaments we have referred to, other protoplasmic processes may be seen especially on a hydroid's tentacles. These filaments pass outwards from the living matter of cells known as cnidoblasts, each of which contain a barbed filament, the living substance of the cnidoblast being connected by means of a protoplasmic fibre with a subjacent nerve-cell. Under certain conditions the animal can discharge a multitude of these barbed fibres with force, employing them as weapons of offence or of defence as its circumstances may require (Fig. 4).

The Jelly-Fishes (Medusoids) differ from polyps in form; they may be represented by a little animal with a very long name, the Gomonemus murbachii. These jelly-fish have been compared in form to an umbrella having a short handle, or to a bell with a clapper; the upper convex surface is known as the ex-umbrella, the lower concave surface is the sub-umbrella, and the handle is the manubrium (Fig. 5).

The margin of the umbrella or bell is fringed with tentacles, and a shelf-like layer projects inwards from the lip of the bell; this layer is known as the velum. The free extremity of the manubrium forms the animal's mouth; it communicates with a passage leading to the gastric cavity, from which four canals radiate through the body of the animal to open into a canal which passes round the circumference of the bell.

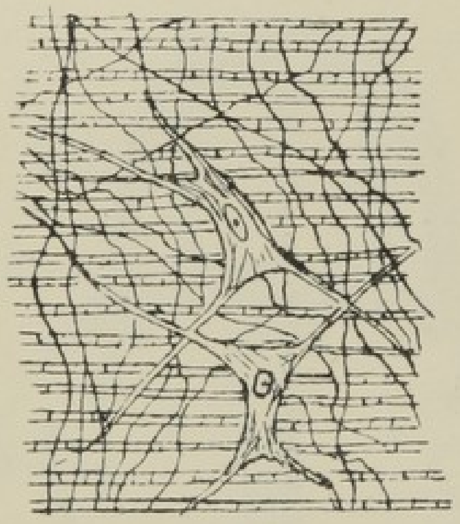

Fig. 6.

Beneath the layer of cells which line the surface of the manubrium, velum, and the under surface of the bell, we find an intricate meshwork of nerve-fibres, derived for the most part from two rows of ganglionic nerve-cells which form a chain encircling the margin of the bell (Fig. 6). At the base of the tentacles and margin of the bell there are a multitude of various descriptions of sensory organs, each of which has become structurally adapted to receive the different forms of stimuli which act upon them from without, and to transmute such forces into energy capable of effecting a discharge from the subjacent nerve-cells, which becomes manifest in work performed by the muscular fibres of the animal whereby its various movements are effected.

Passing from the Hydromedusæ to the next higher class of animals known as the Echinoderms, which include the starfish with its body and five radiating arms and their numerous ambulacral feet or muscular tubes which end in a plate or suckers. By means of these suckers the feet cling to any solid substance that comes within reach of the animal's arms. The nervous structure of these Invertebrata consists mainly of a central system which always retains strong indications of its epithelial origin. It forms a ring surrounding the animal's mouth from which nerves radiate to each of the arms and gives off branches to the various muscular structures, including those of the ambulacral feet (Fig. 7).

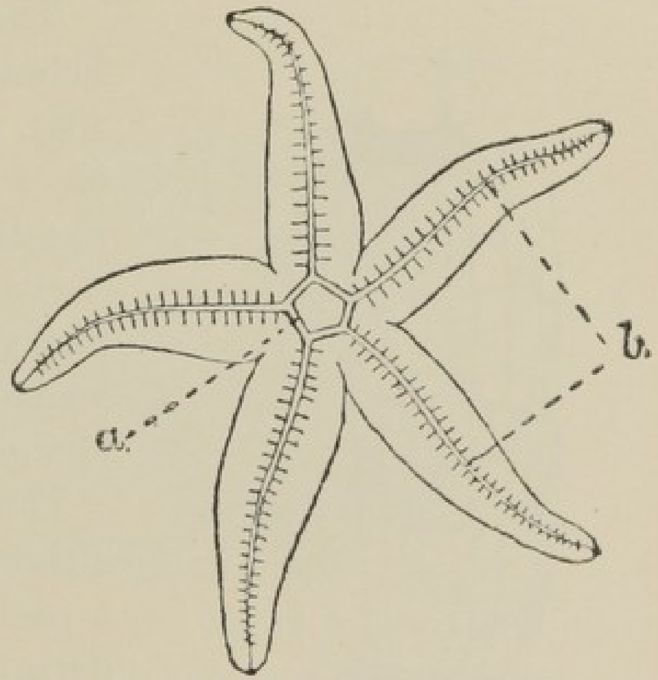

FIG. 7.—Diagram of the nervous [system of a starfish. *a*, central nerve-ring surrounding the mouth; *b*, peripheral nerves of the arms. (J. Loeb, p. 61.)

In the snake-armed starfish (Ophiocoma echinata) a second or deep system of motor nerves exists, the superficial system at the same time being sensory in function.

The sensory organs of this class of animals are but ill developed, and like the nervous system are derived from differentiated forms of the outer sensitive layer of living matter. Pigment cells exist in elevations of the ends of the tentacles and are known as eye specks, they lie on separate points of the "optic pad" and are connected to subjacent ganglionic cells by means of nerve fibres, and in this way also with the general nervous system of the animal.

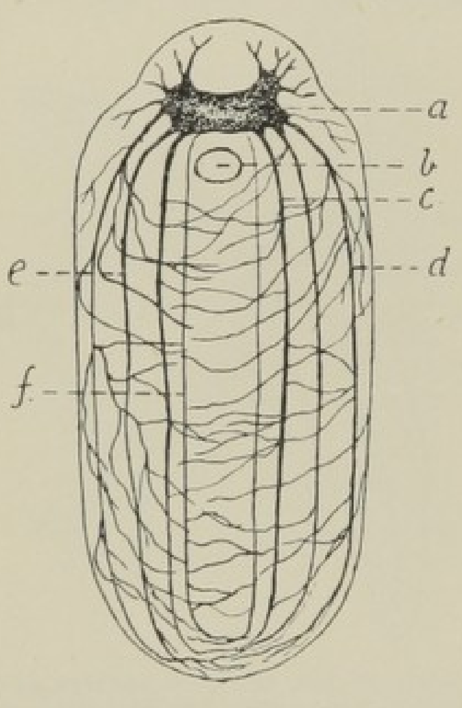

FIG. 8.—*a*, cerebral ganglia; *b*, mouth; *c*, ventral nerve tract; *d* and *e d f*, respectively marginal, dorsal, and medio-dorsal nerve tracts.

The flat worms (Platyhelmia) are mostly parasitic, their nervous system as a rule consists of a number of single ganglionic nerve cells in front of the pharynx or opening which leads to the animal's digestive organs (Fig. 8).

The nervous system, although less immediately a part of the outer (ectoderm) layer of cells than is the case with polyps and jelly-fish, is nevertheless clearly derived from the living matter of this layer. Leading, as most of the flat worms do, a parasitic existence, they do not require the aid of a high order of sensory organs to enable them to procure their nourishment; some of them, however, possess "eye spots" situated near the anterior end of their bodies, from these organs protoplasmic fibres can be traced to the central ganglionic nerve cells.

The segmented group of worms (Chætopoda) which includes among its different species the common earth worm, and the sea-mouse (Aphrodite aculeata) which abounds on our shores, and after storms are frequently washed on to the beach. The central ganglia or brain of the sea-mouse, as compared with that of one of the flat worms, is a complex structure, which for anatomical purposes may be divided into a fore and mid-brain; between these masses of nervous substance a third

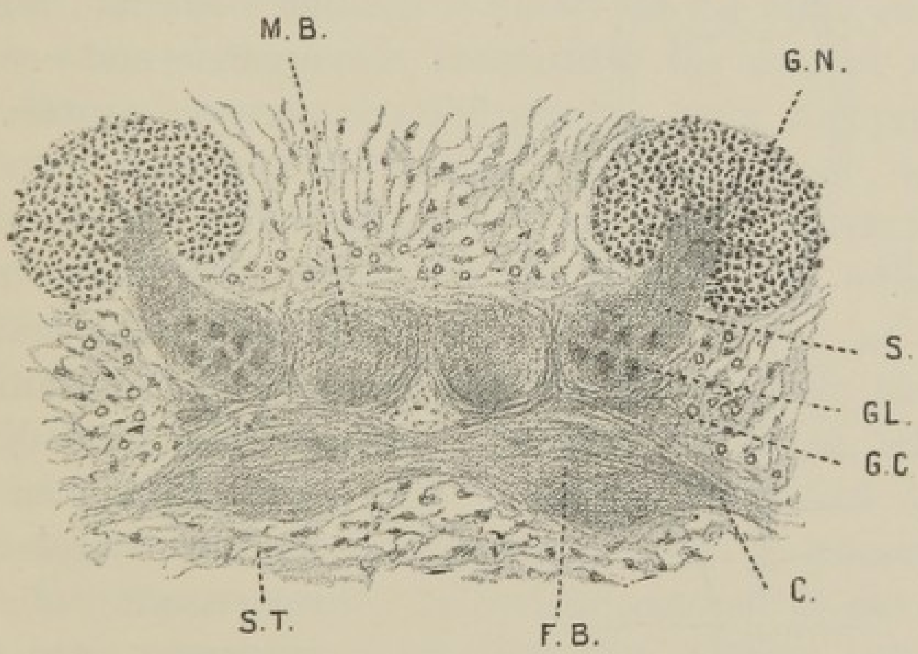

FIG. 9.—Transverse section through the brain of Aphrodite aculeata. ×50. *C*, root of œsophageal connective; *FB*, fore-brain; *GC*, ganglion cells; *GL*, glomeruli; *GN*, ganglionic nuclei; *MB*, mid-brain; *S*, stalk of fungiform body; *ST*, snpporting tissue. (Copied from Fig. 6, Cat. Roy. Coll. Surgeons, Physiological Series, p. 10.)

aggregation of nerve cells and fibres exists, from which a pair of stalk-like processes project and expand into two cellular bodies known as "fungiform masses," which form a conspicuous part of the brain of bees and other insects. Nerves (*C*, Fig. 9) pass from the fore-brain round the animal's gullet to the ventral nerve cord, from which sensory and motory nerves are given off to each segment of the animal's body (Fig. 10).

The next higher class of invertebrate animals is known as the Arthropoda of which the Crustacea form a large order and include crayfishes, crabs, lobsters, shrimps, etc. The first named of these animals affords a good example of a crustacean animal so far as its sensory organs and central nervous system are concerned.

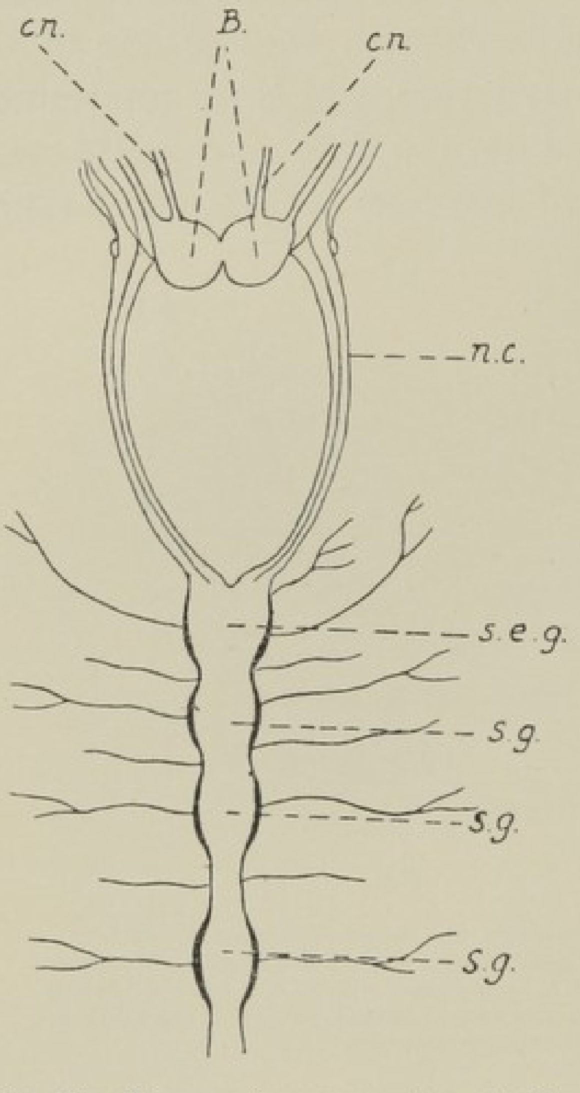

FIG. 10.—*Diagram* of nervous system of a Chætopod. *B*, brain; *cn*, cephalic nerves to supply sense organs of anterior end of the worm; *nc*, nerve cord passing from the brain to *seg*, the sub-œsophageal ganglion; *sg*, segmental ganglia giving off nerves to the corresponding segments of the body.

Fig. 11 represents a section made through the brain of one of these animals magnified 50 diameters, it gives an idea of the complex arrangement of the nervous structures entering into the formation of a crayfish's brain.

It is to be noticed that the nerves proceeding from the animal's eyes and from its olfactory sensory organs terminate in the nervous substance of the middle segment of the brain. In this area of the brain two descriptions of nerve cells may be recognised in some of the larger Crustacea, the one set of cells are of small size and polygonal in form, the other are large pyramidal cells; the former we recognise as constituting the sensory receptive station for afferent or incoming energy passing to it from the sensory organs. The large pyramidal cells we have reason to hold contain the motory elements from which energy is despatched to the muscles of the animal's body. This part of the brain therefore corresponds with that which in the higher classes of animals is known as the basal ganglia.[1] This area of the brain constitutes the central station for lines of communication passing from the principal sensory organs of the animal's head and body, and its office is to co-ordinate this energy and direct it into forms of activity calculated to promote the well-being of the organism.

It will be noticed on referring to the figure that the fungiform matter (*GN*, ganglionic nuclei of Fig. 11) is more highly developed in the crayfish than it is in the brain of the sea-mouse, and that it passes into direct connection with the middle segment of the brain. We have reason to think that this nervous substance is in some way related to the amount of intelligence displayed by the various orders of this class of animals.

The eyes of the crayfish are highly complex organs formed of a multitude of visual rods isolated by pigment cells, one extremity of the rod is turned to the external world, while the other end encloses the end of one of the fibres of the optic nerve. The rod forms the instrument by which the refracted rays of light are brought to bear on the specialised kind of nervous matter at the base of the rod, which transmutes energy

[1] "The Origin of Vertebrates," by Professor W. H. Gaskell.

it receives into a form capable, through the action of the central optic ganglia, of exciting the sensation of light. In front and above the animal's mouth are a pair of long antennæ or feelers, these are kept in per-

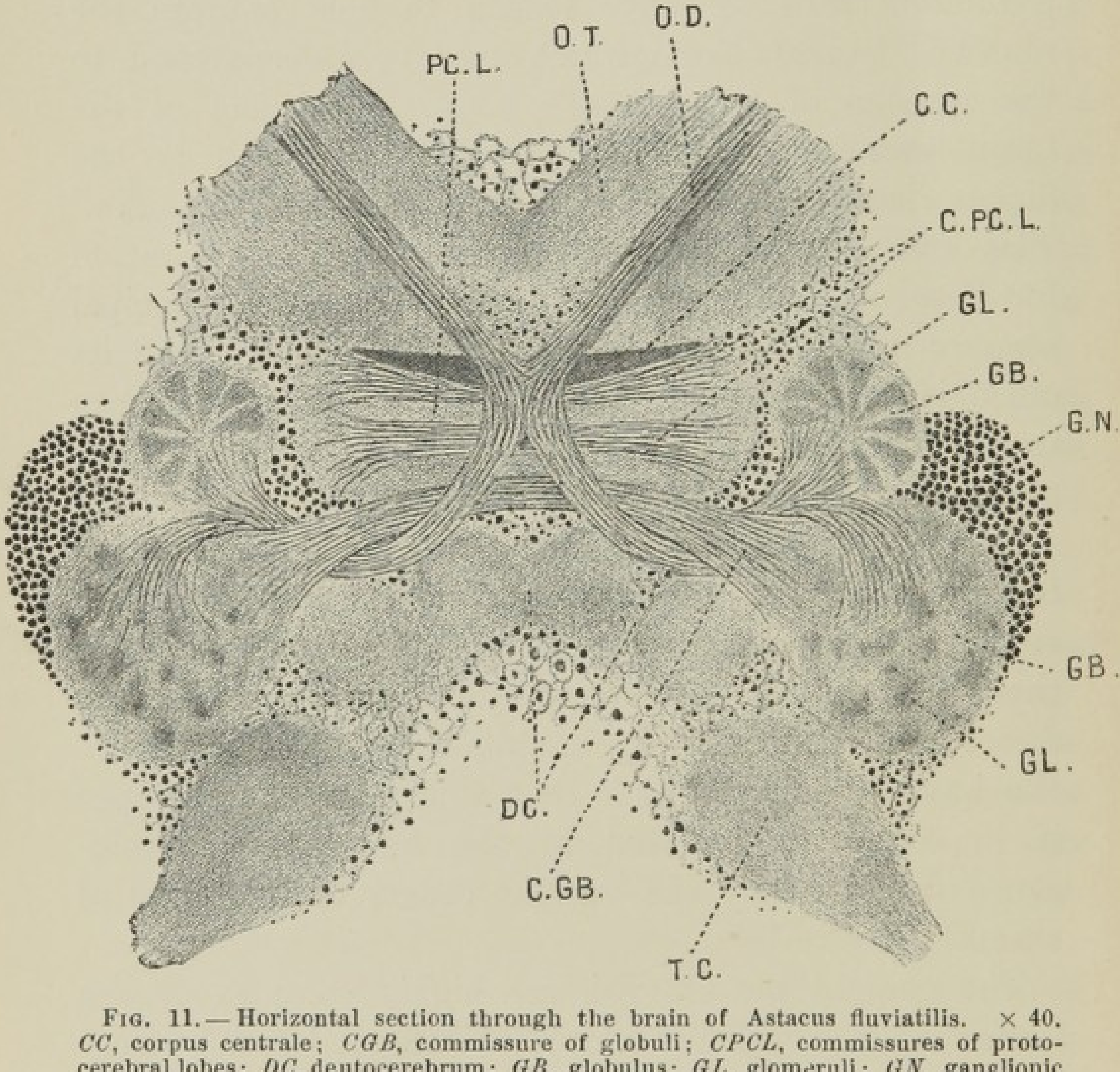

Fig. 11.—Horizontal section through the brain of Astacus fluviatilis. × 40. *CC*, corpus centrale; *CGB*, commissure of globuli; *CPCL*, commissures of protocerebral lobes; *DC*, deutocerebrum; *GB*, globulus; *GL*, glomeruli; *GN*, ganglionic nuclei; *OD*, decussating bundle of optic tract; *OT*, optic tract; *PCL*, protocerebral lobe; *TC*, tritocerebrum. (Cat. Physl. Series, Museum Roy. Coll. Surgeons, vol. ii. p. 22.)

petual motion and form delicate organs of touch; they are supplied with nerves proceeding from the middle segment of the brain.

We may now proceed to describe some of the movements made by the animals to which we have referred, in order to demonstrate that these movements depend on something more than a chain of reactions to external stimuli, although these latter are all important in the evolution and the working of the system through means of which these movements are effected.

Mr G. Wagner has made a careful and interesting set of observations on some of the movements and reactions of the polyp known as Hydra viridis, and we have been able to confirm the conclusions he has arrived at from experiments carried out on the lines he followed. If one of these animals is placed in a position so as to prevent its being disturbed by mechanical or other stimuli, it nevertheless makes quite an extensive series of movements, so as to explore the surrounding space in quest of food. Many of these movements are, as Mr Wagner states, "the result of internal physiological changes, these may very properly be termed spontaneous."[1] The animal effects its purpose by bending its body over to one side and then stretching out a tentacle in advance and clinging by it to a fixed spot, it then loosens its foothold and brings its body up to the spot to which the tentacle had become fixed; this movement is repeated and the animal thus passes from one place to another in search of a new feeding ground.

With regard to the response which the body of a polyp makes to localised mechanical stimuli, it is to be noticed that as a whole, to whatever part of the body or tentacles the stimulus is applied, "there takes place a series of general movements of flexion—as if

[1] *Quarterly Journal of Microscopical Science*, Feb. 1905, p. 598. George Wagner, M.A., on "Some Movements and Reactions of Hydra."

the animal wishes to make itself smaller, and offer less surface to the pain " (of the prick).[1]

A like movement is made under similar conditions by an amœba; the polyp in contracting becomes more clearly spherical, and so reduces its exposed surface to the source of irritation. It is this reduction of the surface of the body, and thus the chance of escaping from injury, which constitutes the adaptative value of the contraction in Hydra. There is no movement to, or from the point irritated, the animal's substance contracts as a whole, and beyond this, if after repeated movements of this kind the animal cannot rid itself of the stimulus, it abandons its foothold and moves away from the source of irritation.

If a morsel of raw meat be placed on one of the tentacles of a polyp the limb contracts, at the same time its other tentacles move up to the food which is thus grasped and carried to the animal's mouth; the tentacles then leave the meat, and return to their former position. Action of this description only takes place in response to the irritation excited by food; a mechanical stimulus alone will not call forth a food reaction. Mr Wagner therefore arrives at the conclusion that reactions of this description are the result of chemical energy derived from the food substance, combined with mechanical energy the result of the contact of the foreign substance with the living matter of the tentacle on which it rests. We concur in his opinion, but it seems to us the action of the other tentacles, and their contortions and contractions so as to bring the food to the animal's mouth, have only to be watched in order to convince us that the purposive

[1] Wagner, p. 598.

action of the living matter is clearly a quantity to be reckoned with in determining the cause of movements of this kind.

If the surface of a polyp is irritated at a number of points, as for instance, by a brush of fine bristles, or of spun glass, a discharge of its nematocysts takes place; a result which would seem to depend on a release of energy from the living matter of the cnidoblast (p. 35) guided by its purposive action on the motory elements of the cell.

The sensory organs, nervous system and general structural arrangement of a jelly-fish are of a higher order than those of a polyp. In like manner its movements are more complicated, and that they are coordinated by impressions received through the sensory organs and the chain of ganglionic nerve-cells which surround the margin of the bell, is proved by the following experiment.

If the entire margin of the bell of a jellyfish is removed so that the excised portion consists of an unbroken ring to which the animal's tentacles are attached, and which contains the bulk of its sensory organs, and the whole of its double chain of ganglionic nerve cells; mechanical and chemical stimuli applied to the surface of the tentacles or to the excised margin of the bell, induce the same kind of movements of the tentacles as those which can be produced by stimulating these parts of the body of an uninjured animal. But after the removal of the margin of the bell, stimuli applied to the cut surface or any other part of the swimming bell fails to elicit any response in the way of movement or otherwise. This state of affairs tends to confirm the idea regarding the controlling influence exercised by specialised elements of the living substance of the combined sensory organs and corresponding ganglionic nerve cells, over the purposive movements of the simplest class of the Cœlentera.

If medusæ are kept without food for some days, and a small piece of raw meat is then held some three inches from the animal, its tentacles are stretched out towards the food, and if they fail to reach the meat, the animal's body moves to the food, several of its tentacles then twine round the morsel of meat which they carry up to its mouth; the manubrium and substance of the bell assist in this movement. The tentacles having deposited the food in the animal's mouth, leave it there and return to their original position.

With reference to these movements Mr Romanes observes—I conclude that in the margin of all naked-eyed medusæ which I have examined, there is situated an intensely localized system of centres of spontaneity, having at least for one of its functions the organisation of impulses to which its contraction under ordinary circumstances are exclusively due. Confirmed by the behaviour of the severed membrane which continues its rhythmical contractions with vigour and pertinacity not in the least impaired by its severance from the main organism, so that the contrast between the perfectly motionless swimming bell and the active contraction of its severed margin is as striking a contrast as it is possible to conceive. Hence if the margin be left in situ while other portions of the swimming bell are mutilated to any extent, the spontaneity of the animal is not at all interfered with. He adds, when nerve-cells are collected into ganglia, they often appear to discharge their energy spontaneously; so that in all but the very lowest animals whenever we see apparently spontaneous action we infer that ganglia are present.[1]

The explanation of the co-ordinate action of the muscle fibres above referred to appears to us to depend on the fact that in the ganglionic nerve-cells of Medusoids, purposive elements, such as those which exist in the living matter of the Protozoa, have become more highly specialised. The ganglionic cells are in communication with one another and with corresponding sensory organs; when the latter are stimulated their released energy passes to the subjacent nerve-cells, and through the medium of its purposive elements becomes manifest in the contraction of definite sets of muscle fibres, and in this way the various movements of the animal are effected.

Mr Romanes states that if a sea-anemone is placed in an aquarium tank and allowed to fasten upon one side of the tank near the surface of the water, and if a jet of sea water is made to play continuously and forcibly upon the anemone from above, the result is that the animal becomes surrounded with a turmoil of water and air bubbles. After a short time the anemone becomes so accustomed to this turmoil that it will expand its tentacles in search of food, just as it does when placed in calm water. If now one of the expanded tentacles is gently touched with a solid body, all the others close around that body in just the same way as they would were they expanded in calm water; although the solid stimulus is clearly less intense than that offered by the bubbles.

[1] The International Scientific Series. "Jelly-fish, Starfish, and Sea Urchins," by G. J. Romanes, pp. 28, 25.

We pass on from the Hydromedusæ to the Echinodermata which include the starfishes among its members (p. 37). If a starfish is laid on its back, the tube feet of its arms are extended and moved about in all directions until the tips of one or more of them turns over and touches the underlying surface upon which the animal is laid, its ventral tube feet cling to this surface, and acting from these fixed points the animal is able in the course of a few minutes to turn and assume its normal position. If, however, before placing the animal on its back, the nerves passing from the central nervous system to the arms are divided, no co-ordinate action of the limbs is possible, but each limb moves on its own account; movements of this description can be accounted for by the presence of ganglionic nerve-cells located among the tissues constituting the arms; it is for the same reason that purposive movements of an amputated starfish's limb takes place and will right itself if laid on its dorsal surface.

Starfish can not only crawl about by aid of their tube feet along the bottom of an aquarium, but also up its vertical glass surfaces. If a piece of raw meat is placed some six inches from a starving starfish, the animal at once, and with precision, crawls up to the food, and if on reaching it the meat is withdrawn, the animal follows it, and can thus be led about from one place to another.

These animals are extremely sensitive to light, but if their eye spots are removed they no longer respond to this form of stimuli.

W. Preyer states that he selected a starfish belonging to a species having slender arms, and slipped a piece of rubber tubing over the middle part of one of these limbs. The starfish tried to get rid of the ring by rubbing the arm against the ground, shaking it by holding it aloft and waving it pendulum-like in the air, holding the ring against the ground with a neighbouring limb, and putting the affected arm out while pressing the other limbs against the ring and so endeavouring by all manner of movements to get rid of it. Should all these efforts fail, as a last resource the animal casts off the limb. Preyer ascribes action of this kind to intelligence, holding that it was a new experience to the starfish to have one of its arms enclosed and thus pinched continuously, and that in adapting means to free itself from this state of things it evinced intelligence.[1]

It would seem that some of the simplest orders of worms possess what we may best describe as memories ; for example, on certain parts of the coast green masses may be seen floating on the surface of the sea, on closer inspection these masses are found to consist of ciliated worms (Convoluta). These beings, as the tide recedes, are left on the sand, and they instantly proceed to bury themselves in its substance. The Convolutæ remain in the sand until the returning tide, when they emerge from it and take up their position again on the surface of the water. The animal thus acquires a habit ; and if then removed from the sea and placed in the still water of an aquarium it continues to float on the surface for a time and then to sink to the bottom of the vessel, thus continuing their periodical action independently of tidal influences.[2] They rise and fall, as they and their ancestors had been accustomed to do with the

[1] "The Animal Mind," by M. F. Washburn, p. 215.

[2] "La Naissance de l'Intelligence," par Dr Bohn, p. 150.

rise and fall of the tide, and having acquired this habit or memory which is distinctly purposive in its action, it continues in operation when placed in different conditions ; because the elements constituting a portion of their living substance had become moulded into a specific form, its work becoming manifest in the movements made by the animal.

The careful way in which worms plug the openings leading to their burrows attracted Darwin's attention. In the first place he found quite young worms followed this practice, which was therefore more or less an inherited habit. In a large percentage of trials it was found that worms draw leaves and pieces of paper into their holes by their narrowest ends, in this way the leaf or other substance could most readily be carried into the burrow. Worms excavate their burrows either by pushing away the earth on all sides, or by swallowing it. The burrow is invariably lined with a thin layer of fine dark-coloured earth voided by the animal, this lining becomes very compact and closely fits the worm's body. The mouths of the burrows are in addition often lined with leaves quite apart from those employed to plug the opening. Pine leaves may be used to form this lining and are then plastered over and made to cohere to one another. The object of this seems to be to form a smooth and warm lining to the upper part of the burrow where the worms are accustomed to remain for a long time. If the burrow passes far into the ground it usually terminates in a little enlargement or chamber, where the worm remains during the winter rolled up in a ball.[1]

[1] "The Formation of Vegetable Mould," by Charles Darwin, pp. 84, 104.

The common crayfish (Astacus fluviatilis) is a well-known denizen of many of our streams in this and other countries, where it may be seen during the warm weather walking along the bottom of the shallow water by means of its four pair of pointed limbs in search of food. At other times we see it at the mouth of the burrow it has made in the banks of a stream, barring the entrance with its great claws, and with protruded feelers keeping watch on passing larva, insects, water-snails and other objects, which it seizes by means of its anterior powerful limbs, and carries to its mouth.

The compound eyes of a crayfish are admirably adapted to appreciate the movements of objects passing before them. The animal makes use of its claws to seize these moving objects, showing that it sees them and can appreciate their distance from its body.

From experiments made by Professor Yerkes, and J. B. Hugins, on the crayfish (Cambarus affinis) it appears that these Crustacea have, to some extent, the power of learning from experience, or as these scientists hold, the animal after passing through a series of reactions drops those movements that are unsuccessful, so that the animal, "on being after an interval of time placed in the same situation, the unsuccessful movements are fewer, and further repetition causes them to be dropped off entirely."[1] Whether this is the method by which a crayfish learns, or whether it acquires knowledge by the registration of useful impressions made on its nervous system by external stimuli, which are re-excited by appropriate modes of energy and

[1] See Professor H. S. Jennings, *Jour. Comp. Neurol. and Psychol.*, 1906, p. 343, on "trial and error" in his paper on "Behaviour of the Lower Organisms."

become manifest in movements such as those to which we have referred, must be left as an open question; the fact however remains, that if a crayfish is placed in a box one end of which communicates with an aquarium in which the animal's food is kept, and "half-way down the length of the box a partition put longitudinally divides the box into two passages, one of which is closed at the end by a glass plate; in sixty trials, the crayfishes which had originally chosen the correct passage 50 per cent. of the times, came to choose it 90 per cent. of the times. A second series with a single animal upon which more tests per diem were made, resulted in the formation of a perfect habit in two hundred and fifty experiments. The glass plate was then shifted to the other passage, and the crayfish was naturally completely baffled for a time, but succeeded in learning the new habit." In more complicated labyrinths the animals were at fault, each followed a habit of its own, one moving directly towards the food, hunting for an opening near it, and then going to the middle where the opening was; the other always following the edge of the screen all the way round until it came upon the opening.[1]

Movements such as those above referred to are instinctive in character, that is, are accomplished by natural hereditary impulses, performed without deliberation, and which tend more or less directly to secure the safety and well-being of the animal. Such for instance as that which leads the duckling untaught into the water, the beaver to build its hut, the bee its comb, the hen to incubate her eggs, etc. Among these instinctive faculties we include the Emotional,

[1] "The Animal Mind," by M. F. Washburn, p. 220.

the expresssion of anger, pain, pleasure, and so on, are bodily manifestations which constitute a natural language of the feelings, and are of a uniform character in each order of animals. The same may be said of the Imitative faculty, among which we may mention the song of birds, and the barking of domesticated dogs.

The evidence we have referred to in the preceding pages shows that in unicellular organisms the body substance as a whole responds to the action of the various modes of energy which act upon it, and is transmuted into a form capable of exciting movements tending to the well-being of the organism. In the simpler classes of multicellular animals the elements which in the lower class of beings were purposive, have become differentiated, and form a part of the living substance of certain nerve cells which on the one hand are in direct communication with the sensory organs or receptors of energy, and on the other hand with motor cells which discharge energy to various sets of muscles.

Following up the development of nerve cells, we find that in the lower classes of invertebrates they have become gradually concentrated into a central nervous system, which increases in its complexity *pari passu* with the structures forming the animal's sensory organs and the other structures of their bodies. In the crayfish we find this system has advanced so far that we come to recognise the development of a central nervous station which receives, and may become impressed by energy passing to it through the sensory organs. From this sensory centre motor impulses pass to the muscles of the body and limbs. Many of the movements made by these animals come under the category of instinctive actions. Work of this kind we judge to depend on a specific arrangement of the molecules of nervous matter, because, if this matter is destroyed, although other organs of the body may continue to work, all instinctive actions are abolished. Beyond this the same kind of activities are effected by widely dispersed but similar species of animals, they are therefore hereditary in their character, and must depend on the action of one and the same description of elements. We hold that this matter has, therefore, been evolved out of simpler purposive elements, being adapted to the requirements of a higher order of beings than those in which simple purposive action was sufficient to direct the forces acting on their living substance, into movements capable of providing for their nourishment and reproduction. We conceive that those orders of beings which have come most completely into harmony with their environment, through means of their various sensory organs, are those which survive and improve in their struggle for existence.

In the following chapter we propose illustrating our ideas on this subject by referring to the instinctive processes displayed by various species of insects.

CHAPTER III

The central nervous system of insects consists of a brain (cerebral ganglia) and of a chain of ganglia which extend along the ventral part of the animal's body, and in many instances are found to have undergone concentration longitudinally: in some insects these ganglia become completely fused together. From this chain of nervous matter sensory and motor nerves are given off to the animal's body. This chain of ganglia is continued upwards into the cephalic ganglia or brain, which for anatomical purposes is described as the fore-brain, mid-brain, and hind-brain.

The fore-brain in insects consists of the optic ganglia together with two masses of nervous substance which are united in the mid-line by communicating fibres. In connection with these lobes we find well-developed masses of nervous substance, which we have referred to as existing in the Crustacea under the name of "fungiform bodies." In the sea-mouse rudimentary structures of this description exist, in the crayfish they are more highly developed; they reach their highest state of perfection in insects. For instance, in the working bee, the fungiform bodies form two deeply concave masses of nervous matter, situated near the dorsal surface of the brain. On section they are found to consist of ramifications of the terminal fibres of nerve-cells, these cells being for the most part on the outer surfaces of these structures. Numerous fibres may be traced from the fungiform bodies to form connections with centres or nuclei of nerve-cells located in the lobes of the brain; so that these structures bear some resemblance to the cortical matter of the cerebral hemispheres of the lower vertebrates. It may be well, therefore, to state that within the same order of beings the size of the fungiform bodies increase in proportion to the intelligence of the insect, and among social forms they may even vary in development between the persons of the society; being, for instance, proportionately larger in the worker bee than in the drone or queen.[1]

The nervous structures connecting the lobes of the fore-brain may be separated into two bands, from one, nerves supply the eyes, the other band, which lies in the centre of the brain is the meeting-place of fibres from the fungiform bodies, and from the optic and antennary lobes.

The mid-brain constitutes the antennary lobes, they are two in number united by transverse fibres. These lobes give off the larger part of the antennary olfactory nerves.

Each half of the hind-brain gives off a bundle of nerve fibres which meet in the mid-line to form a triangular ganglion from which a median nerve runs posteriorly along the alimentary canal. This ganglion also supplies nerves to the sensory organs of taste.[2]

[1] Mr R. H. Burne, Cat. Phys, Series of Comp. Anatomy, R.C.S. Museum, p. 35; also M. Dujardin, An. d. Sci. Nat. t. xiv. p. 195, 1850.

[2] The above description of the brain of an insect is taken from Mr E. T. Newton's models. See specimen D 27, Phys. Series, R.C.S. Museum, also the Museum Cat. p. 34, and the *Quart. Journ. Micr. Sci.*, vol. xix. 1879, p. 340.

We may now turn our attention to the sensory organs of insects, which consist of structures derived for the most part from the epidermis, specially modified either in the form of single or groups of cells which act as the receptors of energy derived from visual, auditory, olfactory, and tactile impressions.[1]

The visual sensory organs of insects consist of compound eyes, in which, what superficially appears to be a single eye is in reality an aggregate of many eyes, each with its own retina and dioptric apparatus separated from its neighbour by pigment-cells.[2]

J. Müller in the year 1826 taught that inasmuch as definition of the image, *i.e.* the localisation of the luminous rays, depends on the co-ordination of the impressions made through the facets on the nervous apparatus of the eye, the degree of definition therefore varies with the number of facets. We can understand why this should be the case, and that the co-ordination of stimuli received from different parts of an object which reach the nervous structures at the base of the

[1] It is probable that the non-nervous elements of the various sensory organs that first receive the external stimulus act like a sieve, arresting certain qualities of the exciting energy and permitting certain other qualities to pass on, so as to act on the specialised living nervous substance of the various sensory centres. These receptors of energy have thus a certain power of selection or natural fitness developed by means of the action of their environment or struggle for existence.—(Professor T. Ziehen, "Introduction to Physiological Psychology," pp. 40, 42.) As we have shown after leaving a sensory organ by nerve paths, energy becomes subjected to further selection through the action of an interrupted system of dendrons, so that by the time it reaches the living matter of the cerebral ganglionic cell it may be said to have assumed a specific form.

[2] R. H. Burne, Asst. Curator, Roy. Co. Surgeons of England, Cat. R.C.S. Museum, Physiol. Series, vol. iii. p. 302.

visual rods, is the work of the ganglionic cells of the optic lobes of the brain.[1]

The motions of ether that produce light do not act directly on the retinal termination of the optic nerve, but produce chemical changes, or motions in the retina. It is the result of these chemical processes that act as stimuli upon the distribution of the optic nerve in the retina.

Professor Graber, from experiments made on some of the lower invertebrates, came to the conclusion, that after he had removed the eyes of these beings they still responded to the influence of light, for when thus mutilated they move from the chemical to the calorific spectrum. Graber therefore concludes, that these animals perceive light by means of the skin, and that in their natural condition the action of light reaches their brains through the cutaneous surface of their bodies. There can be no question as to the existence of the response of the surface of living beings to the stimulus of light, but that is a very different thing from distinguishing for instance a blue from a red object. The dermatropic sensations referred to by Graber, as A. Forel remarks, do not enable the eyeless animal to see by the skin; it only feels the light, its degree, and length of its waves.[2] These experiments, however, emphasise the importance which sun-light exercises not only on the lower, but on the metabolic processes of every form of living matter.

The visual power of insects depends largely on the form and the number of facets possessed by the outer

[1] "The Senses of Insects," by A. Forel, pp. 69, 129, translated into English by Macleod Yearsley, F.R.C.S.

[2] *Idem*, p. 69.

surface of the eye; for instance, the prominent convex eye of the dragon-fly is said to contain from 12,000 to 17,000 facets. We can form an idea of the acuteness of vision possessed by these insects if we try to catch one of them hovering over a pond. The dragon-fly will allow us to approach our net just near enough to miss catching it, when off he darts, seeming almost able to measure the length of the handle of our net, for the insect repeatedly flies off just out of reach of the net in spite of all the trouble we take to hide it. Butterflies and flies are evidently able to measure the distance from them of near objects.

Wasps can judge the size and colour of inert objects by the aid of their eyesight. Thus if some dead flies are placed together with other insects on a table in a room where there are wasps, a wasp will soon fly down and without hesitation alight on a dead fly, which he will carry off, and this process will be repeated over and over again without the wasp taking any notice of the surrounding dead insects. On the other hand, ants and bees have defective vision for small moving objects at a distance, because the facets of their eyes, on whose axis such an object is projected, receive additional rays from too many other surrounding objects.[1] Insects possessing compound eyes direct their flight by sight, distinguishing colours, objects and distances by means of their visuo-sensory apparatus.

The olfactory sensory organs of insects consist of adaptations of epidermal living matter to receive and transmute a special form of energy into one, which on reaching certain cerebral centres becomes manifest in the sensation we designate as odours. By the sense

[1] Forel, pp. 11, 13.

of smell therefore we mean the response made by a specialised system of living matter to definite modes of energy (stimuli) derived from certain bodies.[1]

The olfactory sensory organs of insects are located on their antennæ, where they exist among the stiffer tactile setæ; they are supplied by terminal branches of the antennary nerves which arise from ganglionic cells located in the olfactory lobes of the animal's brain. These sensory organs are not situated on precisely the same part of the antennæ in all orders of insects, but as a rule they are to be found on its terminal free portion, in the form of structures which have been shown to consist essentially of modified hairs.[2]

It has been demonstrated by Lord Avebury and A. Forel that the different genera of ants, who under ordinary conditions are natural enemies and fight to the death when they meet, after having had their antennæ excised may be kept together in the same box where they live on friendly terms. Having no antennæ, and therefore no sense of smell, they fail to recognise their diversity of genera, they can in fact no longer distinguish friend from foe. Male insects after their antennæ have been removed do not recognise the female, they will pass close to their favourite food without noticing it; they guide themselves by the sense of smell, and when their antennæ are removed, fail to retrace their way home from a distance, or to

[1] There are hardly any metallic or other bodies which do not manifest, especially on friction, odours of their own. Berthelot calculates that one gramme of iodoform only loses the hundredth of a milligram in a hundred years, though continuously emitting a flood of odoriferous particles in all directions.—"The Evolution of Matter," Le Bon, p. 237.

[2] "The Senses of Insects," Forel, p. 94.

recognise their companions when they reach their nests.

If an ant is smeared with fluids pressed from the bodies of its nest companions, and then put back among them, they take no notice of the stained insect. But if an ant is smeared with fluids pressed from the bodies of a hostile nest, and then returned among its companions, they at once attack and kill it. Evidently it is of the odour of the fluids in the two cases which affect the actions of the ants through impressions made on their olfactory sensory organs, which pass through the antennary nerves to the olfactory lobes of the insect's brain and re-excites impressions previously established in its nervous substance.

The antennæ of insects are remarkably mobile, so that the organs of smell can be readily turned in all directions, this fact leads one to suppose the sense of smell in these beings may give them ideas of space and of direction. We can thus account for the fact that ants distinguish the right and the left side, the front and back, and know when following a track, in what direction they are following. "Finally, pursuant to the laws of association, it allows in insects an olfactive memory of places such as relational sense alone possesses." [1]

In order to substantiate the fact that the organs of smell are located on the antennæ of flies and other insects, we may refer to one among the numerous experiments which A. Forel has made in order to gain accurate knowledge concerning this point.[2] He placed the body of a dead decomposing mole under a hemispherical wire gauze cover. A fly (Sarcophaga vivipara)

[1] Forel, p. 98. [2] *Idem*, p. 90.

soon arrived and tried to gain access to the dead animal. Forel caught the fly, and after destroying its eyes, let the insect go. It flew about his room, knocking itself against the ceiling and walls, and finished by falling on the floor in a helpless state. He then removed one of the fly's wings and afterwards placed it near the mole which he uncovered. The fly went directly for the dead animal and began to feed on its substance, and quickly recurved its ovipositor and laid three or four eggs. Forel then removed the insect's antennæ. From that moment, despite oft-repeated trials, the fly paid no more attention to the mole than to a piece of stone or a bit of wood. Placed close to the stinking mole the insect no longer sought to direct itself towards the carcase. Other flies were treated in the same way, except that their eye-sight was not destroyed, but after removal of their antennæ they invariably ran about, and although placed on the mole they were indifferent to it, and without exception when mutilated in this way failed to lay any eggs; so much impressed was Forel with this fact that he is inclined to think that the desire to lay is, with these insects, a "general sensation which can be compared to a sexual appetite, and which is provoked by an olfactory sensation; for it ceases immediately after the suppression of the antennæ; whilst other lesions, even the removal of the eyes, which is more dangerous, do not hinder it."

Taste.—There can be no question as to the fact that insects as a rule possess the power of distinguishing between the quality of certain non-volatile substances before swallowing them. For instance, if morphia or strychnine are mixed with honey, ants attracted by the smell of their favourite food begin to eat the mixture, but after taking it into their mouths they leave the tainted honey. If the antennæ and palpi of wasps are removed and the animal's mouth is then brought in contact with honey mixed with quinine, after tasting it the insect immediately turned from the honey.

From experiments of this kind it appears certain that in insects the sensory organs of taste are located within the animal's mouth, and consist in all probability of a series of cup-like depressions connected with the terminal distribution of subjacent ganglionic nerve-fibres. These pits are numerous on the surface of the tongue of most insects, and are well marked especially near the tip and the base of this organ. These ganglionic nerve-cells are brought into connection with nervous centres located in the subœsophageal ganglion, and possibly with nuclei situated in the hind-brain.

Touch.—The sensory organs of touch in insects essentially consist of structures similar to those possessed by the Hydromedusæ (p. 33), being formed of sensorial hairs or bristles which are connected with the living matter of certain epidermic cells and subjacent nervous structures. Modifications of this mechanism have come into existence in the case of insects in consequence of the rigid hard materials by which the bodies of many of them are enclosed. The tactile sensory organs of insects are fairly well dispersed over the whole surface of their bodies, but are specially well developed on their mobile antennæ; their palpi, trochanters, and tarsi, are also regions covered with tactile nerve terminations and are therefore peculiarly sensitive to touch.

Vibrations of various kinds, but especially those produced mechanically, affect these tactile sensory organs, and become manifest in a sensation which we call touch or feeling; and which, as is the case with the other sensory organs, brings previously registered impressions of the central nervous centres into play, whereby relational motory actions are brought into operation.

If we carefully watch the various actions of spiders, it seems evident that they depend on the mechanical vibrations of their webs, the tension and the resistance of which guides them. Their vision is imperfect, but mechanical vibrations affect the whole of their bodies through its action on their tactile sensory organs, resulting in tactile sensations, and particularly the muscular sensation, and corresponding muscular tension destined to re-establish equilibration.[1]

Hearing.—With the exception of crickets and a few other insects, we have no evidence to show that this class of animals possess the sense of hearing. They are extremely sensitive, as already stated, to mechanical vibrations; but to auditory waves insects give no response. We may make as much noise as we like close to a bee engaged in pillaging flowers, but if we protect the animal from the mechanical vibrations of our breath or movements, he takes no notice of the noise we are making.

From the preceding statement it is evident that insects possess visuo-sensory organs, and organs of smell, touch, taste, and the muscular or kinæsthetic sense; some few of them have the power of hearing. Leading directly from each of these receptors of energy or sensory organs, nerve fibres pass to corresponding ganglionic nervous centres located in definite lobes of the brain.

[1] Forel, p. 111.

These cerebral nervous centres are in intimate communication with one another by means of protoplasmic processes, and the whole of this system of sensory organs and cerebral centres are brought into close relation with the nervous matter we have described as the "fungiform bodies," that is a mass of nervous substance which reaches its highest state of development in insects, or that class of invertebrates in which instinctive processes are most perfectly developed.[1]

Through the various sensory organs a flow of visual, olfactory, tactile and other forms of energy are constantly passing during an animal's working hours to the living matter of the ganglionic nerve cells, which constitute the cerebral centres for vision, smell and touch; impressions are thus made on this living matter by these various stimuli. These impressions become more or less permanently fixed on this matter according to the hereditary structure of its elements, and their ability to effect its metabolic processes in a satisfactory manner.

Impressions thus made on the living matter of certain brain-cells are, by means of nerve fibres, brought into intimate relation with one another, the system thus formed constituting the basis substance of memory;

[1] Professor W. James, in his "Text-Book of Psychology," pp. 370, 381, 391, defines *Instinct* "as the faculty of acting in such a way as to produce certain ends, without foresight of the ends, and without previous education in the performance." He adds, "every instinct is an impulse." An *Emotion*, Professor James states, "is a tendency to feel, and an instinct a tendency to act, characteristically, when in presence of a certain object in the environment—emotions are sensational processes due to inward currents set up by physical happenings; they have their bodily expression, which involves strong muscular activity, and it becomes a little hard in many cases to separate the description of the 'emotional' condition from that of the 'instructive' reaction which one and the same object may produce."

in that these impressions are reproduced and co-ordinated by energy received from like stimuli to those which produced the original impression or, it may be, by energy derived from other sources. Memorial impressions in their turn play on specific nervous elements whose action becomes manifest in instinctive movements.

That insects possess memories is demonstrated by their actions, for instance Professor J. Loeb states that a wasp (Ammophila) had made a hole in a flower-bed in his front yard. Towards noon he saw a wasp running along the side walk of the street in front of his yard carrying a caterpillar in its mouth ; the weight of the caterpillar prevented the wasp from flying. The yard was separated from the street by a cemented stone wall up which the wasp repeatedly made an attempt to climb, but kept falling back. The insect failing to scale the wall then ran round the bottom of it until it reached an opening through which it crept into the yard. Then crawling through the fence which separated the two yards it dropped the caterpillar near the foot of a tree, and flew away. After a short zigzag flight it alighted on a flower bed in which were two holes. The wasp soon left the bed and flew back to the tree, stopping twice on the road. It then landed on the caterpillar it had left and dragged it into its hole which it then covered with sand. In this train of action we have clear evidence as to the fact that the wasp was guided by memory.[1]

Again, if some honey was placed on a disc of white paper on a table, a wasp soon appeared and settled down on the disc to eat the honey; having taken all it

[1] "Comparative Physiology of the Brain and Psychology," by Professor J. Loeb, p. 225.

wanted it flew away, but soon returned and went directly to the disc for more food; having satisfied herself she again flew away. This disc was then replaced by a similar one without honey, and another disc of the same size as the former one was placed near it with honey on it. The wasp returned and flew directly to the small disc, but finding nothing on it, raised herself a little in the air and alighted on the disc on which honey had been placed.

Honey was then smeared on white paper cut into the shape of a cross which was put near a disc without honey. The wasp returned and soon found the honey, and having fed on it flew away. The cross was then removed, and on one side of the spot on which it had lain, a white disc was placed, and on the other side a strip of paper with honey on it. The wasp returned and flew straight to the white disc; and finding no honey flew away, but soon returned, and after much searching found the honey on the white strip.

Another band without honey was now substituted for the band with honey, and a cross with honey on it was placed the same distance from the spot where the wasp had been accustomed to feed. The insect returned and flew direct to the new band; finding nothing on it she found her way to the cross. Forel remarks that the wasp remembered the form of the paper on which, at each visit, she had found a supply of food, and she flew directly to the paper having the size and shape of that off which she had fed on her previous visit.

Forel, continuing the description of his experiment, states that—the following day the wasp returned twice to eat at the cross left in the same place as on the previous day. He then removed both the insect's antennæ; she flew away and returned in half an hour to eat of the honey on the cross. After her departure a similar cross without honey was substituted for the first; the wasp returned and alighted directly on this cross hoping to find honey there as usual. Then, although deprived of antennæ, she began to search, doubtless recollecting that the white papers on which the honey was, had already often changed in place and aspect. The insect had lost its sense of smell, but the impressions made on its central nervous matter by the former exercise of its olfactory sensory organs remained, and were brought into play by visual and tactile stimuli; the instinct existed in a latent state, and was put in motion by other forms of energy than those which first produced the impression on the central nervous matter.

Forel, in discussing the nature of the instincts of insects, observes that their *purposeful* movements are not merely reflex or simply automatic, but very well co-ordinated; almost all prompted by the combinations of *instinctive reasoning* by the aid of sensorial impressions, and admirably adapted to their object. He adds, we speak here of the directive acts of the individual and social life of insects, of their "*will*," very inferior no doubt to that of vertebrates, but not essentially different.[1]

As an example of the outcome of processes above described in insects we may mention the slave-making ants (Polyergus rufescens); these insects are incapable of tending their young and even of feeding themselves. At a particular period of the year when the nests of the

[1] Forel, pp. 117, 118.

black ants contain the neuter brood—at a given signal made by certain of the leaders of a nest of red ants, an army of these insects leave their nest, and advance in fairly straight lines, the vanguard which consists of eight or ten ants, continually falling back to the rear. In some cases the whole army separates in search of nests of black ants (Formica fusca or rufibarbis). At last a nest of these latter species having been found, a signal is given by striking the forehead of a neighbour; this signal is passed from one red ant to the other, and the army re-forms. On arriving at the black ants' nest a desperate conflict ensues, which ends in the defeat of the negroes; and the red ants then enter the nest, and leave it almost instantly, each insect holding a larva or pupa in its mandibles, which they carry home with all speed. In the return of the army there is never any hesitation; the olfactory and visual memory of the outward journey is sufficient to make known to each ant the exact road. Having reached home the red ant hands over the stolen larva to a slave, and as a rule sets off immediately to the pillaged nest if it still contains more larvæ, or they may put off the return journey until the following day. Forel states this return journey is never made if the pillaged nest has had the whole of the larvæ removed; he remarks "the fact appears to me to furnish irrefutable proof of their memory. They must remember if the pillaged nest still contains pupæ or not, that is to say, if there are many or few. Neither reflexes, nor odour, nor polarised tracks can explain the thing."[1]

The stolen pupæ are treated by the red ants with great care, and when grown up spend their lives in

[1] Forel, p. 239.

excavating passages, collecting food, carrying larvæ, etc., for their masters as if this had been their original destination, in fact they fulfil the offices of slaves.

Weismann states that the red ants cease to build their own dwellings and in great measure to care for the young, or even search for their own food, all work of this description being performed by their slaves. In the course of time, he argues, the instinct to search for food became unnecessary, was neglected by the selective power of nature, and gradually passed away. He adds, "no instinct, no organ of the body has permanency unless absolutely requisite to the preservation of the species. *Panmixia*, or, if you will, the remission of natural selection, brings it about that the superfluous is reduced to the absolutely necessary—in the end the organ which is no longer indispensable to life is entirely removed, and a complete equilibrium is again established between the structure of the body and the work it has to perform. In this aspect, retrogression is a part of progression.[1]

Many insects guide themselves essentially by vision, as for instance the dragon fly; their antennæ are rudimentary and the sense of smell imperfect. By night these insects are motionless. Ants and many other genera of insects depend on energy received through their olfactory sensory organs to guide them from one to another place. It is by the sense of smell that one family of ants recognise another and the male knows a female; having wandered from its home in search of food, the ant retraces his footsteps by means of his olfactory sensory organs. For if its antennæ are removed it fails to find its path, to distinguish

[1] "The Open Court," pp. 1855, 1857, vol. for 1889.

between friend and foe, or to appreciate the difference between the sexes.

When referring to the structure of the fungiform bodies of insects we stated that their size was found to increase roughly in proportion to the intelligence displayed by various orders of insects, for instance these bodies are proportionately larger in the working bees and wasps than in the male insects. The males, however, have more highly developed eyes and antennæ than the working bee; in spite of their being the most unoriginal stupid beings, their sensory organs and the corresponding cerebral nervous centres are fully developed. Their brains, however, as compared with the working insect, are deficient in respect to the size of its fungiform bodies, or in that part of the cerebral nervous substance in which, as we hold, their instinctive processes are perfected.

With regard to bees there can be no question that they are capable of receiving impressions from their fellows which excite in them *emotions* they are able to communicate to their companions.

If a queen bee is removed from her hive, the workers soon discover their loss and raise a prolonged, acute, and plaintive sound. The queen having been secured in a wire cage was placed in the upper tier of working bees; almost immediately their buzz was changed from a doleful to a joyful sound, which was taken up and repeated by bees in the most distant part of the hive.

A remarkable fact demonstrating the exercise of the instinctive power of bees is afforded us by their action in swarming. Before the queen is allowed to leave the hive, scouts are sent out to seek a suitable locality for the swarm to settle on. After having chosen a spot the scouts return and conduct the swarm to the place they have selected, showing not only a memory of places but a remarkable display of instinctive action in their movements.

Among invertebrates instinctive movements have probably reached their highest point of perfection in ants and bees, and we find a corresponding order of structural organisation of their brains. If there is one organ more than another which increases in complexity as evolution proceeds—which is the most essential organ for upward progress? surely it is the central nervous system, especially that portion of it called the brain.[1]

Assuming that Professor Bellonci is correct in his ideas as to the existence of an area of nervous matter in the mid-brain of insects, which corresponds to that of the basal ganglia of vertebrates, we may assign to this nervous substance the function of directing their instinctive movements, aided by energy received from the nervous matter of their fore brain. Beyond this we cannot overlook the fact of the existence of the fungiform bodies which constitute so prominent a feature of the fore and mid-brain of insects; and which bear a direct relation to their movements.

The energy which directs the instinctive movements of insects or any other beings, cannot arise *ex nihilo*, it must be derived from work performed by some kind of hereditary nervous substance, because the same kind of movements are effected, or it may be restrained, by the same species of insects through numberless generations in all parts of the world, when exposed

[1] Professor Gaskel on "The Origin of Vertebrates," p. 65.

to similar conditions. Instinctive, therefore, without doubt, but none the less, in its natural state, brought into action through work performed by stimuli received through the sensory organs and their corresponding cerebral nervous centres.

CHAPTER IV

In previous chapters we have shown that the simplest known forms of living matter manifest purposive action, and that with an increasing complexity of the structures and organs of the bodies of progressively advancing orders of animals, their purposive actions have become developed into instinctive movements. No hard and fast line, therefore, can be drawn between purposive and instinctive actions; the latter have come into operation in response to the action of the environment on elements which in the lower forms of beings were manifest as simply purposive movements.

We pass on to show that in vertebrates evidence exists confirming the idea of the evolution of purposive into instinctive matter, and also that from this latter substance matter is evolved having psychical or intellectual functions. We conceive that these three forms of matter consist of like elements which have been structurally modified through the action of the environment, and under the laws of natural selection have become perfected or brought into harmony with the forces acting upon them. To illustrate our meaning we might compare purposive matter to the root of a tree, instinctive matter to the stem, and psychical matter to its branches.

A family of animals known as the Protochordata has been held to constitute the link between invertebrate and vertebrate animals. This family is represented by a small creature the amphioxus which is to be found on our coast and that of many parts of Europe. The animal is some two inches in length, is fish-like in form, and swims rapidly through the water by sinuous movements of its body. The amphioxus, however, spends most of its time buried in the sand, the anterior end of its body projecting into the water. An opening exists on this extremity of the animal which is closed by the contraction of muscular fibres encircling it, and is further protected by twelve tentacles provided with sensory epithelial structures.[1] The amphioxus feeds upon minute organisms contained in the surrounding water which passes through its mouth and out by the animal's gill-slits; in its passage the nutrient matter it contains comes in contact with rows of cilia lining the gullet and by their action is directed into the intestine.

An animal leading a life of this kind requires nothing higher than purposive action to direct its movements; and we find, with the exception of tactile sensory organs, the amphioxus only possesses a single median eye-spot, and near it a ciliated slit which is supposed to be olfactory in function.

The animal's central nervous system consists of an unsegmented tubular cord of nervous matter, which narrows to a point at either end, and terminates anteriorly in the median eye-spot, it gives off two pairs of sensory nerves to the snout. From the rest of the nervous cord a series of nerves arise, correspond-

'Comparative Anatomy of Animals," by Gilbert C. Bourne, vol. ii. pp. 172-202; also E. Haeckel's work on "The Evolution of Man," vol. i. p. 416, Plate xi.

ing in number and position to the myotomes or sections of the animal's body. The central canal of the nervous system is lined by a supporting epithelium, outside which is a layer of glanglionic nerve-cells, and external to these non-medullated nerve-fibres. In front the central canal forms a vesicle; from the nervous matter forming the walls of this vesicle protoplasmic processes pass into relation with the structures forming the eye-spot and olfactory sensory organs.

Passing on to the simplest of the true vertebrata, the cartilagenous fishes, which include such animals as the lampreys (Petromyzon marinus), we find a vertebral column forming a support to the other parts of the animal's body, this cartilagenous structure together with a skull are an efficient protection to the central nervous system. These animals possess no trace of limbs, and may be regarded as representing a remnant of an old and simple class of vertebrates, which are far below the structural stage reached by genuine fish.[1]

It is well in this place to give a general outline of the structures which enter into the formation of the brain of this, the simplest class of vertebrate animals, especially in relation to the development of its two *corpora striata*, and *optic thalami*, for it is largely upon work performed by the nervous substance of these parts of the brain that the hereditary character of animals depends. As we shall proceed to show, neither in fishes nor amphibia do we find even rudimentary cortical or psychical nervous areas in connection with their cerebral hemispheres, so that

[1] "The Evolution of Man," by E. Haeckel, vol. ii. p. 102.

the traits of character evinced by this vastly numerous, ancient, and important class of animals

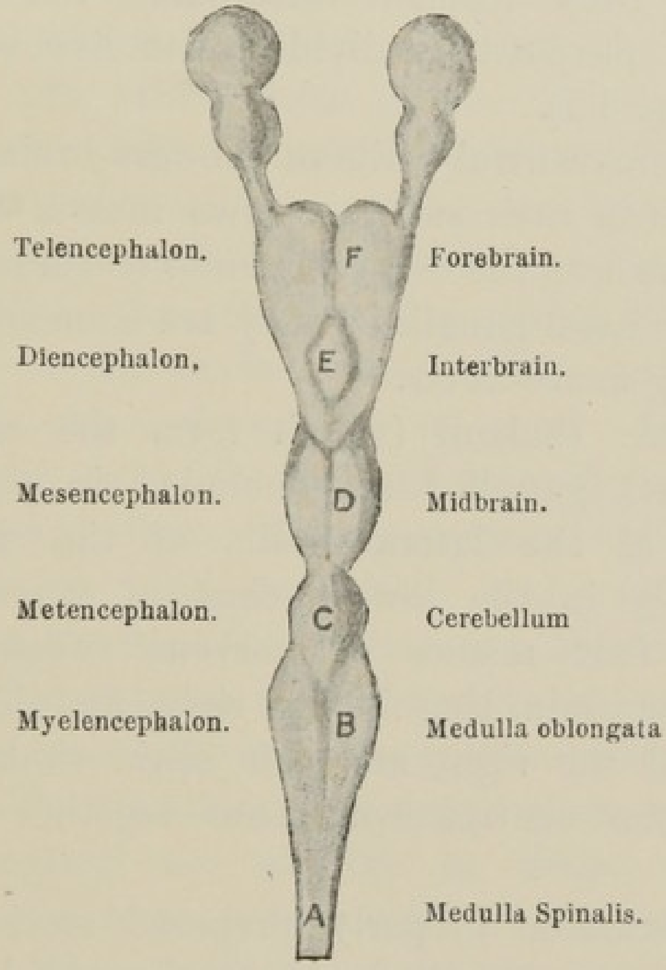

FIG. 12.[1]—*A*, The spinal cord, is prolonged upwards into *B*, the *medulla oblongata* (myelencephalon). In this region the spinal cord seems to widen out into a thin membranous roof covering the central canal (fourth ventricle). The lateral walls of the medulla oblongata contain aggregations of ganglionic nerve-cells, which form the nuclei or place of origin of some of the most important nerves of the body. *C*, The metencephalon forms a short section of the brain, its roof is known as the cerebellum, the arms of which encircle this section of the brain (Pons Varolii). *D, the Mid-brain* (mesencephalon) consists of ventral and lateral walls of nervous matter enclosing a narrow canal (Aqueduct of Sylvius). Its dorsal wall forms the two optic lobes. *E. the Inter-brain* (diencephalon) constitutes, by means of its thickened lateral walls, the *optic thalami*; the dorsal wall is also thickened at one point by fibres which connect the two knot-like portions of nervous substance known as the nuclei habenulæ.[2] *F, the Fore-brain* (telencephalon) consists of paired lateral lobes from the anterior end of which processes pass to the olfactory lobes. A membranous roof connects and covers the lateral lobes of the Fore-brain ventricle, which divides anteriorly into a Y-shaped cavity and is continued into the olfactory bulbs. The common cavity with that of the inter-brain (diencephalon) constitute the third ventricle of the brain; the lateral or olfactory portions are comparable with the lateral ventricles of the mammalian brain.

[1] "The Nervous System of Vertebrates," by Professor J. B. Johnston, pp. 14, 25.

[2] Cat. Roy. Col. Surgeons Museum, p. 87, vol. ii. Phys. Series.

consist of work performed by purposive and instinctive living nervous matter.

In the fully formed vertebrates the brain for anatomical purposes is divided into five sections, as follows (Fig. 12).

The latero-ventral walls of the fore-brain are thick and include in their substance two masses of nervous matter known as the *corpora striata* (forming one pair of the four basal ganglia); they are connected in the mid-line by nerve-fibres.

The optic thalami (which form the second pair of the basal ganglia) are included in the nervous substance of the lateral walls of the inter-brain, consequently in the lowest class of vertebrates we find that four masses of nervous substance exist within their brain, that is the right and left corpora striata, and the right and left optic thalami; these four nervous centres constitute together the *basal ganglia.*

If we examine properly prepared sections of the nervous substance of the basal ganglia of a lamprey we find it consists of an intricate mass of ganglionic nerve-cells and fibres. Among these cells, especially in the corpora striata, large pyramidal cells with well-defined axions may be seen (Fig. 2); these fibres pass into the medulla and spinal cord, and convey motor energy from the living substance of these cells to the muscles of the body. Besides these motory cells a multitude of smaller sensory granular cells enter into the formation of the basal ganglia especially of the optic thalami. Nerves passing from the olfactory, visual, and tactile organs of the animal's head and body terminate in connection with the living matter of these sensory cells.

The point to which we wish to draw special attention is, that in the lowest, that is, the simplest, existing class of vertebrates, four masses of cephalic ganglionic nervous substance constitute the foundation on which the other parts of the animal's nervous system rests. For we find innumerable fibres or lines of communication passing to and from the ganglionic nerve-cells of the basal ganglia, to nerve-cells located in the olfactory and visual lobes of the brain, and to the nuclei of the nerves originating in the medulla oblongata and spinal cord. So that the basal ganglia form the central receiving station for energy passing from all the sensory organs of the animal's body. As we shall subsequently show, energy thus passing into the nervous substance of the basal ganglia plays on matter previously impressed by stimuli, and re-excites such impressions which becomes manifest in the movements we speak of as instinctive.[1]

The lampreys are eel-like in shape, they vary greatly in size from a few inches to three feet and upwards. These animals have a circular mouth armed with numerous hard tubercles which perform the purpose of teeth; the tongue acts like a piston. The animal thus attaches itself to a fish and sucks its blood; it also eats soft animal matter. The upper and lower jaws, and a double nostril, which appear in all the higher vertebrates, are absent in the lamprey, their nasal organs consisting of a single cavity situated in the dorsal mid-line slightly in front of the plane of the eyes. A short passage leads from

[1] Cat. Phys. Series, Roy. Col. Surgeons Museum, vol. ii. p. 67; see also Proceed. of Zoolog. Society, Oct. 1909, "The Anatomy of the Olfactory Organs of Teleostean Fishes," by R. H. Burne.

the nostril to a globular olfactory chamber, the posterior wall of which lies close in front of the brain, and is lined with folds of the olfactory membrane. The lower part of the sac is prolonged into a blind pouch which shares in the alternate expansion and contraction of the branchial cavity, and is thus a mechanism for the production of currents of water into, and out of the olfactory chamber. The passage of the incoming water through the olfactory chamber is ensured by a suitable arrangement of valves situated at the lower end of the first segment of the nasal passage.[1] (See Specimen E 85, Phys. Series, R.C.S. Museum.)

The auditory organs of the lamprey consist of a single chamber and two semi-circular canals. The auditory nerve supplies terminal branches distributed to the saccular appendage of these canals; this nerve originates in an aggregation of ganglionic cells located in the lateral walls of the medulla oblongata. Fibres passing from this nucleus enter into relation with those proceeding from the nerve-cells of the optic thalami.

The next higher class of fishes (Elasmobranchii) include sharks, dogfish, etc. The brain of these animals is remarkable on account of the great development of its olfactory lobes; the optic lobes are also conspicuous. The medulla oblongata or hind-brain of many genera of these animals is of large dimensions, containing the nuclei or ganglionic cells from which important nerves originate and supply of various organs of the body.

The structural arrangement of the nervous matter of the brain of the cartilagenous fishes is complicated,

[1] This description is taken from Mr R. H. Burne's Cat., vol. iii. p. 73, Phys. Series, Roy. Col. Surgeons Museum.

and contains well-developed basal ganglia, its walls however consist of a relatively thin outer and a thick cellular layer surrounding the ventricles; there is not a vestige of cortical structures, that is of specialised living matter having psychical functions.[1]

The olfactory organs of these fishes consist of a passage which is open externally and extends backwards into an olfactory chamber. The walls of this chamber are lined by a membrane in which the olfactory sensory organs are located, the nerve fibres passing from these organs terminate in relation with those of the ganglionic cells of the olfactory lobes of the brain.

A shark's eyes consist of a cartilagenous outer case into which the muscles directing the movements of the eyeball are inserted. The outer transparent layer of the eye is flat and thus adapted for aquatic locomotion; the lens has a sharp anterior curvature to compensate for the loss of a refracting cornea. A muscular diaphragm or iris with a central, often contracted opening (the pupil), is located between the lens and cornea in the space known as the anterior chamber of the eye, which is full of fluid. Behind the lens is another space (the vitrious chamber) lined posteriorly by a pigmented vascular layer (choroid), which is continued forwards into the iris.[2] External to the choroid the retinal or nervous sensory elements of the eye are spread out; these elements are derived from an

[1] Cat. of Roy. Col. Surgeons Museum, Physiological Section, vol. ii. p. 68.

[2] This vascular pigmented layer serves to absorb surplus light passing to it through the transparent media of the eye, and it also supplies nourishment to all the structures enclosed within the outer or sclerotic tunic of the eyeball.

outgrowth of the brain, whereas the lens and other parts of the eye are produced from an invagination of the epidermis. The retina consists of a complicated arrangement of rods and cones.

The organ of hearing in the Elasmobranchi consist of a membranous labyrinth buried in the cartilage of the animal's skull, as a rule it has an external opening leading to a cavity formed by an invagination of the epidermis. This organ is divided into two chambers, one of which is more directly the organ of hearing, the other with alterations in the position of the animal.[1] Fishes can hear, but have no power of discriminating between different qualities of sound.[2]

Taste.—The lips, tongue, mouth and gullet of fishes are covered with aggregations of sensory cells, which are supplied with nerves whose component fibres belong to a special visceral sensory system, and are probably sensory organs of taste.

Touch.—Sensory tactile organs are distributed over the surface of the body of fishes, and certain parts, especially the head in the gurnet, is provided with stiff barbels, which are constantly in use when the animal is feeding at the bottom of the water, and which when swimming about they completely conceal in a groove beneath the head.

The brain of fishes possessing a bony skeleton differs from those to which we have referred, in that their structures are more concentrated, and are remarkable for the strong development of their optic lobes. The cerebrum is represented by a pair of rounded basal

[1] Cat. Roy. Col. Surgeons Museum, vol. iii. Phys. Series, p. 144.

[2] Lee, *Journ. of Physiol.*, vol. xv. 1894, p. 311, and vol. xvii. 1895, p. 192. *Am. Journ. Phys.*, vol. i. 1898, p. 128.

ganglia, roofed over by an epithelial non-nervous structure.

Sharks and rays (Elasmobranchii), constitute the living representatives of the primitive form of fishes, their existence in Devonian strata being a well-ascertained fact ; that is to say, the progenitors of the existing sharks lived on the earth before any land animals had come into existence. The remains of these fishes increase greatly in the deposits of the Coal and Permian periods. The air-breathing or land vertebrates, unlike their water-breathing progenitors, developed lungs and consequently a modification of the circulation of the blood and the organs connected with this system. Other modifications in structures and organs of the bodies of these animals afford us examples of the power which the environment exercises in gradually effecting changes of this kind.[1]

The mud-fishes of Southern Australia, Africa, and South America, retain the earlier mode of breathing through gills in addition to the newly acquired lung-respiration. During the rains they swim in the water like fish and inhale through their gills, but in the dry season they burrow in the mud as it dries up, and breathe air through lungs like amphibians and the higher vertebrates. Their skin is covered with large fish-like scales, their skeletons are soft and cartilagenous. The structure of the brain of these animals (see D 120, Mus. R. Col. Surgeons, Phys. Series, Cat., p. 105) resembles that of primitive fishes, its highest development being in the cerebral hemispheres which resemble those of the amphibia, their walls however are very thin and contain no vestige

[1] Haeckel, pp. 115, 118.

of the layers of nerve cells characteristic of the cerebral cortex of the higher classes of animals.

From experiments made by J. Steiner we learn, if the head of a shark is amputated, the animal's body for some time continues to make swimming movements, in the same way as the body of a salamander or of an eel would do under similar conditions. These movements are due to reflex actions, that is, the surrounding water stimulates the tactile sensory organs of the surface of the body, nervous energy is thus released and passes to the animal's spinal cord, where it re-excites previously existing impressions which pass to motor elements and become manifest in the swimming movements of the body.

The next higher class of animals (the Amphibia) are represented by the Urodeles and the bull frog; their cerebral hemispheres appear to be of comparatively large size, but their walls are thin and show no signs of a cortical layer of cells such as that which forms the neopallium of the higher classes of animals. The hemispheres are oval in shape and project backwards to some extent over the lateral parts of the fore-brain so as to form imperfect occipital lobes. The brain of the bull frog (Rana catesbiana) is remarkable for the size of its optic lobes which form prominent oval bodies separated in the mid-line by a deep fissure.

In fishes, and more distinctly in the amphibia, the free ventral layer of grey nervous matter of the corpora striatas contains a layer of pyramidal cells known as the *Epistriatum*.

This layer of cells sends out protoplasmic processes having a peculiar knobbed structure; many of these fibres come into relation with the ganglionic nerve-cells of the olfactory centres, others pass downwards to communicate with bipolar and unipolar ganglionic cells of the optic thalami, which are connected with visual and gustatory impulses. The hemispheres of the brain in this class of animals may be shown to be formed by a folding-over of the lateral walls of the fore-brain, and the layer of pyramidal cells of the epistratum pass on into the superficial layer of what is known as the hippocampal lobe. This fact demonstrates the intimate connection that exists between the structures forming the corpora straita and the centres for olfactory and gustatory impulses, and affords us a type on which the nervous substance of the neopallium in mammals is built up.[1]

The sensory organs of the amphibia are more highly developed than in cartilagenous or bony fishes, for instance, in the case of the bull frog (Rana catesbiana) in addition to a membranous labyrinth such as exists in fishes, rudiments of structures known in mammals as the cochlea are developed, which play an essential part in the appreciation by the animal of differences in sound. Between the tympanum of the frog's ear and the membrane of the cochlea, a small bone extends, through which vibrations affecting the tympanum are transmitted to the membrane of the cochlea. From experiments made by

[1] See Johnston, pp. 297, 303, 304, 308, 315; also Cat. Roy. Col. Surgeons, p. 213, and Fig. 33, p. 123; also "Further Advances in Physiology," edited by Leonard Hill, article by J. Shaw Bolton, p. 315. In the higher orders of beings, including man, the cerebral hemispheres are composed of white and grey nervous matter, the white pervading nearly the whole of the middle of each hemisphere, where it forms the *medullary centre*, and extending into the convolutions; the grey forming a covering of some thickness over the whole surface of the convolutions (cortex), and occurring also at the base of the hemispheres in the so-called basal ganglion (corpus striatum). Quain's Anatomy, vol. iii. pt. i. p. 163.

Professor Yerkes on frogs, it appears that these animals appreciate differences in sounds not only by their movements, but also by alterations in the rate of their breathing when exposed to alterations of range of auditory vibrations.[1] That these movements depended on the action of the auditory apparatus was shown by dividing the auditory nerves of these animals, that is, the connection between the ear and the auditory cerebral centres; after this operation is performed movements in response to vibrations of sound are abolished.

Having adopted in part a terrestrial mode of life, the olfactory organs of the amphibia have become modified in response to the altered nature of their environment, and afford a direct passage for air to enter the lungs, and also contain the specialised sensory organs of smell. These organs are adapted to receive impressions made on them by odorous elements, and to transmute this energy into a form capable of exciting the sense of smell in corresponding areas of the brain.

The amphibia depend to a large extent upon the organs of vision for their supply of food, and to warn them of approaching danger. These animals appear capable of discriminating between red and white colours; this is demonstrated by forcing a frog to follow a certain track in a simple labyrinth in order that he may obtain a supply of food.[2] At the point where a choice between the right and wrong paths occurred, "a red card was placed on one side and a white card on the other. When the frog had learned to take the correct path towards the white, the cards were exchanged, without any other alteration in the

[1] *Jour. Comp. Neur. and Psych.*, vol xv. p. 279. [2] *Idem.*

conditions, and the decided confusion of the animals indicated that they had discriminated between the red and white cards, and had learnt to react with reference to this discrimination."[1] The small green tree frog after a hundred trials learnt without a fault to follow the right path by which to obtain its food in a simple labyrinth.

Professor Flourens found that after he had removed the cerebral hemispheres of a frog the animal continued to swim when thrown into the water. Movements of this kind, as in the decerebrated shark, are due to stimuli received by the tactile sensory organs of the animal's body, which pass to the nerve cells of the spinal cord and through their motor fibres to the muscles concerned in the act of swimming. The neuro-muscular system of these animals has acquired the power of executing these movements in virtue of the hereditary structural arrangement of its elements, which had been exercised, and thus improved, during the previous lifetime of the animal. But, as Professor Goltz and Schrader have shown, if together with the cerebral hemispheres the basal ganglia are destroyed the animal loses all power of spontaneous or instinctive action; a frog thus mutilated will, if left to itself, remain motionless until in the course of time it dies. But if the toes of the brainless frog are pinched the animal withdraws the limb, reflex action remains, but all instinctive move-

[1] "The Animal Mind," by M. F. Washburn, p. 142.

Professor Schrader concludes from the result of his experiments on frogs that their central nervous system can be divided into a series of sections, each of which is capable of performing an independent function.

ments are abolished with the removal of the cerebrum, including the basal ganglia.

If, however, the cerebrum of a frog is removed *exclusive* of the optic thalami, instinctive actions are retained; if an obstacle is placed in the path of the animal, and it is then excited by a prick on its foot, it moves away and either bounds over or avoids the obstacle. The mere act of leaping away may possibly, in case of necessity, be regarded as a complicated reflex action; but the fact that the frog avoids the obstacle shows that its instinctive elements are still at work, and are located in the nervous substance of the optic thalami.

It is evident that the basal ganglia are more completely developed in the bony than in cartilagenous fishes; and with this more perfect development of the nervous structures of this part of the brain we find its functions are of a corresponding higher order. For instance—in the case of the sticklebacks (Gasterosteus trachurus) during the nesting and spawning season the male fish becomes a metallic green colour, the lower part of his throat a bright crimson, and the back is ash-green. He proceeds to construct his nest on the soil at the bottom of the water he inhabits. The fish collects a quantity of grass-stalks and other fibres, which he cements with mucus that exudes from the surface of his body; in order to accomplish this, he passes backwards and forwards over the materials he has collected. In this way a dome-like hollow structure is reared, at the side of which a small hole is left, its edges being strengthened and rounded off with great care. The fish then seeks a mate, and conducts her to the nest he has made; she enters at the hole, and in a few minutes has laid some eggs, after which she bores a hole on the opposite side of the nest to that by which she had entered and makes her escape. The nest having two openings, a stream of water can pass through it and the eggs are thus kept at a normal temperature. This process is repeated day by day until the nest contains a considerable number of eggs. The male then takes up his position to defend the nest from invaders, a period lasting for a month. During this time he has frequently to fight many battles with often larger fish than himself; in making these attacks the little creature seizes their fins and strikes furiously at their head and eyes. As the young fish appear and grow they are apt to stray; the male brings them back to his allotted precincts until such time as they are able to protect themselves, when he ceases his guardianship and returns to freedom of action.[1]

The action taken by salmon in the preparation of spawning-beds and the care of their young is remarkable; after passing from the sea a pair of fish select a gravelly shallow. The female deposits her eggs in shallow furrows in the gravel, to which they adhere by a thin coating of glutinous matter, the male at the same time shedding his milt over them. The trenches in the sand, according to Mr J. Shaw, are made by the female throwing herself at intervals of a few minutes upon her side, and while in that position, by a rapid action of her tail, she digs a receptacle for her eggs, a portion of which she deposits and turning on

[1] "The Angler Naturalist," by H. Cholmondeley-Pennell, pp. 81, 84.

her side, covers them over with sand. The male seems to take no part in this work, but after it is completed he takes up his place as sentry over the eggs, for which he has at times to fight fiercely, for other male fish are anxious to appropriate his charges. He is thus kept incessantly on the alert until the eggs are hatched and the fry able to take care of themselves.

Mr Pennell states that in company with Mr Bartlett, Superintendent of the Zoological Gardens, Regent's Park, he visited the house in which perch are kept, the keeper of these fish was also present. So long as the keeper walked about in front of the aquarium occupied by the perch they took no notice of him; but on Mr Bartlett directing this man to walk away from the tank towards the cupboard where the net was kept by which food was introduced into the tank; the instant the keeper made this movement the fish became intensely excited, and rushed to and fro across their enclosure erecting their fins and exhibiting unmistakable emotional movements.

Further evidence of this kind might be adduced in order to demonstrate the kind of instinctive and emotional movements effected by animals through means of the nervous substance localised in a definite part of their brain; if this substance is removed during the animal's lifetime all such movements cease.

The emotional characters of these classes of animals vary as much as their instinctive qualities, some of them are pugnacious, bold, cunning brutes, others timid, harmless creatures. But they all have one character in common, which is, that their instinctive and emotional qualities are passed on from one to succeeding generations of beings.

Starting from the rudimentary mid-brain of the crayfish (p. 42) and other invertebrate animals, we trace a gradual evolution and concentration of the nervous matter forming the brain and spinal cord which, in the lowest class of vertebrates, has become developed into a system such as we have indicated. A system by which the various receiving and transmitting stations of in-coming and out-going streams of energy are brought into co-ordination, through means of the living matter contained in the ganglionic nerve cells of a definite area of the brain. The result of this action in the classes of animals we have referred to becomes manifest in instinctive and emotional movements such as those we have described; for we repeat, if this matter is destroyed although other parts of the brain may be spared, and the animal continues to live, all its instinctive and emotional activities are abolished.

It is on these grounds we base our opinion regarding the instinctive action of living elements contained in the basal ganglia of the lowest classes of vertebrates; and in the nervous substance of the mid-brain in the higher orders of invertebrate animals. A system of this kind depends in the first place on the nature of the hereditary arrangement of the elements of which it is formed; secondly, on the efficient supply of materials, and the performance of the fundamental processes appertaining to this matter; thirdly, on the kind of exercise the system has received from the dawn of its existence onwards. It is by means of proper training that the various parts of the system come to work together in harmony for the benefit of the individual and species as a whole.

We defined living protoplasm to be a form of matter which acts as a specific transformer of non-vital into vital modes of energy; in like manner certain constituents of the nervous substance located in the basal ganglia consist of a specialised arrangement of elements which act as a transformer of energy derived from the sensory organs into instinctive movements.

CHAPTER V

Passing from amphibians we come to the next higher class of animals, the reptiles ; before proceeding to consider those parts of their brain with which we are more directly concerned, it is well to state that there are other lobes of the brain than those to which we have referred, considering it well not to overburden a complicated subject with details which do not directly bear on the line of investigation we are following. But it is necessary to state that, in the classes of animals we have described, the nerves proceeding from their olfactory and gustatory sensory organs pass to ganglionic cells located in what are known as the Pyriform and Hippocampal lobes. The exposed surfaces of these lobes on the median and inferior parts of the brain consist of nervous matter which is described as the cortex, mantle pallium or covering of these lobes. The cortex of the Hippocampal lobe contains a layer of cells derived from those of the basal ganglia, but does not contain layers of ganglionic cells such as those which characterise the pallium of the hemispheres of the brain in the higher orders of animals. It is only when we reach the class of reptiles that we find indications of the development of a layer of ganglionic nerve-cells in the cortex or pallium of the cerebral hemispheres, derived, we believe, from the instinctive matter of the basal ganglia (p. 84). To distinguish this *new* development of nervous matter from the pre-existing Pyriform and Hippocampal pallium, Dr G. Elliot Smith has given it the name of the *Neopallium.*[1] This layer of cells is of importance to us, in that we hold the functions performed by its living substance to be psychical in

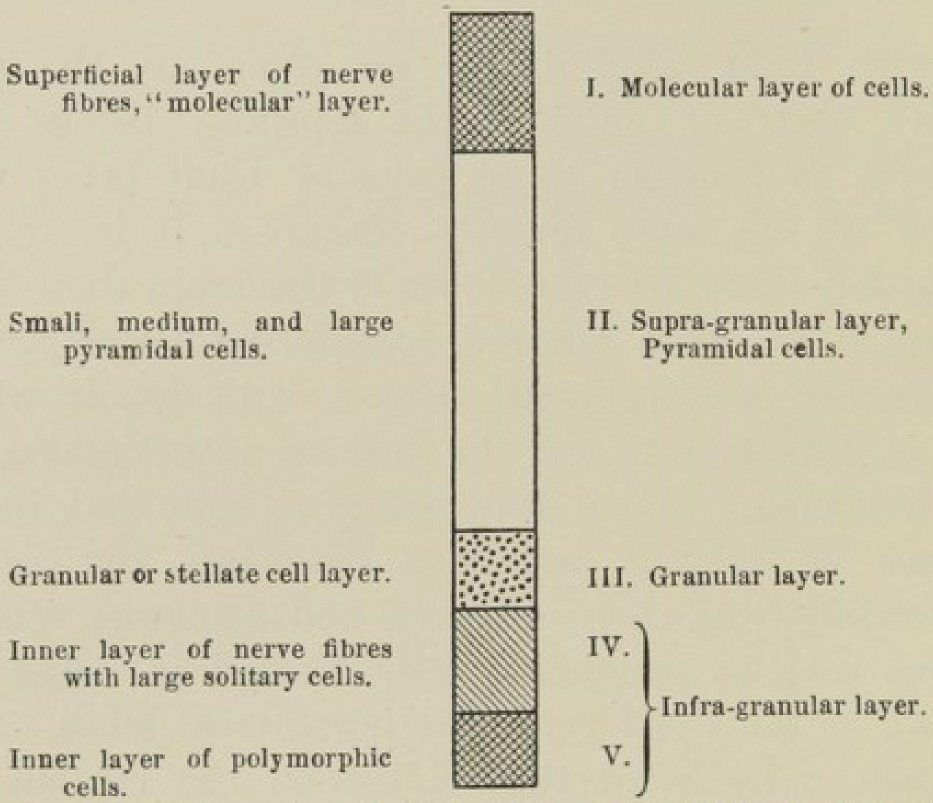

Diagram showing approximately the relative depth of the cerebral cortex or neopallium of an adult human brain. (After J. S. Bolton.)

character, arising, as we have said, out of the instinctive matter of the basal ganglia.

In reference to this subject Dr J. S. Bolton states, that in the higher classes of animals that part of the cerebral cortex known as the neopallium is derived from the polymorphic or inner granular layer of the cortex. He "suggests that in the earliest attempt at evolution of structures which come to be of any

[1] Prof. Elliot Smith has demonstrated that the neopallium—the "organ of mind"—is evolved from the hippocampal system.—*The Lancet, The Arris and Gale Lectures*, delivered at the Royal Col. Sgns., Jan. 1, 15, and 22, 1910.

considerable functional value,[1] the neopallium follows the plan of the cortical architecture long previously in the phylogenetic scale laid down in the Hippocampus, which plan in the latter situation has become fixed, and, as a plan, permanent. The earliest and lowest grade of neopallial representation is thus, as regards structure, a repetition of the hippocampal type, granular and infra-granular cortex. By the accrescence of a supra-granular layer of varying depth and complexity of its component nerve-cells, different grades of representation may be reached, and are reached to some extent in the same animal, even if this occupies a lowly place in the mammalian phylum, and to a greater extent the higher is the position in the scale to which the animal belongs "[2] (p. 84).

Although in reptiles, such as the ringed snake (Tropidonotus natrix), the layer of cells in the cerebral cortex is very limited in extent, and it is doubtful if cortical tracts pass from its cells into other parts of the cerebrum, nevertheless it is particularly noteworthy as indicating the commencement of another order of faculties than those we included under the term instinctive.

In addition to the development of a rudimentary cortex the reptilian brain is larger in proportion to the

[1] "Further Advances in Physiology," edited by Leonard Hill, p. 315, article by J. S. Bolton on "Recent Researches on Cortical Localisation and on the Functions of the Cerebrum."

[2] For further details on this subject refer to Dr Elliot Smith's paper in the *Journ. Anat. and Phys.*, vol. xxxv. p. 431, and to Professor J. B. Johnston's work on "The Nervous System of Vertebrates," pp. 297, 303, 311, 315, Fig. 154, Diagram, Fig. 151, p. 308. See also Figs. 53, 54, p. 173, Cat. Roy. Col. Surgeons Museum, vol. ii. Phys. Series. F. W. Mott and W. D. Halliburton on "Lemur's Brain," Proceed. Roy. Soc. B., Vol. lxxx., 1908.

rest of the nervous system, and more highly differentiated than that of amphibians or fishes. With this increase in the size and structure of the reptilian brain we find a corresponding development of their sensory organs.

The eyes of reptiles resemble those of the amphibia in structure, but in addition possess a mechanism by means of which they have the power of adjusting the focus of their refractive media to near and distant objects. This more perfect power of accommodation is a distinct advance beyond the visual apparatus of any of the lower classes of animals. The auditory organs also of reptiles are more highly developed than they are in the amphibia and approximate to that of birds.

Professor Yerkes has made experiments on turtles and other reptiles in order to ascertain how far they were capable of learning by experience. His plan is to place these animals when starving in a labyrinth which ended in a tank containing food. The test was to see how many times it took the animal to find the nearest path to its food, or in other words to successfully overcome the obstacles placed in its way before it could reach its food. In the early stages of their education it was found turtles took thirty-five minutes to complete their passage through the labyrinth to the tank ; but in the course of time these same animals became so thoroughly acquainted with the obstacles placed in their path, and so apt at avoiding them, that they passed through the labyrinth in some three or four minutes.

Not only did turtles come to learn and to remember their way through the labyrinth, but on reaching the edge of the tank, in place of moving down to the water on an inclined plane made for this purpose, the animals discovered a more expeditious mode of reaching their food was to throw themselves over the side of the tank into the water.[1]

From experiments of this kind we obtain evidence as to the existence in reptiles of a faculty, by which certain elements of their living substance are able to retain and utilise former impressions made upon them by various form of stimuli. With reference to this power of memory as before stated we know that certain flowers close with the setting sun and open with the dawn of day, and we attribute movements of this kind to a response of the living matter of the flower to energy received from the sun. But if flowers of this kind are removed from the light and heat of the sun, and shut up in a dark cool place, they continue for some days to open and close at the same time as when exposed to sunlight. We account for these latter movements in plants by assuming that one of the inherent properties of living protoplasm is, not only to respond but also to retain impressions made upon it by frequently repeated and appropriate stimuli; and that through the constant operation of energy of this kind, the molecular structure of its germinal matter becomes modified so as to transmit these characters to succeeding generations. Matter possessing properties such as those to which we have referred continues to produce movements for a time without receiving a further supply of solar energy, and thus constitutes what we take to be the basis substance of *memory or the power of retaining for future use*

[1] "The Animal Mind," Washburn, p. 222.

impressions received by the action of various modes of energy.

In some of the simplest descriptions of unicellular beings we have evidence showing that they act on impressions they have previously acquired—for instance the amœba, referred to by Professor Jennings, appears to have been guided in its endeavours to capture its prey, as he remarks, by former experiences, or in other words by its memory. The amœba acted by energy derived from impressions it had thus acquired and reversed the course it had been following in order to effect its object.

We may therefore best describe the basis substance of memory as living matter impressed by action previously derived from appropriate modes of energy, and which may be rendered active by the same form of stimulus to that which originally produced the impression, or by other modes of energy. The movements thus effected in unicellular organisms are, as a rule, purposive, being directed by the same form of energy as that which controls movements made on their living substance in response to the direct action of stimuli.

In the class of birds which follow the reptiles in the ascending scale of animal life, we find that the neopallium or outer surface of their cerebral hemispheres consists of a superficial strata of granular matter containing two layers of polymorphic cells; from the inner surface of these cells nerve-fibres pass to and from all parts of the animal brain, some of them extending through the medulla oblongata into the spinal cord (Fig. 13).

After removing the outer layer of the cerebral cortex or neopallium of a bird's brain, we see the large corpora striata projecting into the lateral ventricles, and behind them a part of the optic thalami, a considerable portion of these ganglia are extra-ventricular and lie embedded in the cerebral hemispheres.[1] The substance of the corpora striata consists of aggregations of gray nervous matter with numerous bundles of white fibres,

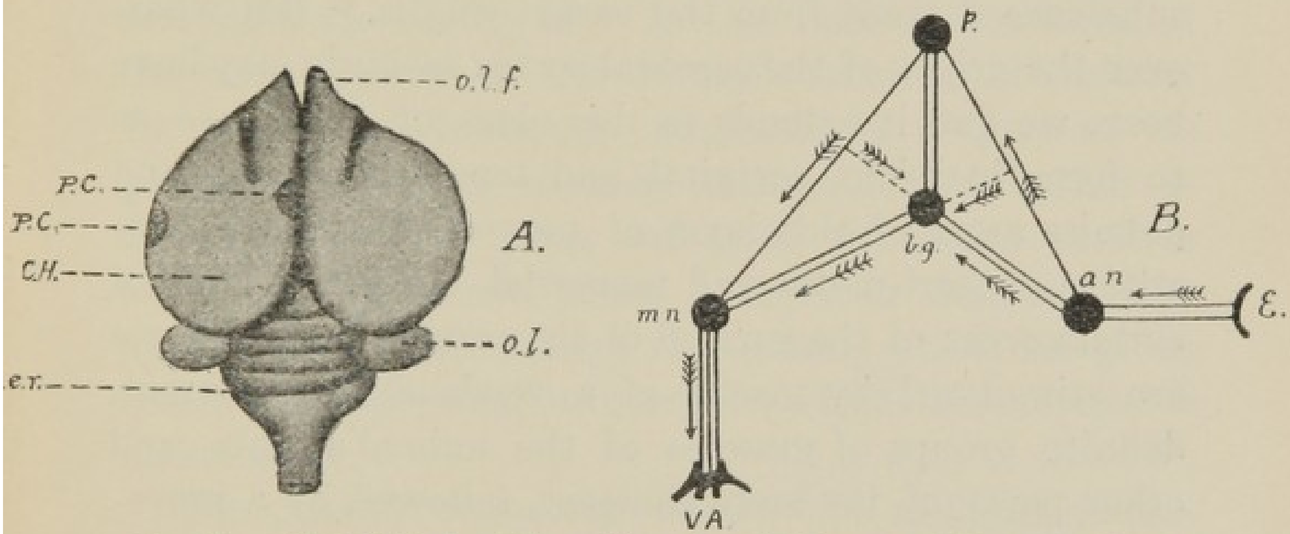

FIG. 13.—(*A*) Bird's brain. *PC*, position of excitable areas; *CH*, cerebral hemispheres; *cer*, cerebellum; *olf*, olfactory bulb; *ol*, optic lobe. (*B*) represents the path followed by energy derived from *E*, the internal ear which passes to *an*, the sensory auditory nucleus, and from thence to *bg*, the basal ganglia; from these ganglia part of the released energy passes directly to *mn*, the motor nucleus of the muscles controlling *VA*, the vocal apparatus; part of the energy from *bg* passes to *p*, the psychical cortical area, from which energy extends to *mn*, and so to *VA*. The second nervous arc starts from *an*, and giving off energy to *bg*, passes direct to *p*, and from *p* to *mn*, giving off energy in its path to *bg*.

which latter may be traced to and from all parts of brain, including the ganglionic nerve-cells which constitute the essential part of the cerebral cortex. It is evident from a structural point of view that, as in the lower classes of animals so also in birds, the basal ganglia constitute the central receiving and transmitting station for impressions received from the whole of the

[1] The intra-ventricular part of the corpora striata is separated from the extra-ventricular part by a layer of white substance (internal capsule) and forms what is known as the nucleus lenticularis which can only be seen by sections made down to it through the hemispheres of the brain.

sensory organs of the head and body of these animals. In addition to this, fibres pass between the cerebral cortex and the basal ganglia.

We have already stated our reasons for considering it probable that the living matter of some of the cells of the cerebral cortex originate in differentiation of the substance derived from the basal ganglia. But whatever the origin of the cerebral cortex in birds may have been, we find it extends in this class of animal so as to form incipient occipital and temporal lobes; and definite areas of this layer of nervous substance constitute sensori-motor and memorial centres. Thus if certain areas of the surface of the cerebral hemispheres are stimulated by means of a weak electric current, definite groups of muscles of the animal's limbs and other parts of its body contract, followed by a movement of the part. If other areas of the surface of the cerebral hemispheres, are irritated, no such movements are induced. We have reason to believe it is in these latter areas that the nervous substance has become specialised, and constitutes what we term psychic or consciousness matter, very limited in quantity and rudimentary in structure in a bird's brain, but becoming progressively developed in the next higher order of animals, the mammalia, and reaching its highest state of development in civilised human beings (Figs. 13 and 14).

In the pseudo-occipital lobes of a bird's brain an area or centre of nervous substance exists in which fibres from their visual system terminate, and from which fibres originate which pass into relation with living matter located in the central receiving station or basal ganglia. If the nervous matter forming the right and left visuo-sensory cortical centres are destroyed, the animal may still have some amount of sight, but its power of appreciating the nature of objects is wellnigh abolished. The same result follows if the fibres forming the lines of communication between the visual centres and other parts of the cerebrum are destroyed. In the natural condition of the visual system, if the animal's retina is stimulated by means of luminous impressions, a part of its potential energy is released and conducted by nerve-fibres to the optic lobes, and so to the visual nervous centres. The result being a more or less accurate appreciation of the nature of the thing which has given rise to the impression or to definite adaptative responsive movements.

The Sensory Organs of Birds.—In addition to the tactile organs contained in the cutaneous surface of the body, in some birds special organs of this kind exist along the margin of their beaks, and upon the surface of their mouths and tongues, which assist the animals in their search for food.

The *Olfactory* system of birds has an external opening leading into a space which is divided into a lower respiratory passage passing to the lungs, and an upper or olfactory chamber over the surface of which the sensory organs of smell are scattered. The olfactory nerves pass from the brain and terminate in these sensory organs. In some birds such as the albatross the olfactory bulbs are of a remarkable size, but as a rule this system in birds is not of a high order.

The organs of *Hearing* in birds, which include those of equilibration, are formed from invaginations of the epidermal layer, which becomes differentiated to form the various parts of the animal's ears. The tympanum lies below the level of the skin at the bottom of a short canal. The tympanitic cavities probably act as resonators ; internal to this cavity is the cochlea, over the surface of which the sensory organs of hearing are distributed. These organs receive the terminal fibrils of the auditory nerves which arise from aggregations of ganglionic cells located in the walls of the medulla oblongata. From these nuclei other fibres may be traced to the grey matter of the optic thalami and the corpora striata ; it is still an open question if fibres pass from what is probably an auditory centre in the basal ganglia to a sensori-motor auditory centre in the cortex of the temporal lobe of a bird's cerebrum.

The *Visual* apparatus of birds reaches a high order of efficiency. The eyes of these animals are large, and in consequence of the wide curve of their posterior wall a considerable expanse of retinal surface is obtained. Provision is also made for a great range of distant and near vision. A special arrangement of the globe of the eye has been developed so as to enable nocturnal birds to see in the dark. With this highly specialised organ of vision a corresponding increase in the size of the optic lobes of the cerebrum takes place, and they become marked features of a bird's brain.

We need not dwell on the instinctive, emotional, and mimetic characters of birds—their skill in building their nests, care of their young, pride, jealousy, pugnacity, love of home, migration, are familiar to us all. Every one of these processes are abolished if the animal's basal ganglia are destroyed, although after being thus mutilated the bird may continue to live. On the other hand, in the natural state, these processes which form such marked features of a bird's character exist with highly developed basal ganglia.[1]

We have in our previous volume described the results produced on the movements of birds by removing their cerebral hemispheres during life; but as these results are important in their bearing on our ideas it may be well to refer to them in this place.

Professor Schrader states that after he had excised the cerebral hemispheres of a pigeon, and subsequently allowed the opening he had made in the skull to heal,[2]—if the bird is placed a few feet above the ground in the centre of a room, he probably remains there for some time as if asleep, but then rouses up and hops down on to the floor, wandering about the room all day and sleeping throughout the night. If a chair is placed in the room the pigeon will fly up and seat itself on one of the arms of the chair. But a pigeon under these conditions must be fed by placing peas well back into his throat, when he will swallow them; the bird would otherwise die of starvation, having lost all desire to take food spontaneously.

From numerous experiments of this kind, Professor Schrader arrived at the conclusion, that after the complete removal of a bird's cerebral hemispheres the animal loses his intellectual capacity or consciousness. A female bird, after excision of her cerebral hemispheres, makes no response to the coo of the male bird or to the rattling of peas in a bag, or to the whistle

[1] Pflüger's Archiv; Professor Max Schrader, "Zur Physiologie Vogelshirns," Bd. xliv. 1889.

[2] Pflüger's Archiv, Bd. xliv. 1889.

which previous to the removal of the hemispheres, made the same bird hasten to her feeding place.

For instance, a falcon some time after the cerebral hemispheres had been removed was shut up in a cage with a mouse. The falcon when the mouse moved pounced down from his perch and caught the mouse in its claws, but made no attempt to devour it. The mouse crawled away from the bird, and when it again moved about the cage the falcon again seized the animal. This process was often repeated until one day the mouse attacked the bird, which made no effort to defend himself, and appeared indifferent to what happened. The movements of the mouse in the falcon's cage excited visual impressions which passed to the bird's optic lobes, and produced movements through the optic thalami leading to the capture of the mouse. But the falcon having seized its prey, had no idea what to do with it.

The movements, therefore, of a falcon mutilated in this way, like those of a pigeon under similar conditions, were to some extent instinctive. The impulses started in the bird's retina, passed to the optic lobes, and through them affected the nervous elements of the optic thalami. The excitation of certain nerve-cells in these ganglia caused a discharge of nerve energy which became manifest in movements terminating in the bird seizing the mouse. If the hemispheres of the animal's brain had not been removed, the excitation of the nerve-cells of the basal ganglia would, in part, have extended to the bird's visual cortical centres, and thus produced conscious visual sensations by means of the connection of these centres with those of the psychical nervous apparatus located in other parts of the cerebral cortex (Fig. 14).

The evidence given in this and the preceding chapters seems to us sufficient to substantiate the following statement.

Purposive action, and modifications in the structural arrangement of the elements of living matter in response to energy derived from its environment, are fundamental properties of every description of this substance (animal or vegetable). If the action of the environment which first produces a structural modification of the elements of living matter be continued for many generations, such changes become hereditary characters. Fixed changes in the structural arrangement of the elements of living matter produce modifications in its functions.

The whole of the living substance of the simplest forms of beings exercises purposive action, but as the elements of this matter undergo differentiation under the influence of their environment, its purposive elements likewise become developed, so that in each succeeding higher class of beings we find evidence of the differentiation and evolution of these elements.

In the lowest classes of multicellular animals purposive matter is connected with the living substance of nerve-cells which are in direct relation with the various sensory organs. We have given an outline of the development of this system, and established the fact that from simple purposive, instinctive matter has been developed, and in birds has attained a high degree of perfection. With this order of perfection we find a corresponding increase in the size and structural arrangement of those parts of the central nervous system in which these elements of living matter have become located.

In fine—the evidence we have given establishes the presumption that, in the various classes of animals we have referred to, their movements are directed by purposive and instinctive living elements; and that these movements are all-sufficient for the preservation and reproduction of these classes of beings, and are directed by specialised elements of well-defined areas of their brains.

CHAPTER VI

We have hitherto been engaged in establishing the fact that the instinctive, emotional, and mimetic actions displayed by invertebrates, and the lower classes of vertebrates, depended on work directed by nervous elements located in a well-defined part of their brain. Movements directed by purposive and instinctive elements of this description are sufficient for the maintenance and reproduction of these classes of animals ; and are of no less importance in the higher or mammalian orders of beings, in that these elements form the basis substance out of which the hereditary characters of these as well as the lower animals are elaborated. But in each ascending order of animals the struggle for existence becomes more intense, and their members must meet these conditions either by following some eminently safe mode of life, or else producing some special protective apparatus by means of which they may avoid extinction. Evolution, as a rule, follows the latter path, and under the action of the environment, has in the case of mammals developed from instinctive elements a higher order of matter endowed with psychical functions. We thus find a gradual increase of the neopallium from the lower to the higher orders of the mammalia, that is, of intellectual or consciousness matter, culminating in the brain of man and thus securing to him the commanding position he holds in the world.

As we have already shown, the rudiments of the cerebral cortex exist in reptiles, in birds they are more highly developed. But even in the lowest classes of mammals there is a decided increase in the dimensions and the complexity of this layer of nervous substance, which spreads so as to separate the visual, auditory, and other sensory areas of the cerebrum, and thus comes to modify its anatomical character. Among other changes effected in consequence of the growth of the cerebral hemispheres is the development of a vast multitude of inter-communicating fibres which bring the two hemispheres into co-ordinate action. The growth of this mass of fibres displaces some of the internal structures which exist in the lower vertebrates, otherwise the conformation of the mammalian brain does not essentially differ from that of the lower classes of vertebrates. This remark is strictly applicable to the basal ganglia, for these important nervous structures are present in the mammalian, as in every other description of vertebrate brain.

Dr Gustav Mann describes the thalamus of the mammalian brain as consisting of two oblong masses of nervous matter which "for convenience of description" he divides into eighteen segments.[1] It is beyond our purpose to attempt to follow Dr Mann's account of the structure and relation of the various parts of the thalamus to one another, but his work on this subject indicates the complexity which the structural arrangement of the nerve-cells and fibres have reached in this part of the mammalian brain.

[1] *British Med. Journ.*, vol. i. 1905, p. 289; see also Professor Johnston on "The Nervous System of Vertebrates," p. 265.

Dr Mann holds that the functions performed by the living substance of the thalamus are mainly sensory, and the corpora striata are motory. In his opinion, therefore, the basal ganglia form two great sensori-motor centres. In fishes sensory impulses pass from the sensory organs to the corresponding nuclei of the thalami, and being correlated with motor areas of the corpora striata become manifest in instantaneous muscular action; in the mammalia, in consequence of a large share of the sensori-motor work of the thalmo-striatum centres being connected with the cortical nervous centres, the responses to visual, auditory, and other impressions are slower than in the lower classes of animals, but they gain in associative precision of action.

The progressive development of the central nervous system, from the simpler to the more complex form of mammalia, has been so recently described by Professor Johnston in his work on "The Nervous System of Vertebrates," that it is unnecessary for us to enter into its details.[1] We propose, therefore, to pass on at once to consider the central nervous system of one of the higher orders of mammalia in so far as it bears on our subject.

In the case of domesticated dogs and other carnivora, the brain attains much larger dimensions in proportion to the size of the animal's body than is the case in birds and the lower orders of mammals.[2] This increase in the size of the brain is attributable

[1] The collection of specimens to be seen in the Museum of the Royal College of Surgeons may with the greatest advantage be studied by persons interested in this subject.

[2] Cat. Roy. Col. Surgeons Museum, vol. ii. Phys. Series, pp. 237, 263.

almost entirely to the increase in the growth of the animal's cerebral hemispheres. In birds and in the simpler orders of mammalia the surfaces of the cerebral hemispheres are almost smooth, but in the carnivora certain fairly constant depressions or furrows are found, known as sulci or fissures, which are produced by an infolding of the cerebral cortex, thus allowing a large amount of its substance to be packed within the narrow compass of the unyielding walls of the skull.

Not only is the cortex of the cerebral hemispheres in the carnivora more extensive both in superficial area and depth, in proportion to the rest of the brain than it is in birds, but the number of layers of cells forming the cortex and their complexity of arrangement, is distinctly of a higher order in the dog than it is in a parrot's brain.

The cortex of a dog's cerebral hemispheres consists of several layers of cells which differ in form, and which with certain modifications are to be found in all parts of the cortex ; the large cells of certain of the motor areas point to the functions performed by the living matter of these cells, and the existence of a polymorphic granular layer of cells is a sure sign of sensory functions.[1] We know that bundles of medullated nerve fibres pass in vertical streaks through the deeper layer of cells ; some of these fibres convey impulses derived from the cortex downwards to the basal ganglia, the medulla oblongata and the spinal cord, other fibres pass upwards from these regions to the cortex. In addition to this system of fibres

[1] Dr F. W. Mott and Professor W. D. Halliburton, "Proceedings of the Royal Society," B, vol. 80, p. 140.

numerous strands of association fibres pass between the cortical sensori-motor centres; and lastly all the sensory organs of the head and body are brought into communication in the substance of the basal ganglia, and terminate in the sensori-motor areas of the cerebral cortex (Fig. 14). Not only can we demonstrate the existence of this intricate system of nerve-fibres

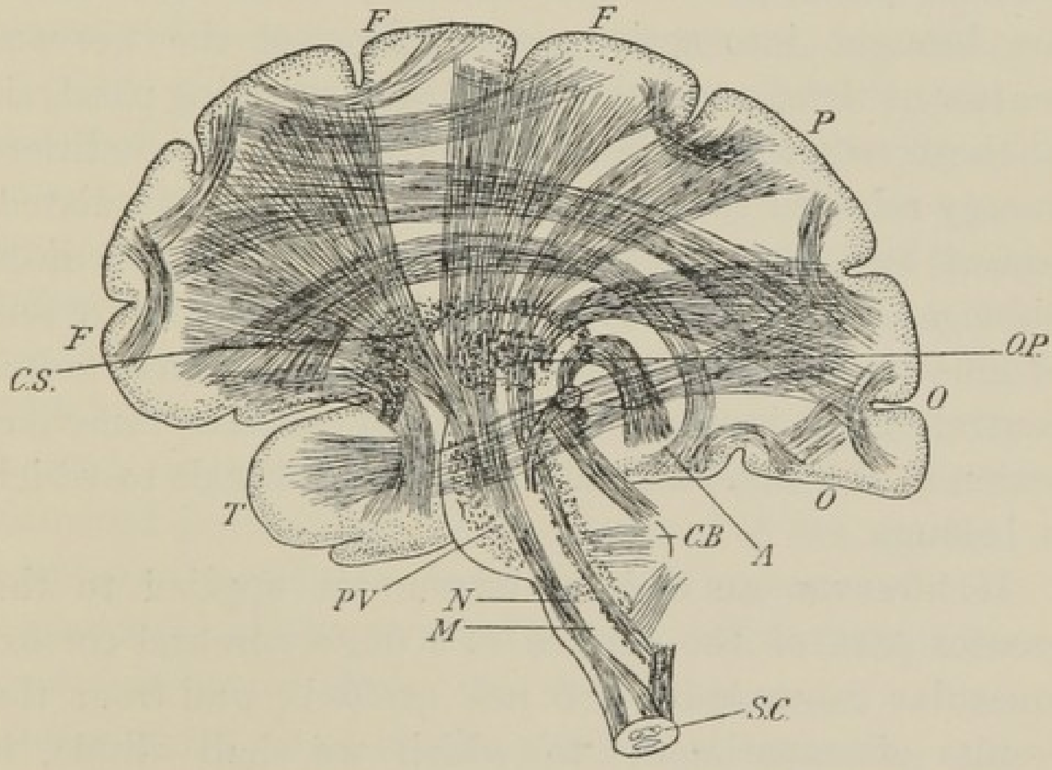

FIG. 14.—Diagram to illustrate the course followed by some of the nerve fibres which pass upwards from the spinal cord and downwards from the brain into the cord, represented by the black lines, other lines indicate the course of some of the principal bundles of *association* fibres. The dots represent the *cortex* (neopallium) of the cerebral hemispheres.

and cells by aid of the microscope, but also from experimental and clinical experience, for if any one or more of the cortical nerve centres are destroyed by injury or disease the functions performed by its living matter are at once interfered with; and the nerve-fibres originating in the cells of the part destroyed degenerate, in this state they may be traced throughout their course to other parts of the central nervous system.

We may now proceed to study the nature of the functions performed by the different parts of a dog's cerebrum. If the surface of the animal's cerebral hemispheres is exposed during life, and a weak electric current applied to definite areas of its surface, certain sets of muscles of the animal's head and limbs are brought into action; extirpation of the nervous matter of these areas produces a corresponding paralysis of these sets of muscles. Under the former condition, energy released from the nervous substance stimulated, passes by motor tracks to the basal ganglia, medulla oblongata, and spinal cord, and thus brings definite sets of muscles into play. Excitation of the same motor central areas is always followed by similar muscular action in the same animal or class of animals to which it belongs.

If however an electric current is applied to the greater part of the surface of a dog's cerebral cortex, muscular movements are not excited; and from the results of experiments to which we shall allude, it appears that these areas of the cortex correspond to those through means of which psychical processes are elaborated. Ideas, or mental images of external objects which are formed in the sensori-memorial cerebral centres of vision, hearing, and so on, are in the psychical or association areas of the cortex brought into connection with one another, the result being a more or less accurate appreciation of the nature of the thing which had given rise to the impression on the nervous matter of the sensory centres, and thus to definite responsive movements.

Professor Goltz removed the whole of the cerebral cortex and subjacent fibres from the brain of a living bitch, and kept her alive after being thus mutilated for some eighteen months. After the animal's death he removed the remainder of the brain from the skull and found it to consist of the hind-brain (medulla oblongata) with the nuclei of the nerves originating in its substance, also of the cerebellum and mid-brain with the optic thalami and a part of the corpora striata, especially that of the right hemisphere. Professor Goltz however states that the substance forming these ganglia (basal) was in a condition of "brown softening," but to what extent the living nervous substance forming these ganglia was able to perform its functions during the animal's lifetime must remain an open question. We may however be certain that the movements made by this bitch from the end of June 1889, when Goltz commenced proceedings for the removal of her cerebral hemispheres, until her death in 1891, were effected independently of the cerebral cortex. This fact is not only demonstrated from the detailed account which Professor Goltz gives of his method of operating and its result on the movements and character of the animal, but also by the coloured drawings which accompany his paper. These drawings show that the thalami and part of the corpora striata remained in situ up to the time of the animal's death, the left measuring 1·7 cm. and the right 3 cm., although, Professor Goltz states, they had undergone pathological changes.[1]

[1] "Der Hund ohne Grosshirn Siebent Abhandlung über die Verrichtunge des Grosshirns," Pflüger's Archiv, Bd. li. 1892. The basal ganglia on the left side measured 1·7 cm., and on the right side

Professor Goltz describes the behaviour and character of the movements made by this bitch after she had been mutilated to the extent above mentioned. He states that the animal as a rule remained curled up, as if asleep, in the corner of the cage in which she was confined. If a horn was blown in a room separated from the one in which she was sleeping, she would rouse up, stand on her legs, and not unfrequently put her paws up to her ears as if something unpleasant had happened. If a current of air was blown through a tube on to the animal's skin she would rise up and shake herself in the same way as an uninjured dog would do under like conditions. When not asleep the dog was restless, if kept without food she performed continuous movements about her cage, or stood up on her hind legs with her forepaws on the front bars. The animal growled and snapped if its paws were pinched.

When this animal was removed from its cage to be fed, she snapped and snarled like an angry brute, and resisted and struggled to be free and return to her cage; on these occasions she showed her anger by emotional signs such as lowering her head, bristling her hair, retracting her ears and upper lip, and growling, biting and snapping. If one of the animal's feet was placed in cold water she at once removed it. In a dark room the animal closed her eyes when a strong light was suddenly allowed to enter the chamber.

To make the bitch eat it was necessary to hold the food near her muzzle; it was then taken into the

3 cm., after the brain had been removed from the skull—the cerebral cortex had been completely abolished.

mouth and masticated and swallowed. If pieces of meat were soaked in a solution of quinine and given to the animal, it refused to eat the meat. The dog was unable to seek for its food. It recognised neither its master nor other dogs. It could not discriminate between scolding and petting. The bitch behaved almost like a blind animal with respect to obstacles placed in her path, rarely turning out of the way.

It is well known that a definite area of the occipital lobes of a dog's brain contains a specialised form of nervous substance, through means of which visual impressions received from external objects become realised. For instance, if these regions of the brain are removed during a dog's lifetime, the animal is no longer afraid of a burning match, or of the whip. H. Monk is of opinion that the image of memory and its power of recognition are lost with the destruction of the areas of the visual cerebral cortex ; but the animal is by no means blind.

Again, this mutilated animal, we are informed, when hungry, was in the habit of rising on her hind legs and with her fore-limbs pawing the bars of her cage in order if possible to obtain her freedom. The sense of hunger brought into play pre-existing impressions of those parts of her cerebral sensori-memorial nervous apparatus which remained in working order, and became manifest in her efforts to gain her liberty. In these efforts, and her repeated snarling and snapping when restrained, we recognise the exercise of memory, of desires, and instinctive processes together with emotional actions, which in conjunction form the basis of personal character in the higher order of beings.

What, then, it may be asked, had this animal lost by the destruction of her cerebral cortex? She could no longer recognise her former master nor distinguish her friends from strangers. Her memory of everything she had learnt during her lifetime was obliterated together with her intelligence.

We cannot tell what would have been the behaviour of this bitch, had it been possible to have destroyed her cerebral cortex without injuring her basal ganglia or other parts of her brain. But we know that large classes of vertebrate animals do not possess a cerebral cortex, but nevertheless evince distinct traits of hereditary character, which in some cases are capable of improvement under a proper system of training.

Doubtless the intellectual powers of a dog are of a far lower order than those possessed by civilised human beings, but this difference, as pointed out by Darwin, is one of degrees rather than of kind—for instance, his well-known anecdote of a retriever illustrates this point. He states that two wild ducks having been shot, fell on the other side of a stream from that on which the sportsman was standing, his retriever tried to bring over both birds at once, but could not succeed; she then, though never before known to ruffle a feather, deliberately killed one bird, brought over the other, and returned for the dead bird. Again, two partridges were shot at once, one being killed, the other wounded; the latter ran away and was caught by the retriever, who on her return came across the dead bird. She stopped evidently puzzled, and after one or two trials, finding she could not take it up without permitting the escape of the winged bird in her mouth, she deliberately killed it, and then brought both birds away together.

This was the only known instance of her ever having wilfully injured any game.[1]

It is actions such as these which indicate the intellectual powers possessed by dogs. Powers it is true which, as compared with those of human beings, are rudimentary in their nature, emerging, as it seems to us, out of an evolution of that form of matter which has produced complex instinctive processes in the lower orders of beings. When discussing this subject, Darwin observes, "the more complex instincts seem to have originated independently of intelligence"; and "some have thought that the intellectual faculties of the higher animals have gradually developed from instincts."[2]

We may, therefore, with advantage endeavour to ascertain the nature of the work performed by the nervous substance of the basal ganglia as manifested by a dog or other carnivora. Professor Pagano has obtained some remarkable results by injecting fluids containing curare into various parts of the basal ganglia of living dogs. "From his experiments he concludes that in the basal ganglia are found, at birth, the physiological pre-organised mechanism of emotional reactions. The cerebral cortex not being functional at birth is, therefore, not indispensable for these emotions. He injects 0·1 c. cm. of 2 per cent. solution of curare, coloured with thionine, into various parts of the caudate (intra-ventricular) nucleus (of the corpora striata). The results obtained are as follows: excitation of the anterior third and of the middle third of the caudate nucleus, especially in their inner half,

[1] "The Descent of Man," by Charles Darwin, vol. i. p. 48, 1871.

[2] *Idem*, p. 37.

provokes the emotional phenomena of fear. They are characterised by the attitude of the body, the physiognomy, the cardiac and respiratory phenomena (intestinal and vesical), the state of the pupils, and menacing noises which exaggerate considerably these manifestations of terror. Excitation of the anterior extremity of the caudate nucleus produces phenomena of psycho-motor agitation of the same kind, and expresses a mingling of the two emotions of fear and anger."[1] Stimulation of the anterior third of this nucleus produces excitation of the genital organs. As a whole these experiments confirm the opinion we have arrived at concerning the important functions performed by the nervous substance of the optic thalami.

Professor Halliburton describes the basal ganglia as being subsidiary centres of movement and sensation. He states that centres of this kind may be compared to the subordinate officers of an army, the principal centre to the commander-in-chief. The highest officer gives a general order for the movement of a body of troops in a certain direction; we may compare this to the principal motory centre of the cortex sending out an impulse for a certain movement of a limb. But the general does not give the order himself to each individual soldier, any more than the cerebral cortex does to each individual muscle; but the order is first given to subordinate officers, who arrange exactly how the movement shall be executed, and their orders are in the end distributed to the individual men, who must move in harmony with

[1] "Two Lectures on the Physiology of the Emotions," by Dr F. W. Mott. Delivered at King's College, London.

their fellows with regard to space and time. So the subsidiary nerve centres or positions of relay (basal ganglia) enable the impulses to be distributed to various sets of muscles which contract harmoniously, and effect the required movements of the head and body.[1]

The sensory organs possessed by mammalia are of a distinctly high order ; in not a few of them the sense of smell is well developed. Dr G. Mann removed the olfactory bulbs of recently born rabbits, and found it impossible to rear these animals in consequence of their inability to appreciate the difference between wholesome and unwholesome food. The aural and visual sense organs of dogs have reached a high state of development, their nervous elements being in intimate relation with ganglionic nerve-cells of the basal ganglia.

We can therefore explain the movements and emotions displayed by a dog after the removal of the cortical substance of his cerebrum, by assuming that energy passing from the various sensory organs reaches his optic thalami and becomes transmuted by its nervous substance into a form which brings motor elements of the corpora striata into play, its action becoming manifest in certain instinctive and emotional movements. The animal's instinctive movements, such as that of taking her food when brought close to her mouth, and her emotional snarl and bark when disturbed, demonstrate the fact that actions of this kind may be effected independently of the cerebral cortex. The animal's memory for all she had acquired during her lifetime was abolished with the destruction of her cerebral cortex,

[1] "The Handbook of Physiology," pp. 680, 681.

but her hereditary character continued to manifest itself in her instinctive and emotional movements, blunted, it is true, in consequence of the damage her basal ganglia had received in the removal of her cerebral cortex.

The animal mutilated by Professor Goltz was at the time fully grown, and her nervous system had been moulded into the form possessed by her through sensory impressions operating on the nervous elements of many pre-existing generations. Structural modifications in the nervous elements of her basal ganglia had thus been established, to be called into action by stimuli of a similar nature to those which had led to these impressions on the living nervous substance of her central nervous system.

For instance, this mutilated animal refused to eat meat which had been soaked in a solution of quinine, its actions showing disgust at the taste of the bitter meat. As Dr Mott observes, the refusal of the animal to swallow the doctored food was an instinctive act in that it was protective to the alimentary canal and the vital organs of the body, just as pain protects the external surface of the body.

That action of this kind depends on inherited instincts is shown by the fact stated by Professor Sherrington. After separating the brain of a nine week's old pup from its connections with the heart and viscera, he offered the animal some dog's flesh as food, which the pup absolutely refused to touch. Professor Sherrington remarks, " this aversion to dogs' flesh was due to olfactory impressions, and that ' dog will not eat dog' may, in the long procession of the ages, have led to the establishment of a pre-organised mechanism by which disgust at dogs' flesh might occur reflexly in the medulla.[1]

Darwin has given us his reasons for believing that domesticated dogs are descended from two species of wolves and several species of jackals. The habits of domesticated dogs in North America and the wolves of that part of the world are very similar, and the same remark applies to the pariah dogs of India and jackals.[2] The habit of barking, however, is an exception to this rule, a habit which is almost universal with domesticated dogs, but is not known to exist in a single natural family of these animals, although the Canis latrans of North America utter sounds which closely resemble a bark ; and our domesticated dogs are said to lose the habit of barking when they pass back into a wild state, but they regain this power when they again return to their former environment, that is, to the society of their barking companions, showing that their mimetic faculties are still in operation.

It is useless for us to speculate as to how or when dogs learnt to bark, but as this was a useful habit to man he doubtless cultivated those species of dogs best able to warn him of approaching enemies. In the course of time the power to bark, like that of the vocal powers of birds, became an hereditary character.

The different barks of dogs with which we are familiar, are the product of long-continued civilisation. Some of the peculiarities of the several breeds, as Darwin observes, have been effected by selection, both

[1] "Two Lectures on the Physiology of the Emotions," by Dr F. W. Mott, p. 19.

[2] "Animals and Plants under Domestication," by C. Darwin, vol. i. pp. 44, 45.

methodical and unconscious, of slight individual differences, the latter kind of selection resulting from the occasional preservation, during hundreds of generations, of those dogs which were the most useful to man under certain conditions of life.[1]

The skulls of the wild species from which our domesticated dogs are supposed to have been derived, retain a marked uniformity of form and size, whereas in domesticated animals great diversity in this respect exists, as for instance between the form of the skull of a bloodhound and a greyhound. Much of this difference is attributable to the fancy of the breeder ; thus collies in their natural state are remarkably sagacious animals, but it having become the fashion to produce long narrow-headed collies by cross breeding, this has been accomplished, but at no less a sacrifice than the loss of character and mental capacity which distinguishes the stock from which these animals were derived. For with the small skull there is a small brain as compared with the body, attended with a corresponding loss of intellectual power.[2]

Darwin was probably correct in his idea that our domesticated dogs are derived from wild species ; if this be the case, it indicates the influence which various modes of energy have exercised in moulding certain elements of the cerebrum into harmony with the action of an altered environment. That a great change has taken place in the characters displayed by wolves and foxes and our domestic dogs is evident ; many of the latter are man's devoted friends, and yet show clearly that their hereditary instincts continue to

[1] See note on this subject, "Human Speech," p. 240.

[2] *Idem.*

influence some of their movements, with a tendency after a few generations to lose their acquired characters and revert to the habits of their progenitors. This point is admirably portrayed in Jack London's story of " The Call of the Wild."

We may capture and bring up a cub by hand ; he will take to romping over the lawn with our dogs, and appears to be on the road to becoming a domestic animal ; but as soon as he is fully grown he deserts our home and returns to the woods and his natural state of life. The animal's hereditary instincts assert themselves and overrule all he has learnt while under our care.

CHAPTER VII

In the previous chapters of this work we have endeavoured to show that the hereditary character of the various classes of animals we have referred to is the result of work directed by purposive and instinctive elements; in addition to which we find in the lower orders of mammals indications of psychical activities. These intellectual processes become more pronounced as we pass from the lower to the higher orders of this class of beings, culminating, as we have elsewhere shown, in man's power to express his thoughts in intelligent language. We have now to explain how psychical elements come into operation.

In this enquiry we cannot overlook the fact that the law of recapitulation clearly indicates that in their past history man and apes are structurally united with the rest of the animal world. It must be borne in mind that man originates by the same physical processes with the animals immediately below him in the scale, that he is identical with them in the early stages of his formation, identical in the mode of his nutrition before and after birth, and that their adult structures exhibit a marvellous likeness of organisation.[1] The main factor in the evolution of each class of animals has been effected by an increase in the organisation of the central nervous system, and this increase has

[1] "Evidence of Man's Place in Nature," by J. Huxley, p. 67.

been determined by the action of the environment acting through the sensory organs.[1]

The man-like or anthropoid apes to which we refer, consist of the gibbons, orangs, chimpanzees and gorillas, as, according to Professor A. Keith, their structures as a whole are most nearly related to those which form the bodies of human beings. The chimpanzee and gorilla are natives of Africa, the former attains a height of nearly five feet when in the erect position ; and the latter as much as five feet, with a circumference round the chest of four feet four inches, its weight being about 180 lbs.

The usual mode of progression of these apes is effected by resting the knuckles of their hands on the ground, they thrust their arms forward, and then give the body a half-jumping half-swinging motion between them. These apes however at times assume the erect position in walking, their bodies being much inclined forwards, and balanced by their arms and hands thrust backwards so as to meet either behind their head or their loins.

Both chimpanzees and gorillas build platforms consisting of small branches and twigs which they entwine together and secure between the branches of a tree on which they rest during the night. In the daytime they wander in groups through the forest in search of fruit and such-like food. The powerful canine teeth of these apes indicate carnivorous propensities, but in no state save that of domestication do they manifest them. At first in confinement they reject flesh, but easily acquire a fondness for it.[2]

[1] "The Origin of Vertebrates," by W. H. Gaskell, p. 498 ; and "Human Speech," p. 140.

[2] Huxley, p. 44.

The chimpanzee is a peace-loving animal who prefers flight as a means of escape from enemies, rather than acting on the defensive; he seldom if ever acts on the offensive. On the other hand the male gorilla is a ferocious brute, and an object of terror to the people of the country in which he lives. When disturbed in his native forest he is said to utter a prolonged shrill cry; his enormous jaws are widely opened, his lips are retracted displaying his formidable array of teeth, the hairy ridge of his scalp is contracted upon the brow, and altogether presents a ferocious aspect.

Other emotions such as those of sorrow are marked features displayed by various orders of primates. Thus, the author was out shooting among the hills near Colgong on the Ganges. Returning home in the evening, we came across a number of Bengal macaques. Among them was a female seated on a ledge of rock with a young one close to her. One of our party, without a moment's thought, fired, and killed the young monkey. Its body rolled down the rock, and after it sprang its mother; when she reached the dead body, she took it up in her arms and fondled it in the way a human mother would handle her sick child, at the same time uttering the most piteous wail, which drew around her a crowd of her companions. The actions of this animal indicated her intense grief at the death of her young—feelings which she expressed in movements closely resembling those of a human being under like circumstances.[1] Our party were one and all much impressed by what they witnessed

[1] As Darwin remarks, the principle of action is the same in the two cases. "The Descent of Man," vol. i. p. 40.

and returned to camp feeling and expressing no small resentment towards the individual who had been the cause of so much anguish to the mother of the young macaque.

From the action taken by the troop of monkeys to which we have referred, it would seem they evinced a distinct sympathy with their bereft comrade in her grief. Beyond this they moved in a body round her, thereby showing social instincts.

Numerous facts are recorded of the services to each other displayed by apes when members of their tribe are threatened by enemies. Brehm states that when in Abyssinia on one occasion he encountered a great troop of baboons which were crossing a valley : some had already ascended the opposite mountain, and some were still in the valley ; the latter were attacked by dogs, but the old male baboons immediately hurried down the rocks, and with mouths wide opened roared so fearfully, that the dogs retreated before them. The dogs were again encouraged to the attack, but this time all the baboons had reascended the heights, except a young one, about six months old, who, loudly calling for aid climbed on a block of rock. Now one of the largest males came down again from the mountain, slowly went to the young one, coaxed him, and triumphantly led him away.[1]

Darwin gives a curious account of the instinctive dread which monkeys exhibit towards snakes. He introduced a live snake in a paper bag with the mouth loosely closed into one of the larger compartments of the monkey house in the Zoological Gardens. One of the monkeys immediately approached, cautiously

[1] " The Descent of Man," by Charles Darwin, vol. i. p. 75.

opened the bag and peeped in, but instantly dashed away. Monkey after monkey, with head raised high and turned on one side, peeped into the bag, and seeing the snake fast asleep at the bottom started back and bolted to a distant corner of the cage. This instinctive dread of snakes is however not confined to monkeys. The author has seen large birds and various carnivorous animals assume a demeanour of abject fear when brought into a room in which a live cobra was confined in a glass case.

The mimetic faculties of apes are proverbial, and one has only to watch their actions when under proper training to be sure that they learn by experience, and by imitating the movements of their instructors. Their power of attention varies even among members of the same species. Mr Bartlett states that a man who was in the habit of training monkeys was willing to pay five pounds for some of them; but he offered to give double the price, if he might keep three or four monkeys for a few days, in order to select one. When asked how he could possibly so soon learn whether a particular monkey would turn out a good actor, he answered, that it all depended on their power of attention. If, when he was talking and explaining anything to a monkey, its attention was easily distracted, as by a fly on the wall or other trifling object, the case was hopeless. If he tried by punishment to make an inattentive monkey act, it turned sulky.

The instinctive, emotional, and mimetic actions and the power of attention possessed by apes, are referable, as is the case with the lower classes of animals, to work performed by the nervous substance of their basal ganglia, in response to impressions received by its living substance from the various sensory organs of the body. The actions we refer to are hereditary in character, such, for instance, as building resting places in trees so as to escape from the attacks of their enemies during the night; the loving timid nature of some, and ferocity of other species, their affection for their young and mode of expressing their grief, the sympathy shown to their companions in distress—are traits of hereditary character displayed by apes of the same species scattered over widely separated areas of the globe.

These characters may be improved by judicious training, but they cannot be eradicated, unless, perhaps, by an alteration of the environment extending over many generations. The power possessed by apes of learning to accomplish certain complex movements, such as those necessary to enable them to take a part in a play, is hereditary, the knowledge they have gained by learning is non-hereditary.

It is true that birds and dogs may be taught to perform various tricks, and reptiles learn by experience to select the most direct of devious paths by which to reach their food. Birds possess a rather higher development of cortical matter than reptiles, and they are capable of reaching a higher order of learning than a turtle. In dogs the cerebral cortex is still more perfectly developed than it is in birds, and their basal ganglia and sensory organs are not inferior to those of apes; it is well known that these animals may be trained to perform acts of a complicated character, and some of them exhibit rudimentary intellectual powers. This latter power, we hold, consists in the association of impressions which by repetition have become fixed in the living matter of the cerebral nervous centres, and which the animal has by practice learned to link together and employ to his own advantage. In apes we find the development of the cerebral cortex, and other parts of the brain and sensory organs, are inferior only to those of human beings, and with this high order of nervous organisation their instinctive, imitative, emotional, and intellectual powers are of a higher order than those possessed by dogs.

We trace therefore in these classes of animals a progressive capacity to learn, extending from lower to higher classes of beings, and this power bears a direct relation to the development of the cortical substance or neopallium of their cerebral hemispheres. With the destruction of this substance the hereditary character possessed by the animal may continue, but all that he has learnt during his lifetime is abolished.[1]

This fact explains our meaning in referring to the hereditary character of animals, including the primates, as being something apart from their intellectual acquirements.

In the first part of this work (Human Speech) we referred to the development and structural arrangement of the nervous substance of the spinal cord and brain, so that it is unnecessary for us to recur to this

[1] The term Neopallium is employed to signify the "pallium" or cortex of that part of the cerebral hemispheres with which we are mainly concerned, as being distinct from the pallium of other lobes or regions of the brain. The term is well chosen by Professor G. Elliot Smith, because this cortex or pallium consists of superadded nervous structures to those which exist in the lower classes of vertebrates (see p. 91).

subject; but in order to explain the commanding psychical powers possessed by human beings as compared with those of the lower animals, we must allude to the increased complexity and to the great development of the neopallium or cortical areas of the cerebral hemispheres in man[1] (Fig. 15).

The cortical substance or neopallium of an educated

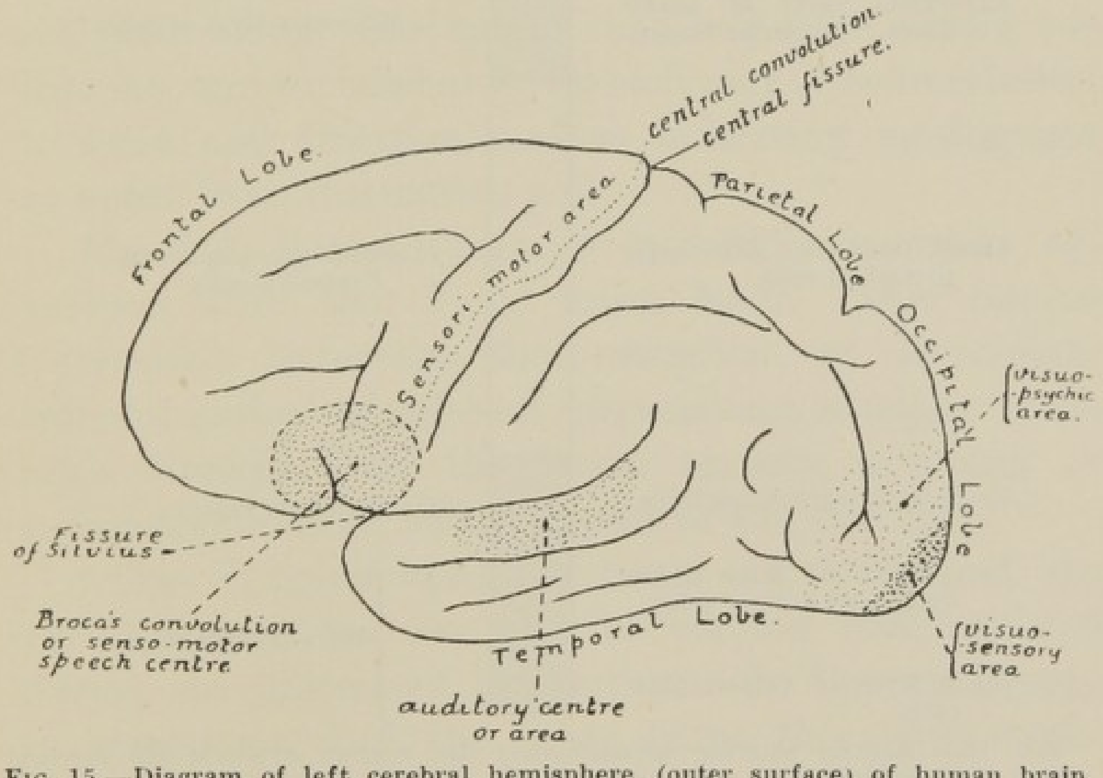

FIG. 15.—Diagram of left cerebral hemisphere (outer surface) of human brain (From Halliburton's "Handbook of Physiology," p. 688.)

Englishman's brain averages, in its exposed and sunken surface, about 200,000 square mm.; its thickness varies, but averages about 2 mm., and is formed of five strata or layers of cells, together with a mass of nerve fibres with their supporting structure (neuroglia), blood vessels and lymphatics.

With regard to the layers of cells which constitute the outer gray substance of the cerebral cortex, they

[1] "Human Speech," p. 154.

may be described as forming five strata, from which fibres proceed to other parts of the nervous system, and in which fibres terminate passing from all parts of the body. These five layers of cortical nerve-cells and fibres may be represented in a diagrammatic form (Fig. 16).

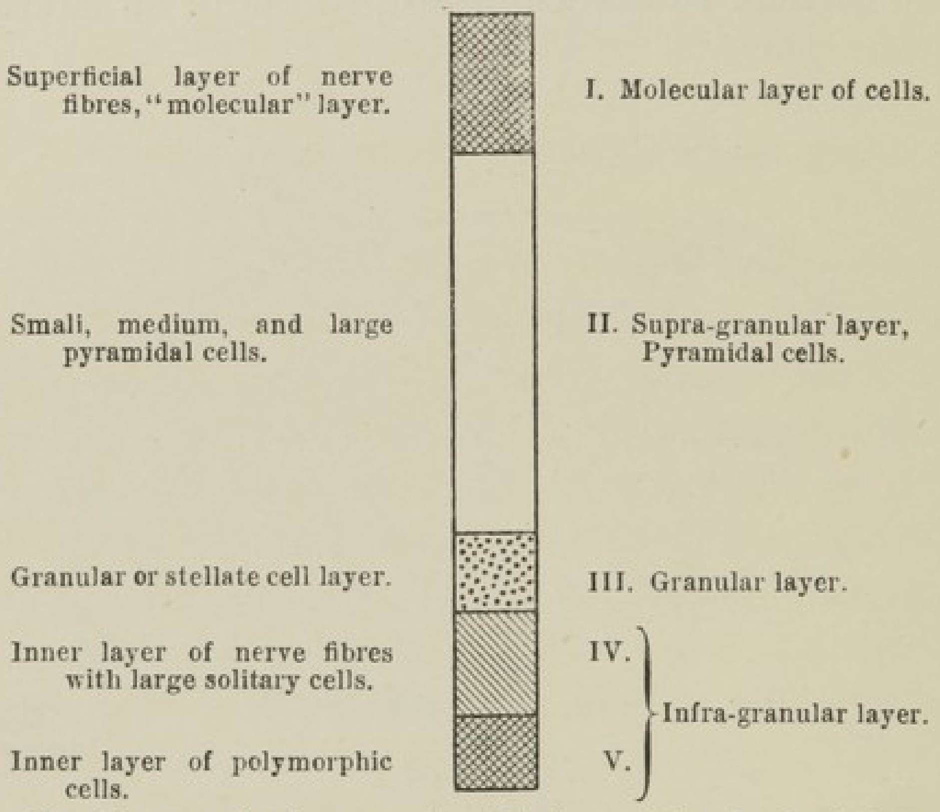

FIG 16.—Diagram showing approximately the relative depth of the cerebral cortex or neopallium of an adult human brain. (After J. S. Bolton.)

The II, or pyramidal layer, to which may be added the outer fibre lamina, I, are the prominent feature of the human cortex, and constitute a "higher level" basis for carrying on cerebral functions.[1] It is the last cell layer of the cortex to be evolved, and the first to undergo retrogression. This layer "subserves the psychic or association functions of the cerebrum;

[1] J. Shaw Bolton, on "Recent Researches on Cortical Localisation and on the Functions of the Cerebrum," p. 295, "Further Advances in Physiology," edited by Leonard Hill.

it is functionally correlated with educability and general intelligence which appears in an increasing degree in the various orders of the mammalian scale.

This supra-granular layer, II, so poorly developed in human beings at birth, and so slow in reaching maturity, is well nigh absent in the lower orders of mammals. When fully matured the living substance of the pyramidal cells of this layer directs those activities which the animal has acquired during his lifetime, and with behaviour which may arise in relation to some new situation, and so indicating intelligence as apart from instinctive acts.

The III, lamina (granule or middle layer) is developed after the V, or inner layer. This lamina "primarily subserves the reception or immediate transformation of afferent impressions, whether these arise directly from the lower sensory neurones or indirectly through other regions of the cerebrum."

"The V, polymorphic, or inner cell lamina of the cortex cerebri, is the first to become differentiated during the process of lamination. In human beings, in association with the inner fibres, this layer "subserves the lower voluntary and instinctive activities of the animal economy, and thus forms a lower basis level for the carrying on of cerebral functions."[1] This layer of cells may be traced back to instinctive matter out of which it has become developed; the superimposed layers, constituting the great association area of the human brain has, in its turn, been evolved from this lower instinctive stratum of living nervous matter which constitutes the polymorphic or granular layer of the cortex.

[1] Dr J. S. Bolton, p. 297, "Further Advances in Physiology," 1909.

We thus come to learn that the inner layer of the neopallium in human beings is derived from living instinctive elements located in the basal ganglia, and that from this layer of the cerebral cortex the outer or psychical elements of the brain have been developed, in other words the nervous substance by means of which the intellectual faculties are elaborated, have been evolved out of matter possessing instinctive and emotional qualities.

It is to be noticed that the cerebral cortex of the human brain is to a large extent constituted of the inner or instinctive layer of living matter, and together with the layers of psychical elements forms the large mass of nervous substance which characterises the human cerebrum. We can thus realise the important part which the hereditary instinctive and emotional faculties take in ordering the likes and dislikes, the pleasure and pain, and many other emotional activities which, to a large extent, influence the personal character and the life-long career of human beings.[1]

The cranial capacity of an adult male gorilla amounts to about 600 c.c., that of tertiary man to 950 c.c., and of an educated Englishman to about

[1] Charles Darwin lays stress on the idea that almost all motions of expression are the result of inherited qualities, and have been evolved from a common source. The facial expression of rage and hate, for instance, in man consists in the retraction of the lips and the exposure of the teeth; particularly of the corners of the upper lips, so that the canine teeth become visible. In the same way dogs, cats, and apes expose the canine teeth when angry, a fitting preparation in their case for battle. In man the advantage of this movement no longer exists; but the movement has been retained as the expression of the specific emotion which accompanies the sight of an enemy.

1485 c.c. This great difference in the cranial capacity of these orders of beings represents the difference that exists between the dimensions of the cortical substance of their cerebral hemispheres. The area occupied by this specialised form of nervous matter is greatly increased by means of the fissures or foldings into which it extends.

According to Dr E. Dubois, there is a more or less intimate relationship between the extent of the cortex or the weight of the brain and the extent of the surface of an animal's body. Since the year 1897, when Dubois promulgated his ideas on this subject, they have been confirmed by independent observers.

The following is a summary of Dr Dubois observations on this subject :[1]—

Dr Dubois starts with the assumption that the brain consists entirely of the central parts of reflex arcs, the function of which is to bring sensory and motor nerves into relation with each other, and concludes that in animals presenting the same degree of psychical development, the number and weight of these reflex arcs would be proportional, approximately, to the number of sensory nervous fibres. In two animals in the same stage of psychical evolution, but of different bulk, the number of sensory nervous fibres will then be proportional to the total extent of the perceptive surface, that is to say, to the extent of the surface of the body. On the other hand, in two animals in very different stages of psychical evolution, but of the same bulk and having therefore approximately the same number of sensory fibres, the animal in whom the central parts of the reflex arcs attain the greater degree of complexity will have the heavier brain. Now it appears that the cube root of the square of the weight of an animal

[1] *British Med. Journ.* for Nov. 5, 1905.

multiplied by a constant which varies with each species expresses with fair accuracy the relative size of the surface of its body. If S and s be the weight of the body of two animals, then the surfaces will be

$$\sqrt[3]{S^2} \text{ and } \sqrt[3]{s^2} \text{ or } S^{0{\cdot}6} \text{ and } s^{0{\cdot}6}.$$

In two animals of the same degree of mental evolution and the same bulk the weight of the brains would be equal. But if the mental development differs, then we have a variable factor, and the problem is to find this, which will express what Dubois calls the relative cephalization, or relative amount of brain corresponding to the difference in intelligence in the physiological sense of the word. In practice the factor by which S is to be multiplied is not exactly 0·6, because in an animal with a very small body a part of the perceptive surfaces of its sensory organs is relatively more extensive, and consequently the terminations of the sensory fibres in the brain are denser, and the extent of the cortex relatively increased. Dubois took a series of animals of similar form, and, in his judgment, of similar intelligence, but differing very much in size, choosing, of course, adult animals of average weight and bulk; by an equation which we need not reproduce, he calculated the value of the factor by which S should be multiplied in each case. He found it to be almost constantly 0·56, the extremes being 0·54 and 0·58. He thus got the equation—

$$E = cS^{0{\cdot}56}$$

where E equals the weight of the brain, S the weight of the body, and c the factor of cephalization indicating the degree of intelligence. Dubois found that the results obtained by calculation in the case of a large number of animals were concordant. Thus the factor of cephalization in man was 2·8186, in the monkey from 0·7607 to 0·4636, in the donkey 0·4390, the horse 0·4380, the cat 0·3284, and the mouse 0·0770. The only obvious defect in his table is that the dog (0·3586) comes below the horse, which is not quite in accord with popular experience. Lapicque and Girard [1] have recently afforded striking confirmation of the accuracy of Dubois's criterion by a series of observations on birds. They found that the factor of cephalization in the various groups corresponded with the accepted opinion as to the degree of intelligence. The parrot was at the head of their list, the barndoor fowl, surely one of the most foolish of birds, at its tail. Crows, magpies, and jays stood very nearly as high as parrots.

Another very suggestive result of these observations is that the equation given above is found to be true not only for the total weight of the brain as a whole but for its several parts, for the cerebral hemispheres, the cerebellum, and the corpora quadrigemina.

There can be no question as to the effects which stimuli received through the tactile and other sensory organs have upon the development of corresponding areas of the cerebral cortex, the living matter of which receives and retains many of these impressions.[2] But the cerebral cortex of civilised human beings contains a vast amount more nervous matter than is necessary to accomplish these processes. It is the extent and organisation of this matter which distinguishes the human brain from that possessed by the lower animals. This excess of cortical substance is employed to associate the sensori-memorial images elaborated by sensory centres, and to transform them

[1] *Comptes rendu de l'Académie des Science*, 10th April 1905.

[2] In this way we explain the far greater size of an elephant's brain than that possessed by human beings. The surface of an elephant's body being very much more extensive than a man's, his tactile sense organs are likewise more extensive, and consequently the size of his cerebral hemispheres are considerably larger than those of a human being, its cortical substance being the ultimate receptive organ of tactile and other sensory impressions.

into the psychical processes which pass to motor areas of the cerebrum, and become manifest in intellectual activities.[1]

We may form some idea of the amount of cortical cerebral substance which is necessary for the reception of tactile and other sensory impressions in human beings, by comparing it with that of an average male gorilla's brain. The weight and extent of the surface of the bodies of an average-sized man and that of a full-grown gorilla do not differ to any great extent. But a gorilla's brain is never more than half the size of the smallest adult human brain. Nevertheless the total volume of the ape's brain is represented by 600 c.c., and is sufficient to receive and respond to the animal's tactile and other sensory impressions. It follows, therefore, that a similar amount of nervous matter would suffice for the same purpose in a human being; but his brain actually contains some 900 c.c. more cerebral substance than is necessary to receive and respond to his sensory impressions. The greater part of this excess of living nervous matter is contained in his cerebral cortex, and the work it performs becomes manifest in his psychical activities.

Professor Elliot Smith, referring to this subject,[2] states, that as the neopallium assumes importance and becomes a condition of survival for the first time in the mammalia, in each successive epoch it is only those mammals whose nervous system has effectually

[1] Psychical processes are those which effect modifications of motion through the agency of intercurrent specialised modes of energy derived from mental images (ideas). Psychical and conscious processes are identical.

[2] Cat. Roy. Coll. Surgeons Museum, Phys. Series, vol. ii. p. 465.

responded to its environment, or have developed special protective structures, who continued to survive. In the higher mammalia the development of a large neopallium as the organ of associative memory, enables them to acquire the skill to evade danger and yet adequately to preserve themselves and reproduce the species to which they belong. In many of the Eocene Mammalia (Dinoceras crania, for example) the neopallium is reduced to such diminutive proportions that the brain resembles the reptilian type; and in each successive generation the neopallium or cerebral cortex becomes more extensive and complicated in structure, or the creature is compelled to adopt some safe mode of life. The hippopotamus and the sirenia are examples of mammals which have not kept pace in the fierce race for neopallial supremacy, but survive by adopting habits of life which are eminently safe. The condition of the human brain represents the other extreme. Here the neopallium has attained its maximum development, yet its possessor has not had to seek refuge either in a retired mode of life or by any protective specialisations of structure either for offence or defence, but has attained a dominant position in the animal kingdom whilst retaining much of the generalised structural features of a primitive mammal.

Each of the sensory organs is adapted to receive a special form of energy derived from the external world or from muscular movements, and to transmit it by nerve fibres which terminate in the living matter of corresponding nervous centres, these areas form the visual, auditory, tactile, and other sensori-memorial nervous centres, their living substance transmutes a part of the energy it thus receives into what we term a sensation, and part of it becomes impressed on the nervous matter to be subsequently released by similar or other impressions made upon it. How excitation of the living matter of the nerve cells forming the visual and other sensori-memorial centres should excite what we call a sensation in us, is neither more nor less unaccountable than any other ultimate fact of nature. But it is clear from evidence to which we have referred, that if the nerve tracts between the receptors of energy and the sensori-memorial centres are divided, or if the living substance of the centre is destroyed, the sensations, which it is the function of this area of nervous matter to elaborate, are abolished.[1]

Not only do the nervous centres for vision respond to the stimulus of light, but certain parts of them are specialised so as to recognise the various colours. Thus in a case we have referred to in our eighth chapter, the individual, as a result of disease affecting definite portions of his visual centres, entirely lost the power of distinguishing one colour from another, but in other respects his vision was normal. Again, in the case referred to (" Human Speech," p. 214), the patient as the result of disease of both areas of her cerebral cortex in which the auditory centres are located, became completely deaf, and also speechless in consequence of the loss of the memory impressions she had

[1] For the sake of clearness we write concerning *the* visual, auditory, and tactile sensori-memorial centres, but it is always to be borne in mind that the brain contains a right and a left hemisphere, and that each hemisphere possesses a visual, auditory and tactile centre; if one is destroyed the other may act.

previously gained of word sounds; in fact her entire auditory mnemic nervous substance had been destroyed, and with it her power to form sensations out of word sounds, or receive new impressions of words to supply those which had been destroyed by the loss of her auditory cerebral centres.

Memorial impressions made on the living substance of specialised nervous matter appear to exist in a latent state for years, and may then not only be re-excited by external stimuli, but also from energy derived from chemical or other sources within the organism. Mr Brudnell Carter describes a remarkable instance of this description which came under his notice some years ago. A lady whose father was English, but her mother of mixed English and French descent, was born in France, and lived there until she was nearly nine years old, speaking only French, and in the care of a French nurse. She then came to England, went to an English school, and the French language lost its hold upon her. As a young woman, she retained a native accent, but she had taken pains to master the English language and to increase her vocabulary, and never spoke French if she could avoid it, being in fact almost aggressively proud of her English nationality. She married, and during her first pregnancy she had a severe illness. She became unconscious. A dead child was born. A day or two after, she began to speak, and constantly repeated, in a sing-song tone, the words "Quand les canards," to which no meaning could be attached. A day or two later she began to recite bits of English verse, and showed evidence of distress when she was unable to continue them for want of the right word. She knew no one around her, and made no other attempt to speak than by these recitations, which were mostly from Lalla Rookh. In time she perfectly recovered, and then her old French nurse came to see her, and on hearing of what had happened at once began to chant

> " Quand les canards s'en vout par deux
> C'est quil's ont à causer entre eux,"

and so went on with the old nursery rhyme which she had sung a hundred times to this lady, when as an infant she lay in her cradle, and which had remained latent in the lady's memorial auditory nervous substance until re-excited probably by impressions derived from chemical stimuli engendered by processes connected with her pregnancy.

Each of the sensori-memorial cortical centres is surrounded by a zone of psychical nervous substance, possessing the power of transmuting impressions received as sensations into ideas or mental images of the form, substance, or the motion of the various objects or organs of the body from which the stimulus causing the sensations are derived. These parts of the nervous system become matured at an early period of child life, in fact long before the corresponding cortical association areas have been fully developed. Young children, therefore, can form ideas of things before they reach the age when their brains are fully developed so as to associate these ideas, and thus enable them to think. The part taken by the living substance of the cells forming the sensori-memorial centres has been compared to gas-pipes used for an illumination. The ganglionic cells of these cortical nervous centres are charged with energy, but it is not until a spark (stimulus) is applied which brings out their latent form and makes the figure a reality.[1]

Anatomical, pathological, and clinical evidence demonstrate the fact that between the sensori-memorial zones of the human cerebrum a vast mass of cortical nervous matter exists which, when fully developed, forms the association areas of the brain. Ideas passing into, or influenced by energy derived from these psychical areas by constant practice, and the employment of symbols or words, enables us to express our thoughts in intelligent speech. It is the clearness, the tone, the grouping, and the associative relations of the ideas which constitute our thoughts.[2] The following diagram may help to explain our meaning (Fig. 17).

We may illustrate our subject by the complex sensation produced, for instance, by a rose. On seeing a rose, the nerve ends of the retina are stimulated, the excitation passes from its nervous elements

[1] Ziehen, " Introduction to the Study of Physiological Psychology," pp. 156, 158.

[2] Mr G. J. Romanes remarks, " because we see that a great many objects present a certain common quality in common, such as redness, we find it convenient to give this quality a name ; and having done this we speak of redness in the abstract, or standing apart from any particular object, and having made this symbolical abstraction we can compound it with other abstractions—so that as in mathematics the symbols which are employed contain, in a manipulated form, the whole meaning of a long calculation, so in all other kinds of reasoning the symbols which we call words contain, in an abbreviated form, vast bodies of signification." The ideas contained in words become associated in the psychical substance of the brain. It is this principle " which renders possible all the faculties of mind, memory, judgment, reason, volition."—*The Nineteenth Century*, October 1878, p. 654, article on " Animal Intelligence."

to corresponding visual cortical centres, and releases a portion of their energy, producing a visual sensation of the rose, other portions of this energy assume the form of a memorial impression of the flower. Not only does a rose produce these visual sensations and impression, but its fragrance acts in the same way on the olfactory centres; and its leaves, by touch, on

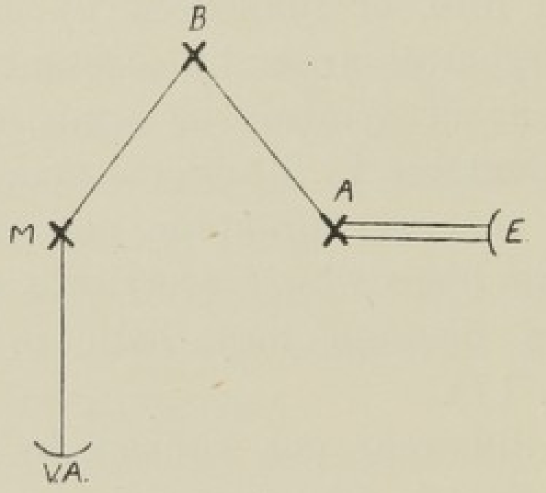

FIG. 17.—*E* represents an auditory sensory organ which receives, sifts, and transmits wave sounds to the auditory cortical centre *A*, where sensori-memorial impressions are formed in the shape of ideas or mental images of the sounds which have produced the sensation. These mental images may be brought into action by various modes of stimulation, and in this form pass to *B*, a psychical cortical area of nervous matter. In areas of this description, ideas become associated and moulded into conscious processes, thoughts, and judgments, and as such come to play upon the living substance of *M*, a motory word centre, and thus become manifest in the action of *VA*, the vocal apparatus, or other groups of muscles.

the tactile centres. So that at least three mental images of the rose, different in quality, are deposited in the memory cells of these cortical centres. The ganglionic cells of these centres are closely connected by associative fibres, and having been often incited simultaneously the three component ideas or mental images are thus associated with one another, and constitute the mental picture of a rose, which acts on the nervous elements of the organ of speech and becomes manifest in the expression of our ideas in the word "rose."

The association of ideas is therefore accomplished by the co-operation of two kinds of impressions; the new sensations received from the external world, and the mental images produced in the living substance of memory cells. It is the re-excitation of these latent ideas which form so important a part in intellectual processes. To further illustrate this point Professor Ziehen remarks—we see a dark cloud, *i.e.* a stimulation has been transmitted from the retina to the sensory living matter of the visual cortical centre, and in conjunction with the surrounding psychical area, has produced a mental image or idea of a dark cloud. A series of related ideas are connected with this idea by association; for example, among them, the idea of rain. The material excitation in the memory-cells of the association areas of the cortex, corresponding to this idea of rain, had been formed by former visual sensations of rain; and the appearance of the cloud brings these memorial impressions into play, and thus the idea of rain becomes associated with the cloud. In the same way this one idea is followed by numerous others; latent images of memory are constantly being brought into play and produce those processes of ideation upon which our thoughts and beliefs are based.

Each idea reproduces as its successor either an idea that is similar to it in significance, or an idea with which it has often appeared before simultaneously. We have elsewhere insisted on the importance of training the association memorial cells of the cerebral cortex in young persons through means of the various sensory organs. The child asks "what is that," and in answer may be told, "a tree," in this way a visual idea and an auditory idea are established. These ideas are wholly unlike each other, but by virtue of constant simultaneous appearance they become closely associated. Professor B. Moore states that "it is the linking of one reaction with another, and the using of the free energy of one to run another, that specially characterises the cell," and so it is with the memory cells of the cerebral cortex, it is the using of one to run the qualities latent in another which constitutes the power of the human brain, and is provided for in the size and complex nature of its neopallium.

Professor Halliburton remarks that the importance of the association of ideas which have for their anatomical basis the association of cortical centres, will be at once grasped when we consider such complex actions as reading aloud or writing from dictation. The position of the main centres involved is shown in Fig. 17. In reading aloud, the impressions of the words enter the eyes, reach that portion of the cerebral cortex known as the visual word centre, travel by means of association fibres to the auditory word centre, where the memory of their sounds is revived; a tract of association fibres connects this to the sensori-motor area of Broca's convolution, whence motor impulses originate which reach the muscles concerned in pronouncing the word originally seen.[1] Again in writing from dictation the course of the impulse is by the auditory channels to the auditory word centre,

[1] "Introduction to the Study of Physiological Psychology," by Professor T. Ziehen, pp. 244, 246.

then by association tracts to the visual word centre, where the shape of the letters composing the words are recorded; another association tract carries on the impulses to the sensori-motor area connected with the movements of the hand, and finally the movement of writing is accomplished. The conscious phenomena depend on sensations by means of which we become aware that the motion has been executed. We see the arm moving, we feel the object seized, and finally the sensory nerves in the interior of the arm inform us that the muscle has contracted. This sensation is known as the kinæsthetic sensation or sensation of motion.

The totality of component ideas when associated with one another constitute the mental image of the object. Beyond this human beings have acquired the power of naming these associated ideas, that is, of uniting them in the form of definite symbols or words which they employ to enable them to think, reason, and to express their thoughts in intelligent language: the materials necessary to form a nervous and muscular system adapted for this purpose are inherited, but the efficient employment of such a mechanism can only be gained by individual practice.

Young children imitate the sounds which they hear; for example, let us suppose the sound to be that of the word "rose." In making an effort to repeat this word a child brings the muscles and ligaments of his vocal apparatus into a definite form of action, thereby exciting the sensory organs of these structures, a part of their potential energy is consequently released and passes to corresponding sensori-motor nervous elements located in the cerebral cortex; a *motor* memorial image of the word is thus formed in the living matter of this motor centre. By practice a system of this kind becomes perfected, and we conceive that if those motor elements which contained this impression were directly stimulated they might discharge nervous energy which would re-act upon the structures that had led to the impression, and so induce a repetition of the vocal sound "rose." Action of this kind would be independent of any psychical influence, the word would possess no more meaning than the sound made by a parrot who had been taught to repeat the word "rose."

As the child grows older the cortical psychical elements of his cerebrum become more fully developed, and he then begins to comprehend the meaning of the words of which he makes use. Sensations excited by sounds such as the word "rose," pass from his ears to corresponding auditory nervous centres, and become there registered in the form of ideas or the mental images of this word. If this nervous matter is stimulated by energy derived from auditory impulses similar to those which produced the impression or from other sources, a part of its working power is released and passes to the motor nervous centres in which the word "rose" exists. By constant practice a system of this kind comes to act with unfailing precision, provided its living matter is in working order, and it possesses a constant supply of potential energy.

By processes such as those to which we have briefly referred we seem to comprehend how the ideas of form, colour, and odour become associated and embodied in the word "rose," which we are enabled to employ either in silent or articulate speech. Language thus becomes the most powerful instrument for the development of thought, serving by means of the association of ideas to represent the object or fact described.

We base these conclusions, as we have elsewhere stated, on the fact that if definite areas of a human being's sensori-motor centre are destroyed, such a person may continue to hear and understand the meaning of words, and may be able to answer questions by writing his reply on paper or on a slate, but he has lost the power of articulation, although he may be able to hear and to think. If a dog, while under the influence of an anæsthetic, has the sensori-motor area of his cerebral cortex stimulated which controls the action of his vocal apparatus, the animal barks, that is, utters a sound which he has learnt from hearing other dogs bark.

If a definite part of the auditory cortical nervous matter of the cerebral hemispheres is destroyed the individual may still be able to hear word sounds, but he has lost the power of comprehending their meaning, a specialised psychical portion of the auditory centres having been abolished. Under these conditions word sounds passing through the individual's ears do not produce mental memorial images of the words he may hear; nor can this power be restored because the psychical nervous matter on which sensations produce the image of word sounds no longer exists.

If an individual is born deaf and blind his brain may be well developed, and its various parts capable of performing their functions, but visual or auditory energy cannot pass in its natural form to the corresponding cortical nervous centres—mental, visual and auditory ideas cannot therefore be formed, and the individual is unable to learn to speak, unless these nervous centres can be brought into play through sensations passing to them from other sensory organs. Such paths as we have explained may be opened up by means of the efficient training of the tactile and kinæsthetic sense organs.[1]

The association areas of the human brain are divided into three principal fields (Fig. 15, p. 131).

The Anterior Psychical or Association field is located in the frontal lobe of the brain ; its nervous matter is brought into close relation with that of the basal ganglia and motor centres of the cerebral cortex. Bundles of fibres likewise bring this field of nervous matter into relation with the visual auditory and other centres ; the functions performed by its nervous matter is directly related to the grade of self-control exercised by individuals, and collectively by the order of men to which they belong. The full appreciation of the self in relation to those by whom we are surrounded, has probably been the last and highest factor in the development of individual social conduct, and is as yet only dimly recognised by the numbers of human beings who are apt to pride themselves on their high standard of civilisation.

Disease or injury of the anterior psychical field is in man often attended with loss of appreciation of individual personality, and of the value of things to him necessary for moral and æsthetic judgment ; uncertainty of action and lack of will are common in

[1] "Human Speech," chap. xiii.

such people. Their self-control suffers, and under the influence of excitement their conduct often becomes immoral or even criminal.[1]

The Middle Psychical field coincides with that portion of the cerebrum known as the Island of Reil, and is situated between the auditory sensory area and that of Broca's centre for speech. We have already referred to the functions performed by the nervous living substance of these cortical centres and their association areas, so that we need not recur to the subject in this part of our work.[2]

The Posterior Psychical field is located in the parieto-temporal region of the cerebrum; its functions "are to construct external objects from the several kinds of sensory impressions, and to form ideas concerning the relation of objects and psychic processes to one another and to the self. In a word, the objective relation of the individual and all those processes which we commonly call 'intellectual.'"[3]

While we fully appreciate the fact that a human being possesses a far more extensive and complex cerebral cortex, as compared with the other parts of his nervous system, than any other animal, and has therefore at his command a high order of mental capacity, we nevertheless hold, that as in the lower classes of beings, his instinctive, emotional, mimetic, and other hereditary characters are the result of work performed by the nervous matter of the basal ganglia and their extension into the inner granular layer of the cerebral cortex.

[1] Johnston, p. 352, "The Nervous System of Vertebrates."

[2] "Human Speech," pp. 196-201.

[3] Johnston, 352.

Mr R. H. Lock in his recent work on Heredity and Evolution, when discussing Sir Francis Galton's ideas regarding the science of Eugenics observes, that you may educate generation after generation, and yet the starting-point from which each individual has to begin his struggle upwards may remain the same, even though each may struggle a little further than the one who came before him. On the other hand, we have all of us met happy people to whom it seemed second nature to do the right thing, and for whom the difficulties of life appear to have no menace. *These qualities are those of nature and not of nurture, and their children inherit them* (the italics are our own). Important as education, sanitation, and the like may be, their effects are strictly limited.[1]

Men, notwithstanding their mental capacities, are animals, they still possess instinctive and hereditary characters, which because they are inherited are more difficult to influence than their acquired intellectual attainments, the latter are comparatively unstable and pass away with the life of the individual, but the hereditary characters continue in operation and to a large extent influence the actions of individuals throughout their lives.

In the second part of this work we endeavour to employ the teaching of biology as a means of throwing light on historical science, and thus to ascertain how far it is possible to trace the existence, and the influence which hereditary character has had in moulding the destinies of individuals and of the race to

[1] "Recent Progress in the Study of Variations, Heredity and Evolution," by Robert Heath Lock, M.A., Fellow of Gonville and Caius College, Cambridge, Second Edition, pp. 287, 288.

which they belong. It seems however, desirable before considering the historical evidence bearing on this subject, to summarise the facts and conclusions we have arrived at biologically, regarding the nature and evolution of the living matter out of which our hereditary and mental capacities are elaborated.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

In a previous volume of the *International Scientific Series* we described the nature and functions performed by those parts of the living matter of our bodies by means of which we gain ideas concerning the external world, and are enabled to formulate and to express our thoughts in intelligent speech. The lines we followed in this investigation led us, in the first place, to consider the fundamental properties possessed by living matter, and then, by the aid of comparative biology, to explain the higher functions performed by the nervous matter of the brain culminating in human speech.

In the preceding chapters of the present work we have endeavoured to establish the fact, that action excited in living protoplasm by various modes of energy is transmuted by certain of its elements into movements adapted to promote the well-being of the organism. We term the elements constituting this kind of matter "purposive," and show they are sufficient to effect all the movements necessary to maintain the existence of the lower classes of beings. But as in the ascending orders of animals the structures entering into the formation of their bodies become more complicated under the action of the environment, so the purposive elements which direct their movements undergo a corresponding evolution, and become developed into matter possessing instinctive, and finally psychical functions. The details on which our conclusions are based necessitated the use of technical terms with which persons who have not studied the science of biology are unfamiliar. We have therefore thought it advisable to summarise in as clear and concise language as we can command, the evidence and the main line of argument we have employed in this and in our previous volume; hoping thus to make clear our meaning to those who may perhaps have had some difficulty in following our line of reasoning.

The physical basis of life, or protoplasm, is made up of a semi-liquid jelly-like or colloidal substance, a form of matter known as protein, with the addition of a small percentage of sulphur, phosphorus and iron. Professor B. Moore states that we are unable to combine the elements forming these substances into any of the proteins of the cells or body fluids, and still less to build them up into living protoplasm, but we have obtained much insight as to the general character of the constitution of proteins, and the main plan upon which details are still to be worked out lies before us.[1]

The proteids or albumenous substances form an extensive group, the different members of which it is believed vary to a large extent through means of alterations in the structural arrangement of their component elements. To illustrate this point we refer to the diversity of properties exhibited by two chemical compounds resulting from alterations in the relation to

[1] "Further Advances in Physiology," edited by Leonard Hill, p. 6.

one another of their elements. For example, the molecules of the two compounds known as Benzonitrile and Phenylisocyanide, each contain seven atoms of carbon, five of hydrogen, and one of nitrogen, but on account of a slight difference in the arrangement of their atoms, one of them is a harmless aromatic fluid while the other is a stinking poison. In like manner we assume that the different kinds of living protoplasm such as that which forms the basis substance of the various animal structures, while chemically identical, possess varied physiological properties, that those material processes that properly belong to living matter. It is not so much the nature of the constituent elements, as the way these elements are arranged, which effects differences in the kind of work they perform.

The bodies of unicellular and of multicellular beings consist of minute particles of protoplasm or cells, which, with the exception of the simplest forms, contain one or more vesicular bodies or nuclei; and as a rule nucleoli, centrosomes and so on (Fig. 18). The nucleus of the cell is enclosed in a membrane during the greater part of its existence; the substance of the nucleus being formed of a meshwork of differentiated protoplasm or linin, holding in its meshes granules of a substance known as Chromatin which many biologists consider constitutes the basis substance of hereditary characters. But as we have explained, the bacteria and lower algæ, which form vast and most important classes of beings do not possess either a nucleus or fully formed chromatin, nevertheless they constitute the most numerous and prolific classes of beings on the face of the earth.

Under the microscope the jelly-like protoplasm of a dead cell appears to be formed of a network of granular fibrillæ ; but the details of the structure of living protoplasm is not so obvious ; and any attempt to gain an insight into the mode of its physiological activities from its apparent structure is useless. We must seek the source of these activities in its ultra

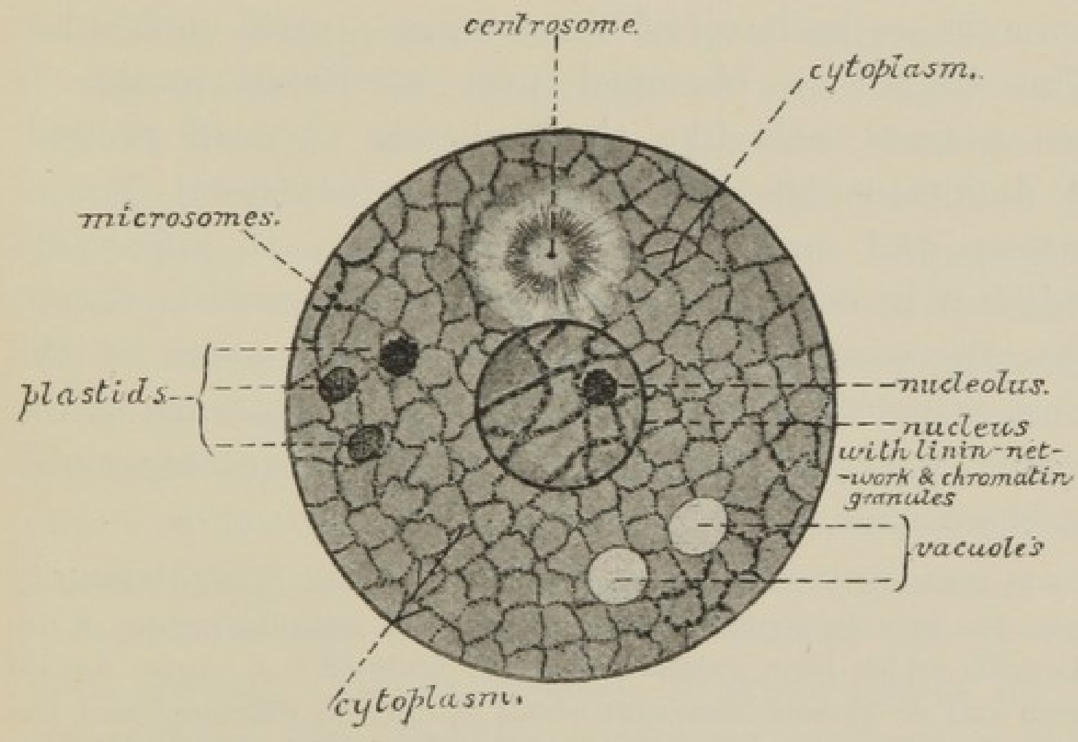

Fig. 18.—Diagram of a cell.

microscopic organisation, accepting the fact, that what appears to be an homogeneous substance is a complex mixture of elements, which within certain limits, undergo structural re-arrangement through the action of various forces. Modifications of the structural arrangement of the elements of living matter thus induced are accompanied by modifications in its functions, which in the course of time become hereditary characters.

It is generally admitted that the changes in form and function of living protoplasm such as those to which we have referred, are attributable to the great size and complexity of its proteid molecules.[1] Each of these molecules are supposed to contain from ten to thirty thousand atoms, whereas the most complex molecule known to the organic chemist consists of less than a hundred atoms. The units or cells of animals are built up of these large proteid molecules. The biogen or chemical unit of living matter is not a fixed unit like the molecule of dead proteid, it maintains itself in virtue of a continual flux of matter and energy.[2] It is necessary to appreciate this fact in order that we should be prepared to accept the otherwise almost incomprehensible nature of the work which is performed by the living substance of the various parts of the central nervous system, especially in the higher classes of animals.[3]

[1] Professor M'Kendrick refers to figures which may perhaps assist us to realise to some extent the magnitude and complex nature of the elements which form animal cells. He finds that a human female germ cell or gamete measures about $\frac{1}{20}$ mm. in diameter, and the male gamete or spermatic cell about $\frac{1}{200}$ mm. Professor M'Kendrick states that when the male cell combines with the female cell this fertilised cell would, according to his calculations, contain 20,000,000,000,000 proteid molecules, one half of which consist of water. He considers this number of organic molecules sufficient to account for the transmission of hereditary peculiarities, and for the development of all parts of a highly complicated organism.

[2] *Science Progress*, No. 2, pp. 197, 198.

[3] From a study of the simplest forms of plants and animals we arrive at the conclusion that their living protoplasm exhibits the same fundamental processes and have therefore presumably been derived from a common ancestral form of matter. Their protoplasm could not have arisen *ex nihilo*, or out of something entirely different from itself, and as we do not meet outside living organisms with matter presenting a like *combination* of phenomena to that manifested by

The theory which seems to us best adapted to explain the phenomena presented by living matter, assumes that it consists of a specific numerical and structural arrangement of elements, which act as a transformer of non-vital into biotic or living energy. The result of this action becomes manifest in certain phenomena which collectively we call life. Life, therefore, is the result of chemical and other modes of energy acting on a specific form of matter.[1]

By a transformer of energy we mean a substance which through means of the structural arrangement of its constituent elements, is specially adapted for promoting certain energy exchanges. Thus some energy transformers possess only the property shared by all forms of matter of acting as general transformers, although varying in degree, while in others the property is specific, and associated with some special arrangement of matter. Thus the metals possess electrical conductivity, and in inverse proportion act as transformers for the conversion of electrical energy into heat energy. The chlorophyll of green plants, on the other hand, has specific powers of converting light into chemical and thus acts as a peculiar energy-transformer. Again, the soluble ferments or enzymes consist of chemical substances secreted by living protoplasm, which may be extracted from the cells in which they have been formed, as for instance the pepsine of the gastric juice. In their capacity as

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living matter, we conclude, therefore, that this substance consists of a peculiar structural arrangement of elements proceeding from a common and simpler combination of atoms.

[1] Professsor B. Moore, "Recent Advances in Physiology and Bio-Chemistry," edited by Dr Leonard Hill, p. 135.

energy transformers they break up complex albumenous products into simpler substances, and thus prepare them for digestion. They effect this change by their presence alone, without appearing in the final product of the action. We have come also to learn that some enzymes possess the power of rebuilding the molecules others have broken down ; by processes of this order an extract of almonds (amygdaline) may be broken up into compounds, which another ferment will put together again and so reconstruct the original compound.

The living protoplasm of animal cells when placed in favourable conditions appropriates the elements prepared by enzymes to replace its worn-out materials, these latter products in conjunction with those left by the enzymes after completing their work, are broken up by the free oxygen of the cell aided by the action of its living matter, and are converted ultimately into carbonic acid, water, and heat, and so pass away from the cell. Processes of this description release a considerable amount of energy which constitutes a supply of potential working power to the living matter of the cell. If, therefore, the protoplasm of the cell is insufficiently or imperfectly supplied with nutrient matter, its potential energy or working power fails ; on the other hand if the ordinary play of its molecules are hindered by the action of an anæsthetic or other poison, its power as a transformer of energy is hindered and its functions are thus impaired.

We laid stress on the fact that all forms of living protoplasm, animal and vegetable, possessed certain fundamental properties, and were therefore probably derived from a common ancestral stock. Among these fundamental processes, we referred to the metabolism, reproduction, respiratory and other properties, including those of sensitivity, as well as to its purposive action, and its power of retaining impressions made upon it by certain modes of energy. Through means of its irritability, living matter responds to impressions made upon it by energy derived from chemical and other sources,—through means of its purposive elements the action thus excited is employed to promote the well-being of the living substance,—through means of its power to register impressions made on it, it comes to form the basis substance of memory, upon which the mental powers of the higher animals, including human beings, depend (p. 65).

The meaning we attach to the term purposive action may be understood by referring to the changes which take place in the substance of some of the simplest known forms of organisms. The living matter of a bacterium consists of what appears under the highest powers of the microscope to be a minute particle of homogeneous protoplasm. In response, generally to unfavourable conditions of the environment, definite movements are excited in the substance forming the body of the organism, by means of which it separates into germinal and somatic elements. The somatic substance nourishes and protects the germinal elements until they are matured and reach favourable conditions for their development, the somatic matter then perishes, and from the germinal substance a new being is produced. The energy required to bring about changes of this description in the living substance of a bacterium is derived from various sources, but the ordering or regulating of the action thus brought into play, is we conceive, accomplished through means of the purposive elements of the living matter, which are adapted to promote the well-being of the organism and of the species to which it belongs. It is well to note that action of this kind is common to bacteria in all parts of the world, and is at once suppressed by an anæsthetic or by any conditions which interfere with the normal metabolic activity of the living matter of the cell, and so of its supply of potential or working energy.

Professor A. J. Ewart, in his work "On the Physics and Physiology of Protoplasmic Streaming in Plants," has given an admirable account of the forces brought into action in effecting movements of this kind in living matter. He states "that a direct physical explanation can however, hardly apply to organisms which possess definite locomotory organs, such as flagella or cilia. It is undoubtedly often the case that physical forces such as surface tension, osmosis, imbibition etc., when intense, may overpower the organism, but there can equally be no doubt that the latter has acquired the power of directing and controlling these natural forces for its own benefit, so that a simple direct physical explanation can hardly be postulated for phenomena which may be due to a multiplicity of interacting factors."[1]

Mr W. B. Hardy, in his paper on "The Physical Basis of Life," states that if we watch the movements of an amœba crawling amid sand, fragments of decayed

[1] On the Physics and Physiology of Protoplasmic Streaming in Plants, by A. J. Ewart, p. 112.

leaves, and living diatoms, we notice that of the particles which it takes into its substance some are nutritious food, some are innutritious and absolutely useless. But there is a decided balance in favour of the nutritious particles. Like Autolycus, it is a picker-up of unconsidered trifles, guided by a decided preference for things useful to itself. "Therefore, the tiny animal manifests discrimination, imperfect no doubt, but clearly recognisable. And the choice is beneficial, it contains an element of purpose."[1]

In the year 1878, Professor Strasburger described the movements made by the zoospores (motile spores) of Ulothrix (Fig. 19), and other algæ, and showed that their power of locomotion resulted from various external forces acting on their irritable living protoplasm.

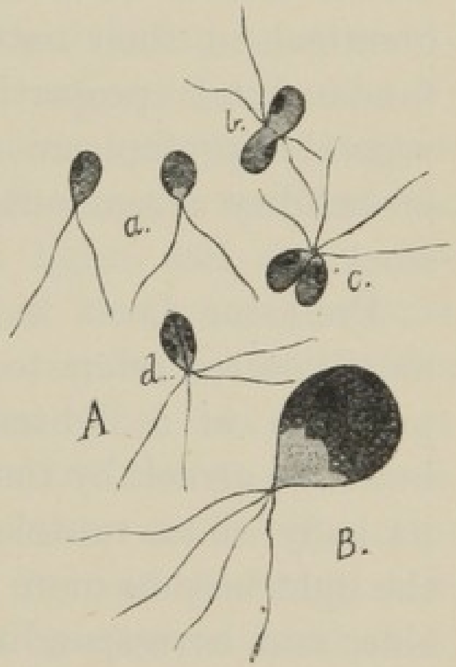


FIG. 19.—*B*, Fully developed spore of Ulothrix *a*, small spore with two cilia; *b*, small spores uniting to form a fertile being.

Professor J. Loeb holds that movements such as those to which we have referred in the lower algæ, not only occur in animal organisms but are referable to the same causes or tropisms. He believes these movements depend, first, upon the specific irritability of certain elements of the body surface, and secondly, upon the relations of symmetry of the body. In his opinion symmetrical elements at the surface of

[1] "The Physical Basis of Life," by W B. Hardy, *Science Progress*, October 1906, p. 182.

the body have the same irritability, unsymmetrical elements have a different irritability. Those nearer the oral pole or anterior end of a being possess an irritability greater than that of those near the opposite pole. These conditions force an animal to place itself towards a source of stimulation or away from it. Professor Loeb rightly maintains that these movements in the lower forms of plants and animals are identical in their nature, as we assume, because the fundamental properties possessed by animal and vegetable protoplasm are identical, both having in all probability arisen out of a common simpler ancestral stock.

Professor Loeb, in order to illustrate the principle he advocates, refers to the movements of a moth in the presence of a lighted lamp. He states that if the insect be struck by the light of the lamp on one side of its body, those muscles which turn the head towards the light become more active than those of the opposite side, and correspondingly the head of the animal is turned towards the light. As soon as the head of the animal assumes this direction and the median-plane (or plane of symmetry) comes into the direction of the rays of light, the symmetrical points of the surface of the body are struck by the rays of light at the same angle; and the animal is rapidly drawn into the flame of the lamp. This action, Loeb remarks, is "nothing more than the chemical and indirectly the mechanical effect of the light, an effect similar to that which forces the stem of the plant at the window to bend towards the source of light." Again, this author states that the same cause which prescribes the course of a falling stone or determines the orbit of planets, namely, gravitation, determines also the path which a butterfly follows that has just emerged from the pupa case. The geotropic irritability is at this time especially strong; the newly-hatched animal remains restless and is compelled to run about until it comes to a vertical wall, on which it can put the longitudinal axis of its body vertically, its head upwards. Here it remains quietly until its wings are unfolded.[1]

Dr Georges Bohn is a recent and strenuous advocate of Professor Loeb's ideas. With reference to Lamarck's views concerning the movements of the inferior animals being due to external causes, such as the action of the environment, of light, and so on, Dr Bohn states that action of this kind, or Tropisms, result from the attraction of living beings to exterior forces which they are unable to resist: he, however, holds that as tropism alone cannot insure the preservation of the life of the animal, other modes of acting are necessarily associated with it, and probably take predominance. Among these modes of action he describes "*sensibilité differentielle*" as being of great importance; he uses this term to express variations in the environmental agents as causes of reaction.[2] For instance, if a cloud passes between the sun and a number of organisms placed in a basin of water, the organisms turn round actively, and then take up their original position. He holds it is through their power of differential sensibility that the lower animals

[1] "Comparative Physiology of the Brain and Comparative Psychology," by J. Loeb, M.D.; also "Studies in General Physiology," by J. Loeb, Professor of Physiology in the University of California, vol. i. pp. 37, 112. Chicago: The University Press, 1905.

[2] *The American Naturalist*, vol. xliii., p. 624, Article by Professor H. S. Jennings.

avoid noxious or harmful movements. We must however refer the reader to Dr Bohn's work in order to become fully conversant with his views on the subject we have referred to, and on tropisms in general.[1]

We consider that movements such as those above alluded to, are directed by energy derived from the purposive elements of the organism; a form of energy which controls the movements of the contractile elements of the living substance. Our difficulty in completely establishing this theory consists in our inability to place our finger on purposive and instinctive elements, so as to separate them from other forms of living matter; as this is impossible, we can only judge the qualities and potentialities of this matter by observing the phenomena it is capable of producing in living beings.

It appears that in the simplest forms of unicellular animals purposive elements are disseminated throughout the protoplasm of their body substance, being however most pronounced in the outer layer of living matter. Thus in a volvox, stimuli applied to its cilia excites a reaction in its protoplasm and releases a portion of its potential energy, which acting on purposive elements, becomes manifest in the movements of the cilia; their action is rythmical, because when a discharge of potential energy has taken place from the protoplasm, a pause is necessary to enable the living substance to become recharged with working power (Fig. 20).

In the Porifera, and in the polyps (Hydroids), among the Cœlentera we find that a differentiation of

[1] "La Nassiance de l'Intelligence," par Dr G. Bohn, p. 26.

the purposive elements of the protoplasm has taken place. From the sensory living matter of the external surface of their bodies and tentacles disseminated ganglionic nerve cells are formed, the living elements of these cells, among other functions, direct a certain portion of their potential energy into purposive action, so that the animal's contractile fibres or muscle-cells are brought into play. Action of this kind would appear to be an amplification of that which brings the cilia of a volvox into operation.

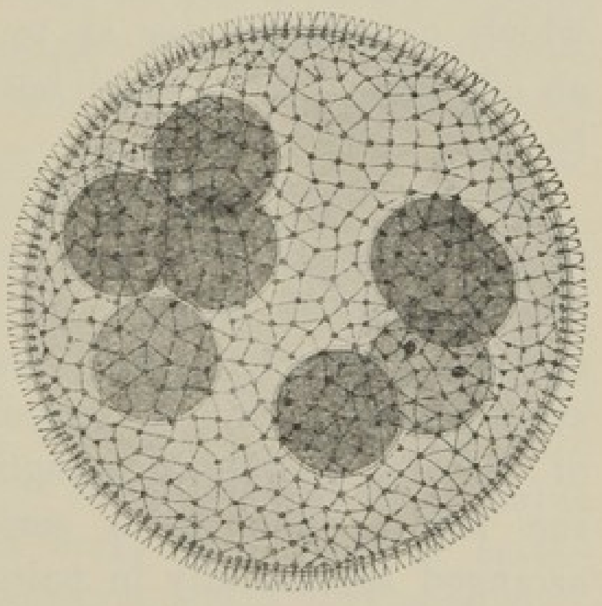


FIG. 20.—Volvox showing the small ciliated somatic cells and seven large germ cells. (Drawn from life by J. H. Emerton. See E. B. Wilson, "The Cell in Development and Inheritance," p. 123.)

In jelly-fishes (Medusoids) the nerve-cells form a chain passing round the margin of the bell, which on the one hand receive impressions made on them through the various sensory organs, and on the other hand transform this energy into force, which passes to the animal's muscular apparatus and bring it into co-ordinate purposive action, thus giving us the first inkling of a central nervous system.

In the next higher class of animals (Echinodermata), which include star-fishes, the ganglionic nerve-cells have become aggregated into a central nervous organ which forms a circumaxial ring with radial cords of nervous matter passing outwards to supply the muscles of the animal's limbs with motor impulses, and to receive impressions passing from the various sensory organs to the central nervous organ. The action of the purposive elements of the central nervous system of these animals is conspicuous in the efforts they make to assume their natural position when they have been turned over on their dorsal surface, and in their action in getting rid of a harmful source of irritation, which extends so far as to cause them to cast off an offending limb; which however is soon regenerated (p. 49).

In the worms (Annelida) there is a more complete co-ordination of the brain than in the Medusoids, a nervous system capable of initiating actions. The central nervous system has assumed a bilateral symmetrical form; it consists typically of a pair of præoral (cerebral) ganglia situated in front of the mouth, and of a series of post-oral ganglia, arranged segmentally in pairs along the ventral mid-line of the body, and united together by transverse commissures and longitudinal connections[1] (Fig. 10, p. 40). In this class are included the lug-worm and sea-mouse, to which we have referred as possessing a more complicated central nervous system than those of the lower classes of animals. In some members of this class of beings, such as the polychæta, definite cephalic sensory organs are developed from the outer sensitive layer of living matter of their bodies, and from these sensory organs nerve fibres pass to ganglionic cells located in the animal's brain. Like other structures these aggrega-

[1] Mr R. H. Burne, Phys. Series, Roy. Coll. Surgeons Cat. vol. ii. p. 5.

tions of cerebral nervous matter increase in dimension, and in perfection of function, in proportion to the extent and kind of energy which is brought to bear upon them through means of their corresponding sensory organs.

As regards the Arthropodia, we referred to the nervous system of the cray-fish and of ants and bees, and dwelt on the fact that as the cephalic sensory organs became more highly developed, a reciprocal increase could be traced in the amount and complexity of their central nervous system.

The cray-fish remains at the mouth of its burrow, barring the entrance by means of its protruding head and long antennæ. In this position the animal is able to feel, and to see the various objects passing within reach of its claws, with which it seizes its food. In order to form an idea of the processes which enable a cray-fish to initiate and carry on a series of movements such as those we have mentioned, it is necessary, in the first place, to bear in mind the fundamental qualities possessed by living matter, and then, that the existing species of cray-fish are derived from a line of ancestors extending over long periods of time, and that in far distant ages this order of animals was probably gradually developed from simpler forms of beings. In each stage of their evolution the living substance forming this order of animals must have become adapted to changes imposed on it by variations of climate, and other conditions to which it had been exposed, otherwise the species would have ceased to exist.

The hard external covering of the head and body of the crustacea however, renders the result of experiments on their brains unsatisfactory, and the central nervous system of ants and bees are so small that to remove definite parts of them during life, so as to watch the results produced on the animal's movements, is wellnigh impracticable. It is therefore desirable to consider the conditions under which these *instinctive* processes are effected by certain of the cartilaginous fishes, that is, by animals forming the lowest class of vertebrates.[1]

The vertebrates, as is well known, are characterised by the presence of a cord of nervous matter extending along the length of their bodies (spinal cord) which is enclosed in a canal formed of either cartilage or of a number of bones (vertebræ), and of a brain which is a continuation upwards of the spinal cord, and is enclosed by the skull (Fig. 14, p. 111). This sub-kingdom of animals is divided into a number of classes, orders, and species. Without exception, from the lowest cartilaginous fishes, up to human beings, their brains are in part formed by four masses of nervous matter, known collectively as the basal ganglia (the right and left optic thalami and corpora striata).

In the three lower classes of animals the elements contained in the nerve-cells of the basal ganglia constitute the central receiving station for energy passing from the visual, auditory and tactile sense organs. It is from the substance of these ganglia that the nervous energy which directs the purposive

[1] Instincts, according to our definition of the term, consisting of a chain of acts which have become formed through means of continual repetition of the same actions following on the same stimuli, so as to become finally fixed into the physiological organisation. The object of these movements being in the main directed to the preservation and reproduction of the species.

movements of the animal's body and limbs is derived.

It is to be specially noticed in the vast multitude of beings which form these three out of the five classes of vertebrate animals, that their brains do not possess what we term a neopallium or that part of the cerebrum in which psychical or intellectual processes are elaborated.[1] Nevertheless, fishes, amphibians and reptiles exhibit instinctive movements, which it has been shown may, in some of these animals, be improved by judicious training (p. 96). If in the classes of animals we have referred to their basal ganglia are destroyed during their lifetime, the creature so mutilated completely loses all instinctive and emotional powers; it may, however, be kept alive for a time and performs simple reflex movements. For instance, if the basal ganglia of a fish are removed, the animal will continue to swim about in an aimless, sightless manner, the surface of its body being stimulated by the surrounding water, and thereby exciting habitual reflex muscular action; but the fish fails to seek food or to exercise any instinctive movements.

It is the existence of emotional and instinctive movements in the three lower classes of animals when the nervous matter of their basal ganglia are in working order, and the abolition of these movements when these masses of nervous substance are destroyed, which leads us to assume that the living matter through means of which instinctive and

[1] Psychical processes are those which effect modifications of motion through the agency of intercurrents of a specialised mode of nervous energy, derived from mental images or ideas.

emotional actions are effected is located in these ganglia.

The living nervous substance of the basal ganglia, therefore, in fishes, amphibians and reptiles, not only constitutes the receiving and dispatching centres for energy reaching them through the sensory organs; but, in addition between the incoming and outgoing energy, instinctive elements are brought into operation, and these direct the motor elements into co-ordinate purposive and emotional actions. The perfection of the muscular movements thus brought into play depends on the living matter of the nervous system being adequately supplied with potential or working power, on the inherent structural arrangement and development of its molecules, lastly on the kind of training they have undergone. Our theory is that the instinctive and emotional actions accomplished by the three lower classes of animals cannot result from psychical or intellectual processes because they do not possess any psychical nor "consciousness matter"; they have no cerebral cortex or neopallium through means of which alone such processes are elaborated (see p. 107). The mode of life of these classes of animals is such that they do not require the aid of intellectual powers, their hereditary instincts being sufficient to meet their requirements in their struggle for existence.

We have already described what we mean by the term *neopallium*, and attributed the origin of this important part of the brain to the instinctive elements of the basal ganglia (p. 94). We also discussed the action of the basis substance of memory in plants and in unicellular organisms. In the higher classes of animals the living elements which constitute this memory substance become differentiated and forms structures located in definite areas of the central nervous system. These areas of nervous substance are connected by protoplasmic fibres with the various sensory organs of the animal's head and body. Stimuli received through these receptors of energy when constantly repeated are registered in the nervous matter of these areas, and thus form what we term the sensori-memorial, visual, auditory, tactile, and other centres. These centres are surrounded and influenced by psychical cortical matter; they are also intimately connected to one another by nerve fibres, the whole constituting an extremely complex system.

The brains of birds are remarkably constant in form, and are distinguished by the great development of the basal ganglia. The hemispheres cover the thalamus and optic lobes, and possess rudimentary occipital and temporal lobes; their outer layer contains two strata of ganglionic nerve-cells. Nerve fibres may be traced from the living matter of the simple cortical layer of cells which constitute a bird's cerebral cortex, to and from the nerve-cells of the basal ganglia, and also to the nuclei of the auditory nerve situated in the medulla oblongata, and onward to the spinal cord. Nerve fibres may also be traced from the nervous elements of the eyes of birds to their cerebral optic lobes and from thence to a certain area of cortical nerve-cells located in the occipital lobes; if these areas or cortical nervous centres are destroyed, the bird will continue to see surrounding objects, but he can no longer recognise what he sees; he has completely lost his power of memory, that is, of acting on visual impressions gained during his lifetime (see "Human Speech," p. 178).

If the outer surface of a bird's brain is exposed during the animal's lifetime, and a weak electric current applied to definite parts of it, certain muscles of the bird's eyes are thrown into action, the other muscles of the head and body remaining at rest. Nerve fibres or conductors of energy may be traced from these centres through the basal ganglia to the nuclei of the nerves of the medulla and spinal cord (Fig. 14, p. 111).

These cortical nervous centres are brought into direct relation with the various sensory organs by means of which they receive a constant stream of energy from the outer world, aud also from muscular and other forms of stimuli; some of the elements of these centres retain certain of the impressions made on them by various forms of energy; and in this way definite, visual, auditory, and other sensori-motor memorial centres have become established in the substance of the cerebral cortex of these animals.

It is however to be noticed that although certain areas of a bird's brain when stimulated excite definite groups of muscles, by far the larger portions of the cortex when stimulated produces no visible effect on the muscles of the animal's head, face, or any part of its body. It is in those portions of the cerebral cortex which intervenes between the sensory and the motor areas of the brain of birds that we have reason to believe psychical processes are elaborated. In consequence of the rudimentary nature of the cerebral cortex in birds their psychical faculties are very limited; but their instinctive actions are remarkable, depending, as we have shown, on the great development of the nervous substance of their basal ganglia. In support of these ideas, it has been shown, that if a bird's cortical substance is removed during the lifetime of the animal, the creature ceases to notice sounds, or the sight of objects which had attracted its attention before its cerebral cortex had been destroyed; in fact, birds thus mutilated lose whatever consciousness they possess. But these birds, when placed on the floor of a room, will fly up and perch on the arm of a chair, and perform other instinctive acts so long as the nervous substance of their basal ganglia remains intact (p. 105).

With a nervous system of this kind in working order, it is possible to conceive how a bird comes in the course of time to repeat word sounds which have been taught him. We know that, in their natural state, birds learn to sing, and some of them to repeat the cry of various other animals. The utterance of word sounds by birds is acquired in like manner, and probably means nothing more to the bird than its natural song, or other sounds it has learnt to repeat; and which seem as a rule directed to attract the attention of beings he has come to recognise. Thus, the parrot we have referred to was constantly in the room with its mistress, who fed and took the greatest care of her pet. She repeated over and over again, in the same tone of voice, short sentences, which after the bird had learnt he remembered for many years.

Birds therefore possess the power of receiving energy derived from wave-sounds which pass through their ears, and in a modified form reach their auditory sensori-memorial cortical centres. Through the medium of the living substance which forms these centres, and the adjoining rudimentary psychical matter, auditory impulses are transmuted into sensations, and mental images of the auditory waves which produced the primary excitation. By the frequent repetition of such modes of excitation, the basis substance of memory is established for a particular mode of stimulation, and a combination of such impressed nervous matter would form an auditory sensori-memorial centre, the impressions it has received being re-excited by similar modes of stimuli to those which produced the impression, and also by other forms of energy.

As a result of the re-excitation of impressed nervous matter of this kind, or by the direct excitation of the living substance of the auditory centre, a part of its potential energy is released and passes along nerve fibres to the basal ganglia, and to the nuclei of the nerve fibres which pass to the bird's muscles of respiration, and his vocal apparatus. The result of this action is the repetition of the sound which had been directly received, or had been previously impressed, on the substance of the auditory memorial centre (p. 100).

The essential point to bear in mind with regard to the cerebral nervous system of birds is, that unlike the lower classes of animals, energy passing from their senso-memorial centres before it reaches their muscles comes into relation with psychical elements, and is thus in part transformed into psychical energy. In birds, from the very limited extent and rudimentary character of the cortical elements of their cerebral hemispheres, the influence of their psychical matter on energy passing from the memorial centres is necessarily insignificant. But still there is evidence in favour of the idea that parrots possess a low order of intellectuality.[1]

Thus, the parrot we have referred to had been taught by its mistress when dressed for her afternoon drive to repeat the words "grannie going out." By frequent repetition the bird's auditory nervous centres had become impressed with these word-sounds, and its mistress's dress at the time she taught it these words had become registered on the bird's visual memorial centres. No sooner therefore did this lady appear dressed in a bonnet and shawl, than the bird's previously impressed visual centres were excited into action by the sight of its mistress's dress, and association fibres brought its auditory centres into play, the result being the vocal sound "grannie going out." If during life the cerebral cortex of this bird's brain had been removed, its basal ganglia being left intact, all that the animal had learnt during its lifetime would have disappeared, but its instinctive or automatic actions would have continued in operation, that is, all those actions inherited by the animal, and which were performed independently of psychical processes.

It seems to us that the specific form of nervous matter contained in the ganglionic cells of the mammalian neopallium, were originally derived from purposive or instinctive substance contained in the basal ganglia, and may be traced back through the class of birds to reptiles (see p. 95). We conceive that this form of matter has been evolved like the

[1] "Human Speech," p. 192.

other structures and organs of the body in response to the demands made on it by the environment, and like other organs it has become specialised, and thus able to elaborate various forms of psychical energy. Psychical matter was not made what it is, but has grown with ascending orders of animals into what it is; those orders of animals which have developed the most perfect neopallium, not only surviving but gradually improving under the strain to which they are exposed in their struggle for existence.

We may now pass on to the Mammalia and consider the nature of the living substance by means of which psychical processes are elaborated.

It is to be noticed that the cortex of the cerebral hemispheres, or that part of it we have described as the neopallium (p. 94), assumes important functions, and becomes a condition of survival, for the first time in the mammalia, and in each successive geological epoch it has been incumbent upon every mammal, either, on the one hand to adopt some eminently safe mode of life or some special protective apparatus to avoid extinction, or on the other hand, in response to the environment to develop a larger neopallium, which as an organ of associative memory would enable it, through means of its psychical properties, to evade danger, and devise means to maintain its own in the struggle for existence. For instance, the hippopotamus is an example of a mammal which has not kept pace in the race for neopallial supremacy, but survives by adopting habits of life which are eminently safe, and has produced an extremely effective protective covering. The condition of the human brain represents the other extreme. Here the cerebral cortex has attained its maximum development, and its possessor has not had to seek refuge either in a retired mode of life or any protective specialisation of structure, either for attack or defence, but has attained a dominant position in the animal kingdom, while retaining much of the generalised structural features of the lower animals.[1]

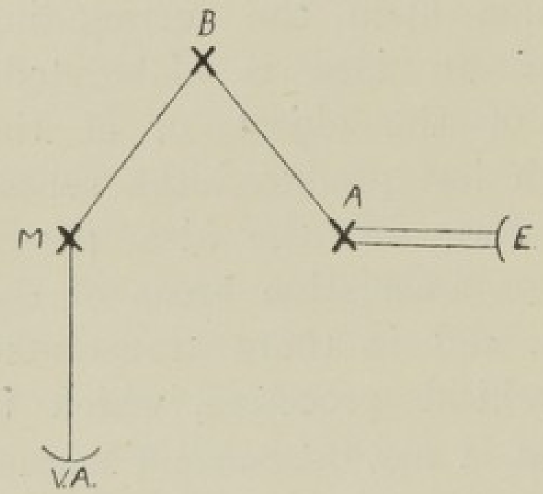
In adult human beings energy derived from various sources, passes through their respective sensory organs to nervous centres located in the cortex of the neopallium, where it becomes manifest as a sensation, and by its action upon the surrounding psychical nervous matter an idea is elaborated; that is, a mental image of the object, or of the muscular movement which has produced the sensation.[2] Energy in the form of the idea passes to the strictly psychical or association areas of the cortex of the neopallium, and is there transmuted into consciousness or psychical processes, which in

[1] Professor G. Elliot Smith, Cat. of Roy. Col. Surgeons Museum, Physiol. Series, vol. ii. p. 465.

[2] The reasons which have considerable weight with us regarding the connection which exists between sensations and ideas rests on the fact that young children form ideas of things and movements at an early age, and long before they can reason or form correct opinions regarding them. This state of affairs may be explained by the condition of development of the nervous system in which ideas and intellectual processes are formed; in childhood, the former has become completed at an early age and so able to perform its functions and elaborate ideas. But the real psychical areas of the cortex are not fully developed and connected with areas of ideation until much later in life, and until their growth is completed their functions are more or less imperfectly performed. With the destruction of the senso-motor and surrounding zone of nervous matter the power of forming ideas is lost, and with the removal of the psychical areas or their extensive damage by disease the reasoning power of mammalia is abolished.

their turn bring various groups of muscles into action. We have described at length in our work on "Human Speech" the mechanism by which psychical energy comes to play on Broca's speech organ, and determines our power of silent speech or cogitation, as well as the utterance of our thoughts in intelligent language. We attempted to illustrate this process by means of a diagrammatic form.

In this diagram the letter E represents the nervous apparatus of one of the sensory organs, which receives energy from the external world, and transmits it to A, a sensori-memorial centre located in the cerebral cortex. In this centre the sensation produced by the stimulus, or mode of energy received from A, takes the form of an idea or mental image of the object that produced the sensation. In the form of ideas energy passes from the centre A to B, where ideas are associated, and by practice elaborated into psychical processes which pass to M, the motor area for word-ideas and becomes manifest in intelligent speech, VA.



The above statement gives nothing more than a bald outline of this truly wonderful and complex system, but it claims our attention for the following among other reasons.

In the first place there is no difficulty, in properly prepared specimens, in demonstrating the paths by which energy is conducted from the sense organs to the cortical nervous centres, and onward to various groups of muscles. Further, we can show that the cortical nervous centres are all intimately connected to one another, and to the basal ganglia and other important structures contained within the cranium and spinal canal (Fig. 14, p. 111).

With reference to the path followed by energy in its passage through the sense organs and cerebrum to its discharge in the various groups of muscles, we are struck by the number of interruptions and transmutations it has to overcome before it reaches its destination. Not only does the form of energy become as it were sifted in its passage through its appropriate sensory organ, but it must undergo modifications at each stage of its progress through the cerebrum. We conceive that this system is in some way adapted to facilitate special modes of energy reaching their destination in living elements of the psychical areas of the neopallium, and is there transmuted into forms capable of promoting the wellbeing of the individual and of the race to which he belongs. Action of this kind must depend largely on the inherent nature of this living matter, and the training it has undergone especially during the early years of life.

We find clearly defined differences in the form, and probably therefore in the functions performed by the various strata of cells which constitute the cortical layer of the neopallium (see p. 94). Beyond this the character of these cells differs in the various lobes and convolutions into which the pallium has been divided for descriptive purposes. With few exceptions the form and structural arrangement of the cells of cerebral cortex are precisely similar in the various families of men scattered over the face of the earth. The exceptions to this rule, so far noticed, consist in a reversion, in the case of the brains of certain Egyptians and natives of Australia, to a type of neopallium similar to that which is found in the man-like apes and certain idiots.

The living substance of a well-recognised *pyramidal* form of cortical cells has evidently become specialised for motory purposes, being the medium through means of which energy received from the psychical elements is transmuted into energy capable of acting upon various groups of muscles.[1]

By way of hypothesis we assume that the living elements having definite functions may elaborate the various psychical processes, but until we have further evidence bearing on the physiological properties possessed by these various forms of matter, it seems premature for us to dwell on this subject.[2]

[1] After amputation of either an upper or lower limb, it is found that the cortical nerve-cells which have supplied nervous energy to this limb before amputation become atrophied, their living substance for some time previous to death not having been used had dwindled away. Dr A. W. Campbell, Abstract of Paper read before the Royal Society, Dec. 3, 1903.

[2] In the English translation of Professor T. Ziehen's work of "Introduction to Physiological Psychology" the reader will, as the translators remark, find an excellent account of the field of physiological psychology in general, based on the English interpretation of the psychology of association in particular. The work, though small in comparison with most books on this subject, embraces within a limited compass the essentials of the science. The author defines clearly the province of this science, and finds the limits that separate it from other related sciences. Throughout the entire work it has been his aim to develop all explanations as far as possible from physical or physiological data, and to account for the presence of certain functions by an application

That certain areas of the cortex possess limited but well-defined functions, is established by cases such as those we have referred to ("Human Speech," p. 214), in which the memorial auditory centre for words was obliterated in both hemispheres of the cerebrum. As regards vision Dr George Mackay has reported the following case, demonstrating not only that the visual cortical centre is located in the occipital lobe, but that it has become differentiated into living matter possessing separate visual functions. This individual, who was sixty-two years of age and whose appreciation of colours such as those of flowers and other objects had been perfect up to this time of life, suddenly lost this power, and became what is known as completely "colour-blind," but he could still see to read, in fact his near and distant vision for objects was perfect, but he had lost all perception of their colour. The patient died suddenly in April 1897, and after death it was found that the part of the cerebral cortex which forms the centre for colour sense had been destroyed by disease of this area of the occipital lobes.[1]

It is, we repeat, through the action of energy received by the sensori-memorial cortical centres that sensations are produced and are elaborated into ideas by the surrounding psychical elements. The idea denotes the thing from which the sensations are

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of the laws of evolution. In fine, the author treats physiological psychology, as it should be dealt with, as a natural science. See Translator's Preface, p. viii., "Introduction to Physiological Psychology," by Dr Theodor Ziehen, Professor in Jena.

[1] From the Laboratory of the Royal Col. of Phys., Edinburgh. See also the Bradshaw Lecture for 1909 by F. R. Cross, F.R.C.S., *Brit. Med. Journ.*, December 18, 1909.

derived, and any sensation in the idea means a feature of the thing. The tone, the smell, colour, as sensations, can thus be communicated indirectly by reference to the sounding, smelling, luminous physical objects, and any degree of exactness can be reached by the increasingly accurate description of the physical side.[1] In the same way we conceive, ideas, the result of work performed by specialised elements of living nervous matter, become manifest through the action of the psychical cortical matter into psychical processes. For instance, the idea of an orange is formed by the association of the memory centres of taste, touch, smell, and vision, aided by the muscle sense in handling an orange. Each sensation has been acquired by its particular sensory centres through means of a course of training which has been going on from the early years of childhood. But it is through the action of the memory and psychical elements of the cerebral cortex we are enabled to think of an orange, that is, to form a complete mental image of it when it is not present to our senses, and to recognise it instantly when it is present (see p. 65).

If any one of the sensori-motor centres or the chain of communication between them is destroyed, the process above described is hindered if not lost, provided both hemispheres of the cerebrum are in like manner affected. Cases of aphasia demonstrate this fact, the power to see the words may continue in operation, but the aphasic person, though he understands their meaning and hears them when repeated, cannot pronounce the words because the region in

[1] "Psychology and Life," by H. Münsterberg, p. 50.

which the motor idea of words is located is out of gear.

The mass of the neopallium has increased in proportion to that of the rest of their brain or of their bodies, from the anthropoid apes up to man of the tertiary period, and onwards through the glacial and post-glacial times to that of men now existing on the earth. With this increase in the amount of living substance of the cerebral cortex there has been a corresponding increase in man's psychical powers. On the other hand, human beings born with imperfectly developed neopallia, or those whose cerebral cortex has been damaged severely by injury or disease, experience a corresponding diminution in their mental capacities.

There can be no question as to the influence which the work performed by the nervous substance of the neopallium exercises over the destinies of the human race; it is not by physical strength or by his inherited instinctive character that man has attained his predominant position in the world, this position he has gained by means of the evolution of the living purposive elements of his cerebrum into the mass of psychical material which he above all animals possesses in the form of a highly-developed neopallium.

Philosophers, however, of the highest rank (Schopenhauer, for instance) have arrived at the conclusion that human beings may " be endowed with acumen and culture, and perceive what is wrong and disapprove of it; but if the personal character of the individual is inclined to wrong-doing the intelligence cannot prevent or even correct his reprehensible inclinations.

Well-doing or wrong-doing do not therefore depend on the intellect, but on the character."[1]

We cannot fully concur in this opinion, but we do maintain that the personal character or inherited instincts of human beings form a kind of substratum (unconscious) to their mental life, and constitute the real cause of most of their actions. It is this substratum of feeling of each individual and race which forms the individual or national character, and may be traced back more or less clearly to their ancestors. In our opinion these characters result from work performed by the living instinctive elements of the basal ganglia and the inner cortical lamina of his cerebral hemispheres. We conceive it hardly possible that this form of matter made its appearance suddenly in some far distant progenitor of the human race, and through him (and her) came to endow with instinct this order of animals. As we have attempted to show, it seems more probable that the evolution of this matter has been effected gradually, and reached its present stage of development in the various classes of animals by means of natural selection.

From early childhood onwards, by constant practice of the maturing chain of nervous structures which constitute our sensory organs, sensori-memorial centres, association areas, and motor centres, we learn to form and to connect ideas, and thus acquire the power to think, and to give expression to our thoughts in intelligent language. We have endeavoured to elucidate the nature of the materials concerned in these processes.

[1] "Contemporary Psychology," by Professor Guido Villa, pp. 219-295.

In our work on "Human Speech" we dwelt on the nature of the organic materials which forms the basis substance of living matter and described its fundamental properties, and its development under the action of its environment into sensory organs and corresponding cerebral centres. We thus arrived at the conclusion that it was through the systematic training of the nervous substance of the sensory organs and their cerebral centres, that we could best hope to develop the psychical cortical substance in young people.

Starting upon this basis, we have shown in the preceding pages that the actions of human beings throughout their lives are, to a large extent, controlled by their inherent personal characters, as distinguished from their intellectual acquirements, and that these hereditary qualities depend on work performed by a definite area of their brain.

In order to substantiate the conclusions arrived at on this subject from a study of comparative biology, we have, in the second part of this work, given the outlines of the history of a tribe of men which demonstrates, not only the existence of inherited personal characters, but also the important part they take in ordering the lives of individuals and the destinies of the race to which they belong.

PART II

CHAPTER I

BEFORE commencing to portray the hereditary traits of character which, to a large extent, ruled the conduct of the people we are about to study, it is advisable to refer to the nature of the locality in which they existed, and to the laws and social condition under which they lived from the dawn of the historical period until the close of the sixteenth century.[1]

These people dwelt in a well-defined part of Ireland now known as County Clare. The southern and eastern boundary of this county is formed by the river Shannon, which in the time to which we refer was fordable at only one place below the existing town of Killaloe. To the east the county is bounded by the Atlantic ocean, and to the north by Galway Bay, and a strip of bog-land, together with the range of Echtye hills, which in former times were covered by dense almost impenetrable forests. This district therefore in ancient times was almost completely isolated from the rest of Ireland and from the outside world.

We have still, in what is known as the Brehon Code, the laws and regulations which governed the lives of the inhabitants of County Clare for many centuries. In this code we find prescribed the regulations which ordered the position of the various classes of the

[1] Much of the following pages is taken from a work published by the author, "The Story of an Irish Sept," which has been out of print for some ten years past.

ancient Irish, the management of their lands, dwellings, and in fact of all their family and social relations.[1] It was not until the year A.D. 432 that St Patrick proposed to revise and commit the Brehon Laws into the form of a written code, expunging from them what was contrary to the teaching of Christianity, "for the laws of nature had been quite right except the faith and its obligations, and in harmony of the Church and the people."

Until the time therefore of the introduction of Christianity into Ireland the Brehon Code had been passed on orally from one to another generation by a class of men known as *Brehons,* who had to go through a course of some twelve years' training before they were allowed to enter the lowest ranks of their calling. The Brehons attempted to meet every possible variety of case by rules, leaving no discretion as to the amount of damages to be awarded, for the award rested upon some previous decision given in an actual or in a hypothetical case laid down by the Code. There was no appeal from the decision of a Brehon unless on the ground of "sudden judgment." Each province had a chief Brehon who was the King's adviser.

There was, however, no direct power of enforcing the law, and this entailed a process known as that of *Distress,* which consisted in the intervention of some extraneous influence to arbitrate between persons who were otherwise unable to settle their own differences. This was a complicated matter in many cases because,

[1] Mr Basil Kennett in his work on "The Law of Nature and Nations," p. 73, states that the Brehon Code in some respects nearly resembles the Visigothic Code, the Forum Judicum, or the Fuero Juzgo of Spain.

as a rule, individuals had no personal property; it was from the common family stock that the payment of all fines had to be met.

If an offender refused to submit his case to the arbitration of a Brehon or declined to meet the award given against him, the injured person proceeded under the law of distress to seize a certain number of the cattle or other effects of the defaulter, after having given due notice of the action he was about to take. If cattle were seized they were placed in a pound and properly cared for. The parties concerned in the action appeared before a Brehon, with witnesses, and all that was necessary to prove the claim. The arbitrator having heard the case on both sides gave judgment in accord with precedence laid down by the Code. This judgment was final, and unless the person against whom it was given, or his family, conformed to the decision, he was excluded from the tribe to which he belonged; if low in the social scale he might be handed over to the creditor as a slave for a specific term of years, or for life.[1]

If a poor man made a claim against a landowner which the latter declined to notice, the plaintiff proceeded to fast upon his more powerful neighbour; that is, he seated himself at the door of the rich man's dwelling and remained there without food until he received satisfaction. "He who does not give pledges to a fasting person is an evader of all; he who disregards all things shall not be paid by God or man." A system of much the same kind still prevails in certain parts of India.[2]

[1] Senchus Mōr, "Brehon Code of Laws," vol. i. p. 107.

[2] Sir H. Maine, "The Early History of Institutions," p. 297.

Homicide under the Brehon laws was punishable by a fine, such as the Brehon considered was sufficient to compensate the family of the murdered man for the loss they had sustained. But cases of homicide were divided into two classes, those committed with forethought, and those without malice. One of the chief difficulties St Patrick experienced in revising this Code was his demand to kill the murderer; and although he prevailed in words, the people declined to follow his teaching, and so murder remained punishable by a fine, and this state of things was one of the chief charges brought against the Code by English lawyers of Queen Elizabeth's time.

One of the volumes of the Brehon Code is given to the subject of *Bee Judgments* or the rights of persons to swarms of bees which had settled on their lands; honey in these early times was a valuable article, being used in place of sugar until well into the sixteenth century. Questions arising out of bee swarming were complicated, and gave rise to all manner of hypothetical and actual judgments, which fill many pages of the Brehon law tracts.

The Tribe and Sept—in the Brehon laws, the word "*fine*" is used for the family, that is, for the children of the same parents; by the term sept (which is the same as the conjoint family in India) is meant the combined descendants of an ancestor long since deceased, who had been one of the sons of the original chief or head of the tribe. The tribe consisted of a group or aggregate of septs. To each sept a specific portion of territory or tribal and common lands was assigned.

The chief of the tribe was elected to office by the free men of the tribe from the "next in blood that was eldest and worthiest." The head of the sept was elected to office in the same way, and was under certain military and financial obligations to the chief of his tribe; the latter in his turn was in later times subject to the King of the Province in which certain tribes and sept were located. The principle underlying this system was that the title to nobility depended entirely on the known character of the man as testified by his fellow-tribesmen. But it was evident that under a system of this kind the tribe or sept might have been left in the midst of a battle or other emergency without a proper leader. To obviate this difficulty when the chief was chosen the tribe or sept also elected a *Tanist* or substitute chief, who as a rule was one of the elder sons of the chief; but "he must be the most capable member of the family," no other claim was allowed. In the case of competitors arising among the tribesmen for the office of leader, the dispute was settled in a speedy and practical fashion by the contending parties meeting, and in combat testing which was the strongest.

The chiefs of tribes and septs had in proportion to their social position, certain areas of land allotted to them which they held in virtue of their office; they also received tribute and cesses from the freemen of their tribe or sept, which were paid in stock. They were in return bound to practise hospitality, to provide, and be ready themselves with their followers to defend their lands and province from external foes.

The family or sept consisted of kinsmen combined for social purposes, its members shared their goods in common, their home was the centre of the family life, and was governed under a system of unwritten laws by an elected head, who was answerable for the good conduct of the members of the family, for the safe keeping of its stock and other goods. There was no executive authority to enforce order, the head of the family was supreme within the precincts of his home and lands, and in case of necessity could expel a member, who thus became an outlaw or in most cases a serf.

It is evident that under a system such as this a man and his wife would, with their children and grandchildren, soon overstock the parental home; and as the lands allotted to a family were limited, it was necessary to restrict the number of sons entitled to become landholders. If there were more than the prescribed number of sons, the excess had to become retainers on the estate or to shift for themselves; on the death of one of the sept the chief made a re-partition of the land belonging to the family, everyone receiving his share according to his position in the family. In this way, and by the method of restricting the partition of the land as above mentioned (gavel-kind), the descendants of the original head of the family claiming land were kept within due limits.

The ownership of land was the centre round which the whole social and political life of the early Irish revolved. It was the possession of land and the means of cultivating it that constituted a freeman, in contradistinction to the landless person, who was a bondsman or serf, and possessed no social position or rights whatever; he could be bought or sold in the same way as cattle, and was evidently in many instances even less cared for than his master's horses.

From the Brehon laws we learn that "persons are of equal rank when they have the same quantity of land"—that "what a man had not bought he cannot sell"—"a man was bound to keep his lands during his life perfect, and leave them with no greater debt than he received with them"—"he must leave his share in the land to the common possession of the family to which he belongs."

Landlords and landholders, as freemen, were divided into classes according to the quantity of land and cattle they possessed; each class being entitled to definite privileges. Thus, the head of a family could only claim admission to the lowest class of freemen if for three generations the family had possessed a certain amount of land, a plough, an ox and harness, a kiln, hand-mill, cooking cauldron, and various other articles; a larger amount of land and stock raised a man a step in the social scale, and so he might rise to the sixth grade, in which class of society the landholder, among other articles, must possess "a head-bathing basin," and other articles described with minuteness in the Brehon Code. The landlords were likewise divided into classes, according to the amount of land they owned. Besides many other things mentioned which a landlord must possess, were beds and bedding, and a kitchen boiler "in which a cow would fit, or a pig in bacon."[1]

A family could thus rise if they acquired and held sufficient lands for three generations to enable its head to qualify for a higher class; on the other hand the loss of property entailed forfeiture of position and with it social privileges.[2] There was no hereditary claim to

[1] O'Curry, "Manners and Customs of the Early Irish," vol. iii. p. 29.
[2] "Brehon Laws," vol. iv. p. 227.

property, and every man was enabled by hard work and skill to raise his family in the social scale.

A landlord having more tribal lands than he required, might hand over the surplus to his relations on condition of receiving tribute, and providing food for the landlord and his servants, as well as military duty when required. Tribute consisted in one case of "a calf, a salted pig, a sack of wheat or malt, and a handful of rushlights." This class of landholder, and those who farmed the private estates of large landowners, soon grew to form an important element in the country, principally because their landlord could at all times demand military service, and the number of his retainers was thus augmented, and as most of these retainers were in debt to their landlord, he compelled them not only to fight for him, but also to build his forts, and construct roads over his estate. But if the landholder had given "food, rent, and service" for seven years, on the death of the landowner the stock on the occupied lands passed to the holder; on the other hand, if the landholder died his family were to a great extent relieved from the obligations which the deceased had incurred.[1]

According to Brehon laws a father was obliged to provide for his daughters either in their own home, or more commonly in the home of foster-parents, until the girl had attained the age of seventeen when she was marriageable. A father was bound to marry his daughters to men of equal rank to his own. He was also obliged to support his daughters if necessary in old age, sickness or trouble. Mothers had to provide for their sons, who had reciprocal obligations.

[1] Sir H. Maine, "Early Institutions," p. 163.

The laws relating to marriage carefully protected the rights of married women. Unlike the Roman law the Brehon Code demanded for the mother of a family a position equal to that of the father, and when they possessed equal property the one could not enter into any contract concerning it, without the consent of the other. We know little regarding the ceremony of marriage, if any, as practised by the ancient Irish people. A divorce seems to have been a matter of mutual understanding even as late as the eleventh century ; for instance, Brian Boru took to himself a wife who had two other husbands, and when he found her too hot-tempered to be agreeable he parted from her without ceremony.

The subject of *Fosterage* formed an important part in the family life of the early Irish people ; it was held by them that discipline, obedience and respect for their superiors, and the work which boys and girls would have to follow in their after lives, was best learnt away from their own homes. Parents consequently sent their children when about seven years of age to a relative, or someone belonging to their own grade of society, to be nurtured and instructed so as to fit them for their future calling in life. The person to whom a child was entrusted was called his foster-father. As the young person's work in life was, in addition to physical exercise and the use of arms, connected with the soil, the cultivation of the land and that which grew and fed upon it was what the boy had to learn. The girls in the same way were instructed "in discipline, the use of the quern, kneading, and all descriptions of domestic work." We hear nothing of the intellectual acquirements of these young people ; in truth no instruction of the kind was possible until well after St Patrick's time. Up to that period the education of the hereditary characters of young persons was the aim of foster-parents, together with training their powers of endurance and preparation for war. To enable the foster-father to fulfil his trust he was, under the Brehon Code, allowed to chastise his foster-son, but never to the extent of drawing blood or leaving a mark on a lad ; heavy penalties were imposed for a breach of this law. In case of illness, inability to learn his duties, or for gross misconduct, the foster-father was allowed to send the lad back to his parents ; on the other hand, if a foster-father kept a boy until he was seventeen years of age, when the lad was under obligation to return to his home, and it was then found he was not efficient in the use of arms and for the work of his future calling, obedient, and in fact properly instructed, the foster-father was heavily fined. The amount of the fine was to be made over to the lad, because, as the Brehon Code states, it was "upon him the injury of the want of learning had been inflicted."[1] While under the care of a foster-father it was prescribed by law that a lad's food should consist of porridge flavoured with salt butter and milk. Among the upper classes honey was added to the porridge. There was an abundance of fish and meat to be had, but these articles were not included in the diet-roll of young people reared in ancient Ireland.

The sons of the higher classes, in addition to the use of arms and the care of land and stock, were

[1] "The Brehon Code of Laws," vol. ii. p. 155. A system which many parents would at the present time gladly see enforced.

taught horsemanship, chess-playing, and swimming. They rode their steeds bare-backed and with only a piece of rope in the animal's mouth to guide him.

The after-training of these youths, up to end of the third century of the Christian era, may be learnt from the descriptions that have come down to us concerning the training of the Fenia or Militia of ancient Ireland. Before a lad could enter this corps he was subjected to an examination, in order to show that he was able to defend himself with a shield and hazel stick, from javelins thrown at him from a distance of twenty yards. It was necessary for him to be a good runner, to leap over a bar up to the height of his chin, and stoop under one as low as his knees. He had to be strong of arm as tested by the use of the sword, battle-axe and mace. Having qualified in these subjects he had to give security that, if killed in battle none of his family should attempt to avenge his death, "the affair of his death must be left wholly in the hands of his comrades, who should take care to do him justice."[1]

The Fenia are described as being keen sportsmen, and after a day's hunting, they sent the game to a convenient spot and roasted part of the venison on spits, baking the remainder after having bound it round with ropes of grass. They ate but once a day; before feeding they stripped, bathed, and dressed their hair. "They then began to supple their thews and muscles by gentle exercise, loosening them by friction, until they relieved themselves from stiffness and fatigue, after which they took their meal, and then constructed booths and prepared their beds of

[1] Keating's "History of Ireland," O'Connor's Edition, p. 271.

brushwood placed on the ground, and over that moss and fresh rushes."

We find references in the Brehon Code to an institution or office known as the *Public Hospitaller*, which existed in Ireland from the earliest times until the sixteenth century. The functions of this individual were to keep open house on the part of his sept, and to receive distinguished visitors, or strangers passing through his district when the chief of the sept from any cause was prevented from entertaining such people. To enable the hospitaller to perform these functions he was allowed five hundred acres of free land, besides other privileges. The hospitaller's house was in truth a kind of public hall, and in it assemblies were held for various purposes connected with the interests of the sept. The dwelling occupied by this official was built at the meeting of cross-roads, and he was bound to keep a light burning over his residence throughout the night, so as to direct wayfarers to the house. The hospitaller was precluded from taking presents from persons who sought his hospitality, for he was supplied with stock for the purpose by the surrounding landlords. He possessed considerable powers over those who abode in his premises and attempted to injure the public property.[1]

These people long before the Christian era made provision for the poor and sick; officers were appointed to discharge these functions. He had large powers, and was allowed under the Brehon Code to levy a rate in kind on landowners for the "wretched and wandering poor." This officer is described as a "pillar of endurance," a truly Irish idea of a relieving officer; he was further to suffer "the reddening of his face with-

[1] "Brehon Laws," vol. i. p. 47; vol. iv. pp. 311, 313, 315.

out insult to his tribe," or in other words was not to account himself as being disgraced because he was abused by beggars. Each tribe was chargeable for the maintenance of its own "sick men and women, and for the keep of those who were incurable." We also learn "with respect to sick maintenance" that it included the attendance of "a physician and for providing food, bedding and lodging, and in guarding the sick from things prohibited by the physician." Careful provision was also made for persons of unsound mind, of the blind, and of orphans.

The physician was much esteemed, and we learn from the Brehon Code that it was not uncommon for a tribe to make him a grant of land, so that he was prevented from "being disturbed by the cares and anxieties of life, and enabled to devote himself to his profession."[1] It is stated that if an unlawful "physician" removes a joint or sinew without obtaining an indemnity against liability to damage, and with notice that he was not a regular physician, he is subject to a penalty with compensation to the patient."[2] If a man was maliciously wounded it was the duty of the physician to certify the same and on his judgment compensation was awarded.

These doctors appear to have appreciated the value of cleanliness, pure water and free ventilation in the treatment of the sick and wounded. The physician's house was the appointed place where sick and wounded people, including chiefs and freemen, were to be cured, a practice which was continued up till the fifteenth

[1] Keating's "History," pp. 131, 138, 143; "Annals of Four Masters," A.M. 3922.

[2] "Brehon Laws," vol. iii. p. 323.

century in County Clare. The house was in every case to be built either on the bank of a running stream, or with a stream passing through the precincts of the house. The building in which the sick were treated was to be provided with four doors, with the object of "allowing all that took place within it to be open to inspection, and to permit one door being left open whichever way the wind blew." The hot air bath was much employed for rheumatism, and shampooing is highly extolled.

The Bards played an important part in the early history of Ireland; they fixed the social and political relations of the ruling and of the tribal chiefs, and recorded the deeds of each and of the sept to which they belonged. The early Irish warriors received no titles or reward from the state, or from their leaders for services rendered in the field, their reward consisted in having their names honourably mentioned by the bards in the annals of the country. Their deeds were sung by the bards and afforded a never-ending source of delight to their families and retainers. It is true the chiefs were "assigned by the bards a distinguishing coat-of-arms, not as a mark of honour, but whereby they might be known from other chiefs, and recognised in the field of battle or at their place of residence."[1] The language of the ancient Celtic bards, when translated into English, seems inflated, in many cases absurd, but at the time it was employed it was highly appreciated. For instance, we are informed that about the year A.D. 960 a labourer, having been employed for a year in Galway, received for wages "a cow and a cloak." Returning home over the hills of Echty he met

[1] Keating's "History," p. 143.

on the road a well-known bard, and having entered into conversation with him and told him the tribe to which he belonged, the bard then and there composed some verses in favour of the tribe, which so much pleased the labourer that he at once handed over his year's wages to the poet, and returned home empty-handed, but still remembering the lines he had heard. This action, and the gracious words contained in the verse, so much delighted the man's fellow-tribesmen, that they made him a present of "ten cows for every quarter of the cow he had bestowed on the bard."

The Druids formed another class of men who exercised a potent influence on the ancient Irish, claiming as they did power to control the spirits presiding over the elements of nature as well as those of men. We find that the Irish Druids were consulted regarding almost every action men and women undertook, and their advice was strictly followed in all private or public affairs; they acted as arbitrators in disputes, and were in the habit of "placing a rod upon a person, and through means of their wand could discover his history."

The old Irish legends are full of the wonders performed by Druids, but in all this literature we read nothing of human sacrifices; they raised mists and storms to confound the enemies of the chiefs they were attached to. They believed and taught the idea of the transmigration of the spirit of a man in order that it might arrive at a state fit to become a part of the all-pervading Spirit of the Universe.[1]

[1] "Silva Gadelica," by Standish H. O'Grady, p. 98; also "Pagan Ireland," by W. G. Wood-Martin, p. 99; and O'Curry's "Manners and Customs of the Early Irish," vol. ii. p. 208.

As late as the year 1644 the inhabitants of the island of Aran in Galway Bay, worshipped with idolatrous superstitions an idol or image of their God, Mac Dara (Dara meaning "oak"). It was in vain the Catholic clergy called on them to desist from this practice and from swearing by Mac Dara rather than on the Bible.

It is however certain that as far back as the year A.D. 266 influences of a higher order than those referred to as existing in Aran had come into operation in other parts of Ireland. Thus Cormac Mac Art, one of the rulers of the country and a distinguished warrior, having sustained an injury to one of his eyes, determined to resign his position and devote the remainder of his life, as he stated, "to meditation and the worship of God, the Creator of Heaven, and also of a place in which the souls of the wicked should be justly punished." He further states "that it was beneath the dignity of a rational being to adore anything in the form of an idol, but that his prayers should be directed to the living Supreme Being who created all things." Keating remarks these were this chief's own words, recorded by himself in a work which existed in the historian's time; but which, like so much other valuable material, has since disappeared, a prey to the fire and sword which has destroyed so many of the ancient records of that country.[1] Cormac had been brought up by a Druid, and he practised their art, for he undertook to cure one of his friends of leprosy by means of magic.

In connection with Cormac Mac Art the following anecdote gives us an idea of the times in which he

[1] Keating's "History of Ireland," O'Connor's edition, p. 283.

lived (A.D. 227 to 266); when a youth he was at his uncle's court at Tara. It appears that sheep had strayed into the Queen's garden and eaten some of the vegetables; the case was brought before the King and he adjudged the sheep to the plaintiff in lieu of the trespass and damage done. Young Cormac hearing the sentence came forward and stated openly, that the judgment would have been more equitable if the shearing of the sheep had been ordered in damage of the green stuff cropped; for he said the stuff will grow again, and so will the wool upon the sheep.[1]

The soil had evidently been prepared by St Ailbe, Declan, and Palladius, for the coming of St Patrick who arrived in Ireland about the year A.D. 432. The place of his birth is uncertain, but he had been carried a prisoner into Ireland as a youth and employed by his master to tend sheep. He remained in this service for six years, and during that time must have learnt the language spoken by the people; he then escaped from Ireland, and after much suffering and a long probation he returned to that country as a bishop.[2] He appears to have built up the Irish Celtic church on the tribal and family system he found in Ireland; and so long as the superstitions and ideas of the people were not at variance with the spirit of Christianity he seems to have wisely left them alone.

We have now, in order to ascertain the nature of their instinctive or hereditary dispositions, to determine the race or races of people from which the

[1] "Silva Gadelica," p. 357.

[2] "The Tripartite Life of St Patrick," by Whitley Stokes, Introduction, p. cxli.

Irish Celts were derived; if we can arrive at a reliable conclusion on this subject, it will be our object to show that the conduct of these people for a long period of time was dominated by their inherent personal characters.

The earliest human inhabitants of Ireland, like those of the southern and central part of Europe, consisted of what is known as the Iberian or Mediterranean stock. They were a long-skulled (dolechocephalic), small, brunet people, with brown or grey eyes, and dark curly hair, a type to be still found in considerable numbers among the inhabitants of County Clare.[1] The chipped flint instruments used by these people are found in post-glacial deposits over various parts of Ireland, and some of their skulls and other parts of their skeletons have been discovered in that country, as well as in England and many parts of the continent of Europe.[2] These people are probably best represented at the present time by the inhabitants of the coast line of Catalonia northward along the Gulf of Lyons and the valley of the Rhone. The predominant features in their character is its marked instinctive qualities, the emotional side of their nature being very pronounced; they are frequently referred to in the ancient legends of Ireland as being a treacherous race; when we first meet with them in the west of Ireland they had emerged from their primitive state and developed into tribes under the leadership of a chief, who for long resisted the Celtic invaders of Ireland.

[1] "A Short History of the Irish People," by Professor Richey, p. 26.

[2] "Origin and Character of the British People," by N. C. Macnamara, p. 183; also "The Races of Europe," by Z. Ripley, p. 53.

The question is, who were these so-called Celts and where did they come from? Our opinion is, they were an offshoot of the ancient Aryan stock, doubtless modified to some extent by climate and the intermixing with other races of men during their slow migration from Asia into the west of Europe. The home of this race was probably on the mountain ranges which extend north and south of Kokan. These Aryans spread east and west, the latter branch ultimately reaching the British Isles, and the south-eastern branch extending into India.

The Aryans were a vigorous hardy race, tall, fair, and evidently originally reared in a bracing atmosphere. They possessed, like the Iberians, long skulls (dolecho-cephalic), they buried their dead chiefs in the long dolmens or temple tombs scattered over Ireland, England, and most of the other countries of Europe, where their skeletons and the stone implements they used are still found. They spoke an inflected language, the vestiges of which exist in the Erse, Manx and Gallic tongues.

The Aryans appear to have been an imaginative race of beings, given to the study of astronomy; they worshipped a Supreme Being, a power more or less manifest to their senses in the various phenomena of nature. The spirits of the departed, they held, possessed power over the actions of the living. It was in this belief they placed their dead in tombs in which sacrifices could be made to propitiate the departed spirit of the dead.

The Aryans, when they entered India, were led by their king and rulers of their tribes; each tribe having its own chief, who, like the king, was elected from among the living descendants of the progenitor of the tribe. The tribe consisted of a number of families, each of them having its own head, and all bound to the chief of the tribe by consanguinity. Each tribe, therefore, formed an organised society in itself, and for all practical purposes was independent, making war or peace with its neighbours according to its own will. But in times of national danger the king, as head of an assemblage of tribes, could command the services of a large following. The whole system, from the king to the head of the family, tended to promote particularisation of individuals, and this led to rivalry and to constant war among the various chiefs and tribes. This fact was manifested among the Celts of India, for they had no sooner overcome the aborigines of the country than they divided the land into tribal and personal estates, and then commenced to fight with one another, each chief claiming possession of his neighbour's property.

It would appear from the ancient legends of Ireland that the country was invaded in pre-historic times by a people who answer to the description of the Aryans. They were said to have arrived in vessels from the south-west of Europe, and to have landed in the south of Ireland, but they were defeated and driven out of the country by its Iberian inhabitants.

At the close of what is known as the neolithic period we find a race of broad-skulled (brachycephalic) people had passed from Asia into Europe and had settled among its Iberio-Aryan population. With the advent of this race in the west, bronze implements came into use, and supplanted in the course of time stone implements. This broad-skulled race was of a

Mongoloid type; they had discovered how to make bronze out of a mixture of copper and tin. This latter metal as an alluvial deposit was rare in Europe but abundant in parts of Asia, the consequence was this Mongolian race became indispensible as traders in bronze to the rest of Europe, and ultimately formed an important element in the constitution of the people inhabiting central and eastern Europe. They spread through the south of France to the Atlantic, and were largely dispersed throughout the south of England and Ireland. From an anthropological point of view these people constitute the only true Celts, but this term had before the year 1865 been almost invariably applied to the tall blonde people, who as we have stated, were of Aryan descent, and it is now very difficult to break away from this terminology. We shall therefore still continue to apply the term Irish Celt to this latter race represented at the present time in considerable numbers among the inhabitants of the French districts of Dordoyn, Geronde, and Charente. Cæsar seems to have referred to the progenitors of these people as "those who in their own language are called Celts, in ours Gauls." Monsieur Thierry, the historian of the Gallic Celts, and Professor Mommsen in his "History of Rome," from a close study of the history of this race have arrived at the following conclusions regarding the hereditary character possessed by these people.

Mommsen.	Thierry.
1. "The whole ancient world presents no more genuine knight."	1. "Personal bravery unequalled among ancient nations."
2. "Incapacity to attain or even to tolerate any organisation, either military or political."	2. "Marked dislike to the idea of discipline and order."

Mommsen.	Thierry.
3. "Laziness in culture of the fields."	3. "Want of perseverance."
4. "Love of ostentation."	4. "Extreme ostentation."
5. "Extravagant credulity."	5. "Open to all impressions."
6. "Inclination to rise in revolt under the first chance leader."	6. "Perpetual dissensions."
7. "Irresolute and fervid."	7. "Extreme susceptibility; impetuous, and excessively vain."
8. "Clever."	8. "Remarkably intelligent."
9. "A delight in singing and a talent for poetry and rhetoric."	9. "A free spirit."
10. "In a political point of view thoroughly useless as a nation."	10. "As a nation the personal sentiment, the idea of self, far too much developed."

Mommsen adds that the Celt was remarkable for "his childlike piety, unsurpassed fervour of national feeling, and the closeness with which those who are fellow-countrymen cling together, almost like one family, in opposition to a stranger."[1]

Dr Richey, who was Professor of Feudal and English Law in the University of Dublin, and to whose admirable "History of the Irish People" we are so much indebted for our knowledge on this subject, states that, in his opinion, the admitted failure of the Celtic race is not so much attributable to the inferiority of their organisation, as to the fact of their possessing a highly organised and sensitive disposition. They are therefore extremely susceptible of emotions and perceptions, and apt to arrive at rapid conclusions, which are not always lasting. They shrink against the staying power of the Teutonic race, the Celt's ideas being too often matured before the Saxon has mastered even the premises on which his opinions are founded.

[1] Mommsen, "History of Rome," vol. iv. p. 280.

The stolid, persevering, and fixed purpose of the Saxon has and must prevail over the light-hearted, sensitive, and comparatively indolent Celt.[1] Dr Richey, like Mommsen, dilates on the remarkably tenacious feeling which the Celt has for his fellow-countrymen, his family, and, when they existed, for his chiefs ; and the Rev. Dr Todd, in his "Life of St Patrick," observes that the "keynote of Irish history is the spirit of clanship among Irishmen, together with adhesion to ancient traditions."

From a general description of the kind to which we have above referred, we may give an example of the character displayed by a Celtic chief, who must have flourished in Gaul about the time of the second inroad of Ireland by people of this race.

Cæsar having invaded Gaul from the south, and the Germans from the east, the Celts were almost completely subjugated. In the year B.C. 53 there was little left of them beyond Brittany, and there, under the leadership of one of their chiefs, Acco, they for some time resisted the Romans. But at length their last stronghold, Veneti, fell ; Acco was taken prisoner and executed by the Romans. This act was sufficient to rouse the whole Celtic people to revolt, and they elected Vercingetoria as their chief. He, despairing of defeating the Romans in the open field, determined to mobilise a large force of cavalry, and by its means destroy the enemy's supply of food, and to cut off his means of communication with Italy. Vercingetoria abandoned all weak places of defence and concentrated his efforts on strengthening those points he believed he could hold with success. In this way he defended

[1] A. G. Richey, pp. 30, 32.

Bourges, inflicting terrible losses on the Romans. For some time Cæsar's position in Gaul was extremely precarious. He failed to capture Gergoria, although he was himself in command of the siege operations. This defeat, the first Cæsar in person had ever suffered, gave great encouragement to the Celts. On the other hand, the Romans became disheartened, and, at a Council of War, Cæsar was advised to retire into Italy. This he refused to do; and, by a rapid concentration of his army and enormous personal exertions, he at length succeeded in shutting up Vercingetoria and a large portion of his army in the fortified town of Alesia. The Romans invested the place for ten miles and completely cut off the supplies of the 80,000 men within its walls. Vercingetoria dismissed his cavalry, and they managed to make their way through the Roman lines, and although 250,000 Celts collected for the relief of Alesia, the Romans had in the meantime rendered their position impregnable. Alesia fell, and with it the Celtic nation. The defeated Celts were allowed to disperse because Vercingetoria refused to take flight, but decided in a Council of War, that, since he had not succeeded in breaking off the alien yoke, he was ready to give himself up as a victim, and to avert as far as possible the destruction of his people, by bringing it on his own head. This was done. The Celtic officers delivered their chief—the solemn choice of the whole nation—to the enemy of their country for such punishment as might be thought fit. Mounted on his steed, in full armour, the Chief appeared before the Roman proconsul and rode round his tribunal; then he surrendered his horse and arms, and sat down in silence at Cæsar's feet. Five years afterwards he was led in triumph through the streets of Rome, and while his conqueror was offering solemn thanks to the gods on the summit of the capital, Vercingetoria was beheaded at the base of the hill. Mommsen adds, "as after a day of gloom the sun breaks through the clouds at its setting, so destiny bestows on nations in their decline a last great man. The whole ancient world presents no more genuine knight than Vercingetoria, the Celtic Chief."[1]

[1] Mommsen, "History of Rome," vol. iv. p. 280.

CHAPTER II

As we have explained in the previous chapter, the earliest inhabitants of Ireland were derived from an Iberian stock; subsequently people known as Celts invaded that country. It was not, however, until the end of the fourth century that the Celts under a leader named Lughaid Menn subjugated the Iberian inhabitants of that part of Ireland, then known as Thomond, but which is now included in County Clare.

Tradition states that Lughaid Menn was directly descended from a Celtic chief named Angus, who with his followers had passed over from Gaul into the south of Ireland. According to our theory, therefore, Lughaid should have inherited to the full the traits of personal character which we have described as being common to the Celtic race (p. 211). In the following chapter we have to ascertain if the actions displayed by this chief and by his direct descendants substantiate our theory, and demonstrate the existence of these characters in the lives and conduct of these individuals and of their followers.

It may be well, however, in the first place, to show how Lughaid came to be the leader of the Celtic tribe known as the Dalcasians; the legends concerning him also afford us an insight into the character and the conditions under which the people of the West of Ireland existed in the fourth century of our era.

The Province of Munster was governed by the chief above mentioned, named Angus, from about the year 184 A.D. to 234 A.D., his eldest son, Eoghan, and six of his brothers were killed in a battle fought against their half-brother Mac-Con, in spite, as the historian states, of their having all been "nursed on the same knee, and at the same breast." Mac Con appears to have been a delicate, peevish child, and, when nothing else would pacify him, those under whose care he was, brought the boy to Angus' favourite wolf-hound, who was so tender and fond of children that young Mac Con and the hound became fast friends, so much so that he received the name of Mac Con (son of a hound). When Mac Con had grown to manhood he was entrusted with certain duties by his step-father, and, having failed in his trust, he was banished by the king from Munster. He sought refuge with the King of Scotland without revealing his name and position, and was received on friendly terms. One day some Irishmen arrived in the Scotch king's presence while he and Mac Con were engaged in a game of chess; Mac Con questioned the strangers as to the state of affairs in Ireland, and then turned the conversation to that of his own family in Munster. "Oh!" said the strangers, "with them nothing goes well; they are under the bondage of women;" upon hearing this remark, Mac Con seized some of the heavy chessmen he was playing with and flung them at the strangers. "A fit of affection," exclaimed the King of Scotland; "it is evident to whom you belong." Mac Con then related his history to the king, and sought his help to regain his position in Ireland. The king accepted this obligation, and, having obtained help from Britain, they assembled "what there were of ships and galleys and barges in the coast of Britain and Saxonland, so that they filled the King of Scotland's ports."[1] The troops on board these vessels were placed under the command of Mac Con, and Beine, a Prince of Wales. The army landed in Ireland near the site of the present town of Galway. The monarch of Ireland, hearing of the invasion of his country, joined his forces with those of Angus, and the allies, led by Eoghan (Angus' eldest son) and six of his brothers, marched to resist their step-brother Mac Con and his allies. In the battle which ensued, not only was the King of Ireland killed, but also Eoghan and his brothers. So crushing a defeat was at once taken advantage of by Mac Con, who proceeded to Tara and caused himself to be proclaimed monarch of the country. He adopted the son of the former king, and this lad subsequently became the famous Cormac Mac Art.

Before his death Angus appointed, with the consent of his tribe, one of his remaining sons, Cormac Cas, as his tanist or successor. At the time Angus made this arrangement he did not know that his eldest son had married the daughter of a Druid the night before the battle in which he was killed, and that the result of this marriage was a son. So soon as Angus was assured of this fact he revoked his former decision, and arranged that Cormac Cas should succeed him; but he decided that, as Eoghan had a son, he or his heirs must succeed Cormac as Chief of Munster, the province being thus governed alternately by the family of Eoghan and then by the heirs of Cormac

[1] "Silva Gadelica," by Standish Hayes O'Grady, p. 352.

Cas "without quarrel or dispute."[1] The descendants of Eoghan formed the tribe of Eoghanists, and the descendants of Cormac Cas formed the tribe of the Dalcasians.[2]

From this history we can understand how the Dalcasians came into existence; they were a division of the original tribe, of which Angus was head, into the Dal-Cas, or sons of Cas, forming one branch, and the descendants of Eoghan the other branch of the Dalcasians.

Lughaid Menn left a son called Connal whose foster-father was known as Crimthan, at that time ruler of Ireland; he belonged to the Eoghanist division of ruling families, and came to occupy his high position in consequence of the rightful heir being at the time too young to fill that office. Crimthan was an intrepid soldier and carried the Irish arms not only into Scotland and England, but also into the heart of France, and from all these places he took hostages and great booty. He had no children, and the succession to the throne was therefore an open question, a fact which Crimthan's sister hoped to turn to the advantage of her son. To compass her end she determined to poison her brother, though "it should cost her her own life in doing this." Crimthan therefore was invited to Connaught by his sister, and while there she poisoned his wine; having first drunk some of this wine, she passed the cup to her brother. They both died. This deed made a deep impression on the Irish, and there can be no mistake

[1] Keating's "History of Ireland," O'Connor's edition, 1630, p. 234.

[2] O'Curry's "Manners and Customs of the Early Irish," p. 387.

as to the fact or the year of Crimthan's death, A.D. 378.[1]

Connal, who was of the Dalcasian tribe, being a foster-son of Crimthan, lived with his uncle from boyhood, and the king became so fond of him that he offered to have him inaugurated as Chief of Munster. The men of that province however declined to accept as their ruler a nominee of the King of Ireland in place of one elected by themselves, they rather inclined to select Corc, a wise and brave prince, as their Chief. Connal agreed to submit the question to arbitration, and the case being decided against him he resigned all claim to be ruler of Munster, and betook himself to govern his own tribe, the Dalcasians of Thomond. Crimthan had such confidence in Connal that he handed over to his care the many hostages he had taken, because, we are told, he felt that he could "rely on the integrity of a prince who delivered up the possession of a crown that he was able to defend, for no other reason but because he had no right to it."

Connal's eldest son was named Cas, and on the death of his father he was elected Chief of the Dalcasians; he had twelve sons who became heads of Septs. The lands constituting the province of Thomond was allotted to these chiefs in proportion to their importance; a part of the territory being reserved for freemen; another part to maintain the poor and the old and infirm of the tribe; and a part was retained as common land which under certain provisions every member of the tribe was entitled to use.

Cas's second son, called Caisin, became the first of

[1] "Silva Gadelica," p. 375.

the chiefs of the section of the Dalcasian tribe known as the Clancuilein Sept. Until Brian Boru's time, family names were not employed by the Irish, they were recognised by names derived from some peculiarity of their features, but not unfrequently from some marked trait of their personal character.

Cas therefore was the immediate progenitor of the Clancuilein Sept in the same way as Cormac Cas was of the tribe of the Dalcasians; from his time the office had passed in unbroken succession through seven generations, Cas being the last of the seven. The territories conquered by Cas's father and grandfather from the aborigines or Iberians were sufficient to allow of their being partitioned among his sons as tribe lands; and in this way the district we now call County Clare came to be subdivided among the members of a Celtic tribe. As time went on the four eldest sons of Cas migrated from their father's home and had lands assigned to them under the provisions of the Brehon laws within the boundaries of Ui-Cas.

During the three centuries following the death of Cas we hear very little of Clare in the annals of Ireland, it would seem that during this period the province enjoyed a period of peace and prosperity, which was only seriously broken by an invasion of Danes in the ninth century. But it is evident the chiefs of the Clancuilein Sept maintained their position as second only to the head of the Dalcasians (O'Briens) in Thomond. Thus we find in the year A.D. 847 the head of the Sept filled the post of Marshal of the Province, his office was to inaugurate the head of the tribe as King of North Munster or Thomond. The office of Marshal, we are told, "was a highly honour-able one and was hereditary,"[1] and so far as the province of Thomond was concerned had been held for many generations by the chiefs of Clancuilein.

In the year A.D. 877 an individual called Flan was ruler of Ireland and demanded a tribute from the Dalcasians which they refused to give. In spite of the warning given him by his Bard, Flan marched into Thomond and pitched his camp on the sacred spot of Magh Adhair. Having challenged one of his followers to a game of chess they commenced to play, but were not allowed to complete the game for the Clancuilein Sept, headed by Sioda their chief, with a strong force attacked Flan ; the King however escaped with some of his followers into the neighbouring forests ; after three days' fighting he had to surrender to Sioda, who, we are informed, treated Flan courteously, fed his followers abundantly, and then escorted them on their way homewards as far as the Shannon.

The chief of South Munster had selected Sioda to be his successor, and the two were on the most friendly terms. Upon a certain occasion, however, Sioda proceeded to Cashel to visit the chief, but on arriving there, declined to enter the King's house until he had received a formal invitation to do so. It is by casual references to incidents of this kind that we gain ideas as to the personal character of the early Irish Celtic chiefs.[2]

[1] Joyce's "Short History of Ireland," p. 63.

[2] Matthew Arnold remarks that Irishmen are distinguished by an "organism quick to feel impressions, and feeling them strongly ; a lively personality, therefore keenly sensitive to joy and sorrow. Quick and strong perception and emotions are to the soul what the senses are to the body ; it means genius. But sensitiveness must not be allowed with impunity to master the mind ; balance, measure

Keating, writing of this period, observes, that the great prosperity of the people of Ireland towards the close of the eighth century led many of them to adopt "corrupt manners, vice, and profaneness—principally among the landowners," from which they were suddenly roused by the cruel hand of the Danes.

The expulsion of the Norsemen from Ireland was the work of Brian (Boru) chief of the Dalcasian tribe. In his career, therefore, we obtain further evidence regarding the hereditary traits of character possessed by one of the Celtic chiefs of western Ireland; characters precisely similar to those displayed by his progenitors.

The two first expeditions which the Danes made into the west of Ireland took place A.D. 795 and 801; on both occasions they were repulsed by the Irish.[1] But from A.D. 812 to 835 a great number of Norsemen flocked into Ireland, pillaging and committing every conceivable cruelty on the inhabitants of the country.

Turgesius, the leader of the invaders, became the acknowledged King of the north of Ireland; he hoped to establish a strong government and so to overcome the discord and anarchy which existed in the country; he also desired to banish Christianity from Ireland; he placed his wife to rule over Clonmacnois: we are told that she was accustomed to preside at the high altar of the principal Church of the monastery, and work the oracles of her religion from that position.[2] In the year A.D. 879 the Irish rose against Turgesius,

and patience, are necessary, and these the Celt does not possess. He is ever chafing against the despotism of facts, straining under the effects of emotion; eager to enlist in the fray, but 'always to fall.'" —See "Manners and Customs of the Ancient Irish," vol. ii. p. 101.

[1] Keating's "History of Ireland," O'Connor's edition, p. 470.

[2] Introduction to the "Wars of the Gaedhil with the Gael," p. xlviii.

and having killed him drove most of his followers out of Erin.[1]

The Norsemen however soon returned, and the west of Ireland, from the year A.D. 890, was overrun by them; we are informed that they occupied the homes of the Irish, so that the owners had not even power to "give milk or eggs to the sick or infirm man; the foreigners claimed the right over everything." The Norsemen were better armed than the Irish. It was in circumstances of this kind Mahon and his brother Brian, chiefs of the Dalcasian tribe, appeared on the scene. From its geographical position, and in consequence of the dense woods which covered its hills and plains, Clare was not so completely occupied by the Norsemen as other parts of Ireland. At any rate from the account given in the wars of the Gaedhil with the Gael, we learn that Mahon and Brian, with the greater part of the Dalcasians living east and south of the Shannon, crossed the river into Clare so as to escape from the invaders of their country; and they "dispersed themselves among the forests and woods situated between Loch Durge and the Fergus"; from this locality the Irish proceeded to sally forth and kill all the foreigners they could lay their hands on. The effect of these tactics was to compel the Norsemen to concentrate their forces on the Shannon, where they built a fort in the district of Tradraighe, which was the subsequent site of Bunratty castle. In these operations Brian's forces suffered terribly from constant fighting and want of food; and his brother Mahon, hearing of his condition, urged submission to the Norsemen.

[1] Keating, p. 440.

The Celtic records state that Brian absolutely declined to follow this advice, and taunted his brother with cowardice; he is said to have asked him if he thought their father or their grandfather would have made peace while an enemy occupied Ireland. Mahon admitted all this, but argued that if they had not the power to resist the invaders it was useless holding out against the foe; he asked Brian if he wished to see the whole of his tribe in the same state as his own followers. To this Brian replied "that such an argument was bad, because it was *hereditary* for him to die, and for the whole of the Dalcais likewise, as their fathers had passed away so must they; but it was not natural or hereditary for the Dalcais to submit to insult or contempt, their forefathers had never submitted to this, and no power on earth would make him do so."[1] The tribe on hearing this assembled to resist the invaders, and met them at Sulcoit in Tipperary. In this battle the Norsemen were defeated and fled to Limerick, which town Brian took, and destroyed its fortifications, inflicting great loss and injury to the enemy, A.D. 968.[2] This victory added greatly to the prestige of the Dalcasians, so much so that the Eoghanites (p. 218), or rather their chief Malloy, murdered Mahon (A.D. 976). Brian was not slow to avenge his brother's death; he first sent a challenge to Malloy to meet him in single combat, and directed his messenger to add, that nothing short of the death of one of them would suffice. Receiving no satisfactory answer, Brian marched his followers into South Munster and met Malloy, a battle

[1] "Wars of Gaedhil and the Gael," p. 61.

[2] "Annals of Innisfallen" (MS., British Museum),

ensued, in which that chief was killed by one of Brian's sons. In the year A.D. 977, Brian, assisted by the Clancuilein Sept, stormed the Island of Scattery, driving the Norsemen he found there into their ships, and completely cleared the district of Thomond from the invaders.

Brian[1] was now proclaimed King of Munster, but Malachy, who at the time was King of Leinster, seeing the rising power of Brian, determined to assert his own position as monarch of the country; he therefore entered Thomond and pitched his camp on and around Magh Adhair, he uprooted the sacred oak-tree which grew on this mound (A.D. 982).[2] This was followed by a succession of battles between Brian and Malachy until at length the latter solicited help from the Danes who still occupied Dublin. Brian however overcame the confederates and then sacked Dublin, carrying off a vast amount of treasure to his home at Kincora.

Brian (A.D. 1002), became the supreme ruler over Ireland and received tribute in the form of live stock and agricultural produce from all the chiefs of his country; their order was fixed at Brian's table, and behind each seat we are told the chief's arms were suspended.[3] The tables were covered with gold-mounted cups; the food consisted of beef, pork, game, fish, oat-cakes, cheese, curds, onions and watercress;

[1] Brian received the name Boru or Boroimhe because he revived the payment of the tribute or tax known as the Boromean Tribute which had been abolished since A.D. 680. See "Manners and Customs of the Ancient Irish," p. 231.

[2] "Annals of Innisfallen," and "Annals of the Four Masters."

[3] O'Curry, "Manners and Customs of the Ancient Irish," vol. ii. p. 127.

wine, beer, and mead, together with the bilberry-juice. The food seems to have been cooked in the dining-hall.[1]

Brian also gave surnames to the principal families of Ireland with the object of "avoiding confusion, and that their genealogies might be better preserved." The family name given to the members of the Clancuilein Sept was Mac-con-mara.

Kincora became Brian's place of residence situated on the heights overlooking the Shannon from the Clare side of the river; a wooden bridge at this time crossed the site of what had been a ford. The houses were built of timber and clay and extended along the bank of the river; there were two churches one of which still exists. It is unnecessary for us to do more than refer to the fact that Brian took to wife a female called Gormflaith, who had already been married, first, to the leader of the Norsemen and then to Malachy. This marriage on the part of Brian therefore would seem to have been of a political character; however this may be, Brian and Gormflaith quarrelled, and she fled back to Dublin to incite the Danes and Norsemen to rise against Brian.

Although in his seventy-third year of age, Brian was still vigorous enough to make the necessary arrangements to meet his enemies; and he determined to stake his cause, and that of his country, on the issue of a single battle; Brian however felt it beyond his power to do more than collect and take his army into the field, for a commander in those days had not only to lead his men, but also to fight hand to hand

[1] "Killaloe," by T. J. Westropp (*Journ. Ry. Ant. of Ireland*, 1892, p. 404).

in the thick of the battle, especially at weak points, Brian therefore left the command of the army to his son Morrogh.

Every man of Brian's family marched with him towards Dublin, among them his grandson Turlough, a youth of sixteen years of age, who was his father's (Morrogh) standard-bearer.

These leaders were surrounded by Dalcasians, "the children of Cas," Clancuileins, led by their chiefs, among them Keating mentions Menma Mac-con-mara. From the "Annals of the Four Masters" we learn that Menma died A.D. 1015, so that he must have been one of the few chiefs who survived the battle of Clontarf.

On the morning of Good Friday, April 23, 1014, the Irish army took up their position on the field of battle; the Dalcasians with Morrogh as their leader held the van, the centre was formed of South Munster Septs, and the rear by those from Connaught. The Norsemen and Danes under their leader, together with their Irish allies, formed a line extending along the shore of Clontarf with their backs to the sea. Many of the Danes were clad in armour, but the Irish were dressed in their linen tunics, and were armed with spears, swords and axes. No horsemen were engaged on either side, and each army numbered about 20,000 men. Every man appears to have fought on his own account, those in the rear taking the place of those in front who were killed or disabled. And so they fought throughout the day without interruption. Towards the evening the Irish made a final effort and carried all before them; the Danes and their allies were completely vanquished and fled from the field of battle.

Brian, although unable to lead his army, watched its movements from a distance throughout the day. We are told that his attention was constantly fixed on the standard of his son Morrogh, for as long as he saw it carried aloft he felt sure all was well with the Irish. Towards evening Morrogh's banner disappeared. At first Brian tried to persuade himself that it was his faulty sight and anxious watching that prevented him from recognizing his son's standard, but when the truth came home to him the old man's grief was extreme, he could no longer watch the battle; he was urged to retire but refused to leave the spot, for he declared that Aoibhel of Cragliath had appeared to him the night before and told him this was to be his last day. Some of the Danes in their flight from Clontarf came to the spot where Brian was, and recognising him, overpowered and killed the old man.

Morrogh after fighting throughout the day, found his hands so much swollen that he was unable any longer to grasp his battle-axe, in this condition he was wounded mortally in the side, and died the following day.

Young Turlough fought with his father, and after the latter had received his mortal wound, seems to have pursued the Dane who inflicted the blow to the banks of the river, where the lad's body was found, his hands entangled in the long hair of his enemy.

There is reason to believe that not less than a quarter of the Irish army were left dead on the field of Clontarf, and among their number were included many Dalcasian chiefs. The result of this action, however, was the complete annihilation of the power of the Danes and other Norsemen in Ireland, a power they never again attempted to regain.

After the death of Brian Boru dissensions arose between two of his sons as to the right of succession, which ended in the election of a grandson of Brian's named Donough to be the ruler of the Province of Munster. During succeeding years we read of nothing but fighting between the various rulers of Ireland, and of the plunder and burning of towns and monastic establishments. In all this turmoil the Clancuilein Sept and their chiefs are frequently referred to as taking a leading part in repelling attacks made by the rulers of Leinster and Connaught on Munster. Donough at length became weary of the strife, and was too old to take part in it; he consequently retired, and proceeded to Rome where he died in the monastery of St Stephen, A.D. 1064. He had indeed been beset with difficulties, for we are informed that in consequence of "much inclement weather in Ireland, its corn, milk, fruit, and fish were destroyed, and the people grew dishonest, there was no safety for any one." In these circumstances a council was assembled at Killaloe, and we are told that laws were then enacted "to restrain every injustice, great and small; and in consequence God gave peace and favourable weather."

A petition was presented to Anselm, Archbishop of Canterbury, A.D. 1070, by the inhabitants of Waterford asking him to consecrate a monk of Winchester to fill the office of bishop of that city. It appears the Celtic Church in Ireland up to the eleventh century depended on their own bishops, natives of the country, to administer the affairs of their Church, which, as before stated, had been established by St Patrick and his immediate followers upon the tribal system. Bishops, however, were changed without order or regularity, and multiplied to such an extent that at one time, it is said, there were 700 bishops living in Ireland. The Irish monks, like their tribal chiefs, were constantly fighting with one another. Lanfranc, referring to these and other irregularities of ecclesiastics in Ireland, states that men in Ireland left their wives without any canonical cause, married others, although near in blood to themselves or to the deserted wives. They even exchanged wives. Holy orders, he states, were given to Celtic bishops for money, infants were not baptized, nor matrimony nor consecration performed according to the Roman canon. The Archbishop affirms that all this wrong was done in Ireland because the Celtic Church was independent in matters of discipline of the Roman Pontiffs. St Malachy, some fifty years before the invasion of Ireland by Henry the Third, describes the Irish as "unbelieving in religion, Christians in name, but Pagans in reality"[1] (see p. 206).

The Brehon laws were in full force by which a freeman, that is a person holding a certain amount of land, had a right to seek protection from wrong, his social status was ruled by the amount of land and cattle he held. Neither the chief or anyone else could raise a member of the sept in the social scale, for it was the unalterable right of the humblest freeman by patient industry to raise himself and his family from one grade of society to a higher one by acquiring land, and cultivating it to advantage; but this industry and perseverance had to be the work of more than

[1] Morrison's "Life of St Bernard," p. 242.

one generation, the process was a gradual one; thrift and industry were consequently the stimulants, the road and only way to advancement in life. Each rise in the social scale was attended with corresponding privileges.

Crimes were considered as wrong committed by one individual against another, and might, therefore, be condoned by the person who was judged to be the aggressor, giving compensation for the damage he had inflicted on the injured party.

It is not difficult to picture to ourselves the conditions under which the members of a sept, such as the one we have referred to, existed in Clare from the fifth to the eleventh century. These people held lands covering a space as large as the county of Middlesex. In this area (Ui-Caisin) the sept or family of Casisin, son of Cas, were absolute masters, the Iberian aborigines had been reduced to the condition of slaves. The members of the founder of the sept multiplied, but as they were all descended from a common ancestor, the tie of hereditary character and of consanguinity bound them to one another; their social life depending on their share of the soil, it was by means of its produce they lived, their privileges as freemen depended on the land. At one end of the social ladder was the Chief of the Sept, who with the headmen had the power of making war or peace, of controlling the redistribution of the tribal lands, and guided by his Brehons had almost unlimited freedom of action over the sept. At the other end of the ladder was the bondsman, who, so far as freedom was concerned, was on a par with the cattle he tended. Unless we appreciate this fact it is impossible to comprehend either the ancient or the modern history of the Irish Celts. Their hereditary qualities, and dependence on the soil, were of far greater antiquity than their history, these qualities were borne by their remote ancestors through numerous generations back to their Aryan home; characters which had grown to be as fixed a part of these people as their physical formation.

We must here pause to refer to the manner in which Ireland was absorbed by the King of England, as this act had a marked effect on the character and destinies of the people of that country.

We have shown that up to the middle of the 12th century the inhabitants of the west of Ireland, now included in the limits of County Clare, had retained their absolute independence, and still held the lands, and were governed by the laws and usages bequeathed to them by their ancestors. They spoke Celtic, a " member of the Aryan family " of languages.[1]

In the year A.D. 1155 Matthew Paris states that Henry II. of England cast in his mind the conquest of Ireland, for he saw it was commodious for him, and considered that they were but a rude and savage people, " whereupon in his ambitious mind he sent to Adrian, Bishop of Rome, one John Salisbury with others, delivering his suit to that effect." Adrian, being a man of English birth, heard England's ambassadors the more willingly, and granted the king his request, as follows: after the usual mode of salutation the Pope wrote to Henry that he had " been very careful and studious how he (Henry II.) might enlarge the Church of God here on earth—as for Ireland and

[1] O'Curry, " Manners and Customs of Early Irish," vol. i. p. lxvii.

all other lands where Christ is known and the Christian religion received, it is out of all doubt, and your Excellencie well knoweth, they do all appertain and belong to the right of Saint Peter, and of the Church of Rome—you have advertised and signified unto us that you will enter the land and realme of Ireland to the end to bring it to obedience into Law, and under your subjection root out from among them their foul sinnes and wickednesse, as also to yeeld and pay yeerly out of every house, a yeerly pension of one penny to Saint Peter, and besides also will defend and keep the rites of those churches whole and inviolate. We, therefore, well allowing and favouring this your godly disposition and commendable affection, doe accept, ratifie and assent unto this your petition; and doe grant that you doe enter to possess that land, and thereto execute, according to your wisdom, whatsoever shall be for the honour of God, and the safety of the realme; and further also we doe strictly charge and require, that all the people of that land doe with all humbleness, dutifulness, and honour, receive and accept you as their Liege Lord and Soveraigne, reserving and accepting the right of holy Church to be inviolably preserved: as also the yeerly pension of Peter's pence out of every house, which we require to be truly answered to Saint Peter and the Church of Rome."[1]

We thus see that Ireland was made over by one foreign power to another foreign potentate; the remarkable circumstance being that neither of these powers had the slightest right to the country they thus disposed of. The Celtic Church had in matters

[1] Dr Hanmer's "Chronicle," p. 216.

of discipline been independent of Rome, but surely this was no reason why Adrian IV. should have made a gift of the country with all its lands and inhabitants to Henry II. of England.

Henry the Second at the time of receiving Adrian's sanction to assume the government of Ireland was engaged in Normandy, and had neither men nor money with which to enter on the conquest of Ireland, for he was perfectly well aware that the Irish would not submit tamely to the Pope's Bull. But in the year 1166 he was invited by Mac Murrogh, King of Leinster, to send a force of English over to help him regain the position from which he had been expelled by his own people. Henry II. recognized the advisability of taking advantage of this invitation so as to obtain a footing in Ireland. The King therefore issued orders from Normandy conferring powers on certain Anglo-Norman barons to go to the aid of Mac Murrogh ; among them was Robert Fitzstephen who passed over to that country with his retainers and landed at Wexford A.D. 1169. He at once joined forces with Mac Murrogh, and some of their first acts were to pillage and burn ecclesiastical establishments such as Kells, Slane, and Clonard.

Dermot Mac Murrogh died in the spring of the year 1171, and the Earl of Pembroke, who had married Dermot's daughter, according to English law succeeded to the title and estates of Chief, or King of Leinster. This however was going rather faster than suited Henry of England, he therefore recalled Strongbow, and determined to proceed himself to Ireland.

King Henry landed at Waterford (November 1172) accompanied by Strongbow, De Burghs and other barons, and was met by the various Irish Chiefs, who made submission to the King, among them was Donald O'Brien chief of Thomond, who however returned to his province and carried on the government exactly on the old lines. King Henry on the other hand gave away the whole of Ireland to some ten of his Anglo-Norman barons, who were to take possession of their lands, if necessary by conquest.

King Henry took no steps whatever to maintain authority over Ireland, nor did he make an effort to establish English law in that country, as Sir J. Davis observes the King "neither left behind him one true subject more than he found there at his coming over, which were only English adventurers,"[1] Before leaving the country however (A.D. 1172) the King issued a decree that—"near kinsfolk should not marry, children must be baptised, and the bodies of dead Christians buried within the precincts of a Church."

Strongbow, finding that Donald O'Brien openly scoffed at the idea of a King of England ruling Thomond, marched with a strong force (A.D. 1174) as far as Thurles, intending to pass on westward, but he was at this place met by Donald and completely defeated with the loss of a number of his men. Another attempt was made by the English to enter Thomond (1192) but without success; the Dalcasians in conjunctiou with the Clancuilein sept defeated the invaders and drove them eastward across the Shannon at Killaloe.[2]

[1] Sir J. Davis, "A Discovery of the True Cause why Ireland was never subdued," p. 110, also Geraldus Cambrensis, book i. chap. xxxiv.

[2] "Annals of the Four Masters."

Donough O'Brien subsequently seems to have entered into some kind of arrangement with Henry III. by which he was to obtain and hold full possession of his own lands on paying tribute to the King. Directly this compact became known to the Clancuilein and other septs they rose to a man and drove Donough their chief out of Thomond "because he seemed to be favourably disposed to their enemies."

Donough O'Brien was succeeded by his eldest son Conor who was inaugurated on Magh Adhair as Chief of Thomond, by Sheeda Mac-con-mara A.D. 1242. Conor married a daughter of Sheeda O'Brien, an event which had an important influence on the destinies of Thomond, as it brought the chiefs of Clancuilein and of the O'Briens into more intimate relations than had lately existed between these Celtic families. Through many years of terrible strife this friendship was faithfully maintained against a rival section of the O'Briens, supported by the Anglo-Norman Earl De Clare and his followers. The King of England had granted De Clare possession of Thomond so soon as he could conquer the inhabitants and bring them under the subjection of the English crown.

Conor O'Brien's sister married the Chief or King of Connaught, and having thus gained his aid, and that of the Clancuilein sept, he felt himself sufficiently strong to attack the English. "He did this with such success that we are told he did not suffer one of the English nation to inhabit the size of the meanest hut in the kingdom over which he was chief."[1]

[1] Macgrath's "Triumphs of Turlough," Standish Hayes O'Grady's translation, p. 2.

CHAPTER III

In the year 1258, a council of chiefs of the four provinces of Ireland was convened in order to take united action against the English throughout Ireland; after a long and fruitless discussion as to which of the four rulers was to be supreme, the council broke up without arriving at any decision on this, to them, all important point. Thus ended the last chance of effective union for National defence among the native Celtic chiefs of Ireland. Conor O'Brien was represented at this Council by his son Teige, who died soon afterwards. His father seems to have been crushed by this double blow to his hopes, for we are told that "he refused to drink, or take comfort, and to such a depth, and for so long was his grief prolonged, that his tribe rose against him; his sorrow they respected, but when it passed into settled gloom" they led their chief to understand that he must make way for some one else, if he desired to indulge in inordinate grief. "The Four Masters" inform us that during the latter part of Conor O'Brien's reign, Thomond was not only at peace, but that the seasons were favourable and the people consequently prosperous. The inhabitants however became over-rich and turbulent, refusing to pay their cesses. Sioda Mac-con-mara seems to have speedily quelled this insubordination throughout the east of Thomond; but Conor in attempting to put down the insurrection in

Burren lost his life, together with that of his third son and a daughter.

Conor O'Brien was buried in the Abbey of Corcomroe, where his tomb is still to be seen in good preservation in the north side of the chancel.

Conor was succeeded by his second son Brian Roe who was inaugurated King or Chief of Thomond by his uncle Sioda Mac-con-mara; but his elder brother had left a son called Turlough, who at the time of his grandfather's death was only nine years of age, and consequently too young to succeed to the Chieftainship of Thomond. Brian Roe therefore reigned at Clonrod for nine years "and fought the English, governing with a strong hand," but in the year 1277, Turlough revolted against his uncle, and his cause was espoused by the Clancuilein sept, his grandmother having been the daughter of their Chief, Neil Mac-con-mara, and because he was the rightful heir to the position held by Brian Roe; the latter was therefore driven out of Clonrod, and fled to Limerick and placed himself under the protection of the Anglo-Norman, Earl de Clare, who undertook to assist Brian, provided he would assign the lands between Limerick and Athsollus to him and his heirs.[1] These terms

[1] Thomas de Clare, Governor of London, was the second son of Richard Earl of Gloucester, and he (Thomas), having borne arms against the king at the battle of Lewes, eventually came over to the king's side, and with his brother Gilbert arranged a plan by which Edward the king's son escaped from custody. This brought them pardon, and Henry III. made Thomas his secretary; Gilbert was married to the Princess Joan of Acre, and Thomas de Clare got licence to settle in Ireland (1269), but he did not go there until after Edward's return from the Holy Land. He married a daughter of Lord Desmond, and got a grant of his lands in trust from Prince Edward. De Clare had a nominal right to part of Thomond, for

having been agreed to, De Clare obtained help from the Fitzgeralds and other Anglo-Norman barons, and together with Brian Roe's followers sallied forth to attack Torlough O'Brien with the intention of placing Brian Roe at the head of affairs in Thomond. Thus we have a repetition of the old story, mutual jealousy between Celtic chiefs, one of whom to strengthen his position called in the aid of foreigners to assist him in overcoming his adversary. The Anglo-Normans were probably better trained soldiers than the Irish, but the latter with their shields, lances, and swords, their half naked bodies and long matted hair tied with thongs over their eyes, fleet of foot and enduring as the beasts of their forests, were men which the more heavily armed Anglo-Normans had to contend with.

De Clare advanced as far into Ui-cas-ein as Quin, at which place he strengthened the fort which existed in that place, erecting flanking towers, which still remain, and also part of the massive walls of the fort which form a part of walls of the existing Quin Abbey.

The Clancuilein sept not being strong enough to give battle to De Clare, retired northward to the hills of Echty; in the meantime Turlough passed into the district of Burren and was joined by some of the retainers of the De Burghs's (Bourkes) of Galway, he

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Robert de Musegros, a former grantee, had surrendered Tradree to the king (p. 99). The king subsequently granted Thomas de Clare in fee the province of Thomond, including Tradree. Thus De Clare was established, so far as Edward King of England could secure him, in the south of co. Clare, in the angle made by the rivers Fergus and Shannon, north of which lay the Ui-Caisin lands (T. J. Westropp's "Normans in Thomond": "Journal of the Royal Society of Antiquaries of Ireland," 1890, pp. 285-286.)

then joined the Clancuilein sept and the combined forces at once commenced offensive warfare against De Clare and the other Anglo-Normans who had fixed their headquarters in the district of Tradree. In the year 1277, Turlough and Sioda Mac-con-mara felt they were sufficiently strong to meet the enemy in the open, and they gave battle to De Clare at Mongressan. De Clare was completely beaten, and his brother-in-law and other Norman knights were slain. Brian Roe and De Clare escaped to the Castle of Bunratty, where the Earl's wife denounced Brian as a traitor, and as having been the cause of her brother's death. The unfortunate Irish chief was seized and brought into the castle yard, where he was "bound to a strong steed" and dragged to death, his body was then suspended by its feet from the gallows. This murder was perpetrated by De Clare notwithstanding having entered into a sacred alliance with Brian, upon which occasion they swore by the most solemn oath to support one another, and mixed their blood in token of friendship. The details of this crime are recorded by the "Four Masters," and were also transmitted by certain Celtic chiefs to Pope John XII.

De Clare endeavoured to come to an arrangement with Turlough, but the latter declined so much as to listen to words of peace after what had happened to Brian Roe.

Turlough proceeded with his victorious army to Magh Adhair and was proclaimed ruler of Thomond by Sioda Mac-con-mara. No mention is made of any religious or other ceremony on this occasion, the same form seems to have been observed in the year

1276 as that followed on similar occasions from the earliest days of the Celtic conquest of the west of Ireland.

Many of the facts given in the preceding and in the following pages are drawn from a work by John Macgrath who wrote an account in the year 1459 of the "Triumph of Turlough." A copy of this Celtic manuscript and a translation of it exist in the Egerton Collection of the British Museum Library. The original is in Dublin, and has been translated by Mr Standish H. O'Grady, who kindly allowed us to consult his work. Macgrath states that he wrote this history from information given him by persons who had witnessed the scenes he describes. Professor O'Curry remarks that the "Wars of Thomond stand unrivalled, the style and composition is extremely redundant; nevertheless it possesses a power and vigour of description which independently of the exciting incidents it describes, will amply compensate the reader's study."[1]

De Clare having failed to induce Turlough to come to an agreement, felt that the charter he had received from the King of England granting him possession of Thomond was about as valuable as the paper on which it was written; but he still hoped to gain his end, not so much by direct conquest as by inciting the jealousy of the Celtic chiefs against one another, and through their mutual destruction to step into the position he so much coveted in Clare. His next move therefore was to induce Donough the son of Brian Roe to join the English, and Donough consented to co-operate with

[1] "Lectures on Manuscript Materials of Ancient Irish History," p. 235.

his father's murderers in their efforts to destroy the power of his relation Turlough O'Brien. The confederates started off on a raid through the west of Clare, and then suddenly turned eastward and appeared before Clonrod ; Turlough was taken by surprise and with difficulty made his escape and sought refuge with Sioda Mac-con-mara ; he was followed by a portion of De Clare's forces led by Donough, who that night encamped at Quin. Macgrath states that Sioda Mac-con-mara with a small force of retainers determined to attack Donough's force, hoping during the confusion produced by a sudden onslaught to reach Donough and engage him in single combat. So desperate was this attack that Sioda penetrated into the midst of the enemies' camp, but he and his followers were surrounded and were overborne, the whole party including their chief being killed.

After the death of Sioda, Clancuilein assembled at Magh Adhair and elected his son Coveha as their chief ; the historian remarks that in this choice Clancuilein had not exchanged a stone for an egg, but had taken gold in place of silver, for he adds—now the *Cu* or Wolf-dogs anger rose against those that bordered on his confines. Coveha married Sheila, daughter of O'Carroll the Celtic Chief of Ely. It seems that the author of the records from which Macgrath compiled his history had strong feelings in favour of Coveha, and of his son Lochlain, and grandson MacCon ; he constantly refers to their prowess and feats of arms, although he is by no means sparing in his commendation of other Dalcasian chiefs.

Turlough O'Brien and Coveha failing to obtain aid from MacCarthy of Desmond or from other sources came to the decision that they must in future depend on their own resources if they were to get rid of the Anglo-Normans. They consequently set about organising their forces, over which Donald, a brother of Turlough's, and Coveha Mac-con-mara were chosen leaders. De Clare was not slow in making counter preparations, and the opposing forces met on the plain near Tulla ; the Delcasians, by a dexterous flank movement, broke in on the main body of the Anglo-Norman forces and completely overcame them. Coveha ordered the arms of the enemy who had been killed to be collected and sent to Turlough, who at the time was occupied east of the Shannon ; but the " spurs of the knights and their shields and armorial bearings he directed should be defaced and sent to De Clare. Turlough followed up this victory by marching through Tradee up to the walls of Bunratty Castle, and compelled De Clare to banish Donough Brian Roe. But in the following year for the sake of peace Turlough agreed to make over the western part of Clare to Donough, retaining the eastern portion. This arrangement was hardly likely to lead to permanent peace, and in fact complications soon arose between the two chiefs.

In the year 1284 Donough and Turlough agreed to meet and settle their quarrels ; the former chief, we are told, came to the appointed place—sufficiently well drunk to make him noisy, and he abused Turlough in no measured terms ; the consequence was that a fight between the followers of the respective chiefs took place, from which Donough escaped, but being pursued and wounded, he plunged into the river Fergus and was drowned. Turlough was thus left the undisputed ruler of Thomond.

On the 29th August 1287 Thomas Earl de Clare was killed with some of his principal knights in an encounter with the Dalcasians, and was succeeded by his brother Richard de Clare.[1]

Turlough built the beautiful Abbey of Ennis, the ruins of which are still in good preservation; he died on the 10th of April 1306, and was buried in the church he had so lately completed. His son Donough was inaugurated ruler of Thomond in his place.

Coveha Mac-con-mara survived his chief for two years; he died a natural death, and was buried close to the grave of Turlough in the Abbey of Ennis. The Clancuilein Sept elected Donchadh, son of Coveha, as their chief. Macgrath states the Sept "honoured him for his flawless integrity, his perfect chivalry, valour and loyalty to the head of the province." He further states that Donchadh was always ready to help any man in trouble whose cause was good, his hospitality and generosity were proverbial, "he was gentle and winning with women, and a handsome purveyor of the wine-feast."[2] We refer to these traits of character as given by the historian, because they indicate the qualities possessed by a Celtic chief living in the early part of the fourteenth century, which gained for him the respect and obedience of his retainers and other members of his Clan.

In the following account of the Clancuilein Sept we have quoted extensively from Macgrath's history, which he states was compiled in the year 1459, from documents belonging to the families of the men who took an active part in the scenes to which he refers.

[1] State Papers, Ireland, No. 1301.

[2] Translation of "Triumphs of Turlough," p. 34.

The author of this work was descended from a long line of the official Dalcasian bards. In his history, therefore, we possess not only glimpses of the personal characters displayed by Celtic chiefs living in the early part of the fourteenth century, but also an example of the Celtic literature of this and a somewhat later period which demonstrates the spirit of the age, and of the environment which prevailed among the inhabitants of County Clare up to the year A.D. 1459. If we compare the account given by Macgrath of the Dalcasian chiefs of the period comprised in his history, we find the qualities he describes as belonging to these men are identical with those which M. Thierry and Mommsen state, characterised their progenitors, the inhabitants of ancient Gaul (p. 211).

From the date of Earl de Clares' death in August 1287 until the year 1310, the peace and prosperity of Thomond was almost undisturbed; the jealousy of the Irish septs among themselves was then the cause of a small war which broke out in the north-eastern part of the province. The Anglo-Normans still living in and around Bunratty were not slow to avail themselves of the weakness caused by the strife that was raging amongst the neighbouring Celtic Septs of Clare; Richard de Clare at once formed an alliance with Dermod Brian Roe. Clancuilein in the meantime had elected Lochlain, brother of Donchadh Mac-con-mara, as their chief, who Macgrath describes as being "a favourite with his retainers for his courage, with his hospitallers for his good-nature and justice, with little children for his mildness, and with ladies for his affable temper." We are informed that the English and their confederates made several attempts during the year 1312 to possess the lands owned by Clancuilein, but that in each attempt the leader of the raid returned to his home "altogether penitent."[2] This constant conflict was carried on to such an extent that the country was brought into a condition of abject wretchedness, and Lochlain Mac-con-mara at the request of his Sept, having received a safe conduct from De Clare, proceeded to Bunratty Castle with the object of entering into negotiations with the Earl regarding the questions at issue. On arriving, however, at De Clare's castle, Lochlain was seized, and carried away to Lough Colmen, where he was beheaded, together with his nephew, and their bodies were then thrown into the lake.

Dermod Brian Roe was at this time taken seriously ill. Macgrath states that "after he (as a matter of habit) had been let blood, he never nursed the infirmity, but rashly persisted to run, hunt, ride, and practise sword and spear exercises. All of which combined oppressed him greatly, and the ailment grew exceedingly, until from its intensity he took to his bed, and died."

After the murder of Lochlain by De Clare, the Clancuilein Sept elected his brother MacCon as their chief. Overtures were at once made to MacCon by the Anglo-Irish confederates to the effect that he should join them and thus restore peace to the country. He, however, declined so much as to listen to any such overtures or to desert the cause of Mortough O'Brien, and so throughout the years 1314 and 1315 there was perpetual fighting, not only between the various

[2] "Triumphs of Turlough," p. 54.

sections of the Dalcasian tribe, but also with the Anglo-Normans led by Earl de Clare with his ally Donald Brian Roe, who had succeeded his father Dermod. In one of these encounters Mortough with his friends of Clancuilein completely routed De Clare and Donald Brian's forces, and the latter chief with his brother were expelled and had to take refuge in Connaught, where they entered into negotiations with King Robert Bruce, and urged him to bring an army over from Scotland for the conquest of Ireland. Bruce willingly accepted this invitation, hoping thereby to weaken his enemies the English; he therefore despatched his brother Edward with a well equipped army into Ireland. The Scots with the followers of Donald Brian Roe passed southward from Ulster, ravishing and burning the country "like a black cloud with vapour creeping offshoots and dark mist, hard to meet." Edward Bruce ultimately reached Cashel, where he was joined by King Robert Bruce. Brian Roe urged them to attack Thomond and sack Limerick; and so we are informed, the Scots, with the intent of entering Thomond, arrived on the Shannon's banks at Castleconnell, the Dalcasians under Mortough O'Brien being encamped on the opposite bank of the river; some skirmishing ensued between the two forces, and we are informed by Macgrath that "as for such as were hurt of the Albanachs, they are not the gentry to bemoan; but on this hither side was wounded an imp of the genuine stock, Hugh Mac-con-mara." [1]

At this critical moment the English and Irish chiefs met at Limerick and determined to combine their forces, the whole of which were placed under

[1] "Triumphs of Turlough," p. 84.

command of Mortough O'Brien, and they at once marched against the enemy. The Bruces, however, retired, and soon afterwards King Robert gave up the idea of conquering Ireland and returned home, his brother Edward being subsequently defeated and killed in an engagement with the English at Dundalk. The "Four Masters" referring to the Scottish invasion of Ireland observe: "Edward Bruce, the destroyer of the people of Ireland, both English and Irish, was slain by the English. No achievement had been performed in Ireland for a long time before from which greater benefit has occurred to the country than from this; for during the three and half years Bruce spent in Ireland a universal famine prevailed to such a degree that men were wont to devour one another." We cannot overlook the fact that the English, who had assumed the right to govern Ireland, stood by for three years, while the Scotch destroyed the inhabitants of the greater part of the country County Clare escaped much of this suffering, for we learn that neither the invader nor the plague reached the people of that province.

Brian Roe, who had already brought so much trouble and distress on his country, having in the year A.D. 1316 heard that his friend Richard de Clare had failed in his attempt to persuade the English Council to recognise his claims as Chief of Thomond, determined again to try what he could do by an appeal to arms; he therefore called on his former supporters, and the chiefs of western Clare, to assemble on the hills of Burren above Ballyvaughan.

Mortough O'Brien was away in Dublin, and his brother Dermod therefore summoned the landholders of his territory to meet him in council; among them we are informed came Mac-con-mara. The council determined to raise all the Septs of eastern Clare in order to oppose Donough Brian Roe. Each member of the council, therefore, returned to his home "to get on with all that was needed for the emergency of that formidable encounter, on which, towards the recovery of their patrimonial rights, they were resolved; and the place of meeting which was appointed for the last muster before the march was Ruane, of the grass-clad caves."

All preparations having been completed, Macgrath states that these devoted "Gael of the true breed, with new standards and burnished arms—with a sound appetite for the fray, they covered the distance to Ruane, where cheerily the contingents welcomed each other. Not a man of those present but longed to fall to, and among them cordial words of welcome passed—without failure they kept that tryst, and were moved as it were by the spirit of one man."

Mac-con-mara with few words addressed the assembly as follows:—"A hard and fierce battle ye will have this time: one such as for long has not been fought, but one which will end in the final triumph of our cause. The head and chief of our enemies will fall, among them Donald their leader, and far famed Teige of Limerick. My favourite mailshirt, which Donald now holds, I will bring home again. In order to back up which good forecast I will be the first to join battle."

"With such words his followers were rejoiced, and northward as straight as an arrow urged their way towards the enemy, until they reached the Abbey of

Corcomroe, in Burren, within the precincts of the monastery they secured their cattle. During the night many of them slept on the floor of the church, others in the more comfortable cubicles, where they enjoyed soft luxury and secured deep sleep; others passed the night in mirth, although on the morrow they might die or lose the soul of some dear friend."

Donald Roe and his forces in the meantime had assembled on the hills west of Corcomroe; he told his men to remember that the purpose with which they had come on this perilous expedition was to gain the battle, and so make an end once and for all of the long dispute for the lands of the tribe, a matter which must be decided either by your antagonists' destruction or your own death, one and all. Macgrath repeats that Donald explained to his men that friends and foes were children of Cas, so that they were of the same blood "with whom your close embrace of kinship will be that of steel to steel."

At the dawn of day the army resting round Corcomroe were awakened by the report of the advance of the enemy with colours flying, and with gilt spears. MacCon issued from the abbey, and Macgrath observes, "a strange sight it was to see those Clancuileins come tumbling out and wriggle on their harness as they ran; nor ever, out of any monastery whatsoever had there streamed an order more grimly bent on fighting *for their lands.*" We are informed that "the septs ranged themselves each under their own individual lord apart, and they then closed order under Dermod." Macgrath states that MacCon got himself into his armour, hard mail of proof, over which was a tunic, in which garb, as the chief was a-harnessing, his attendants in haste put it back in front upon him; he bade them return it carefully, and said: "We shall all the better be for this oversight, which portends some gain still [even greater than that looked for]. Now steadily hook on the tippet and clasp the mail, fasten my helmet on my head, for this armour I will not change until as its price from yonder folk I win a better set."

"Here Clancuilein's phalanx fell in about their lord, and the leading gentlemen of the attack were Nicol Mac Coveha, extreme particular spear point on all onset, special shield of deadly retreat; he was a ruddy youth of open countenance and handsome features, red-lipped, close bearded, stalwart, and staunch, whose lot it was in this affair to take his brother and chief's right shoulder; nor surely we may pity one that at this juncture hath a shoulder prop such [as this of MacCon's] in battle. Young Hugh also, bushy and curly-headed, a genuine heir of Clancuilein, who stepped to his kinsman's other shoulder to be his guard."[1]

They advanced with spears to the fore, and colours flying. Macgrath inform us that MacCon proclaimed: "In this field we will, if it so please you, have no precedence of kindreds, but every man that wishes to be to the fore let him for the first onfall race even as I will race; he that prefers the centre or is satisfied with the rear, according to his fancy, let him hang back and do such service as he may. MacCon further called on the chosen one hundred of his sept that had

[1] "Triumphs of Turlough," translated by Standish H. O'Grady, p. 96.

vowed to fall with him to come to the fore; but these words were hardly uttered before the "whole of Clancuilein answered with one voice, and rushed to surround their chief."[1]

And so the opposing forces reached the plain, whose face was scored with irregular seams; the foremost ranks let fly their stones and javelins, darts and arrows. The two sides then met hand to hand with ringing cheers, and spears well to the fore. Macgrath gives a detailed account of the battle and of the valour shown by the chiefs of the various septs engaged, which may best be read in Mr O'Grady,s translation of Macgrath's history. As regards Clancuilein, he states that on MacCon "fell the task of keeping the battle braced together; there he stood rooted and held the key of the position, dealing death to his enemies. For out of the West hardly was there come champion or great chief's son, chieftain or noble captain of Clan Brian Roe but continually and wildly cried out for MacCon"—and in response to them his chiefs, one after the other, sprang to meet his challengers. MacCon had no easy game to play, as he found himself planted in the centre of the fight, encircled with a trusty band of his Sept, who parried many a blow for him—among these, Nicol fought desperately—and the feats that he performed, which, but for his shield, that proved his salvation, could never have been carried through. Hugh likewise did doughty service, though but a stripling, and so on with other members of the sept.[1] At length Donald Brian Roe was slain and his followers were completely defeated by Dermod O'Brien

[1] *Ibid.*, p. 98.

and the Clancuilein and other septs of the Dalcasian tribe under his command.

Dermod addressed his soldiers, urging them not to be overcome by grief for the friends that had been slain.

The Sept of Clancuilein suffered severely. Twenty-one of their leaders were killed, and among their slain chiefs was the lad above referred to.

The bodies of Donough Roe and his chiefs were carefully buried by the Dalcasians, side by side of their own dead, "branches of the parent vine who had ceased to strive for the chiefry." After this Macgrath states, "hastily binding up their wounds, fathers, with weak steps, were tending their sons, or sons their fathers, or in bearing them to their abiding places of clayey mould." He adds: "So the army after toil and travail had respite: some of the victors counting their own successes; others bewailing their own losses, etc. Mac-con-mara was taken to Clonroad to be cured of his wounds, and his other standard bearer was brought to Ennis where "his body, though it recovered not, yet his soul's cure was the result."

In the following summer, under a guarantee given by De Clare's wife and son, MacCon, as representing Murtough O'Brien, went to offer the Earl and his party terms of peace. Richard de Clare, however, rejected these proposals; and endeavoured to lure MacCon into accepting terms to his personal advantage, in fact he offered him "all sorts of privileges and great wages," if he would only turn and join the Anglo-Normans, who would protect him and his people. MacCon at once replied that he would not so much as listen to such proposals, but to those only of which Mortough O'Brien approved, "seeing (he said) that whether for peace or war by him he would stand." MacCon then took his leave of De Clare and went home to confer with O'Brien and the chiefs of Thomond. Macgrath states that MacCon observed "at the hands of yonder abominable perverse English gang, cruel and insatiable, overbearing, surly, sullen, full of spite and ill design, never except as by virtue and bravery and skilful conduct in battle, will you expell them from our lands, or have freedom or true peace and goodfellowship. Hence we must act on the defensive against De Clare."[1]

De Clare on his part determined to make a last effort to overthrow the Celtic chiefs of Clare; he had played one faction against another for years without success, and it seemed to him necessary now to rally all the Anglo-Normans he could collect, and in conjunction with such of the Irish as would follow him, to do his best to crush the chiefs who had for so long stood between him and the possession of the land we now know as county Clare. Having mustered all his forces he marched to Quin, where he rested for the night, and then passed over the river Fergus westward to attack the stronghold of the O'Deas. That chief was, however, on the lookout for De Clare, and had placed a number of his followers in some woods near a causeway and ford, over which it was necessary for De Clare to advance. On the following morning, De Clare, having detached a part of his troops to make a flank movement, so as to attack O'Dea in the rear, advanced with his main body on Dysert. O'Dea sent a number of his retainers to

[1] "Triumphs of Turlough," p. 120.

appear as though engaged in driving cattle over the ford. De Clare attacked them; and as they turned to defend the causeway De Clare and his knights rode to the front. The O'Deas retreated, and were followed by De Clare over the ford, and so became separated from the main body of his followers, when he was suddenly set upon by the Irish previously hidden among the bushes on the side of the road leading from the ford; and before his men could come up to his help De Clare and sixteen of his bravest knights were killed.

Too late to save their leaders, the main body of the English force made their way with difficulty across the stream and beset the survivors of the O'Deas in the wood. Just then O'Conor and his troops appeared on a hill above; they charged down the slope, and fell on the English. These stood their ground bravely headed by De Clare's son, who fought hand to hand with O'Conor; but the brave youth was overcome, gallantly dying on the field of battle, as became the the heir of so noble a race as the De Clare's.

Lady De Clare, directly she heard of the death of her husband and son, placed her belongings in boats, and passed over the Shannon; before leaving Bunratty she ordered the place to be set on fire. This was the last of the Anglo-Normans in Clare; they had absolutely failed, after fifty years' fighting, to obtain possession of a single acre in that part of Ireland.

The O'Briens, Clancuileins and other Dalcasian Septs had manfully and with success resisted, first the invasion of Thomond, by the Norsemen, they had turned back Robert Bruce and the Scots and lastly, had expelled the Anglo-Normans from that part of Ireland,

and thus succeeded in preserving their lands from the intrusion of strangers; a condition of affairs which they maintained until as late as the year A.D. 1654.

The opinion of the best informed Irishmen as to the social and political position of their countrymen during the earlier half of the fourteenth century is to be found in a document which they drew up and forwarded to King Edward the Third, of England. According to this document the leading Celtic chiefs urged the King to adopt one of two courses: either to govern Ireland by English law, or else to leave the country to govern itself according to her own laws and customs. The King referred this petition to his advisers in Dublin, and they determined that action in the matter was unnecessary. Sir John Davies, Attorney-General for Ireland in the time of James the First, in his able work on the "True Cause why Ireland was never subdued," refers to this appeal of the Celtic chiefs. He observes: "I note a great defect in the policy of England; in that for the space of many years after the so-called conquest of Ireland, the English laws were not communicated to the Irish, nor the benefit and protection thereof allowed into them, though they desired and sought the same." Sir John states that no true idea can be formed of Irish history unless full weight is given to this fact. This may be true, but the real cause of the discontent and disaffection of the Irish arose from a far more potent cause than the administration or enactments contained in a code of laws prevailing in the country; this fact is clearly set forth in a petition they sent to the Pope on the subject. This communication details, in the first place, all that the inhabitants of Ireland had suffered since Henry the

Second had entered the country ; they inform the Pope that the English "are incessant in their pursuit after us, endeavouring to chase us from among them ; they lay claim to all our lands, and allege that the whole country of right belongs to them. From these causes arise the implacable hatred and dreadful animosity of the English and the Irish towards each other."

This memorial states that the system established by the English in Ireland may be summed up as follows:—

1. "Every man who is not Irish, may, for any kind of crime go to law with any Irishman, while neither layman, nor ecclesiastic who is Irish can under any cause of provocation resort to any legal measure against his English opponent."

2. "If any Englishman kill an Irishman perfidiously and falsely, noble or plebeian, innocent or guilty, including the clergy, the crime is not punishable before our English tribunal."

3. "If any Irishwoman marry an Englishman, on the death of her husband she becomes deprived of one-third of the property and possessions which he owned."

4. "If an Irishman fall beneath the blow of an Englishman, the latter can prevent the vanquished from making any testamentary deposition, and may likewise take possession of his wealth."

The Sovereign Pontiff was sufficiently impressed by these and other usuages complained of, to forward this document to King Edward III., with the observation that, having "considered the matter maturely, we behest your majesty that you remove the cause of these misfortunes by fulfilling the duties of lord and master you may afford no subject for complaint, by which means the Irish, guided by a wise administration, may obey you as lord of Ireland" ; advice which, unfortunately, King Edward neglected, although he was distinctly warned by the Pope that "*those* *complaints should not be neglected in the beginning, lest evils increase by degrees, and the necessary remedies be applied too late.*"[1]

Wiser advice was never given, or more conspicuously neglected, until it was indeed " too late."

Sir John Davies, writing two centuries later regarding the state of Ireland, observed that " so long as the Irish were out of the protection of the law, so that every Englishman might oppress, spoil, and kill them without control, how was it possible they should be other than outlaws and enemies of the Crown of England? If the King would not admit them to the condition of subjects, how could they learn to acknowledge and obey him as their Sovereign, when they might not converse or trade with any civil man, nor enter into any town or city without peril of their lives; whither should they fly but to woods and mountains, if the English magistrate would not rule them by law which doth punish treason, and murder, and theft with death, but leave them to be ruled by their own laws and lords, why should they not embrace their own Brehon laws which punisheth no offence, except by an eric or fine."

It was to preserve their tribe and people from untold misery created by such a state of society as that described by Sir J. Davies, that impelled the Celtic Dalcasian chiefs to fight so obstinately and so effectively during the twelfth, thirteenth, and following centuries; their object from first to last was possession of their tribal and common lands, their own laws and social usages, and to this end prevent the English

[1] "The History of Ireland," by the Abbe Macgeoghegan translated by Patrick O'Kelly, pp. 324-326.

from gaining possession of Thomond. All the misery and hardships these people had undergone for centuries had only tended to rivet more firmly than ever their inherent yearning for their own lands. This clinging to the soil had grown to be a part of their nature or hereditary character, something independent of intellectual acquirements, and as much a part of their being as the form of their skulls or features.

With reference to the family life of the chiefs inhabiting the West of Ireland during the middle of the fourteenth century, we find it very difficult to obtain any reliable information, but it would not appear to have been of a lower order than that prevailing at this period in England ; for instance Gerald Fitzgerald, Earl of Desmond, had been taken prisoner in an engagement fought with the Dalcasians in July 1369 ; he was taken by O'Brien to his residence at Clonroad in the centre of Clare (Ennis), and was detained there by Brian O'Brien and his wife, who was a Mac-con-mara.[1] Desmond was at this period the representative of the King of England in Ireland, and was versed in the manners and customs of the English Court.[2] It is a remarkable fact that we find this nobleman some years later (1388), forwarding a request to Richard the Second, asking the King to allow him to send his son James (subsequently the famous Earl of Desmond) "to be brought up and educated" at Clonroad by

[1] O'Brien's "Memoirs," p. 134.

[2] Fitzgerald, Earl of Desmond and Kerry, was granted the County Palatine, formed of nine counties and called the Irish Pale. The lord who ruled the Pale had power to make peace or war ; he held royal courts, created barons and knights, and appointed judges and administered laws.

O'Brien, Ruler of Thomond.[1] This request was granted, and the lad was reared in the Celtic chief's household, in the centre of Thomond, which, if we are to believe the accounts given by some historians, was in the fourteenth century inhabited by a set of inhuman, bloodthirsty barbarians; this was evidently not the opinion of the Earl of Desmond, who must have known them well when detained among them as a prisoner of war.

It is evident that although the Brehon laws were still in force in Clare that the tenure of land had undergone change by the middle of the fourteenth century; a deed, for instance, bearing date A.D. 1365, enters into details as to the debts due to Teige Mac-con-mara's children. Reference is made to rents due for twenty years, with interest on the same; and we have also the decision of the Brehon respecting a mortage on these lands.[2] We possess also a copy of the lands held under the lordship of Mac-con-mara, A.D. 1375. This rent roll was made by the stewards and shows that the Chief of Clancuilein then received tribute from some 130 town lands, and that his wife received tribute "exclusive of the lord's rights."[3] This tribute amounted to about 1820 ounces of silver, which in practice was paid in cattle. This amount did not include rents and profits arising from the chief's own estates. Beyond this the head of the Sept still possessed the right of "food in the towns lands (over which he was lord) once a year," which meant he could

[1] O'Brien's "Memoirs," p. 139; also Patent Roll, dated 1388, of Richard II.'s reign.

[2] *Trans. of Roy. Soc. of Ant. of Ireland*, vol. xv. p. 20.

[3] *Idem.*, p. 45; also Frost's "Clare," p. 182.

every twelve months billet himself and his servants free of charge, on those landholders who farmed or occupied the lands above referred to. In this way a chief of such a Sept as that of Clancuilein would have possessed a large income, and his power over his retainers was technically without limit, but practically he had to conform to the will of his tribesmen as a body, for he was not only elected to office by them, but would speedily have been made to yield had he attempted to violate public opinion. There is no reason to believe that the Celtic chiefs abused their right to "coyne and livery" or billeting their retainers on their landholders, as their English neighbours within the Pale certainly did, for in the preamble to a Bill passed by the Dublin Parliament of 1449, we read that "in the time of harvest companies of English soldiers were in the habit of going with their wives, children, servants, and friends, sometimes to the number of hundreds, to the farmers' houses, eating and drinking, and paying for nothing." They "many times rob, spoil, and kill the tenants and husbandmen, as well by night as by day," and their horses were turned out to graze in the meadows and in the ripe corn, ruining all the harvest, and if there was any show of resistance, they burn, rob, spoil, and kill, and for the most part the land is wasted, and destroyed.[1] We have no evidence whatever of practices such as these in that part of Ireland which was governed by the native chiefs under the Brehon laws.

[1] "A Short History of Ireland," by P. W. Joyce, LL.D., p. 337; Gilbert's "Viceroys," p. 355.

CHAPTER IV

THE "Four Masters" inform us that in 1428 the "Chief of the Clancuilein died a charitable and truly hospitable man, who suppressed robbery and theft, and established peace and tranquillity in his territories. Again in A.D. 1444 we are told that Sioda Mac-con-mara died, "he was the chief protector of the men of Ireland," and he is also referred to in the Annals of Ulster and of Munster as having been renowned for his hospitality. We take these posthumous observations at their probable value, but as they are recorded in the Annals of Ireland, we are therefore justified in making use of them as evidence of traits of character of Celtic chiefs of the fifteenth century.

This century was not destined to close in peace so far as the inhabitants of Clare were concerned. Sir James, a natural son of the sixth Earl of Ormond, arrived in the West of Ireland, claiming to be the heir to the title and lands of his father. Sir James was received by the O'Briens, Clancuileins, and the Clanricardes. These families being closely connected by marriage with the late Earl, were glad to support an Ormond in opposition to the Earl of Kildare, who since Ormond's death had assumed paramount power over Ireland, and had been appointed Lord Deputy of that country by Henry the Seventh. Kildare, however, had been recalled to England by the King, and while there married the sister of the lawful heir to the

Ormond estates in Ireland. On the Lord Deputy's return to Dublin he quarrelled with the O'Briens, his real motive being to punish them for the support they had afforded to Sir James Ormond. Kildare marched into Clare with a considerable force and surprised and took one of the strongest of the Clancuilein fortified dwellings. Leaving a garrison in this place he moved on to Quin, where he was met by O'Brien, the Clancuilein and other Dalcasian Septs, and was utterly defeated (A.D. 1499). Kildare with difficulty made good his retreat across the Shannon.

The result of alliances made through the intermarriage of the O'Briens and Mac-con-maras with the neighbouring Anglo-Norman noblemen, produced in the end disastrous results to the Celtic chiefs. The head of the Clanricardes at this time was Ulick Bourke, whose first wife had been a daughter of Sioda Mac-con-mara; after her death he married a daughter of the Lord Deputy Kildare; but he was accused of ill treating this lady. At any rate, she left him, and so angry was Kildare that he determined to be revenged on his daughter's husband; and at the same time he hoped by weakening the Clanricarde's power in the West of Ireland to enable the English more effectually to humble the O'Briens, and other Septs of Thomond.

Kildare persuaded the chiefs of the North of Ireland to espouse his cause. On the other hand, the Clanricardes and the O'Briens obtained the aid of the southern chiefs; so that the whole of the Irish of the northern part of the country were brought into battle array against the natives of the southern half of the island. What is more remarkable, the commander of the Irish of the north was the Earl of Kildare, and the commander of the southern Irish army was Clanricarde, a nobleman of Anglo-Norman descent. It is hardly possible to conceive a more desperately hopeless condition of things than that the Celtic Irish or any other people should have been thus divided, and brought into the field of battle by commanders who belonged to a different and hostile race, and whose object was to urge on the natives to destroy one another, so that the English might profit by this act of national suicide. Kildare no doubt to some extent made Clanricarde's treatment of his daughter the ostensible cause of the conflict; but in the battle he withdrew his English troops from the field, and allowed the Irish of the north and south to slaughter one another; which they did most effectually. Not a single Englishman was even wounded in this battle.

The two armies met at a place called Knocktow, near Galway, on the 19th August 1504. The "Four Masters" state that a victory was gained over Clanricarde and the army of the South of Ireland; only a small number of their fighting men survived. The northern Irish also suffered so terribly that they were unable to follow up their victory, but collected their scattered forces and retired from the field. It is said at this moment Lord Gormanston proposed to Kildare that the English should "consummate their good fortune by slautering the remains of the Northern army who had fought for them."[1]

The Earl of Kildare does not seem to have taken advantage of the weakened state of the Dalcasians

[1] "Memoirs of the O'Briens," p. 156; Macgeoghegan's "History of Ireland," p. 378.

after the battle of Knocktow; but in the year 1510, having overcome the Irish of South Munster, he determined to destroy their power in the West of Ireland. The Lord Deputy, therefore, marched an army westward, and reaching the Shannon at Killaloe he destroyed the wooden bridge over the river, and then marched northward east of the river, intending in the first place to attack the O'Carrolls of Ely. Torlogh O'Brien, with Clancuilein and other Dalcasian Septs, forded the Shannon, and coming up on Kildare's rear completely overcame the English; they slew the Barons Kent and Barnewall and many other men of distinction. "The English only escaped by flight, and the army of O'Brien returned home in triumph and with great spoil."

In the year 1522 we learn that Teigie O'Brien, while leading an attack was killed "by a shot of a ball."[1] And from another notice we find that artillery had come into use in Ireland; it was gunpowder and cannon that sealed the fate of the Irish Celts, for the native chiefs had no means of obtaining firearms, and as opposed to such weapons their swords and spears were useless. The last battle had been fought under the old system of warfare employed by the Dalcasians against the English, and as on so many previous occasions, physical strength and courage, with such weapons as they had, enabled them to drive back their foes, and to preserve their lands and homes in Clare. In the long run, however, it is not to the swift and strong, but by science and brains that the victory was won.

We learn something of the condition of Ireland at

[1] "Annals of Four Masters."

this period from the State Papers of the reign of Henry VIII. Ireland was then ruled by some sixty chief Captains or Princes, each one of them "only liveth by the sword, and obeyeth unto no temporal person but only to himself that is strong"; the son of such a chief "shall not succeed to his father without he be the strongest of the tribe, and by election." There be "also petty captains, and every one maketh war and peace for himself, without licence of the chief captain." The English folks in Ireland "be of Irish habit, of Irish language, except in the cities and walled towns." But the English, it is argued, would gladly accept the King's laws, and protection were it not for the "Irish enemies." No tribute could be collected. There were no bishops, priors, or vicars to preach the word of God; only "poor friar beggars." Every semblance of English government had passed away from Ireland. "The King had no envoy or ally, native or English, in Ireland, outside its walled towns."

The Celtic chiefs must have felt weary of constant internal wars and that it was useless, if desirable, to oppose King Henry VIII., in fact the time had arrived for something approaching a settlement of their troubles, if only their lands could be preserved to them and their tribesmen; which they were led to believe it was the King's intention to secure to them and their heirs.

In the year 1542 St Leger, who was Lord Deputy of Ireland, summoned a Parliament to meet at Limerick with the object of legalising an agreement with the Chiefs of Thomond regarding the tenure of the land, and for other questions concerning the legal government of that part of the country. Morrogh O'Brien and Sioda Mac-con-mara came to Limerick to meet the Lord Deputy with documents which they had prepared, stating the terms upon which they were willing to hand over their lands to the Crown, the basis of this undertaking being that the landlords of Clare should receive their lands back with titles drawn up according to English law and procedure. These title deeds are still in existence, dated December 10th, A.D. 1542, after being confirmed by a Patent, 35 Henry VIII., A.D. 1543.

When Henry VIII. accepted the terms proposed by the landowners of Clare, he directed the Lord Deputy to take special care that "neany of them suffer any displeasure nor damage hereafter for their submission, but you are to aid them and see the same revenged as the case shall require."[1] Nevertheless, under this agreement it was assumed, in spite of immemorial usage, that the land was to become the absolute hereditary property of the chiefs who agreed to Henry VIII.'s terms, to the detriment, therefore, of their tribesmen and the real occupiers of the soil, and was therefore a great and irreparable injury to the humbler classes.[2] So far, however, as the leaders of the Clancuilein Sept were concerned, it seems clear that they urged the ruling powers to extend English land tenure into the West of Ireland. They understood the nature of the agreement they were entering into with the Crown on "behalf of themselves and all the rest of the gentlemen and freeholders of the said Sept in the baronies of Bunratty." It was in that

[1] State Papers, vol. iii. p. 476.

[2] Lecky's "History of Ireland," vol. i. p. 16.

area that the Sept originally obtained their tribal lands in the fifth century, and they were in possession of these same lands in the year 1654, or a century after entering into their agreement with Henry VIII. The object of that arrangement was to bring the titles of the landed property from under the Brehon laws, into such form that they could be held in conformity with English law. The King thoroughly appreciated the difficulty that existed in granting negotiable titles to the owners of the old tribal lands on equitable terms, but whatever the technical difficulties, his Government were emphatic in their orders as regards the parties concerned, who were to lose nothing that was essential to their interests or customs; the King had no idea of making the transfer of land from the old to the new system a means of confiscation or damage to the landowners. But the question at once arose as to how the land in Clare, which was freehold, a part of the old tribal lands, could be brought under English law. As Edmund Spenser remarked, the "lawes ought to be fashioned into the manners and conditions of the people for whom they are meant, and not to be imposed upon them according to the simple rule of right, for then, instead of good, they might work ill, and pervert justice to extreame injustice."[1] It would have been well for Ireland had Henry VIII.'s policy been adhered to by his successors.

Among other things the King determined to establish courts of justice in Ireland, which were to be constituted of the bishops of the diocese and some of the principal landowners. The officers forming these courts were to be charged with extensive powers,

[1] "View of the State of Ireland," by Edmund Spenser, p. 17.

embracing military operations; at the same time sheriffs were appointed, and a nucleus formed from which a regular judicial system might have developed to enforce order and law in the province. Beyond this, schools were to be established and maintained by local cesses raised for the purpose. But there was no adequate provision made for enforcing these salutary reforms; they were mostly arrangements the outcome of good intentions, but wanting in material support to carry them into effect. For instance, Sir E. Fitton had been appointed President of the province of Connaught, and in A.D. 1570 he proposed holding a court of eighteen days' duration, in the Monastery of Ennis, County Clare, "to administer justice" and to reduce Clancuilein and other Dalcasian Septs to order. Teigie O'Brien was appointed the first sheriff of Clare, and he placed a quantity of food and drink in the monastery for the use of the President; and seems to have considered this to be all that was necessary.

For on the day following when Sir Edward arrived, he sent off a message to the Earl of Thomond and summoned him to Ennis. On receiving this message, we are told, the Earl came to the resolution of making a prisoner of the President and his officers. Sir Edward Fitton finding his position rather uncomfortable, escaped from the monastery on foot, and was fortunate in finding a guide to conduct him over the narrow passes and intricate paths of the district.[1] Queen Elizabeth, who had come to the throne, would not tolerate this kind of thing, and the Earl of Ormond was directed to proceed at once with a sufficient force into Clare to bring the Earl of Thomond into order.

[1] "Annals of Four Masters," A.D. 1570.

He accomplished this purpose, and in the following year the President of Connaught came to Ennis, accompanied by a strong force and "established laws and rules, and abolished injustice and lawlessness." To secure obedience to these laws he carried hostages from among the Clancuileins and other Septs of Thomond along with him to his headquarters in Athlone. The "Four Masters" state it would be difficult "to calculate the hundreds of cows given to the President of Connaught by the men of Thomond during the two years he remained in the territory," in other words, he took such large bribes that, even in those lax times, the Government were compelled to recall him to England.

Edmund Spenser refers to these corrupt practices in Ireland as very prevalent in his day. Writing of military commanders he observes: "the captaine, halfe of whose souldiours are dead, and the other quarter never mustered, nor scene, comes shortly to demand payment of the whole accompt, where by good meanes of some great ones, and privy shareing with the officers and servants of other some, he receiveth his debt, much less perhaps than was due, yet much more indeede than is justly deserved" ("View of the State of Ireland," by Edmund Spenser, p. 154).

The Lord Deputy Sidney made an official visit to Clare in the year 1571; he states he there met "two Lords of Thomond called Mac Nemarroes, who came lamentinge the ruyn and wast of their countries"; the Lord Deputy adds "they were cheife gentlemen of that countrey, which, if it were quiet, they might lyve lyke principal Knights of England." Sidney states, of all the chief men he met with in his tour he "*could not find one descended in English race.* They all complained of the Obryens for the ruyne of their countrey ; and truly in such desolation and waste it is." The Lord Deputy remained for some time in Galway, and bound the O'Briens "by bonds of great sommes," and further he carried off the Earl's brother with him to Dublin, where he "still deteined hym in iron." Sir H. Sidney states that "the root and origine of all this trouble was the uncerteine grannte, and unstable possession of their landes, whereupon grewe their warres." He further informs the English Government that "I brought them to agree to surrender into the Queene's handes, and to take it of her Highness agayne, and yeilde both rent and service, and therefore I have confidence to make a good reckninge for the Queen"

The Lord Deputy proposed, therefore, in place of the cesses and other charges formerly paid by the landholders to their landlords and chiefs, that they should pay a fixed rent to the landlord, and that the latter were to yield to the Crown a definite amount per annum in proportion to the extent and value of their landed property. This, however, was an altogether different arrangement to that the landholders had just before made with the Crown; it substituted the system of land tenure of England for that which had existed from time immemorial in Ireland, and for which its people had striven through so many generations to maintain.

In the year 1570 the "Four Masters" refer to the death of "Mac-con-mara, Chief of Clancuilein, a most noble and majestic man," who was followed as head of the Sept by his tanist, so that not only was this form of succession in force among members of the Sept at the latter part of the sixteenth century, but also the old system of the chieftainship of the clan was also a recognised condition of their social system. We further discover from a deed dated January 27, 1585, relating to property held by a certain John Mac-conmara who had recently died, that although a large landowner he could not give any account of his rental during his lifetime to the appointed governor of the province. Sir R. Bingham states that "neither the owner of the lands, nor anyone else, knew for certain how much rent they had or ought to pay on any of these lands." The estates referred to belonged to the son of the Chief of Clancuilein who had signed the agreement with the Crown in Henry VIII.'s time on behalf of himself and the other landlords of his Sept. They had in truth never received rent as understood by Englishmen. The excess of land which the possessor did not require for his own purposes, he made over to various members of the family to cultivate, they supplying him with a certain quantity of stock to enable him to keep open house, and also with personal service. The management of the property was still a conjoint family affair. The outturn of the soil was consumed by man and beast living on the land which produced the stock and grain.

In the deed above referred to we find that the "Borome" tax was still collected in Clare. This tax consisted of a certain number of cows which had to be handed over by landholders every year to their chief. Besides this, upon "the marriage of his eldest daughter the number of xx cows was received from the barony," and further, "that the towns and villages named (they form a long list) were bound to keep and beare the said Mac-con-mara's horses and horse-boys, with sufficient horse-meat and boys-meat every Christmas and Easter, when he kept any of the said feast at his house or town of Dengen and not els." This tax might be compounded by a yearly payment of sixteen pecks of oats. The landlords, kearntyes, and huntsmen had "dutys upon certain quarters of lands in the barrony always freely acquitted and discharged free of all demands." The contents of this document therefore proves that cesses instituted by the early Celts of Clare were in force at the close of the sixteenth century.

The arrangement concerning the tenure of land by Sir H. Sidney and other Elizabethan officials, beyond destroying the old system of land tenure was attended with the intrusion of the middleman or land agent into Ireland. These individuals were the instigators of rack-rent, and of a large part of the land passing into the hands of non-resident landlords, who cared nothing for their property, or the tenants and labouroughs on their lands. As far back as the year 1596, Lord Burghley complained that the Englishmen who succeeded to the estates of the ancient Celtic landowners, made over their lands to "deputies, who take greater rents than that allowed by Her Majesty, and so they are forced to re-let the ground to the Irish without maintaining any English on the property."[1] Lord Burghley corroborates the accuracy of the statement made by the Earl of Kildare, that the middleman demanded extraordinary cesses over the whole country, a practice which rapidly developed and

[1] State Papers of 1596-7, p. 182.

caused infinitely greater hardships than the cesses enforced under the Celtic customs and laws.

For our purposes it is unnecessary to follow the history of members of the Clancuilein Sept through the reigns of James the First, and of Charles the First, until they were for the most part dispossessed of their lands and dispersed by Cromwell. We have in another work given an account of some of the descendants of the members of this Celtic family from the commencement of the seventh century up to the present time.

Goethe observes, that the history of a people is their character; it was from a study of the history of the early Celts in Europe which led M. Thierry, and Mommsen to form the opinions we have referred to (p. 211) as to the hereditary character possessed by this race of human beings. By comparing the conclusions arrived at by these historians on this subject, with those to be derived from the history of the Irish Celts, it is evident that the traits of hereditary character which governed the conduct and career of the progenitors of these people, also ruled the conduct of individuals and the destinies of the Irish Celts. For we find them to have been—

A chivalrous people (p. 220), that is, a generous, high-minded and brave set of men; as an instance in point, we may refer to the action of one of their remote ancestors, Connel. As the historian observes, "his integrity was such that he delivered up possession of a crown which he was able to defend, because he had no other right to it." It must be remembered this was the action of a man who lived in times previous to the introduction of Christianity into Ireland.

Another example of the chivalrous conduct of these people is afforded by the action of Sioda, who, in the eighth century, having with his Sept been deeply injured, and the sacred mound of Magadhair desecrated by the King of Ireland, after three days' fighting Sioda took the King prisoner. But so far from torturing or punishing the vanquished chief, we are told that Sioda treated him sumptuously, and conducted him, and the remains of his forces homewards across the Shannon.

If we pass on to the fourteenth century we find De Clare attempting to bribe Mac-con-mara to desert the cause of his chief O'Brien. Mac-con, however, and his retainers, without hesitation refused to listen to overtures of this nature, and he and Clancuilein remained staunch supporters of their lawful ruler; in fact it was through their assistance that Mortough O'Brien retained his position as Chief of Thomond. This incident occurred at a period when, according to Mr Freeman, an English Ealdorman not only deliberately betrayed his country to the invader, but that "to do so now became the regular course on the part of royal favourities."[1]

In the year 1370 we find the Earl of Desmond in command of a force of English troops, bent on reducing the Dalcasians of Clare to submission to his rule; the Earl however was defeated, taken prisoner, and conducted to the residence of the O'Briens at Clonrode. Desmond was so strongly impressed with what he saw of the life and training of the Celtic O'Briens that he sent his son James to be reared among them. We might refer to other examples illustrating the chivalrous

[1] "History of the Norman Conquest of England," p. 139.

character of the leaders of the Dalcasians. Shortly before their expulsion from their homes, we have evidence bearing upon this subject given by English officials, who had no love for the men they refer to. The first of these, we may mention, is that of the Lord Deputy, dated A.D. 1543; he wrote to Henry VIII. suggesting that Sioda Mac-con-mara should be created Baron Clancuilein, "because he and his ancestors have in those parts alwayes borne a great swynge, and one that for himself is of honest conformatie, whose lands lye holy on the farsyde of the Shannon." [1]

Brave to a fault were the members of this Sept, foremost among a tribe, whose pride it was to lead the van of an advancing force, and who claimed equally as their right the honour of protecting it, and forming the rearguard in time of disaster and retreat; and so we find them at Clontaf, and in many another hard fought battle. O'Donovan and others well versed in the history of Thomond, assert that had it not been for the personal bravery and devotion of the Chiefs of Clancuilein, the O'Briens could not have held their own in Clare or prevented the Northesmen, and subsequently the English, from taking possession of their lands in the tenth and fourteenth centuries. The leaders of Clancuilein placed their lives absolutely at the service of their leaders; they were ready to fight and to die in defence of his interests; and in these old times war made men staunch and true to one another. We could hardly have a better instance of this than in the case of S. Mac-con-mara, who, when a hostile force approached Quin in the year 1278, with a small band of retainers entered the

[1] Patent 34, Henry VIII., Dec. 10, 1542.

enemy's camp at daybreak, with the object of engaging the leader of the hostile force in single combat. He fought his way onwards until overpowered and he and his followers were all slaughtered. Then again in the account of the battle of Corcomroe, Macgrath dilates on the conduct of the leader's youthful relative who came to his support in a critical moment; we have a similar instance in the case of the lad Turlough O'Brien, who was his father's standard-bearer and fought by his side throughout the day, dying in the grasp of one of the enemy. In the description the historian gives us of the after scene of the battle of Corcomroe there is nothing of slaughter of the wounded, but rather that "they were no longer foes but brothers in trouble." War was one of the duties of life among these people, the serious side of the subject did not afflict the soul of these light-hearted Celts.

Loyal were the head of this Sept and their followers to their own chiefs and to their province, patriotism in its true sense was one, if not the most potent influence in guiding their actions. However desperate the venture the head of the Sept could at any moment command the devoted services of a thoroughly trained body of his relations and dependants, who were prepared to accompany him in any warlike expedition his leaders had determined to carry out. When the split took place in the thirteenth century among the O'Briens, it became necessary for the Clancuilein Sept to choose which faction they should support, and they determined to throw in their lot with Turlough O'Brien because he had married the daughter of their chief; and so in other cases their hereditary qualities bound them to one another and to their ruler, qualities inherited from a common ancestor, and having a common aim, the freedom of their homes and lands. This bond of union was the keystone on which their actions were based. Their chiefs were elected by the members of their Sept as being by birth and personal prowess the fittest man to rule and to lead them, and so far as the history of Thomond goes, there is no evidence of tyrannical or unjust dealings recorded of any one of the Clancuilein leaders. The members of the Sept were not only loyal to their chiefs, but also to themselves; they did their duty and were content to leave the issue to be judged of by its results, and in the hands of the bards. Gentlemen at heart, that is having a tender regard for the feelings of those with whom they were brought in contact, unselfish, and reserved as to their own acquirements and actions.

Light-hearted and hospitable. These qualities seem to have been marked features in the character of the Celts and were conspicuous in members of the Clancuilein Sept; frequent references are made to members of the clan, who are described by the "Four Masters" and other writers as being "charitable and a truly hospitable man," of another as being "renowned for hospitality," of a third as "being a favourite of women and children, by reason of his gaiety and pleasantry," and so on. In selecting these, out of the many references made of a similar nature to members of the Sept, we have not chosen those favourably noticed and excluded unfavourable references to members of the family; the latter, if they exist, do not appear in the various annals of Ireland.

The love of money was a snare to which the early Irish Celts were never exposed or into which they were likely to fall; not that they were improvident, but the members of a Sept like that of Clancuilein existed without money until the middle of the sixteenth century, The Pope's Nuncio, in one of his remarkable reports on the people of the West of Ireland in the year 1648, observes that these people "rarely touch money, and as rarely quarrell about it."

Imaginative. Mr Lecky states that Irishmen are endowed in an extraordinary degree with retrospective imagination, which quality, he remarks, is characteristic of these people. Too many of them live habitually in dreams, largely drawn from the past, and of future honour and glory, to which they have not sufficient perseverance to attain by steady application and hard work. If we refer to any of the writers who attempt to portray the character of Irish men and women, we are struck with the frequent references they make to the scenes and customs of the ancestors of those who play a part in these narratives. The bards were versed in this ancient lore, and nothing so much pleased the Celts as to listen to their tales, concerning the part taken by their ancestors in the struggles through which their country had passed.[1] There are no people in which the past plays so important a part in their daily life as the Irish.

[1] Mr A. J. Balfour has well expressed this fact when he stated, "Anybody who had not realised that the whole history of Ireland consisted of memories, not only of 250 years or 500 years old, he would venture to say had not begun to understand the history of that country" (speech delivered in the House of Commons, June 7th, 1895, in opposition to Mr Morley's proposal to raise a statute to the memory of Oliver Cromwell).

Sir J. Davis has recorded an interesting example of the devotion of the Brehons to their employers, and the great value they set upon the ancient documents committed to their care. Sir John writes, A.D. 1603, as follows: "Touching the certainties of the duties and provisions yielded to McGrath out of these lands, they referred to an old parchment roll, which was in the hands of one O'Brislau, a chronicler and principal Brehon of that country; whereupon O'Brislau was sent for, who lived not far from the camp, who was so aged and decrepid, as he was scarce able to repair to us; when he was come, we demanded of him a sight of this ancient roll. The old man seemed to be much troubled with this demand, made answer that he had such a roll in his keeping before the wars, but that in the late rebellion it was burnt among other papers and books by certain English soldiers. We were told by some present that this was not true, they affirmed that they had seen the roll in his hands since the wars. Thereupon my Lord Chancellor being present with us did minister an oath to him, and gave him a very serious charge to inform us truly of what had become of the roll. The poor old man, fetching a deep sigh, confessed that he knew where the roll was, but that it was dearer to him than life, and, therefore, he would never deliver it out of his hands unless my Lord Chancellor would take the like oath that the roll should be restored to him. My Lord Chancellor, smiling, gave him his hand and his word that he should have the roll re-delivered unto him if he would suffer us to take a view and copy thereof. And with tears in his eyes the old Brehon drew the roll out of his bosom, where he did continually bear it about him. It was not very large, but it was written on both sides in fair Irish characters; howbeit, some part of the writing was worn and defaced with time and ill-keeping. We then caused it to be translated into English, and perceived how many vessels of butter, and how many measures of meal, and how many porkers, and such gross duties did arise unto McGrath out of the lands." [1]

[1] "Tracts relating to Ireland," by Sir J. Davies.

Credulous. It has been said with truth that the Celt is endowed with intuitive appreciation of all that touches the mystical and supernatural. Their implicit faith in their druids, and the deep and lasting impression they entertain concerning "banshees" and other superstitions which play a very real and important part in their lives.

The emotional disposition of Celtic Irish men and women has above all other obstacles barred their progress as a people, and prevented them from co-operating in that long and steady pull necessary for the firm establishment of a nation. The preponderance of the emotional processes over the intellectual leads the Celt to form rapid conclusions, which are by no means always lasting, and so he too frequently lends himself to schemes which upon mature consideration would prove to have but little to recommend them. He is thus apt to be carried away by words flowing from a fluent tongue to follow political and other phantoms, rather than by persevering effort to ensure success in life. It has been fairly said the creed of the Celt is that "it ought to be—it must be—it is," and so for no better reason, they too often waste their talents and mental powers in efforts wide of the mark at which they have aimed.

As an individual, the over-sensitive Celt easily takes affront, and is apt to consider himself injured by persons possessing a more stable mental basis; the advancement of another person in life thus becomes tantamont with failure on the part of the less fortunate individual, and so jealousy and unreal grievances are apt to add trouble and bitterness to the other burdens of an Irishman's life. The sensitive Celt is seldom able to bear the hard blows endured by a tougher race, and is apt to shrink within himself under the strain; he is often therefore shy and reserved, especially in the presence of strangers; he cannot bear ridicule, a weakness the bards of old realised; for their taunts were the severest punishment a chief or any other man could be exposed to in former times. The Celt cannot forget a wrong, real or imaginary, especially if perpetrated by one who has been his friend; for the bond of friendship with the Celt is something real, and so in proportion is the offence of one who breaks this tie. Among his own people, and in polite society, where the genius, wit, and vivacity of the race has full play, the Celt is seen to the greatest advantage from a social point of view. Beyond the confines of his own home his intense love of nature, deep sympathy, and yearning for comradeship not unfrequently attract men strongly to him. As soldiers and the leaders of men, this quality, now, as of old, is often invaluable; we could hardly have a more apt example of this than in the person of India's Viceroy, Lord Mayo, the devotion and respect he gained from the native princes was very remarkable.

The brightness of the Celt, both in men and women, is the result of their inherited emotional natures, and is eminently calculated to endow life with a charm which has marked influence for good in this careworn age. There is, however, another side to the picture; the qualities which render Celtic Irishmen light-hearted, renders him terribly alive to the pain and grief suffered by others. The anguish of mind thus produced he is apt to keep to himself, and the greater his grief the more he conceals his feelings in silence;

his sensitive nature too often shuns sympathy, and turns for relief to its own bitterness.

The old Irish Celts held their women in tender regard, and so females were treated by them with consideration such as they then received among few other nations. Especially in the case of the lower classes, Irishwomen were never held to be the slaves of men ; they were employed in attending to their children, in weaving, looking after the domestic creatures belonging to the family, and such like occupations. "These women were chaste as girls and as wives, and when young endowed with taste, and an amount of refinement and manner to be met with among few other classes in any part of Europe."

It is difficult to realise a state of society such as that which existed among the members of the Clancuilein Sept until the middle of the seventeenth century. Money was still practically unknown to these people, there was no such thing as wealth outside the possession of land and stock ; no tenant, no tithes, or taxes, beyond a fixed tribute on the land ; no titles, the social scale being regulated by the amount of land a family possessed ; there was no central government, no army, navy, or police ; no poor laws, but the aged and sick were nevertheless cared for, as they are under the conjoint family system in India at the present day. The land was all in all to these people, not only was their social position ruled by it, but it had supplied them and their forefathers for many generations with the necessaries of life in the way of food and garments, and they had come to love it, and cling to it with an intensity of feeling such as that referred to by Mr W. R. Le Faun, in his excellent retrospect of a long and genial life spent in Ireland ; he remarks, "that it is impossible for one who has not resided in Ireland, and been on intimate terms with the people, to realise the intense longing which animates them for the possession of land, no matter how small the holding."

The conditions under which their progenitors lived for centuries in dependence on the soil for their existence, and their social and political status had engendered hereditary characters or impression on the living substance of their central nervous system which to a large extent influence, their conduct throughout their lives. It is in this way we can best account for that intense longing for the possession of land by the Irish to which Mr Le Faun refers.

We can thus perhaps to some extent realise the intense bitterness of feeling which must have been excited in the minds of the Celtic Irish at the loss of their lands under the ruthless confiscation carried out by Englishmen during the Elizebethan and Cromwellian periods. This bitterness has also become habitual, and can only be appeased by means which tend to restore the lands of Ireland to those who with their families will, as of old, live upon their own holdings, and cultivate it for their own advantage.

M. Thierry and Professor Mommsen have both arrived at the conclusion that the Celts as a nation are too emotional to form a stable form of government (p. 212). Without entering on a discussion as to the political condition of Ireland at the present time or of the treatment her people have received by their English rulers, we find incontrovertible evidence in the history of these people of the inability of their

Celtic chiefs to sacrifice their own interests for that of their country. From the third century onwards we find their leaders inviting foreigners into Ireland to help them to enforce their own claims. When first the Anglo-Normans entered on the conquest of Ireland her provincial kings were so deeply engrossed in thier own quarrels that they failed to resist the common enemy. Again, in the year A.D. 1258, the four Provincial Chiefs of Ireland met in order to settle on a common line of action of defence for the country; the meeting broke up because these four men could not determine which of them was to take precedence at their council. Almost the last battle fought by the Irish Celts under the old order of things was the culminating point of the nation's madness; for in this fierce engagement the inhabitants of the North and South of Ireland were brought into the field by Anglo-Norman commanders, with a force of armed Englishmen standing by to watch the Celts destroy one another.

In the preceding pages we have brought together sufficient evidence to demonstrate the nature of the hereditary characters possessed by the men of a Celtic tribe, who lived in a fairly constant environment for many centuries; and if historians are correct in their ideas regarding the early Celts of the Continent of Europe, we find a striking affinity between their inherent characters and those possessed by their descendants in Ireland. The emotional and instinctive qualities displayed by the Irish Celts depended mainly, according to our theory, on their hereditary characters rather than on the result of what they learnt or their intellectual acquirements, which were hardly of a higher order than those of the wild animals who roamed through the forests of Thomond.

In applying this principle to the members of the Clancuilein Sept we have the advantage of knowing, that until the early part of the last century many of them remained pure Iberio-Celts, for they did not intermarry with other races. This fact is proved by referring to the pedigrees of some of these families which have been carefully preserved, and we find from the earliest times, that as a rule, the principal landholders of the Sept always married into Celtic families; as Sir H. Sidney observes, he "could not find one descended in English race." Further, these people for many centuries lived the life of agriculturists, and their surrounding varied but little throughout this long period. They were never conquered until Cromwell's time, and their physical and hereditary characters at present are similar to those possessed by their ancestors, who took possession of Clare in the fifth century.

We hold that rightly to appreciate the actions of human beings we should become acquainted with the nature of the materials through means of which these actions are elaborated. It is on these lines we have proceeded in this, and in our previous book on "Human Speech," endeavouring to test the operation of the principles we advocate by reference to the history of a certain tribe of individuals. Led by the same reasoning, in the year 1899, we ventured to predict, what in our opinion would be the ultimate relation existing between the English and Boers in South Africa. It is hardly necessary to observe at the time when the following opinion was published, we were in the midst of a severe struggle with the Boers, and that national feeling on both sides was strained to the uttermost, it therefore required firm faith in our opinions to enable us then to write as follows on this subject.[1]

"If the inhabitants of the Transvaal and Orange Free State had been thoroughly acquainted with the English language, and so with our real sentiments and ideas, they would never have been led into the terrible conflict in which they are now engaged. The Boers are of the same Teutonic stock as the Anglo-Normans, having less of the Iberian element in them than the majority of the inhabitants of the British Isles. Nevertheless, like ourselves the Boers are derived from a Teutonic branch of the human family. It remains for our Government, when the time comes to re-settle the revolted provinces of South Africa, to bear in mind the racial character of the people with whom they have to deal. A brave, self-reliant, freedom-loving, independent race, who under just laws and with a strict regard to their prejudices and hereditary characters, will in time fraternise with Anglo-Saxons. They have fought hard, like the Aryans of India (Sikhs) for their country, but when fairly beaten they are bound, as education spreads among them, and they learn to comprehend our language and modes of thought, to become a strong and important element in the British Empire."

[1] "Origin and Character of the British People," by N. C. Macnamara, pp. 224, 225 (Smith, Elder & Co.).

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