(6) The first and simpler planula stages, though often characteristic of the larger divisions of the animal kingdom, do not possess, as a rule, the essential, diagnostic characters of the larger divisions to which they belong, and he proposed to call them 'neoembryos.' Examples: the *Cinctoplanula*, the planula of the *Cœlenterata*, the *Pluteus*, the *Trochosphere*, the *Pilidium*, the earliest planula-like ciliated stages of *Amphioxus*.

(7) The latest of the more specialized planula-like stages are either directly transformed into, or else give rise to, other forms in which the characters of the larger divisions or types of the animal kingdom begin to appear, at least so far as essential characters are concerned. Examples: the *Ascula* and *Ampullinula*, the *Actinula*, the *Gulinula*, the *Veliger*, the internal worm-like form arising in *Pilidium*, the stage of the formation of the notochord in *Amphioxus*. He proposed, therefore, to interpret these relations by naming the embryo in these stages the 'typembryo.' This term can be applied to the *Nauplius* of *Crustacea*, and the *Echinula*[1] of *Echinodermata*, as well as to those above noted.

The application of such principles to the study of the younger stages of fossil *Cephalopoda* was productive of what seemed to be satisfactory results. The protoconch of Owen is, according to this nomenclature, a shell of a univalve *Veliger* among the cephalous *Mollusca*, and a typembryo, which, though eminently characteristic of that group, has no exact morphological equivalent among normal adult forms of recent or fossil shells.

The true larval, or, as they are here named, silphologic (Σίλφη, 'a grub') stages began with the formation of what Owen appropriately called the apex of the conch or true shell. Among nautiloids this was a short living chamber occupied by the body of the animal, but having no siphon or septum. It was completed by the deposition of the apical plate, which sealed up the aperture of the protoconch, thus closing the opening, and cutting off communication between the two interiors. This stage can therefore be named the 'asiphonula' or siphonless larva.

The second larval stage in *Nautiloidea* was composed of a living chamber, closed apically and completed by a single septum, which had a cæcal prolongation reaching across the first air-chamber and resting upon the inner side of the cicatrix. It is proposed to call this stage the 'cæcosiphonula,' since it is undoubtedly the primitive stage of that organ. The cæcosiphonula may indicate the former existence of an ancestral form having a central axis composed of similar closed funnels or cæcal pouches.

The third silphologic stage in nautiloids was completed by a septum (the second in the apical part of the shell) having an open funnel extending apically and joined to a loose-textured siphonal wall which reached down into and lined the cæcum, thus forming a secondary closed tube. In accordance with the structure, this has been named the 'macrosiphonula.'

The fourth larval stage of the nautiloids was completed by the building of the third septum. This septum had a long funnel and attached porous wall, but this wall formed a true siphonal tube opening apically into the next section, the macrosiphon. This was the beginning of the small siphon, and can be appropriately termed the 'microsiphonula.' The microsiphonula was the typical stage of nearly all the known genera of nautiloids, beginning with the *Orthoceratites* of the Cambrian, and found at the present time in *Nautilus*, and also of all ammonoids and belemnoids without exception.

It has also been found in tracing the descent of forms within sub-orders, families, and genera, that it is practicable to prove, that characteristics usually appear first in adult stages, and are then inherited at earlier and earlier stages in successive species of the same stock, whether they occur on the same horizon or in different horizons. The adolescent stages are therefore of as great importance for tracing the genealogy of small groups as are the silphologic characters in larger groups. Thus one can speak in definite terms of the relations of the nealogic (Νεαλης, 'youthfulness') stages, and their meaning, and importance in tracing the genealogy of families and genera, without danger of confusing them with the characters of any of the silphologic stages.

After the silphologic and nealogic stages have been disposed of, there still remains the adult period, which is equally important in genealogical investigations, since it enables the observer to study the origin of many characters which afterwards become silphologic and nealogic in descendant forms.

The use of a distinct term for the adult period becomes necessary not only on this account, and to separate its relations from those of preceding periods, but also because of the constant recurrence and importance of representative forms. The term 'ephebology' ('Εφηβος, 'the age of puberty') has accordingly been adopted for the designation of the relations of the adult stages, and under this term can be classified also the representation of similar forms in different groups or morphological equivalents. These are often so exact that it becomes very difficult to separate them. They have been and will continue to be the most difficult and misleading obstacles to the student of genealogy and classification.

In former essays the senile transformations and their correlations with the degraded forms of the same groups have been described and defined by the term 'geratology' (Γέρας, 'old age').

There were two stages of decline or old age among ammonoids. The first of these is the clinologic (Κλίνω, 'to incline downwards') stage. This immediately succeeded the ephebolic stage, and during its continuance the nealogic and ephebolic characteristics underwent retrogression. Ornaments, spines, and sutures degenerated and lost their angularity; the ribs or pilæ, and often the keel and channels, when these were present, became less prominent; and before this period closed, the whorl itself sometimes decreased; showing that degeneration in the growth-force of the animal had taken place. In man the baldness of the head, loss of teeth and resorption of the alveoli, loss of the calves and rotund stomach, and return of early mental peculiarities, are phenomena of similar import.

The last changes in the ontology of the animal took place in what can be called the 'nostologic' (Νόστος, 'a return') stage, and during this period these tendencies reached their highest expression. Among ammonoids the ornaments were all lost by resorption, the whorl became almost as round and smooth as it was in the silphologic stage, and in extreme cases it even separated from the next whorl, leaving a perceptible gap. This almost complete reversion to the aspect of the silphologic stage can of course only occur in animals which attain an extreme age.

[1] Address at the American Association by Alexander Agassiz, vol. xxix. 1880, p. 410 reprint, p. 22, shows that there is a stage of the embryo common to all orders of living *Echinodermata*. This stage, however, was not named in the address above quoted, which was intended as preliminary to an illustrated essay on the same subject; and Mr. Agassiz has supplied that omission in the following note, which I quote from a letter to me: "I intended some time, when revising my 'Address on Paleontological and Embryological Development,' to call the earliest common stage of echinoderm embryos, 'Echinula,' for convenience in making comparisons. — A. AGASSIZ."

MENTAL SCIENCE.

Aphasia.[1]

IN 1861 Broca suggested before the French Society of Anthropology that the only method of determining the functions of the brain was to co-ordinate marked symptoms during life with the lesions found in a post-mortem examination. Some months later he announced his belief that the third frontal convolution of the left hemisphere of the brain was the seat of spoken language, and described a case of a patient called 'Tan' because that was the only word he used, helping himself out with various gestures. He had no paralysis, and seemed to understand what was said to him. The posterior half of the second and third left frontal convolutions of the left hemisphere was the seat of the organic lesion. In the same year a quite similar case of a man with only such scraps of words as 'oui,' 'no,' etc., but with mental and motor powers intact, showed in the autopsy a definite lesion in the third frontal convolution of the left side of the brain. These remarkable cases drew attention to diseases of this kind; and in the end of 1863, eleven cases were on record in which the power of vocal speech was almost or entirely lost, the common anatomical element of each of which was a lesion in the posterior third of the third frontal convolution of the left hemisphere. Broca called this condition 'aphemia,' and gave as its symptoms the loss of the power to express ideas by vocal movements without any motor paralysis or mental impairment. He concluded that memory was not a single

[1] Abstract of an address delivered before the Anthropological Society at Paris by M. Mathias Duval, *Revue Scientifique*, Dec. 17, 1887.

faculty, but that the memory of each kind of mental acquisition was separately organized, and that the cerebral seat of the memory for motor speech-signs was in the third frontal convolution of the left half of the brain. The most startling fact about this discovery was the association of the malady with a lesion in the left half of the brain only. Broca explained this by taking into consideration that we were all organized with a preferred side of the body, and that to be right-handed means nothing else than to have one's best-developed motor centres in the left half of the brain, inasmuch as the fibres cross over in their descent from brain to muscles. In the same way our speech-movements get associated with the left hemisphere; and in left-handed persons the reverse condition may be expected to occur, and has since been found.

Trousseau substituted the word 'aphasia' for the disease, leaving Broca's term to denote that particular form of it which he brought to notice: for it was soon afterwards observed that with the loss of speech sometimes went the loss of writing as well, and sometimes not; that, again, the power to write may be lost, and that of speech retained. Other patients could speak and write, but not read; and others, again, could read, but not speak or write. A complexity of symptoms variously combined have arisen in which order is now to be put. Four types can be distinguished:—

First Type.— In describing such types, it should be noted, general and typical symptoms alone can be noticed. The patient, perhaps as a sequence to an apoplectic stroke, sinks into a condition apt to be mistaken for a condition of deafness and idiocy; but careful observation soon shows that he is sensitive to noises, such as the opening of a door, and even hears the sounds of the human voice. Inferring that he is spoken to, he may attempt to answer, but will say something entirely irrelevant. Gradually appreciating that he is not speaking to the point, he may with some impatience ask you why he cannot understand what you say. He thus shows his ability to express his thoughts, to hear perfectly, and, besides, he reads and writes, plays chess, and is able to do every thing but understand spoken words. Your speech is as an unknown language to him,— just so much sound. What he has lost is the power to get meaning out of sounds; the slowly acquired associations between the word-sound and the idea are broken down; his memory for word-meanings is lost. He is not deaf to sounds, but deaf to words,— a 'verbal deafness,' as it is called. We have thus a memory for the meaning of the sounds of words, having its centre in the first temporal convolution of the left half of the brain, and losing its function when that region suffers degeneration.

Second Type.— Here, again, the cause may be an apoplectic stroke, which, after the immediate effects have passed off, leaves the patient in an apparently normal condition. He may prepare to attend to his business affairs; will perhaps sit down to write a letter; does so, and, remembering that he omitted something, takes the letter out to read it again. To his surprise, he cannot do so. He takes out his account-books, and finds he cannot read them; he picks up the newspaper, and again it says nothing to him. This patient hears, understands, and speaks: he is not aphemic in Broca's sense. Moreover, he can write; but his writing shows that it was written as though writing in the dark, guided by the muscle-feelings of the hand alone. He cannot read what he has just written, nor can he write from copy. His own name, that has been well impressed upon his motor centres, he writes very well, but he cannot read it. A book or a manuscript is to him as though it were written in Chinese. The disease here, then, is in the loss of the memory for the visual word-signs: the patient is not blind, but 'word-blind.' The remembrance of the forms of letters as retained by the movements executed in making them is intact, the lesion being a purely visual one. The brain lesion in such cases is quite definitely made out. It is in the second parietal convolution or inferior parietal lobule, behind and above the lesion in word-deafness, and, like it, is confined to the left hemisphere.

Third Type.— Here the patient can speak, can read manuscript or print, but he cannot write. He takes the pen in hand to write a word, knows what he ought to write, how it would look if written, but he cannot write it. He has lost the memory of the movements necessary to form the letters. The association between the movements made in writing and the word has been lost. He is not word-blind or word-deaf, but the *motor word-sense* is defective: he is 'agraphic,' as the term goes. A more careful observation shows how closely his malady is limited to this loss. He can use his hands dexterously for all other purposes; he can even draw and copy from a drawing. He can in this way copy script or print, but he draws the letters slowly, as we would copy a Chinese word. We see, then, that the auditory, the visual, and the motor elements of the word are to some extent independent, and that the memory for one of these may be lost while the others are retained. We may expect to find a localization for the motor defect, as for the others; but, owing to the fact that the disease seldom occurs without other complications, the localization is not as certain. Yet the bulk of the evidence points to the posterior portion of the second frontal convolution as the centre disturbed in aphasia. The lesion is again confined to the left half of the brain, and, to complete the connection of this with the phenomena of right-handedness, such patients can learn to write with the left hand by submitting themselves to a process similar to that gone through with in learning to write in youth. They thus cultivate the right hemisphere of the brain.

Fourth Type.— This is the type described by Broca as aphemia, and now called motor aphasia. The loss here is the link between the idea and the appropriate movements of tongue, etc., necessary to make the sounds of words. Often the patient retains a few phrases used on all occasions: in one case it was 'cousisi,' in another 'monomomentif.' The poet Baudelaire, when thus affected, would constantly say 'cré nom.' Here the power of hearing and understanding is retained, writing and reading are intact, and speaking alone has dropped out. The lesion is in the third frontal convolution, mainly the posterior portion, of the left side of the brain.

These pathological states suggest that individual differences with regard to the prominence of these several word-memories in our minds should be discoverable, and that the brain-centre corresponding to the preferred memory should be more highly developed than the others. It has often been observed that to many persons the eye is the chief avenue of knowledge. Extreme instances of this faculty, such as artists copying portraits from memory, and calculators doing their work upon an imaginary blackboard, are well known; but, confining ourselves to the memory for written or printed words, we find an excellent type of this faculty in a case recorded by Charcot. A gentleman of great culture and experience had the power of reading pages of his favorite authors from the visual images of the printed page. Two or three readings of a passage were sufficient to fix it in his memory. If he wanted a letter in a voluminous correspondence, he at once thought of its appearance; and so, too, with regard to all visual experiences in general. For music and other auditory occupations he had no taste. The importance of the case is doubled by the fact that through disease this faculty was lost, and he had to resort to his auditory memory, and cultivate it by having things read to him, and in other ways. He could not remember what he had seen, be it words or other objects; and, in short, from being a 'visual-worded' and 'visual-minded' man, he was forced to become an 'auditory-worded' and 'auditory-minded' one. This type of mind is common, and many persons have the habit of seeing the picture of the page from which they quote, the appearance of their manuscript, and so on. Unfortunately we have no autopsies of normal persons who had been marked cases of this type, to see whether in them the second parietal convolution was especially developed. Passing to the auditory type of mind, one could again easily find extreme cases, and note many instances in which what is heard, and especially in words, is most readily and deeply impressed. Persons to whom writing is easier than speaking, whose thoughts flow off the end of their pens and not of their mouths, may be classed among the 'graphic-motor' type. Deaf-mutes are apt to develop this faculty in another direction, and think in terms of hand-movements. There remains the 'motor-verbal' type. Stricker describes himself as of this type, and tells how he thinks in terms of the muscle-feelings in the organs of articulation. Such persons talk to themselves when they think, and are well represented by a character in a French tale, who could not compose unless imagining himself formally delivering what he was dictating. Unlike the other cases, there is here some anatomical corroboration; and a collection of the brains of

lawyers, statesmen, and others, all celebrated for the fluency of their speech, shows a surprisingly large development of the third frontal convolution of the left hemisphere. The brain of Gambetta is a marked instance of the same fact. Here this convolution is so highly developed that it is actually doubled by a slight fissure in the middle, no trace of this development being found on the right side.

What is above described includes merely what is most surely and definitely known, — a vast field for future research remains open, and even now enigmas are waiting to be answered. That certain aphasic patients are unable to count, and others do so normally; that some can tell time, distinguish the beats, but cannot count; and so on, — are facts as yet without meaning. So, too, the loss of the power to express one's self in gestures, and to use the ordinary conventionalities of life, may some day find a definite cerebral localization. Sometimes only certain kinds of signs are lost, and the rest retained; sometimes the patient can talk only by singing. All these facts may, in the science of the future, be as definitely explored as the main types of aphasia are to-day.

THE PSYCHOLOGY OF HANDWRITING. — In the *North American Review* for January, the editor, Mr. Rice, prints a series of the autographs of Napoleon, written at various epochs in his eventful life. Starting in his earlier years with a bold and clear signature, it retains most of these characteristics in the days of his greatest successes; but parallel with the declining fortunes of the great man, is a degeneration of his autograph, until at the end we have nothing more than the rudest, characterless scrawl. The autographs cannot but suggest the ravaging changes in the nervous system that were the physiological concomitant of the turmoil raging in the hero's mind.

HEALTH MATTERS.

Foot-and-Mouth Disease, and its Relations to Human Scarlatina as a Prophylactic.

AT a recent meeting of the New York Academy of Medicine, Dr. J. W. Stickler of Orange, N.J., read a paper entitled 'Foot-and-Mouth Disease as it affects Man and Animals, and its Relation to Human Scarlatina as a Prophylactic.' He said that it had long been known that foot-and-mouth disease could be communicated from animals to man through the milk of the affected animals, and by the introduction of the virus into wounds. When human beings are the subjects of this disease, the glands become enlarged, vesicles appear in the mouth and upon the hands and feet, and in some cases an eruption which resembles that of scarlet-fever. Hertwig and others, who purposely contracted the disease by drinking infected milk, were affected in this way. In 1884 there was an epidemic of sore throat, together with glandular enlargements and vesicles, in Dover, England. Upon investigation it was shown that it was due to the drinking of milk from animals sick with foot-and-mouth disease. Two years after this, an investigation was made in one hundred and eighty-two of the cases which had suffered from the sore throat in 1884. None of them had since had scarlet-fever, and from other points in their history it appeared that they had been rendered insusceptible to that disease. Dr. Stickler had himself inoculated three children with virus from milch-cows, and subsequently exposed them to scarlet-fever. One of these, after having fully recovered from the inoculation, was taken to the bedside of a scarlet-fever patient, and inhaled the latter's breath, and placed his head upon the pillow of the sick one. The child did not contract the fever. Two other children, similarly inoculated and similarly exposed, have not contracted the disease. In concluding his paper, Dr. Stickler said, that, while it was by no means proven that scarlet-fever could be prevented by such inoculations, the results thus far obtained were very suggestive, and proposed to continue his investigation.

In the discussion which followed the reading of the paper, Professor Law of Cornell University said that he was sceptical as to the prophylactic value of these inoculations against scarlet-fever. In Great Britain there were frequent outbreaks of foot-and-mouth disease, affecting cattle and the persons who came in contact with them, and, if it was a protective disease against scarlet-fever, he thought the latter should be much less prevalent than it was. He had himself been over and over again exposed to foot-and-mouth disease, but had never suffered, while, on the first exposure to scarlet-fever, he contracted it; his system being susceptible to the one, and not to the other. He thought it would be dangerous to investigate this subject very much in the United States, as it would be a very serious matter if the foot-and-mouth disease should be introduced among American cattle. He also feared that scarlet-fever might be more widely disseminated if these inoculations were to be made general. While he had great respect for Pasteur, he could not help believing that he had increased the spread of anthrax by scattering abroad his modified anthrax virus, as, under favorable conditions, this weakened virus might become potent and dangerous. He considered it a fact that there had been more rabies in England since Pasteur's discovery than before; and the same danger existed in the attenuated virus of rabies as in that of anthrax.

Dr. L. McLean of Brooklyn said that there was no such natural disease as bovine scarlatina. If cows contracted the disease, it could only be by inoculation from affected human beings. He did not believe that foot-and-mouth disease was prophylactic of scarlet-fever. There had been but two outbreaks of foot-and-mouth disease in this country, — one in Maine; and one in the vicinity of New York City, extending up the Hudson as far as Poughkeepsie.

Dr. J. Lewis Smith said, "Since the time of Jenner the hope has been awakened that some of the other fatal infectious diseases, and especially scarlet-fever, might be prevented, as small-pox has been, by the substitution of a milder and modified disease, derived from the lower animals. As regards scarlet-fever, two propositions of great interest and importance have arisen: first, is there a disease in the bovine race which is true scarlet-fever, or which communicates genuine scarlet-fever to man? and, second, if there be such a disease, does it produce a mild and modified form of scarlet-fever in man? Many instances have been recorded in the last five or six years in which epidemics of scarlet-fever have arisen from the use of milk furnished by healthy cows, and infected with the scarlatinous germ after the milking; but in the St. Marylebone and Hendon epidemic, occurring two years ago, and described in the *British Medical Journal*, May 20, 1886, the outbreak of scarlet-fever appeared to be clearly traced to diseased cows. Now, the point to which I wish to call attention is this. The sickness of the cows was mild, not appreciably impairing their appetite, nor diminishing their milk, but the disease which the use of the infected milk produced is described as an 'intense outbreak of scarlet-fever.' Instead of a mild disease being propagated from the cow, for which we are looking and hoping, the reverse occurred. A mild form of the disease in the cow produced a severe one in man; so that it appears from the history of this epidemic, that, by inoculating with the bovine scarlatinous virus, we might produce severe and fatal epidemics, instead of a mild and modified form of the disease."

Dr. Stickler closed the discussion by saying, that, if he produced only a slight and harmless attack of scarlatina by his inoculations, he could see no objection to the use of the scarlatinal virus for this purpose; and, when the terrible effects of the unmodified disease were taken into consideration, he thought it of extreme importance that a method of protection should be secured if possible. As to the disease from which the Hendon cows suffered, it had, he thought, been clearly demonstrated that it was nothing else than scarlatina, since it was precisely the same affection as was ordinarily produced in cows by the inoculation of scarlatinal virus from the human subject.

THE BACILLUS OF CANCER. — Dr. Horatio R. Bigelow, in a letter from Berlin to the *Boston Medical and Surgical Journal*, expresses his conviction that Scheurlen has discovered the bacillus of cancer. This discovery is confirmed by S. Guttmann and Stabsartz Schill. In every case of cancer which Scheurlen has examined, he has found the bacillus. Dr. Bigelow believes that there is a bacillus of cancer just as really and absolutely as there is one of consumption. Its morphological characteristics are not yet clearly defined, and there are many other doubts to clear up and questions to answer; but all of this can come only after many months of hard and patient labor. At a recent meeting of the Berlin Society of Internal Medicine this discovery of Scheurlen was discussed. Fraenkel regarded the methods employed by