1. A posterior root, the ganglion of which is stationary in position and is connected with both splanchnic and somatic afferent nerves.

2. An anterior root, the ganglion of which is vagrant, and is connected with the efferent small-fibred splanchnic nerves.

Also it is not a fundamental characteristic of a spinal nerve that the anterior root should necessarily pass free from the spinal ganglion, for it is clear that both anterior and posterior roots may pass into the same stationary ganglionic mass if the whole or part of the efferent ganglion has not travelled away from the parent mass. This passage of the fibres of the anterior as well as of the posterior roots into the spinal ganglion is common enough in the lower animals, and is a peculiarity of the first two cervical nerves in such an animal as the dog. If, then, the cranial nerves are formed on the same plan as the spinal, their efferent roots ought to be divisible into a large-fibred non-ganglionated portion and a small-fibred ganglionated portion, the ganglia of which may be vagrant in character, while their afferent roots should possess stationary ganglia near their exits from the brain; also the centres of origin for the different sets of nerve fibres, *i.e.* for the splanchnic and somatic nerves, ought to be the direct continuation of the corresponding centres of origin in the spinal cord. Such I find to be the case; if we leave out of consideration the nerves of special sense, viz. the optic, olfactory, and auditory nerves, the remaining cranial nerves are found to divide themselves into two groups—

(1) A foremost group of nerves, which in man are entirely efferent, viz. third, fourth, motor part of fifth, sixth, and seventh nerves.

(2) A hindmost group of nerves of mixed character, viz. ninth, tenth, eleventh, and twelfth nerves, and the sensory part of fifth.

The nerves of the first group resemble the spinal nerves as far as their anterior roots are concerned, for they are composed of large-fibred non-ganglionated motor nerves and small-fibred splanchnic efferent nerves, which possess vagrant ganglia, such as the ganglion oculomotorii, the ganglion geniculatum, &c.

They resemble spinal nerves also as far as their posterior roots are concerned, for they have formed upon them a ganglion at their exit from the brain corresponding strictly to the stationary posterior root ganglion of a spinal nerve. One great difference, however, exists between their posterior roots and those of a spinal nerve, for neither the nerve fibres nor the ganglion cells of these roots are any longer functional; they exist simply in the roots of this group of cranial nerves in man, and other warm-blooded animals, as the phylogenetically degenerated remnants of what were in ages long since past doubtless functional ganglia and functional nerve fibres.

This foremost group of cranial nerves, then, is built up on precisely the same plan as the spinal nerves; the apparent difference being due to the fact that the afferent roots with their ganglia have degenerated.

The hindmost group of cranial nerves is also composed of the same constituents as the spinal nerves, and their different components arise from centres of origin in the medulla oblongata and in the cervical region of the spinal cord which are directly continuous with the corresponding groups of nerve cells in other parts of the spinal cord. Here, however, the deviation from the spinal nerve type which has taken place consists not in the suppression of any particular component, but in the scattering of the various components, so that none of the nerves of this group form in themselves complete segmental nerves, but rather the whole of them taken together form a broken up group of segmental nerves which are capable of being rearranged not only into afferent and efferent but also into splanchnic and somatic divisions of precisely the same character as in a group of spinal nerves.

I conclude therefore that both these two great groups of cranial nerves are built up on the same plan as the spinal nerves, not only with respect to the structure, function, and distribution of their nerve fibres, but also as far as the arrangement of the centres of origin of those nerve fibres in the central nervous system is concerned; and I think it probable that the reason for the deviation of the cranial nerves from the spinal nerve type is bound up with the changes which occurred at the time when a large portion of the fibres of the foremost group of cranial nerves lost their functional activity. I imagine that in the long past history of the vertebrate animal some extensive tract in connection with the foremost part of the nervous system has become useless and disappeared, and in consequence the nerves supplying those parts have degenerated. In this phylogenetic degeneration the whole of the splanchnic and somatic afferent nerves of that region were involved, and probably also some of the efferent nerve fibres, with the result that certain only of the motor elements have remained functional. In the further history of the vertebrate, the parts which have replaced those which became useless have received their nerve supply from tracts of the central nervous system situated behind this foremost group of nerves; in consequence of which the component parts of that hindermost group have become more or less separated from each other. The extent of the area involved is especially well seen when the sensory nerves of this area, both somatic and splanchnic, are considered; for we see not only that the sensory part of the trigeminal, representing the somatic sensory elements, and the sensory part of the vagus, representing the splanchnic sensory elements, are derived from their respective ascending roots, *i.e.* arise in connection with a series of nerve segments extending well into the cervical region, but also that the peripheral distributions of these two nerves are very extensive. Without speculating further at present upon the nature of the change which has disturbed the orderly arrangement of the cranial nerves, enough has been said to prove that the cranial nerves considered in this article are built up on the same plan as the spinal nerves. Further it is worthy of notice that just as the division into somatic and splanchnic has thrown great light upon the conception of the manner in which a segmental nerve is formed, so also it lends aid to the consideration of the segmentation of structures other than the nervous, for we find that two distinct segmentations exist in the body which do not necessarily run parallel to each other: the one, a segmentation which may be fitly called splanchnic, and is represented by the orderly arrangement of visceral and branchial clefts; and the other, a somatic segmentation, characterized by the formation of somites, *i.e.* of vertebræ and somatic muscles arranged also in orderly sequence.

The splanchnic segmentation is most conspicuous in the cranial region, the somatic segmentation in the spinal region, and it is most advisable to remember that a valid comparison between cranial and spinal segments can only be made when like is compared with like, for it by no means follows that the somatic and splanchnic segmentations have proceeded on identical lines; consequently, in comparing cranial with spinal nerves, we must compare structures of the same kind, and seeing that the spinal nerves are arranged according to somatic segments so also must the cranial nerves be arranged in accordance with their relation to the somatic muscles of the head, and not in relation to the branchial and visceral clefts.

It is not advisable in this article to enter upon any discussion as to the number of segments supplied by the cranial nerves, or to speculate upon the nature of the changes which have taken place in the past history of the vertebrate animal, whereby the present distribution of the cranial nerves has been brought about. I desire only to put as shortly as possible before the readers of NATURE the general results of my recent investigations into the structure of the cranial and spinal nerves.

W. H. GASKELL.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. T. C. Fitzpatrick, of Christ's College, has been appointed an Assistant Demonstrator of Physics.

Prof. H. M. Ward, M.A., of Christ's College, has been appointed Examiner in Botany in the place of Prof. Bayley Balfour.

Dr. R. D. Roberts has been appointed an Elector to the Harkness Scholarship.

The name of Mr. Adami, the new Demonstrator of Pathology, was misprinted Adams in our last issue.

SCIENTIFIC SERIALS.

Bulletin de l'Académie Royale de Belgique, February.—Researches on the colloidal state, by C. Winssinger. This is the first part of a memoir describing a series of experiments undertaken to determine the various conditions of the colloidal state—that is, of the state assumed under certain circumstances by bodies generally insoluble in water. For the present the author confines himself to describing the mode of preparation and the chief properties of the colloidal substances. All the fifteen sulphides studied by him (those of mercury, zinc, tungsten, molybdene, indium, platinum, gold, palladium, silver, thallium, lead, bismuth, iron, nickel, and cobalt) have been obtained in the colloidal state. They bring up to thirty-one the number of colloids now known to science. Some have been prepared by Graham's method, others directly by treating the oxides suspended in the water with hydrosulphuric acid.—On the pretended pro-atlas of mammals and *Hatteria punctata*, by Jules Cornet. The bony process between the occipital and the atlas known as the pro-atlas or proto-vertebra, and found in crocodiles and some other reptiles, is here shown not to exist in the mammals as supposed by some naturalists. The view of Smets regarding its absence from Hatteria is also confirmed.—On the process employed by the fresh-water Gasteropods for crawling over the liquid surface, by Victor Willem. This process is shown to be somewhat analogous to that of snails moving on dry land, being effected by secreting a mucus which enables the mollusk to adhere to the surface.—Researches on the volatility of the carbon compounds; chloro-oxygenated compounds, by Louis Henry. The object of these researches is to examine, in reference to their volatility, the compounds in which chlorine and oxygen are simultaneously combined with carbon. The subject is discussed under three heads: (1) the compounds comprising the system $>C-O$; (2) the system $\rightarrow C-OX$; (3) the mixed derivatives simultaneously including both these systems.

Rendiconti del Reale Istituto Lombardo, March 22.—Observations made in the Brera Observatory, Milan, during the total lunar eclipse of January 28, 1888, by G. V. Schiaparelli. These observations were made under favourable conditions in accordance with the instructions issued by the Pulkova astronomers, with the ultimate view of determining more accurately than has yet been possible the exact length of the diameter of the moon. In the accompanying tables are given the results of the observations, comprising the comparison-stars with their magnitudes and numbers as in the catalogue distributed by the Pulkova astronomers.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 22.—"The Chemical Composition of Pearls." By George Harley, M.D., F.R.S., and Harald S. Harley.

(1) As regards oyster pearls. Of these, three varieties were examined—British, Australian, and Ceylonese.

The qualitative analyses showed that they all had an identical composition, and that they consisted solely of water, organic matter, and calcium carbonate. There was a total absence of magnesia and of all the other mineral ingredients of sea-water—from which the inorganic part of pearls must of course be obtained. Seeing that ordinary sea-water contains close upon ten and a half times more calcium sulphate than calcium carbonate, one might have expected that at least some sulphates would have been found along with the carbonates, more especially if they are the mere fortuitous concretions some persons imagine them to be; a view the authors cannot indorse, from the fact that by steeping pearls in a weak aqueous solution of nitric acid, they are able to completely remove from them all their mineral constituents without in any way altering their shape, and but very slightly changing their naked eye appearances, so long as they are permitted to remain in the solution. When taken out they rapidly dry and shrivel up. Dr. George Harley will take occasion to point out in his next communication, which will be on the microscopic structure of pearls, that a decalcified crystalline pearl bears an intimate resemblance to a decalcified bone, in so far as it possesses a perfectly organized matrix of animal matter. No phosphates whatever were found in any of the three before-named varieties of pearls.

The next point being to ascertain the exact proportions of the substances composing the pearls, and pure white pearls being expensive, from having ascertained that all the three kinds they were operating upon had exactly the same chemical composition, instead of making separate quantitative analyses of them, they simply selected two pearls from each variety, of as nearly the same size and weight—giving a total of 16 grains—and analyzed them collectively, the result obtained being: carbonate of lime 91·72 per cent; organic matter (animal), 5·94 per cent; water 2·23 per cent.

(2) Composition of cocoa-nut pearls.

A portion of a garden pea sized cocoa-nut pearl, weighing 14 grains, was subjected to analysis, and found that, like shell-fish pearls it consisted of carbonate of lime, organic matter (animal), and water.

It had all the external appearances of the pearls found in the large clams (*Tridacna gigas*) of the Southern Ocean, being perfectly globular, with a smooth, glistening, dull white surface, and resembling them exactly in microscopic structure. Besides which in chemical composition it bore no similarity to cocoa-nut milk, to which it is supposed to be related; for cocoa-nut milk is said to contain both the phosphate and the malate, but not the carbonate of lime. That there are pearls found in cocoa-nuts the authors do not presume to deny; all they mean to say is that they are doubtful if the specimen examined had such an origin.

(3) As regards mammalian pearls.

These so-called pearls have been met with in human beings and in oxen.

In so far as naked-eye appearances are concerned, a good specimen of the variety of pearl now spoken of is quite undistinguishable from a fine specimen of Oriental oyster pearl, from its not only being globular in shape, and of a pure white colour, but from its also possessing the iridescent sheen so characteristic of Oriental oyster pearls of fine quality.

In chemical composition, however, mammalian pearls bear no similarity whatever to pearls found in shell-fish, for they are composed of an organic instead of an inorganic material—namely, cholesterin. In microscopic structure again, they bear a marked resemblance to the crystalline variety of shell-fish pearls.

April 19.—"On Hamilton's Numbers. Part II." By J. J. Sylvester, D.C.L., F.R.S., Savilian Professor of Geometry in the University of Oxford, and James Hammond, M.A. Cantab.

§ 4. *Continuation, to an infinite Number of Terms, of the Asymptotic Development for Hypothenusal Numbers.*

In the third section of this paper (Phil. Trans. A., vol. clxxviii. p. 311) it was stated, on what is now seen to be insufficient evidence, that the asymptotic development of $p - q$, the half of any hypothenusal number, could be expressed as a series of powers of $q - r$, the half of its antecedent, in which the indices followed the sequence $2, \frac{3}{2}, 1, \frac{3}{4}, \frac{5}{8}, \frac{1}{2}, \ldots$

It was there shown that, when quantities of an order of magnitude inferior to that of $(q-r)^{\frac{3}{4}}$ are neglected,

$$p - q = (q-r)^2 + \tfrac{4}{3}(q-r)^{\frac{3}{2}} + \tfrac{11}{18}(q-r) + \tfrac{10}{81}(q-r)^{\frac{3}{4}};$$

but, on attempting to carry this development further, it was found that, though the next term came out $\frac{88}{1215}(q-r)^{\frac{5}{8}}$, there was an infinite series of terms interposed between this one and $(q-r)^{\frac{1}{2}}$.

In the present section it will be proved that between $(q-r)^{\frac{3}{4}}$ and $(q-r)^{\frac{1}{2}}$ there lies an infinite series of terms whose indices are—

$$\tfrac{5}{8}, \tfrac{9}{16}, \tfrac{17}{32}, \tfrac{33}{64}, \tfrac{65}{128}, \ldots$$

and whose coefficients form a geometrical series of which the first term is $\frac{88}{1215}$ and the common ratio $\frac{2}{3}$.

We shall assume the law of the indices (which, it may be remarked, is identical with that given in the introduction to this paper as originally printed in the *Proceedings* but subsequently altered in the Transactions), and write—

$$\begin{aligned} p - q = {} & (q-r)^2 + \tfrac{4}{3}(q-r)^{\frac{3}{2}} + \tfrac{11}{18}(q-r) + \tfrac{10}{81}(q-r)^{\frac{3}{4}} \\ & + \frac{2^3}{3^3}A(q-r)^{\frac{5}{8}} + \frac{2^4}{3^4}B(q-r)^{\frac{9}{16}} + \frac{2^5}{3^5}C(q-r)^{\frac{17}{32}} \\ & + \frac{2^6}{3^6}D(q-r)^{\frac{33}{64}} + \frac{2^7}{3^7}E(q-r)^{\frac{65}{128}} + \text{\&c., } \textit{ad inf.} \quad \ldots (1) \\ & + \Theta^* \end{aligned}$$

The law of the coefficients will then be established by proving that—

$$A = B = C = D = E = \ldots\ldots = \tfrac{11}{45}.$$

If there were any terms of an order superior to that of $(q-r)^{\frac{1}{2}}$, whose indices did not obey the assumed law, any such term would make its presence felt in the course of the work; for, in the process we shall employ, the coefficient of each term has to be determined before that of any subsequent term can be found. It was in this way that the existence of terms between

* In the text above, Θ represents some unknown function, the asymptotic value of whose ratio to $(q-r)^{\frac{1}{2}}$ is not infinite.