The first of these is the fact that, generally speaking, spots in the north hemisphere have much about the same latitude as those occurring at the same, or nearly the same, period in the south, both sets widening or contracting together. We may perhaps, therefore, suppose, by applying this law, that the latitude of the spots which cause the positive extremes in the above series is not greatly different from that of those which cause the corresponding negative extremes.

The second observational law is that which tells us that spots about the same period have a tendency to attain their maximum at, or near, the same ecliptical longitude. Now, if we suppose that in the foregoing three series the greatest positive extremes were caused by the positive spots attaining their greatest size, and the greatest negative extremes by the negative spots attaining their greatest size, it would follow that the two sets, positive and negative, must have taken their rise at places on the sun's surface 180° of longitude different from each other, inasmuch as the one set about 12 or 13 days before, or after, passed (let us say) the same ecliptical longitude as the other.

But if the positive set have the same latitude as the negative, and if the one is 180° of solar longitude different from the other, it would mean that *the two outbreaks are at opposite ends of the same solar diameter.*

This conclusion is an interesting one; but, of course, it requires to be verified by further observation before it be finally received. Meanwhile we are engaged in mapping out systematically the positions of the various outbreaks upon the sun's surface, and we shall soon, therefore, be able to find whether or not there be any truth in this conjecture.

XIII. "On the Structure and Development of the Skull in the Pig (*Sus scrofa*)." By W. K. Parker, F.R.S. Received May 17, 1873.

(Abstract.)

I have for some years past determined to concentrate my attention on some one type of Mammalian Skull, so as to be able to present to the Royal Society a paper similar to those which have already appeared on other Vertebrate Skulls. I was led to work out this MEDIUM TYPE, and not a more generalized form, such as the Guineapig (see "On the Development of the Frog's Skull," Phil. Trans. 1871, p. 203), through the circumstance of an offer from my friend Mr. Charles Stewart to put some seventy embryos of the Common Pig into my possession. In the present communication I have had the invaluable help of advice and oversight from Professor Huxley; whilst the labour of my hands has been lightened by my son, Mr. T. J. Parker, who prepared for me all the more delicate sections. The embryos ranged in size from two thirds, or less, of an inch in length, with the head only equal in size to a *sweet pea*, whilst the head of the largest specimen was the size of that of the Common Squirrel. To these

I have added young pigs at birth, and have taken as the last stage the skull of a half-grown individual.

The most important results of the present investigation may be stated as follows:—

1. In a pig-embryo, in which the length of the body did not exceed two thirds of an inch, and four postoral clefts were present, the cranio-facial skeleton was found to consist of:—(*a*) the notochord, terminating by a rounded end immediately behind the pituitary body.

(*b*) On each side of the notochord, but below it, there is a cartilaginous plate, which in front ends by a rounded extremity on a level with the apex of the notochord, while behind it widens out and ends at the free lower margin of the occipital foramen. These two plates, taken together, constitute the "investing mass" of Rathke. In this stage they send up no prolongations around the occipital foramen; in other words, the rudiment of the basioccipital exists, but not of the exoccipital or super-occipital.

(*c*) The large oval auditory capsules lie on each side of the anterior half of the investing mass, with which they are but imperfectly united: there is no indication of the stapes at this stage.

(*d*) The *trabecular* or first pair of præoral visceral arches inclose a lyre-shaped pituitary space; they are closely applied together in front of this space, and, coalescing, give rise to an azygous prænasal rostrum. They are distinct from one another and the investing mass.

(*e*) The *pterygo-palatine* or second pair of visceral arches lie in the maxillo-palatine processes, and are therefore subocular in position. Each is a sigmoid bar of nascent cartilage, the incurved anterior end of which lies behind the internal nasal aperture, while the posterior extremity is curved outwards about the level of the angle of the mouth. The pterygo-palatine cartilages are perfectly free and distinct from the first præoral and from the first *postoral* arch.

(*f*) The *mandibular* or first pair of postoral visceral arches are stout continuous rods of cartilage which lie in the first visceral arch behind the mouth. The ventral or distal ends of these arches are not yet in contact; the dorsal or proximal end of each is somewhat pointed and sharply incurved, pushing inwards the membrane which closes the first visceral cleft and is the rudiment of the membrana tympani.

(*g*) The *hyoid* or second pair of postoral arches are in this stage extremely similar to the first pair, with which they are parallel. They are stout sigmoid rods of cartilage, which are separated at their distal ends, present an incurved process at their opposite extremities, and are not segmented.

(*h*) The *thyro-hyal* or third postoral arches, which correspond with the first branchial of the branchiate vertebrata, are represented by two short cartilaginous rods which lie on each side of the larynx.

(*i*) The olfactory sacs are surrounded by a cartilaginous capsule, which

has coalesced below with the trabecula of its side; while, within, the mucous membrane lining the capsule presents elevations which indicate the position of the future turbinal outgrowth of the capsule.

In this stage the posterior nares are situated at the anterior part of the oral cavity, as in the Amphibia, and the roof of the mouth is formed by the floor of the skull, the palatal plate of the maxillæ and palatine bones being foreshadowed by mere folds. The outer end of the cleft between the first and second præoral arches is the rudiment of the lachrymal duct, while its inner end is the hinder nasal aperture. The gape of the mouth is the cleft between the second præoral and first postoral arch. The auditory passage, representing the Eustachian tube, tympanum, and external auditory meatus, is the cleft between the first and second postoral arches. The proximal end of the mandibular arch, therefore, lies in the front wall, and the hyoid in the hinder wall of the auditory passage.

2. In an embryo pig, an inch in length, (*a*) the notochord is still visible; (*b*) the investing mass, the halves of which are completely confluent, has become thoroughly chondrified, and is continued upwards at each side of the occipital foramen to form an arch over it.

(*c*) The auditory capsules are still distinct from the investing mass, and a plug on the outer cartilaginous wall of each has become marked off as the stapes.

(*d*) The hinder ends of the trabecular arches have coalesced in front of the pituitary body, but they are not yet confluent with the investing mass.

(*e*) The pterygo-palatine rods have increased in size; they have not become hyaline cartilage, but are beginning to ossify in their centre.

(*f*) In the mandibular arch the proximal end has become somewhat bulbous, and is recognizable as the head of the malleus, whilst the incurved process, still more prominent than before, is the *manubrium mallei*. The rest of the arch is Meckel's cartilage; outside this a mass of tissue appears, which is converted into cartilage, rapidly ossifies, and eventually becomes the ramus of the mandible.

(*g*) The proximal end of the hyoidean arch, similarly enlarging and articulating with the corresponding part of the mandibular arch, becomes the incus, the incurved process attaching itself to the outer surface of the stapes and becoming the long process of the incus. The incus, thus formed out of the proximal end of the hyoidean arch, becomes separated from the rest of the arch by conversion of part of the arch into fibrous tissue, and by the moving downwards and backwards of the proper hyoid portion of the arch. A nodule of cartilage left in the fibrous connecting band becomes a styliform *interhyal* cartilage, while the proximal end of the detached arch becomes the *stylo-hyal*.

(*h*) The *thyro-hyals* have merely increased in size and density; they closely embrace the larynx by their upper ends.

(*i*) The olfactory capsules are well chondrified; their descending inner edges have coalesced with each other and, below, with the trabeculæ to form the great median septum: the turbinal outgrowths are apparent.

In this stage, the alisphenoids and orbito-sphenoids appear as chondrifications of the walls of the skull, quite separate from the investing mass and from the trabeculæ.

The floor of the pituitary space chondrifies independently of the trabeculæ and investing mass, but serves to unite these four cartilaginous tracts.

3. In an embryo pig, $1\frac{1}{3}$ inch in length, (*a*, *b*, *c*) the primordial cranium is completely constituted as a cartilaginous whole, formed by the coalescence of the investing mass and its exoccipital and superoccipital prolongations, the modified trabeculæ, the subpituitary cartilage, the auditory capsules, and alisphenoidal and orbito-sphenoidal cartilages, and the olfactory capsules. The notochord is yet to be seen extending in the middle line from the hinder wall of the pituitary fossa (now the "*dorsum sellæ*") to the posterior edge of the occipital region.

(*d*) The trabecular arches form the sides of the sella turcica, the presphenoid, and the base of the septum between the olfactory capsules; in front, where they form the azygous "prænasal," they are developed backwards as "recurrent bands," elongations of their free recurved "cornua."

(*e*) The pterygo-palatine arches, still increasing in size, but not chondrifying, are rapidly ossifying; they are half-coiled laminæ bounding the posterior nasal passages.

(*f*) The mandibular arch and the rudimental ramus have become solid cartilage, and the latter is ossifying as the dentary; the distal part of each mandibular rod unites with its fellow for some distance.

(*g*) The hyoid arches are each fully segmented as incus, with its "orbicular" head, interhyal, stylo-hyal, and cerato-hyal.

(*h*) The thyro-hyals are merely larger and denser.

(*i*) The olfactory capsules have the turbinal outgrowths all marked out as alinasal, nasal, and upper, middle, and lower turbinals.

4. In pigs of larger size the form and proportions of the parts of the cranium become greatly altered, and ossification takes place on an extensive scale, but no new structure is added.

5. It follows from these facts that the mammalian skull, in an early embryonic condition, is strictly comparable with that of an Osseous Fish, a Frog, or a Bird at a like period of development, consisting as it does of

(*a*) A cartilaginous basicranial plate embracing the notochord, and, like it, stopping behind the pituitary body.

(*b*) Paired cartilaginous arches, of which two are præoral, while the rest are postoral.

(*c*) A pair of cartilaginous auditory capsules.

(*d*) A pair of cartilaginous nasal capusles.

Further, that in the Mammal, as in the other Vertebrata the development of the skull of which has been examined, the basicranial plate grows up as an arch over the occipital region of the skull, and coalesces with the auditory capsules, laterally, to give rise to the primordial skeleton of the occipital, periotic, and basisphenoidal regions of the skull. The trabeculæ become fused together, and, uniting with the olfactory capsules, give rise to the presphenoidal and ethmoidal parts of the cranium; and the moieties of the skull thus resulting from the metamorphosis of totally different morphological elements become united and give rise to the primordial cranium.

As in the Salmon and Fowl, the second pair of præoral arches give rise to the pterygo-palatine apparatus; in the Frog this arch is late in appearance, and is never distinct from the trabecular and mandibular bars, serving as a conjugational band between them. The mandibular arch, which in the Salmon becomes converted into Meckel's cartilage, the os articulare, the os quadratum, and the os metapterygoideum, in the Frog into Meckel's cartilage and the quadrate cartilage (which early becomes confluent with the periotic capsule), in the Bird into Meckel's cartilage, the os articulare, and the os quadratum (which articulates movably with the periotic capsule), in the Pig is metamorphosed into Meckel's cartilage and the malleus, which is loosely connected with the tegmen tympani, an outgrowth of the periotic capsule.

Meckel's cartilage persists in the Fish and in the Amphibia, but disappears early in the Bird, and still earlier in the Mammal. The permanent ossifications of the mandible are all membrane-bones in Fish, Frog, and Fowl, but in the Mammal (exceptionally) the ramus has a cartilaginous foundation. The hyoidean becomes closely united with the mandibular arch, and then segmented, in the Fish, into the hyo-mandibular, the stylo-hyal, cerato-hyal, and hypohyal—the hyo-mandibular, or proximal segment, articulating with the outer wall of the periotic, and many of the segments of the arch becoming dislocated.

In the Frog, the hyoid also becomes segmented, but only after extensive coalescence with the mandibular arch. The proximal segment becomes the suprastapedial (hyo-mandibular) with its extrastapedial process, and, extending inwards as mediostapedial and interstapedial, articulates with the stapes, developed by segmentation from the outer wall of the auditory capsule. The stylo-hyal is dislocated and becomes connected with the auditory capsule below the stapes (opisthotic region).

In the Bird, the hyoidean arch remains distinct from the mandibular. Whilst in its primordial condition it coalesces by its incurved apex with the auditory capsule in front of the promontory, before the stapedial plug is segmented. It then chondrifies as three distinct cartilages—an incudal, a stylo-hyal, and, distally, a cerato-hyal. The stapes becomes free from the auditory capsule, but remains united with the cartilaginous part of the incus (mediostapedial); the ascending part is largely fibrous

(suprastapedial), and the part loosely attached to the mandibular arch is the elongated extrastapedial. The short stylo-hyal afterwards coalesces with the body of the upper or incudal segment by an after-growth of cartilage (the *interhyal* tract); a long membranous space intervenes between it and the glossal piece (cerato-hyal.) Thus the "columella" of the Bird is formed of one periotic and three hyoidean segments.

In the Pig, the hyoidean arch is distinct, but articulates closely with the mandibular; its upper segment (hyo-mandibular) is converted into the incus, and becomes connected with the stapes. The stylo-hyal is dislocated and coalesces with the opisthotic region of the auditory capsule.

XIV. "Results of the Comparisons of the Standards of Length of England, Austria, Spain, United States, Cape of Good Hope, and of a second Russian Standard, made at the Ordnance Survey Office, Southampton." By Lieutenant-Colonel A. R. Clarke, C.B., R.E., F.R.S., &c., under the direction of Major-General Sir Henry James, R.E., F.R.S., &c., Director-General of the Ordnance Survey. With a Preface and Notes on the Greek and Egyptian Measures of Length by Sir Henry James. Received May 21, 1873.

(Abstract.)

The following account of the results of the Comparisons of the Standards of Length of England, Austria, Spain, United States, Cape of Good Hope, and of a second Russian Standard at the Ordnance Survey Office has been drawn up by Lieutenant-Colonel Clarke, and is a sequel to the abstract of the results of the Comparisons of the Standards of Length of England, France, Belgium, Prussia, Russia, India, and Australia which the Royal Society has done us the honour to publish in the Philosophical Transactions for 1867, vol. clvii. p. 161.

The accurate determination of the lengths of the various standards employed by so many nations in the measure of the bases of their triangulations, which are now being united into one vast network of triangles, covering the whole of Europe, can scarcely fail to be of great importance for the advancement of physical science. To the comparison of these lengths I have added the result of our endeavours to recover the correct lengths of the most ancient measures of length with which we are acquainted, viz. those of Ancient Egypt, not only because our own measures are obviously derived from them, but also because we thus obtain the accurate relative value of the measures and distances given in the most ancient works on Astronomy and Geodesy which have come down to us.

The Ancient Egyptians employed two measures of length, viz. the common and the royal cubits.