

in the equator at such a rate that the difference between its right ascension at any time, and that of the true sun, consists entirely of periodic terms. This difference is called the equation of time, which, therefore, by its very nature, cannot contain any term increasing indefinitely with the time. Mean noon at any place is determined by the transit of this imaginary body over the meridian of the place, just as apparent noon is determined by the transit of the true sun.

Thus mean time is defined with reference to a natural phenomenon; viz., the transit of the real sun over a given meridian: and we cannot have one length of a mean solar day according to Bessel, and another length according to LeVerrier, any more than we can have different lengths of the apparent solar day.

A mean solar day, according to Mr. Stone's theory, is something totally different from that above defined. It has no reference to the average length of the apparent solar day, but is purely artificial or conventional in character. Practically, Mr. Stone's mean solar day is the time during which the mean *longitude* of the sun increases by some definite amount. Bessel gives one determination of this amount, and LeVerrier a different one: hence Mr. Stone is obliged to employ two mean solar days, which are of different lengths, according as Bessel's or LeVerrier's mean motion of the sun is used. On this principle, every fresh investigator of the sun's motion would require a mean solar day peculiar to himself. We are tempted to ask, What was the meaning of the mean solar day before Bessel's time?

The origin of Mr. Stone's misapprehension on this point seems to be the following. In the ordinary practice of an observatory it is usual and convenient to deduce the mean solar time from the sidereal time supposed to be known, instead of finding it by direct observation of the sun. In order that this conversion of sidereal into mean solar time, however, may be correctly performed, it is necessary to employ the correct mean longitude of the sun at the given instant. Any error in the assumed mean longitude will produce an equivalent error in the mean time deduced; and, if the sun's mean motion be incorrectly assumed, the error of time thus produced will gradually accumulate.

Thus the error of mean solar time as deduced from sidereal time by means of Bessel's formula, which amounted in the year 1864 to a little more than half a second, has increased to a little more than six-tenths of a second at the present time. The increase of the error of mean solar time in nineteen years is in reality rather less than eight-hundredths of a second, whereas Mr. Stone's theory makes it amount to twenty-seven seconds! In fact, the error, according to Mr. Stone's theory, is about three hundred and sixty-five times as great as it should be. The reason is, that mean time is measured, *not* by the sun's mean motion in *longitude*, as Mr. Stone's theory supposes, but by its mean motion in *hour-angle*, which is about three hundred and sixty-five times as great; so that the error in time produced by a small error in the

mean motion in longitude is only about $\frac{1}{365}$ of that which would be produced if the error in time bore the same proportion to the time that the error in the mean motion in longitude bears to this mean motion itself.

If n denote the sun's mean motion in longitude in a mean solar day, then the ratio of the length of a mean solar to that of a sidereal day is

$$360^\circ + n : 360^\circ.$$

And if $n + dn$ denote a slightly different determination of the mean motion in longitude, this ratio will be altered to

$$360^\circ + n + dn : 360^\circ.$$

Hence the measure of the sidereal interval corresponding to any given number of mean solar days will be altered in the ratio of

$$360^\circ + n + dn : 360^\circ + n,$$

$$\text{or} \quad 1 + \frac{dn}{360^\circ + n} : 1;$$

that is, since 360° is nearly equal to $365n$, the sidereal measure of the interval will be altered nearly in the ratio of

$$1 + \frac{1}{366} \frac{dn}{n} : 1$$

instead of in the ratio of

$$1 + \frac{dn}{n} : 1,$$

as it should be by Mr. Stone's theory.

In conclusion, we will test Mr. Stone's theory of mean solar time by supposing an extreme case. Let us imagine that the sun had *no motion* in longitude, but, like a fixed star, retained a constant position in the heavens. On this supposition, mean solar time would be just as intelligible as it is at present, and it is evident that the mean solar day and the sidereal day would become identical with each other; but what would become of mean solar time according to Mr. Stone's idea of it?

MORPHOLOGY OF THE PELVIS AND LEG.

MISS ALICE JOHNSON, at the suggestion of the late F. M. Balfour, has investigated the development of the pelvic girdle and hind-limb of the chick (*Quart. Journ. micr. sc.*, xxiii. 399). On the fourth day of incubation the limb is merely a local exaggeration of the Wolffian ridge, consisting, like it, of a mass of rounded mesoblastic cells crowded together. The first trace of the skeletal parts appears on the fifth day; the mesoblastic tissue of the axis of the limb becoming more condensed, and, by the seventh day, converted into recognizable cartilage. Ossification begins very late. The entire skeletal *anlage* of the girdle and limb is at first continuous, making a T, of which the stem represents the limb, and the cross the girdle running dorsoventrally. The pelvic *anlage* soon expands, above the centrally placed acetabular region, into a broad plate, the ileum; below, and in front, into the narrow pubis. A little later the pectineal process grows out in front from the upper part

of the pubis, and the ischium appears behind as a downward expansion below the acetabulum. The further change consists chiefly in the expansion of the ileum, and in the growth of the pubis and ischium; which last two become inclined backward, and acquire a considerable posterior prolongation. During these changes the pelvis passes through a stage which is permanent in *Apteryx*. The division of the primitive anlage into the skeletal parts is produced by the known histological changes at the joints. The author thinks that Hofmann's 'epipubis' (*Nederl. arch. zool.*, iii.) is the true pubis, and his 'pubis' in reptiles a process of the ischium. She also corrects some errors of Bunge.

These observations throw much light on the homologies of the pubis, of which the pectineal process is a branch, so that the pubis is biramous. A comparison of the bird with mammals (in which the pectineal process is often reduced, and sometimes absent) and dinosaurs at once determines the homologies of the pubis in these forms. In reptiles the pubis has also two branches, — the main body of the pubis; and the

detail with Baur's (*Morphol. jahrb.*, viii.): we therefore note merely the presence of five metacarpals, and the failure to find a separate origin for the intermedium; but, in opposition to Morse, she is inclined to concur with Baur in describing the ascending process of the astragalus as an outgrowth from the tibiale. Morse's conclusion may be due to his having studied different birds (aquatic species). It is a pleasure to praise this excellent paper.

C. S. MINOT.

RECENT WORK ON BRACHIOPODS.

THE important though rather fragmentary observations of Kovalevski on the development of the brachiopods have long remained sealed in their original Russian from western naturalists, who have only had access to more or less incomplete synopses of the original. MM. Oehlert and Deniker have prepared for the latest volume of the *Archives de zoologie expérimentale* a careful analysis of the paper in question, illustrated by rough but sufficiently clear figures reproduced from the original. The result is a paper of some twenty pages, which may be obtained separately, and will have a value for all biologists, whatever their position as to the author's theories.

In a note on *Terebratula* (*Centronella*) Guerangeri, M. Oehlert signalizes the existence of two or three forms of this genus in the Devonian of Europe. He discusses the relations of *Centronella*, *Leptocoelia*, and *Renssellaeria*, and concludes that they probably represent an arrested development, which would, if carried out, bring them into relations with *Waldheimia*, and that they should be referred to the same sub-family. The absence of punctation in the test is referred to metamorphism, as in *C. Guerangeri* all stages were discovered, from impunctate to completely punctate.

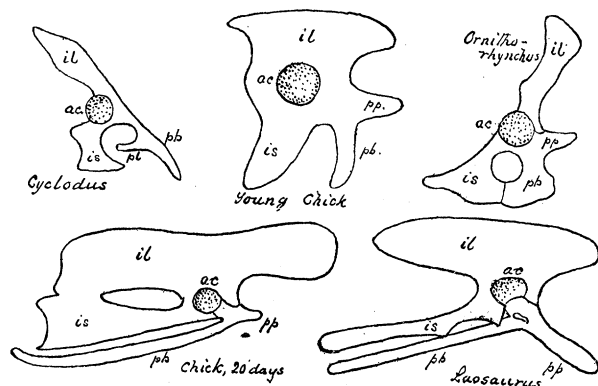
The same author, in the *Bulletin de la société géologique de France*, discusses the Devonian *Chonetes* of western France, where four species are found in the grauwacke and calcaire beds, but are absent in the grits. One of the species, *C. tenuicostata*, is new, and all are figured; while the characteristics of the genus are thoroughly reviewed.

In the same publication the author describes two new species of *Acroculia* from the lower Devonian of Mayenne, reviews the genus, and shows that the prior name of *Platyceras* Conrad, being doubly preoccupied in insects, must give way to *Acroculia*.

Lingula Norwoodi, from the Cincinnati limestone, is redescribed and figured by U. P. James in the *Cincinnati journal of natural history*.

Glottidia pyramidata Stimpson has been found by Hemphill in South Florida, considerably extending its range, and leading to the suspicion that *G. antillarum* Reeve, described from the West Indies, may be identical with it.

W. H. DALL.



EXPLANATION. — *il*, ileum; *ac*, acetabulum; *is*, ischium; *pb*, pubis; *pl*, processus lateralis; *pp*, pectineal process.

posterior ramus lateralis, which may be wanting, however, as is the case with crocodiles. After discussion of the subject, the writer concludes, we think rightly, that the so-called pubis of reptiles is homologous with the pectineal process, and the lateral ramus homologous with the pubis of higher forms. The homologies are given in the following table, and differ, it will be seen, very widely from those current:—

Reptiles.	Dinosaurs.	Embryo bird.	Birds.	Mammals.
1. Pubis.	Pubis (Marsh).	Anterior branch of pubis.	Pectineal process.	Pectineal process.
2. Processus lateralis.	Postpubis (Marsh).	Posterior branch.	Pubis.	Pubis.

Miss Johnson also investigated the development of the limb. Her observations agree in almost every