THE AFFINITIES OF RICHTHOFENIA.

DR. W. WAAGEN considers the results of his recent study of the new genus Richthofenia Kays. (Anomia Lawrenciana Koninck) so remarkable as to deserve a preliminary notice (*Rec. geol. surv. India*, xvi. 1). Mr. Barrande and Professors Valérin and Möller were of opinion that this fossil was more nearly related to the corals than to any other class of animals, while Professors Zittel and Lindström seemed to be in favor of the view that it was a brachiopod. In favor of the latter view, the microscopic structure of the shell is the most important point. Its silky lustre is identical with that of Productus, though this seems to be effected by different means. In the shell of Productus it is caused by obliquely ascending prisms, whilst in Richthofenia it depends apparently on the fine lamination of the shell, as in Placuna or similar genera. Of great importance is the prismatic structure of the single laminae of which the shell of Richthofenia is composed. Such a prismatic structure is chiefly characteristic of mollusks and molluscoids. Dr. Waagen has never yet observed this structure in corals. In Calceola sandalina, which seems the most kindred form among corals, a microscopic section through the larger valve showed well its radial septa ; but all these septa exhibited a granular, not a prismatic structure. The punctation of the shell is very similar to that of Productus, and so are the hollow root-like tubes which penetrate the shell-substance of the larger valve, and adhere to other bodies. The smaller valve can also be very well compared to the same valve of Productus, although it is doubtful whether the thick parallel ridges on the hinge-line of this valve of Richthofenia can at all be compared to a cardinal process, and whether the impressions on the valve can be taken as muscular impressions. Reniform bodies are most certainly absent. Nevertheless, among the brachiopods, the Productides are the only ones to which the genus Richthofenia might stand in any relation.

Richthofenia possesses certain points of resemblance with rugose corals, — the irregular partitions in the lower part of the larger valve ; the columella-like portion, which is divided off by three vertical septa ; these septa themselves, which can well be compared to the primary and the two lateral septa of a rugose coral ; the cellular structure of the shell ; the septa-like ridges on the outer wall of the animal chambers, which are in connection with the hollow canals which pierce the substance of the shell ; and the tortuous tubes themselves, into which the canals are prolonged on the outer side of the larger valve. There can be no doubt, that on first inspection, ignoring the silky lustre of the shell, one would be far more likely to regard this fossil as a coral than as a brachiopod.

The points of similarity between Richthofenia and the Rudista, chiefly Hippurites, are not very numerous. If we make a section of Richthofenia from the hinge-line to the opposite wall, so as just to touch the median vertical septum, we obtain a figure very similar to what a Hippurites shows when cut so as to touch the first columellar fold. Another point of similarity consists in the direction of the prisms, of which the substance of the shell is composed. The Rudista differ from all the other groups of Pelecypoda in having the prisms of the outer shell arranged vertically ; i.e., longitudinally to the whole extension of the shell. The same is the case in the median shell-layer of Richthofenia. A third point of great importance exists in the pallial impression which is common to Richthofenia and the Rudista ; and, finally, it is not quite certain that the sinuations of the large valve of Richthofenia on both sides of the hinge-line, which stand in so close a connection to the lateral vertical septa, may not be regarded as the beginning of the infoldings of the shell, so characteristic of the Rudista. The distance in time between Richthofenia, which comes probably from the limits between the carboniferous and Permian formations, and the Rudista, which are for the most part upper cretaceous, is so enormous, and the absence of every connecting-link so complete, that a close affinity between the paleozoic and the cretaceous forms should not be expected. It will therefore only be possible to prove the connection between the present fossil and the Rudista, when further members of such a developmental series are discovered.

As the case now stands, it will be most prudent, in accordance with the microscopic structure of the shell, to consider the fossil as something like a brachiopod. As far as Dr. Waagen's opinion goes, he is convinced that Richthofenia is a member of a series, which, branching off somewhere from the rugose corals, has reached in Richthofenia a brachiopod-like stage, and is going to terminate its career as a Pelecypod, as one of the Rudista. But opinion is nothing in science, and proofs are every thing. As yet, it cannot be positively denied that Richthofenia may be a predecessor of the Rudista.

J. B. MARCOU.

THE GREENWICH OBSERVATORY.

AMONG the leading points referred to in the report of the astronomer royal, W. H. M. Christie, F.R.S., to the board of visitors of the Royal observatory, Greenwich, read at the annual visitation on June 2, are the following: —

Besides the regular subjects of observation with the transit-circle, — the sun, moon, planets, and fundamental stars, — a new working-list of 2,600 stars, comprising all those down to the sixth magnitude inclusive, and not observed since 1860, has been prepared, and was brought into use at the beginning of March. The entire number of transits observed with this instrument during the year was 4,488; determinations of collimation-error, 354; determinations of level-error, 323; number of circle-observations, 4,485; determinations of nadir-point, 298; reflection-observations of stars, 484. Comet *a* 1882 was observed seven times on the meridian, and comet *b* 1882, three. The routine reductions of all the observations with this instrument are reported in an extraordinary state of forwardness. From the beginning of this year, a correction of $-0''.39$ has been applied to the

results of the nadir-observations to make them agree in the mean with the results of the reflection-observations of stars. This discordance was insignificant in 1878, and is on the increase: its source has not yet been traced. Three determinations of flexure have been made during the year. The correction for $R-D$, the error of assumed co-latitude, and the position of the ecliptic, have been investigated for 1882. The value for the co-latitude, from the observations of 1882, is 38° 31′ 21″.93. The correction to the tabular obliquity of the ecliptic is + 0″.44. The mean error of the tabular right ascension of the moon, from observations with the transit-circle, is + 0ˢ.82.

The observations of the moon with the altazimuth have been restricted to the semi-lunation between last quarter and first quarter; and some limitations have been adopted in the computations which render the reduction of observations with this instrument comparatively light. The moon's diameter has been measured thirty-three times, counting measures in both co-ordinates with the transit-circle and the altazimuth.

A very valuable addition has been made to the instruments of the Royal observatory by the gift of the Lassell two-feet reflecting equatorial, generously presented by the Misses Lassell. This is the instrument with which the Saturnian satellite Hyperion was discovered in 1848. It was removed from Maidenhead early in March, and has been suitably mounted in the grounds of the Royal observatory. The telescope has two large mirrors available for use; and the astronomer royal contemplates attaching one of them to the tube of the 'south-east equatorial,' which has a firm mounting and a perfect clock-work, and employing it for spectroscopic and photographic work. The Lassell telescope itself is well suited for the observation of faint satellites and comets which are beyond the present instrumental means of the observatory.

The observations of the solar eclipse of 1882, May 17, with the south-east equatorial, have been completely reduced, and the final equations solved.

Spectroscopic observations during twelve months have been somewhat restricted through the pressure of photographic reductions at the time of a maximum of sun-spot frequency. The solar prominences were observed on eight days, and four sun-spots were examined on eight days with reference to broadening of lines in their spectra. The spectrum of the great spot of 1882, Nov. 12–25, showed some remarkable reversals of the lines of hydrogen and sodium, and extraordinary displacement of the F line.

As regards determinations of motion of stars in the line of sight, a hundred and forty-two measures have been made of the displacement of the F line in the spectra of twenty-three stars, and twenty-six measures of the line b_1 in nine stars. The observations of Sirius during the past winter tend, on the whole, to confirm the impression that the rate of recession of this star had diminished progressively since 1877, and that its motion is now on the point of being converted into one of approach.

The spectrum of comet *a* 1882 was examined on three nights; that of the great comet *b* 1882, also on three nights; and that of comet *a* 1883, on one night. The spectrum of the first-named object showed the yellow sodium-lines with great brilliancy just before perihelion passage. The spectrum of the aurora was also examined in 1882, Nov. 17. The spectroscopic observations of all kinds are completely reduced to 1883, May 20.

During the year ending at this time, photographs of the sun were taken on two hundred days, and three hundred and thirty-nine plates have been selected for preservation. The sun's disk was free from spots on seven days; and, since the extraordinary outburst of last November, the sun has been comparatively quiescent. The astronomer royal proposes soon to employ a modified photoheliograph for this work, so as to obtain photographs of the sun eight inches in diameter instead of four. The measurement of a large number of Indian and other photographs of the sun, required to fill gaps in the Greenwich series, has been completed, these photographs having been received from the Solar physics committee.

The course of the magnetic observations has remained the same as in former years. Improvements have been made in the methods of photographic registration. There has been considerable magnetic activity during the year. The disturbances of November last are to be detailed graphically in the 'Greenwich magnetic results for 1882.' Particulars of magnetic disturbances are regularly communicated to the *Colliery guardian* newspaper, for the information of mining surveyors.

The mean temperature of 1882 was 49°.6, or 0°.1 lower than the average. The highest air-temperature was 81°.0, on Aug. 6; and the lowest, 22°.2, on Dec. 11. The mean monthly temperature was above the average from January to May, then below until September, and differed little from the average during the remainder of the year. The mean daily motion of the air was 306 miles, 27 miles greater than the average. The greatest daily motion was 758 miles, on Nov. 4; and the least, 30 miles, on Dec. 11. The greatest hourly velocity was 64 miles, Oct. 24. The number of hours of bright sunshine, as recorded by Campbell's sunshine instrument, was 1,245; that is, 40 hours above the average of the five preceding years. The rainfall of 1882 was 25.2 inches, slightly above the average.

In conclusion, the restriction in the observations of the moon with the altazimuth enables more attention to be given to observations with the equatorials. Two observers are now available for spectroscopic observations during the coming year. Mr. Christie characterizes the past year as, in some slight degree, one of transition, and preparation for future work. Some administrative changes have been made; but the regular course of observation and reduction has not been disturbed, and the standard meridian observations have been maintained in full vigor.