

the Trias to the Tertiaries; but I have been unable to refer the shell under consideration to any of these genera.

Our *dernier ressort* then appears to be in the genus *Rostellaria*.

There are more than 70 species of fossil shells referred to this genus, ranging from the Neocomian to the Tertiaries, although some of these may belong more correctly to the genus *Aporrhais*.

The shell in *Rostellaria* has "an elongated spire; the whorls are numerous, flat; the canals long, the posterior one running up the spire; outer lip more or less expanded, with only one sinus, and that close to the beak."¹

The fossil on Plate III. agrees very fairly with the above diagnosis. The spire is elongated, the whorls are numerous (probably not fewer than fourteen, but about one inch of the apex of the spire is lost); the sutures are not depressed, and the whorls are flat (not tumid, as in *Chemnitzia Woodwardii*). The fine spiral striæ (with which the whorls are ornamented) are confined to a narrow band next the suture upon the upper border of each whorl, as is the case in the modern *Rostellaria curta* and other species. The last whorl is twice the breadth of the preceding whorl. The outer lip is expanded, nearly semicircular in form, and smooth-edged; the anterior canal nearly one-fourth the entire length of the shell (a small portion of its extremity is wanting); a slight ridge along the border of the penultimate whorl may possibly indicate the posterior canal, which in many species of *Rostellaria* exhibits a well-marked ridge along one or more of the whorls—even to the apex in some species. Fine lines of growth are the only other ornamental markings upon the surface of the shell in addition to the spiral striæ along the sutural border of each whorl already referred to. The length of the last whorl, including the anterior canal, probably equalled the length of the entire spire when the termination of both the spire and canal were perfect. Length of actual specimen preserved $7\frac{1}{2}$ inches. Probable length when perfect 9 inches.

Believing, as I do, that this shell is really the representative of a new species of Cretaceous *Rostellaria*, I have ventured to name it *Rostellaria Pricei* in honour of its discoverer, in whose cabinet the original specimen is preserved.

II.—ON THE METHOD OF FORMATION OF THE PERMIAN BEDS OF SOUTH YORKSHIRE.

By A. H. GREEN, M.A., F.G.S.

PROFESSOR Ramsay in a recent paper² put forward the notion that the Magnesian Limestone and its associated beds of the north-east of England were formed, in part at least, by chemical precipitation in an inland sea. Given such a sea, without outlet, and with streams flowing into it holding in solution the necessary salts (bicarbonate of lime and sulphate of magnesia would answer the purpose), it is clear that by continued evaporation a state of

¹ Woodward's Manual of the Mollusca, p. 105.

² Quart. Journ. Geol. Soc. of London, vol. xxvii., p. 245.

saturation would at length be brought about, and precipitation would take place, and Dr. Sterry Hunt has shown that dolomite and gypsum would be the probable products.

Such a state of things would be by no means favourable to animal life; few creatures could exist at all under such circumstances, and the few that did manage to live on would show by their dwarfed and stunted forms how trying were the conditions against which they had struggled. Professor Ramsay pointed out that this was just the character of the Magnesian Limestone fauna, that the species were few and the individuals puny, and he showed how in this respect it agreed exactly with the fauna of recent inland seas, such as the Caspian and the sea of Aral.

The paper dealt with broad, general views, and did not pretend to enter into details. On reading again, however, the paper of Mr. Kirkby on the Permians of South Yorkshire,¹ the palæontological minutiae, so admirably worked out therein, seemed to me to confirm in a remarkable way Prof. Ramsay's theory; and I think it is worth while to call attention to them, especially as I do not know that their bearing in this direction has been noticed before.

The Permian beds of South Yorkshire fall into the following subdivisions:—

6. Upper Marls and Sandstones with Gypsum.
5. Upper Limestone or Brotherton beds.
4. Middle Marls and Sandstones with Gypsum.
3. Small grained Dolomite.
2. Lower Limestone.
1. Quicksands.

Certain red beds below the quicksands, which were supposed by Prof. Sedgwick and other geologists to represent the Rothliegendes, are omitted here, because there is every reason to believe that they are nothing more than Carboniferous rocks stained by infiltration.²

No. 1. Pure unconsolidated sand, mostly finely grained, but occasionally containing small quartz pebbles; excessively current-bedded; very irregular in its occurrence. No sign of passage into the overlying limestone.

Loose sandy beds are found in places beneath the Lower Limestone, which are nothing more than the sandy residue of the limestone itself, the calcareous matter having been carried away by percolating water. Such beds, however, are totally distinct from the quicksands, and can be easily distinguished from them.

No. 2. Dolomitic limestone containing a large quantity of sand. Mr. Kirkby describes 31 species of fossils from this division. The mollusca are for the most part stunted, but some, notably *Axinus dubius*, are robust and abundant in individuals.

No. 3. Dolomite far purer and freer from mechanical admixture than the bed below: often crystalline or sub-crystalline. No fossils except a few traces in the lowest beds.

No. 5. Flaggy limestone, sparingly or not at all dolomitic, with thin way-boards and beds of red, purple, and green marls. Of the

¹ Quart. Journ. Geol. Soc. of London, vol. xvii., p. 287.

² See a paper by Mr. J. C. Ward, Quart. Journ. Geol. Soc., 1869, vol. xxv., p. 291.

31 species found in No. 2, which disappeared in No. 3, two reappear here, both excessively dwarfed. With the exception of some doubtful traces of plants, these are the only fossils known in this division.

Such are the facts, the meaning of them I take to be as follows :—

When the body of water in which these beds were deposited was shut off from the main ocean, some time would elapse before a state of saturation high enough to cause precipitation was reached, and during that time mechanical deposits alone would be formed. These are the Quicksands. One great characteristic of these beds is their irregularity, they occur in patches of various sizes, but are often absent altogether, and they thin out and disappear very rapidly. Their excessive cross-bedding shows too that they were formed by the action of currents. The most likely explanation of these facts seems to be that the Quicksands are the deltas of the streams which emptied themselves into the inland sea.

After a time the water became sufficiently saturated to cause dolomite to be thrown down to a moderate extent, and the chemical precipitate mixed with the sand brought down by the rivers gave rise to the sandy dolomite No. 2. The conditions, though not favourable, were not such as altogether to prevent the existence of animal life : hence fossils are found, but they are mostly dwarfed.

As the state of saturation increased precipitation went on more plentifully, so that the chemical gained the mastery over the mechanical element, and the purer dolomite No. 3 was produced. The animals could no longer hold their own, and were either killed off, or struggled on in nooks and corners, perhaps a little way up the rivers, where the state of the water was less trying to them.

Mechanical deposits predominated again during the deposition of No. 4, but the gypsum shows that chemical action was still at work.

During the formation of No. 5 the magnesian salts had so far disappeared, that the water became just habitable ; and those hardy species, which had managed to live on, came back, showing, however, by their puny size how hard had been the struggle they had gone through. As far as we know, only two species survived, and it is worthy of note that one of these two is the lusty *Axinus dubius*, remarkable among the original fauna for its vigour and abundance.

One point still wants clearing up. Where did the supply of salts come from ? The Permian epoch was one of great volcanic activity, and it was probably from mineral springs produced by volcanic action that the ingredients of the chemical parts of the deposits we have been considering were derived. Thus, though we do not find, as in Scotland and Germany, such convincing proofs of contemporaneous volcanic action as lavas and ash-beds, there is reason to believe that the Permian beds of South Yorkshire are indirectly of volcanic origin. To the same source we must look for the abundant supply of peroxide of iron which gives the colour to the red beds of the formation, and it is worthy of note that another formation, still more conspicuously red and also probably of lacustrine origin, the Old Red Sandstone, was formed during a time when volcanos were at work in Britain.