in a S. S. W. direction, across the olive plantation, and down a gentle declivity, until it was lost sight of.

The following is the mean of two analyses that were made of the purest specimens of phosphorite that could be selected:

<p>| | | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Silica</td>
<td>1.70</td>
<td></td>
</tr>
<tr>
<td>Peroxide of iron</td>
<td>3.15</td>
<td></td>
</tr>
<tr>
<td>Fluoride of calcium</td>
<td>14.00</td>
<td></td>
</tr>
<tr>
<td>Phosphate of lime</td>
<td>81.15</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
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The authors take occasion to remark that, in seven varieties of Apatite which were analysed by Gustavus Rose, from 4.59 to 7.69 of fluoride of calcium were detected; and they call the attention of chemists to the association of the elements of Fluorine and Phosphorus which takes place in the Phosphorite of Estremadura, as it does in recent and fossil bones and teeth.

The only practicable route at present for conveying this mineral to the coast is by a six-days' journey in bullock cars, or on the backs of mules, to Seville.


The cretaceous and tertiary deposits of America, which intervene between the Alleghany mountains and the Atlantic, bear a great resemblance in mineral character to the sandy and argillaceous portion of the formations of the same age in the south-east of England. If all the white chalk, with its flints, together with the cherty beds of the green sand, were omitted, the remaining cretaceous strata in our island would consist of loose incoherent sand with green particles, red and highly ferruginous sandstones, white sands, and (in some places) beds of lignite; the overlying tertiary deposits, consisting of marls, clays, and variously coloured sands occasionally exhibiting green particles, like those of the green sand below the chalk; and as in the bottom of the London basin near Reading. Such, for the most part, is the succession of the beds in New Jersey; and, further south, in Maryland and Virginia, the Eocene strata are often as full of green particles as the cretaceous, so that they are only distinguishable by their fossils and relative position. Even the Miocene strata are sometimes, as in Virginia, of a bluish-green colour, and contain green particles of a similar kind. This fact alone of the identity in lithological character of the secondary and tertiary strata of the United States is calculated to put us on our guard against inferring that the green and ferruginous sands of New Jersey correspond in age to the lower rather than the upper part of the European cretaceous.
PROCEEDINGS OF THE GEOLOGICAL SOCIETY.

system. It is scarcely possible, on recognising so many of the common organic forms which are familiar to us in connection with the cretaceous rocks on this side of the Atlantic, and seeing them occur in beds which have the exact mineral type of the beds below the Gault, not to feel a strong inclination to regard them as the equivalents of our greensand, and to consider the white chalk as wanting. But when we dismiss from our minds, as we ought to do, the bias derived from the consideration of the mineral aspect of the beds, and compare the fossils of New Jersey with those derived from the European chalk, we find the agreement upon the whole to be far greater with the beds occurring in Europe above the Gault, than with those which are found below it. We are indebted to Dr. Morton for having pointed out, in 1834, the general agreement of the organic remains of the American and European cretaceous fossils, while, and at the same time, he and Mr. Conrad correctly observed that almost all the species were different. He divided the strata of New Jersey into the ferruginous sand, which he compared to our green sand formation, and the calcareous strata, which he identified with the white chalk of Europe. Prof. H. D. Rogers has since divided the New Jersey cretaceous beds into five formations, which are very useful, topographically considered, but which may be overlooked in the present paper, because only two of them, namely, those alluded to by Dr. Morton, have as yet yielded a sufficient number of fossils to entitle them to rank as palaeontologically distinct.

In an excursion which I made in New Jersey, in September, 1841, in company with Mr. Conrad, we went first to Bristol, on the Delaware, next, by Bordentown, to New Egypt, and returned by the Timber Creek, recrossing the Delaware at Camden. On this occasion I had an opportunity of examining the strata of both these formations, and I collected nearly all the fossil species described by Dr. Morton, together with some few additional ones. I shall now, therefore, briefly notice these two deposits and their fossils, and consider them in reference to their European equivalents.

Although in this part of New Jersey there is no white chalk with flints, so characteristic of rocks of the same age in Europe, it is still impossible to glance at the fossils and not be convinced that Dr. Morton was right, as before hinted, when in 1834 he referred the New Jersey deposits to the European Cretaceous era, and remarked that the American species of shells were nearly all new or distinct from those before described, and yet very analogous to those of the chalk already known. Of the two well-marked subdivisions of the Cretaceous system the lower consists in great part of green sand and green marl, and was supposed by Dr. Morton, as already mentioned, to be the equivalent of the English green sand, while an upper or calcareous rock, composed chiefly of a soft straw-coloured limestone with corals, was thought to correspond with the white chalk of Europe. But after carefully comparing my collection, comprising about sixty species of shells, besides
many corals and other remains, I have arrived at the conclusion that the whole of the New Jersey series agrees in its chronological relations with the European white chalk, or, to speak more precisely, with the formations ranging from the Gault to the Maestricht beds inclusive. Among the shells, in determining which I have been assisted by Professor E. Forbes, not more than five out of sixty seem to be quite identical with European species; but several others approach very near to, and may be the same as Europeans; and at least fifteen may be regarded as good geographical representations of well-known chalk fossils belonging for the most part to beds above the Gault in Europe. There are a few very peculiar forms among the American testacea, such as Terebratula Sayii Morton; and I found among the univalves a Bulla, but casts of the genus had previously been mentioned by Dr. Morton, and although not yet known in the European chalk a species occurs on the Continent in beds of the Jurassic system.

In the upper or straw-coloured limestones, I found on the banks of the Timber Creek, twelve miles south-east of Philadelphia, six species of corals* and several echinoderms, chiefly allied to upper cretaceous forms. The same calcareous formation also abounds in Foraminifera characteristic of the chalk, comprising, among others, the genera Cristellaria, Rotalina, and Nodosaria. Besides the shells there are also several remains of fishes, and of the series obtained by myself all those referred to the genus Lamna resembled species occurring in our chalk. They have been examined for me by Sir P. Egerton. One of them seems to approach very closely to Lamna appendiculata, and another comes very near to Galeus pristodontus; and indeed, if we may judge by so few specimens, seem identical. These are fossils of our upper chalk in Europe. There are also several forms of Carcharias not very unlike some tertiary species given me from the New Jersey chalk, several of which are figured by Dr. Morton; I will not dwell upon these however, since in Europe also there are many of the cretaceous Squalidae which can scarcely, when the teeth alone are considered, be distinguished specifically from tertiary fossils.

There are three Saurian vertebræ in the New Jersey green sand in the collection of the Geological Society, which I have submitted to Mr. Owen's inspection. One of these, from the green sand of Mullica Hill, is the anterior dorsal vertebra of the Mosasaurus. Another is the posterior cervical vertebra of a Pliosaurus, a genus which Mr. Owen has constituted to include a portion of the Pleiosauri, and which approach still more nearly to the true Saurians. The vertebra in question resembles very closely that of Pliosaurus brachydirus of the Kimmeridge clay. Until very lately, the Pleiosaurian type was not known higher in the series than in the Oolites; but it has now been shown to ascend to the chalk of Europe, so that its occurrence in the New Jersey strata is in strict accordance with European analogies. The third specimen (pre-

* These have been described by Mr. Lonsdale, and the description and figures will be given at the end of the present paper.
sented, I believe, by Professor H. D. Rogers) is labelled, "Woods- town, New Jersey;" a locality where those beds occur to which the great mass of shells before alluded to belong. It is a vertebra, penetrated by the green particles of the sand. Mr. Owen refers this to the dorsal vertebra of a crocodile of his Procelian division, or those which, like the recent crocodiles, have the concavity in the forepart, and the convexity behind. This fact is important, as hitherto the Procelian crocodiles in Europe have not been found in beds older than the eocene.

In concluding these remarks on the ferruginous and green sand formation of New Jersey, I may observe that the identification of four or five species out of sixty fossil shells with European cretaceous fossils would give an agreement of about seven per cent., which is by no means a small amount of correspondence, when we consider that the part of the United States above alluded to is distant between 3000 and 4000 miles from the chalk of Central and Northern Europe, and that there is more than 10° difference in the latitudes of the two districts compared, on the opposite sides of the Atlantic. It may doubtless be true, that the influence of temperature during the Cretaceous period was less powerful in limiting the range of species than it is now; and that the same forms prevailed more uniformly from India to Sweden, than they do at present. Nevertheless, the cretaceous fossils of Northern and Southern Europe differ sufficiently to show that the climate had then no small influence in causing distinct geographical provinces of species; and it seems natural that those species which are very abundant in Europe, such as Belemnites mucronatus, or those which have a great vertical range, such as Pecten quinquecostatus, should be the fossils found, if any, to recur in a distant part of the globe.

In the next place I proceed to give some account of the upper fossiliferous division of the New Jersey cretaceous deposit, which is for the most part arenaceous, but contains, in many places, layers of limestone and calcareous sand, with corals slightly aggregated together. It has been traced by Mr. Rogers to a distance of about 60 miles in a north-east and south-west direction, from Prosper Town to near Salem, having rarely a breadth of half a mile, and the thickness being from 6 to 20 feet. Its importance is derived, geologically speaking, from its fossils, and, in an economical point of view, from its affording the only lime procurable in this district. I saw the formation in question, on the banks of Timber Creek, a stream which flows into the Delaware, three miles below Philadelphia. The principal locality is twelve miles S. E. of Philadelphia, about a mile and a half south of the village of White Horse, in Gloucester County, New Jersey. Here a bed of soft calcareous stone, about 20 feet thick, is seen made up, in great part, of corals of the genera Eschara, Escharina, Cellepora, Tubulipora, and others*, together with the remains of echinoderms, such as Cidaris and Spatangus. It contains also some shells, as Scalaria annu-

* See the description of these corals by Mr. Lonsdale, in the Appendix.
lyell on the cretaceous strata of new jersey.

lata, gastrochona, and teredo, the whole indicating the sandy bottom of a shallow sea. i was so strongly reminded of the coralline crag of sudbourn, and other places in suffolk, when examining this rock, that i had some difficulty at first in persuading myself that it was not a tertiary deposit. it is, in a great part, a mass of white calcareous sand, more or less aggregated together, and the upper surface has been irregularly scooped out and rendered undulating, and is covered with a newer deposit of red clay and gravel, without fossils, the surface of which is even and level. this white sand and limestone pass downwards into light-green and ferruginous sand, with quartzose grains.

near hornerstown, i saw, on a branch of the timber creek, to which mr. conrad conducted me, a bed of this coralline aggregate, 8 feet thick, resting on the green sand or lower deposit before mentioned, with its characteristic fossils.

we have now to consider whether the calcareous or upper formation has been referred with propriety to the chalk. mr. forbes has examined the echinoderms, and is of opinion that they are decidedly analogous to cretaceous forms. one of the species of spatangus belongs to the same group as s. subglobosus of goldfuss, a group which forms the genus holaster of agassiz, and which that naturalist regards as very characteristic of the upper part of the cretaceous system.

one also of two species of cidaris is allied to c. vesiculosus, and to other upper cretaceous species of europe.

dr. morton had already observed, in regard to the corals, that some of the species resemble a maestricht fossil, figured by goldfuss; and the reader is referred to mr. lonsdale's comments on this subject in the appendix.

the fossil called by dr. morton "belemnites ambiguus," though probably not related to the belemnite, is closely allied to a fossil which i have collected myself in the chalk of sweden, associated with belemnites mucronatus.

the last-mentioned, or upper of the two fossiliferous formations of new jersey, has been called by dr. morton and mr. conrad the medial cretaceous, because there are others still higher in position in the southern states, which they refer to the chalk period. one member of these, a white limestone, seen extensively on the santee canal, and in other parts of south carolina, as well as at jacksonborough and shell bluff in georgia, i have shown, in a former communication to the society, to be eocene tertiary. another portion, called the nummulite limestone of alabama, i have not examined, and can therefore offer no opinion respecting it.

upon the whole, the collection of fossils which i made in new jersey confirms the principal conclusion to which dr. morton arrived, that there is a remarkable generic accordance between the fossil mollusca, corals, echinoderms, fish, and saurians of the cretaceous group, in new jersey and in europe. but the general analogy of the generic, and the identity of some specific forms, which mr. forbes and mr. lonsdale have assisted me in comparing,
has led me to refer all the fossiliferous formations of New Jersey to that part of the European series which ranges from the Maestrichtt beds to the gault inclusive.

**North Carolina.**

Of the same age are certain strata in North Carolina, at a place called Lewis's Creek near South Washington, forty miles north of Wilmington, and 340 geographical miles south-west of New Jersey, where I found *Belemnites mucronatus*, *Ostrea vesicularis*, *O. subspatulata* (a remarkable and new species figured in the Appendix), *Cellepora tubulata*, and other fossils.

The association of *Cellepora tubulata*, which abounds in the upper cretaceous formation of New Jersey at Timber Creek with *Belemnites mucronatus* in this locality of South Carolina, is important, as helping to show the near relation of the coralline limestone of New Jersey to the green sand containing Belemnites.

**Georgia.**

Some fossils have been communicated to me by Dr. Cotting, from Georgia, which make it probable that there are cretaceous strata there, lower than those of New Jersey; as among them are a *Pholadomya* and an *Ammonite*; both of which Mr. Forbes finds to be closely allied to certain Neocomien species from Neuchâtel.

In the collection of Mr. Conrad, from Alabama, I saw a species of Hippurite, derived from the cretaceous strata of that State, which I believe is the only example of any fossil of the Rudist family derived from the cretaceous rocks of North America. It affords another point of analogy between the cretaceous fauna co-existing on opposite sides of the Atlantic.

It is interesting to find, as the result of this investigation, that the marine fauna, whether vertebrate or invertebrate, testaceous or zoophytic, was divided at the remote epoch under consideration, as it is now, into distinct geographical provinces, although the geologist may everywhere recognise the cretaceous type, whether in Europe or America (and I might add India). This peculiar type exhibits the preponderating influence of a vast combination of circumstances prevailing at one period throughout the globe, circumstances dependent on the state of the physical geography, climate, and organic world, in the period immediately preceding, together with a variety of other conditions.