OF course it would be rather hazardous for me to say that the American scorpion, described in a former number of *Science*, was not the young of Eusarcus scorpionis (Grote and Pitt), in as positive language as Mr. Julius Pohlman says it is; for our knowledge of the embryonic features and development of the Eurypteridae is yet too little to allow of many positive assertions, where not accompanied by absolute evidence. Still I must say that I do not believe it to be the young of that or any other Eurypterid. The form of the limbs, the existence of the nipper-shaped palpus and of an apparently true mandible, resembling so much those of the Scorpionidae, are features which we should scarcely look for in an embryonic or undeveloped form of Eurypterus. If Mr. J. Pohlman had seen the photographs of the specimen instead of the rude cut, or had examined the specimen itself, I think he would have expressed a very different opinion.

R. P. WHITFIELD.

The geology of natural gas.

I do not wish to enter into a further discussion of the interesting question of the geology of natural gas, in anticipation of the results of a special investigation which has just been commenced in the oil and gas regions by Mr. John F. Carll for the State geological survey, but, in reply to Prof. I. C. White's criticism of my letter on this subject, I desire to state a few facts in support of my conclusion, that the 'anticlinal theory' alone is insufficient to account for the existence of natural gas, in all localities in the Pennsylvania and adjoining gas regions. In order to clearly understand this communication, reference should be made to *Science*, June 26 and July 17.

In the first place, it is important to know that the general statements contained both here and in my letter of July 17, refer, not only to all the gas regions of Pennsylvania which, with possibly the exception of the Erie district, are geologically connected with the oil-fields, but also to those other gas localities in New York, Ohio, and West Virginia which are not in the vicinity of producing oil-wells. The facts relating to the geology of natural gas, now in the possession of any one geologist, are not sufficiently numerous or connected to permit of the deduction of any ultimate theory; and it is only possible, for the present, to deduce special geotectonic conditions under which natural gas has so far been exploited. Some of these conditions are so varying and apparently antagonistic, that it is only possible to differentiate any one of the general laws controlling the occurrence of natural gas by a comparison of the individual facts obtained from innumerable well-drillings.

The facts given here will serve to elucidate my previous article, and I hope will prove to be sufficient to clearly define the few conclusions at which I have arrived, from field observations extending over a period of ten years, and from numerous studies in conjunction with Mr. Carll, of the results of his surveys, which are more thorough, complete, and valuable than any examinations which have ever been made bearing on the geology of both petroleum and natural gas.

The general structure of the strata drilled through by the gas-wells in the vicinity of Pittsburgh) now considered the most important gas district is the same as that of the strata in the different parts of the Devonian and carboniferous series pierced by the oil-wells at the Smith's Ferry (30 miles N. 60° W. from Pittsburg) and the Slippery Rock (34 miles N. 20° W. from Pittsburgh) districts, where in both districts heavy oil is obtained from the base of the coal measures, and amber oil from the Berea grit; in the Thorn Creek (25 miles N. 5° E. from Pittsburgh), and south end of the Clarion, Butler, and Armstrong (28 miles N. 20° E. from Pittsburgh) districts, where oil is obtained from the Venango (Devonian) sands; and in the Pleasant Unity (30 miles S. 65° E. from Pittsburgh), Dunlap Creek (31 miles S. 12° E. from Pittsburgh), Whiteley Creek (45 miles S. from Pittsburgh), and Dunkard Creek (48 miles S. from Pittsburgh) districts, where oil is obtained from the Mahoning sandstone (lower barren coal measures) and overlying strata. The discovery of oil at Mount Nebo, about eight miles north-west of Pittsburgh, and the several small oil-wells reported to have been obtained in close proximity to the Washington (Chartiers Creek) gas-wells, together with traces of oil found upon special examination in the gas from wells which are supposed to produce absolutely dry gas (the gas obtained from the Carpenter well on the Daum farm, Westmoreland county, was supposed to be free from oil or water: when, however, the gas was confined under a pressure of a hundred and sixty pounds to the square inch, water was precipitated), the existence of natural gas, either in or near *all* the productive oil-pools, under geological and physical conditions similar to those found to obtain in what are frequently spoken of as 'natural-gas regions proper,' are all sufficient reasons for considering the districts producing either oil or gas exclusively (?) one in a geological sense.

Gas-wells are not entirely confined to narrow belts (one-fourth to one mile wide) along the crests of anticlinal folds, nor are those which have apparently been found in synclines necessarily in the vicinity of subordinate crumples or anticlinal rolls which are so frequently found in extensive basins. The "dip of the gas-sand and the position of the anticlines and synclines" is the third of the five principal geological and physical conditions, which I have already enumerated (*Science*, July 17), which seem to influence the occurrence of natural gas, and in special cases would seem to be the most important consideration. Most of the saddles and basins in western Pennsylvania have a progressive dip along their axial line toward the south-west; and a well, drilled half a mile to the north-west or south-east of a given point on the crest of an anticline, will encounter any given stratum at the same elevation as a well drilled immediately on the crest of the same anticline at a distance south-west from the given point, the distance in each case being dependent upon the intensity of the dip in the three directions. The anticline along which the famous Murraysville gas-wells in Westmoreland county have been drilled is an instance.

About ten miles north-east of the village of Murraysville, two large gas-wells have been obtained about three miles apart (north-west and south-east), one on Beaver Run, the other on Pine Run. The total dip of the Upper Freeport coal-bed, from the Beaver-run well to the Pine-run well, is two hundred and fifteen feet, or at the rate of seventy feet per mile toward the north-west. The former well is found in close proximity to the anticlinal axis along which the great Murraysville wells are obtained, farther to the south-west; while the latter well is near the synclinal axis. The extension of the general direction of this anticlinal line to the north-east of the Beaver-run well crosses the Conemaugh River near the mouth of Roaring Run, where a well was drilled, evidently on account of the existence of the anticline at that point; but no gas was found. The Apollo well, about three miles north-east of the Pine-run well, along a line parallel to the structural lines of the district, found no gas. In the

case of the Roaring Run and Apollo wells, it may be possible that no porous stratum, which could serve as a gas reservoir, was pierced by the drill: this, as already stated (*Science*, July 17), is the first necessary condition of the existence of gas.

The Ridgway gas-well is located in a syncline, and not on a subordinate anticline, as has been suggested, but at a point where there is a certain regular dip of about 1° toward the west, on the side of the syncline. The Kane gas-wells — including the large one at Kane, which is now supplying the residents of the town with light and fuel, and the famous Kane geyser (gas) well — are both in a syncline, the south-east dip, in the one case, and the north-west dip, in the other case, toward the centre of the basin, being less than fifty feet per mile; and the south-west dip along the axis of the basin being from fifteen to twenty-five feet per mile. The great McMullen & Hallet gas-well, commonly known as the 'Mullen snorter,' is not in the vicinity of any anticline. The gas-sand at this well is nearly horizontal, having a dip of about eleven feet only in a direction S. 15° W.

The gas-wells found in the vicinity of the city of Erie are located in a region where no anticlines or synclines have been discovered. The dip of the rocks here is toward the south-west, at the rate of about twenty feet per mile, from recent surveys: or from the surveys made nearly fifty years ago, by the First geological survey, as pointed out by Professor Lesley, the average dip was estimated to be fourteen feet per mile. Gas-wells have been drilled in the vicinity of Fredonia, New York, one as early as 1821. Gas is still obtained here; and, as far as the structure has been made out, no anticlines exist in the vicinity of the Fredonia wells.

While these few facts would seem to be enough to show that all gas-wells, either in the vicinity of productive oil territory, or at considerable distances removed therefrom, are not necessarily in the vicinity of anticlines, many instances might be cited, particularly in the gas regions recently developed in Pennsylvania, to show that some of the largest and most productive wells are either on or in the vicinity of anticlinal crests. I am free to admit, as I have already done, that the position of anticlines and synclines have an important bearing upon the location of profitable gas-wells; but I cannot believe that, in view of our present knowledge, the 'anticlinal theory' is sufficient to account for all occurrences of natural gas. As to whether it will be possible for facts still to be recorded to give any geologist an adequate basis for the formulation of an ultimate theory, we must await the results of Mr. Carll's present investigation.

CHAS. A. ASHBURNER,
Geologist in charge Penn. surv.

907 Walnut Street, Philadelphia,
Aug. 24.

Annuaire géologique universel.

The undersigned being mentioned, under the name of Dr. *Svedonius*, amongst the collaborators in the above-named work recently published by Dr. Dagincourt in Paris, and two articles on Sweden and Norway appearing in the same, signed in my name, of which I had no knowledge *until after* their publication, I do hereby declare that the said articles are not composed by me, but are uncritically compiled from two pamphlets printed in the years 1874 and 1878, and are, consequently, now substantially antiquated pamphlets, with the authorship of which I had nothing whatever to do. These pamphlets, together with several others on the same subject, I have, at the request of a Swedish man of science, forwarded to Dr. Dagincourt, emphatically pointing out the time of their publication; and to this my collaboratorship in the annual is restricted.

DR. F. SVENONIUS,
State geologist.

Stockholm, July 31.

Probable period of gestation in the 'horned toad.'

On the 15th of May last I captured a very fine specimen of an adult female Phrynosoma Douglassii. The fact having long been known to me that these reptiles are capable of sustaining prolonged fasts without any apparent inconvenience, I determined to test the question for my own satisfaction and information. Accordingly, this specimen was placed where it was impossible for it to secure any food. One month after its incarceration it was taken out to be examined. No particular change was noticeable; the barest traces of emaciation could be seen in the limbs; but the creature upon being teased puffed itself up, as they do, and made short leaps with open mouth at my finger. It also ran nimbly about my study.

It was replaced in its limited quarters, and another month passed by without its having taken a particle of nutriment. Its eyes now had a slight sunken appearance, and some shrinkage of the limbs could be detected. I dipped it in water for a moment, and once more introduced it to its narrow prison. At this stage of the proceedings my chief surprise arose from the fact that the body of the animal still retained its rotund contour, and was, if any thing, plumper than at the time of the inauguration of the experiment.

Upon this date it had passed no excrementitious matter for nearly three weeks.

My surprise was great, when, in looking into the box on the afternoon of the 10th of the present month, to find strewed about the bottom of it no less than seven newly-born young. These were all dead, and enveloped in their membranes, which latter also enclosed a bright yellow yelk about as large as a small pea. At the time, circumstances prevented me from making any further examination; but, two hours later, my astonishment was at its pitch, when I found *fourteen* more young had come to light. Two of these were without the membranes and yelk, but every one of the twenty-one was dead.

Upon examining the mother, it was at once evident that her labor had not terminated; and, indeed, within the next ten minutes she was delivered of three more young ones. These were all born tail first: two of them were living, and had to be simply freed from their envelopes, the yelks having been absorbed. The remaining one was like the majority of the others, and lived but a moment or two.

As I write these lines I have before me twenty-two of the young in alcohol, two live and active little fellows of the same brood, and the mother-lizard, who, though she has lost much of her original activity and flesh during her *three months*' test, looks for all the world as fully capable of enduring many more days of it.

Taking all the circumstances I have related into consideration, I believe it will be found that about one hundred days is the period of gestation of this viviparous reptile.

It will be of interest to state, in the present connection, that other lizards endure these fasts as well as Phrynosoma; for I have a large Sceloporus, un-