mal in others, and the name is an unhappy misnomer.

Finally, the rule stated in the latest English text-book of geology, that faults give rise to little or no topographic feature, so that their existence would commonly not be suspected, is conspicuously violated in the northern part of the Great Basin, over an area about as large as England. In this region, as well as in others of similar structure farther south, the faults break through all formations, including the recent; and the heaved masses stand up, bordered by abrupt cliffs that have not retreated perceptibly from the line of fracture. The depressions among the tilted blocks are occupied by numerous lakes, which are thus, in respect to origin, as novel as the distinct forms of the faults themselves; for, among the thousands of lakes in other parts of the world, it is difficult to name half a dozen examples whose origin is so directly due to this kind of displacement.

VISITORS TO SWITZERLAND in the last twenty years have seen one characteristic part of that charming country at a disadvantage. The glaciers that the guides or their fathers remember seeing well advanced into the valleys have been found greatly reduced in size, shrinking back a thousand feet or more from their fresh-looking moraines, and uncovering broad surfaces of bare rock and gray rubbish, not attractive to the general visitor, however interesting they may be for the glacialist. The little huts built a few years ago at the foot of the ice, for the reception of tourists, have been left quite out of place, as the ice melted away uphill behind them. Now the good news arrives that a good number of glaciers have come to a halt in their retreat, and that for two or three years an advance has been observed. This is well for our children, who may now see the glaciers in good size again in ten or twenty years, if the advance is as persistent as the retreat that preceded it.

LETTERS TO THE EDITOR.

The sculptures of Cozumalhuapa.

THE suggestion in *Science* (vol. v. p. 524) that the shell-carvings figured by Mr. Holmes in the last report of the bureau of ethnology may indicate a common origin with those of Cozumalhuapa, will naturally lead to the inquiry, What branch of the American race executed the latter?

Unfortunately this is not easily answered. Perhaps we may proceed most safely by the method of exclusion. When Cozumal was discovered, three entirely dissimilar stocks occupied the immediate vicinity. The locality itself was held by the Cakchiquels. According to their annals, as preserved by the native chronicler, Francisco Ernantez Arana Xahila, they had occupied that territory but shortly before the Spanish conquest, driving out either the Xincas or the Pipiles, both of whom continued to live at no great distance. The Pipiles were a Nahuatl-speaking colony, of the same blood and language as the Aztecs, and were skilled in the same arts. The Xincas, on the contrary, were a savage people, whose culture-words were borrowed from either the Pipil or the Cakchiquel tongues. They may therefore be excluded.

The Cakchiquels were one of four tribes closely allied in language, culture, government, and geographical position; the others being the Quiches, the Tzutuhils, and the Akahals. They were familiar with picture-writing, stone-cutting, the metallurgy of gold, silver, and copper; erected massive buildings of stone and mortar; and were adepts in carving designs and weaving cloth. They certainly had the technical ability to execute such work as that on the slabs of Cozumal; but what is lacking, is evidence that it is in the style of their art. It differs very widely from that of Palenque and Copan.

The deficiency here pointed out is one most desirable to have filled. The vicinity of Iximche and Gumarcaah, the ancient capitals of the Cakchiquel and Quiche nations, might still yield a harvest to the persevering archeologist, in spite of the reports of Mr. Stephens. The Archbishop Garcia Pelaez, writing in 1850, stated that the government of Guatemala had 'recently' caused a careful survey, with maps and drawings, to be made of these remains (*Memorias para la Historia de Guatemala*, tom. i. p. 15); but I cannot learn that these were ever published, nor have my correspondents in Guatemala been able to ascertain the whereabouts of the originals. I may also add, that I have endeavored in vain to find out what became of the manuscripts left by Dr. Habel, the discoverer of the remains at Cozumal. Many of his notes had not been published, and it is quite possible that they would throw further light on this interesting question. D. G. BRINTON.

Media, Penn., July 2.

The geology of natural gas.

Prof. I. C. White's article on the geology of natural gas (*Science*, June 26) must necessarily attract no little attention from those who have never been in the oil and gas regions of south-western New York, western Pennsylvania, and eastern Ohio, where these wonderful and natural products are obtained; and also from those who are familiar with its commercial value and usefulness, but who have never made a study of the geological phenomena connected with its occurrence. In fact, the geology of this interesting region is so imperfectly understood by some of our leading professional geologists, who have never had

an opportunity to investigate in the field all the geological conditions under which petroleum and natural gas are found, that I fear Professor White's necessarily brief article, based upon his field studies, will mislead many.

Although it is to be regretted that no general work "has been published on the subject which would prove of any value to those engaged in prospecting for natural gas," yet Mr. John F. Carll, geologist in charge of the survey of the oil regions, and myself, among others, have collected a vast amount of information on the subject to elucidate many of the intricate questions connected with the exploration of natural gas.

Professor White's theory, that 'all great gas-wells are found on the anticlinal axes,' cannot be accepted until he shall limit, by definition, all great gas-wells to exclude all gas-wells, both large and small, comparatively, which produce gas from strata not found either on anticlinal axes or in close proximity to such structural lines. The Kane gas-wells, the Ridgeway well, the 'Old Mullin snorter,' and several Bolivar wells, are notable instances among many which might be mentioned where large gas-wells have been drilled in or near the centre of synclines.

Although it is a fact that many of our largest Pennsylvania gas-wells are located near anticlinal axes, yet the position in which gas may be found, and the amount to be obtained, depend upon (*a*) the porosity and homogeneousness of the sandstone which serves as a reservoir to hold the gas; (*b*) the extent to which the strata above or below the gas-sand are cracked; (*c*) the dip of the gas-sand, and the position of the anticlines and synclines; (*d*) the relative proportions of water, oil, and gas contained in the sand; and (*e*) the pressure under which the gas exists before being tapped by wells.

All oil-bearing sandstones contain a greater or less quantity of gas; and most gas-producing sandstones contain some oil, although a number of wells said to produce 'dry gas,' or that in which no oil or water can be detected, contain gas to the exclusion of fresh water, salt water, or oil.

Many facts could be cited which would disprove or render insufficient Professor White's 'three or four general rules' connected with the occurrence of natural gas in Pennsylvania formulated on the basis of his theory. This theory, in many cases, apparently explains the occurrence of gas; and what have proved large gas-wells have been located on anticlinals; but the theory, as a practical basis of successful operations generally, has no more claims as a final statement than 'Angell's belt theory,' which accounted for the occurrence of petroleum, as understood by him in 1867, when his theory was first announced. Many successful oil operations have been based on the 'belt theory,' and fortunes made; but it has long since been found to be insufficient to account for the existence of petroleum in all the Pennsylvania districts.

CHAS. A. ASHBURNER,
Assistant geologist Penn. surv.
907 Walnut Street, Philadelphia,
July 1.

In reply to Mr. Ashburner's criticism of the views advanced in my article on natural gas, I would say that the necessary brevity of the paper in question prevented the mention of many facts that might have rendered the conclusions clearer, and less open to challenge. One of these is, that my communication had especial reference to the natural-gas regions proper; i.e., where the gas is unconnected with oil-fields. Most geologists know that natural gas in large quantity exists with, and contiguous to, every oil-pool, apparently as a by-product in the generation of the oil; and of course the rocks are filled with it wherever it can find a reservoir. To gas-wells from such sources Mr. Ashburner's criticism may sometimes be found applicable; but, even with these, by far the larger ones will be found on the arches of the rocks.

The cases that Mr. Ashburner mentions, where large gas-wells have been found at the centre of synclines, do not necessarily contradict my conclusions; for no one knows better than he that a subordinate crumple or anticlinal roll often runs along the central line of a syncline. Messrs. Ashburner and Carll have indeed collected and published many well records, and other data concerning oil and gas, that are invaluable with reference to the contiguous oil and gas regions already developed; but, if they have written any thing that would prove a guide to one in search of new gas-fields, the writer has failed to get access to the same.

My excuse for writing the article on natural gas was that I might be of some service in preventing the waste of capital that has been going on within a radius of fifty miles from Pittsburgh by an indiscriminate search for natural gas; and it is a sufficient answer to Mr. Ashburner's criticism to point him to the brilliant lights along the crests of the Waynesburg, Pin-Hook, Washington, Bull-Creek, Brady's-Bend, Hickory, Wellsburg, Raccoon, and other anticlinals, and also to the darkness that envelops the intervening synclines, in which hundreds of thousands of dollars have been invested without developing a single profitable gas-well. The same result has been proven in other portions of the country. The Great Kanawha valley above Charleston has been honeycombed with borings for salt, and the only gas-wells developed were found within a belt a few rods wide, which coincides with the crest of the Brownstown anticlinal, where immense flows were struck. In this connection, I should state that Col. Allen of Charleston says he can trace the Brownstown anticlinal by the escaping gas across streams, and even mountains, from the Kanawha River to the Big Sandy, where, on its crest, near Warfield, two of the largest gas-wells ever known have recently been struck. At Burning Springs, on the Little Kanawha, the only large gas-wells were found on the very crest of the great uplift in that region. The gas-belt of western Ohio, through Findlay and other towns, follows closely the line of the Cincinnati arch; and the same story is repeated in other localities too numerous to mention.

Mr. Ashburner can, if he chooses, interpret these facts as mere coincidences, and explain them to himself as having no more bearing on the question of finding gas than 'Angell's belt theory' of oil; but the practical gas-operator can no longer be deluded by such logic into risking his money in water-holes (synclines) where so many thousands have been hopelessly squandered.

With regard to the anticlinal theory not being 'a practical basis for successful operations,' I deem it a sufficient reply to state that all the successful gas companies of western Pennsylvania and West Virginia are getting their gas from the crests of anticlinal axes, while those that have confined their operations to synclines have met with uniform financial disaster.

The statement was distinctly made in my original communication, that gas would not be found on all anticlinals, nor at all localities along one that actually

produces gas, since other factors have to be considered, as there stated; but, with the facts before us, it would certainly prove a great saving of capital in the search for gas, if operations were confined to the crests of the anticlinals; and I fail to perceive how Mr. Ashburner's fears for the 'misleading' character of my article can be realized. I. C. WHITE.

Mountain-Lake Park, Md., July 11.

A rare dolphin.

On the 3d of June the national museum received from Messrs. Warren & Co., fish-dealers in Pensacola, Fla., a very beautiful and highly interesting dolphin, which was captured in the Gulf of Mexico. The upper surfaces of the body were dark slate-color, sprinkled with whitish spots about the size of a cent; while the under surfaces were white, spotted with dark gray. The species belongs to the genus Prodelphinus, — a genus closely allied to Delphinus, of which the dolphin of the ancients, D. delphis, is the type. Numerous species of Prodelphinus have been described from single skulls, but scarcely any thing is known regarding their external forms or relationships. The recent discovery of great schools of this spotted species in the Gulf of Mexico, and also, still more recently, by the U. S. fish-commission steamer Albatross, off the coast of North Carolina, gives the hope that we may soon be able to clear away the obscurity now resting upon the genus.

F. W. TRUE.

U. S. national museum.

The scenery of Arizona.

The unique character of western Arizona leads me to add a few words to the article of 'A. G.' in your issue of June 26. Only ignorance of the extreme attractiveness of this almost unexplored region explains the fact that so few tourists find their way thither.

My chief object in addressing you is to mention an easily made excursion from Flagstaff, fifty miles to the south, through Oak-Creek valley, and into the valley of Beaver Creek, to Fort Verde. Oak Creek is more like a White-Mountain stream than any other creek that I have seen in Arizona. The valley broadens to a considerable width, after dropping down a thousand feet or more from the mesa upon which the creek rises, and is enclosed by lofty bluffs of sandstone, the lower half of which is deep red, while the upper half is bright gray. The line of demarcation between these colors is remarkably distinct. These rocks, of mesozoic age, have been sculptured by eroding waters in the most wonderful manner.

This region is easily explored by following the trails on horseback. The rocks have not, of course, the sharpness and steepness of limestone mountains (the Alps, for instance); but it has never been my lot to view scenery elsewhere so graceful and picturesque. I feel at liberty to speak with enthusiasm on this subject, for none that visit Oak-Creek valley will come away disappointed. R. SPAULDING.

Montclair, N.J., July 4.

The classification and paleontology of the U. S. tertiary deposits.

Although much tempted to make some comments on the remarkable statements of Dr. Otto Meyer relative to the south-western tertiaries, in his late article in the *American journal of science*, I had determined to keep silence until the second part of his work, presumed to contain the stratigraphical evidence he might have to present, should have appeared. In view, however, of Heilprin's notice of the subject in the issue of *Science* of June 12, I desire to enter a *caveat* on both sides of the question, as one who has spent eighteen years, more or less, in the study of these formations. I emphatically agree with Heilprin as to the impossibility of subverting the cumulative stratigraphical evidence to the effect that the relative superposition of the several principal stages — the Burstone, Claiborne, Jackson, and Vicksburg groups — cannot be otherwise than as heretofore ascertained in hundreds of localities, by others as well as by myself; even supposing that the geographical distribution, with relation to the progressive elevation of the continent, could leave any doubt in the premises. I recall to mind that years ago I had occasion to repel a similar attempt, on the part of Mr. Conrad, to subvert the relative position of the Jackson and Vicksburg groups upon supposed paleontological evidence (see 'Remarks on the Shell Bluff group of Mr. Conrad,' in *American journal of science*, 1867). As Dr. Meyer seems to have been on the spot, and must have seen the Jackson strata disappearing beneath those of the Vicksburg group (if he ever descended Pearl River below Jackson), and the Claiborne and Jackson vanishing beneath the same and the Grand Gulf rocks (if he descended the Chickasawhay River), apart from what is proven by the exposures on the Tombigbee and Alabama rivers in the state of Alabama, his prediction that 'probably' the whole series might have to be turned upside down, is strongly suggestive of the periodic attempts to subvert the 'Copernican system' of astronomy.

Aside, however, from Dr. Meyer's stratigraphical vagary, I strongly sympathize with his views in respect to the transition of so-called species, mostly named by Conrad, from one of the stages to another; I repeatedly called Conrad's attention to the impossibility of maintaining a number of his distinctions, especially among the genera Pleurotoma, Fusus, Voluta, Corbula, Venericardia, and others; and finally, finding that every variation, clearly apparent to me as such, was by him interpreted as a new species, I ceased to send him fossils from the south-western formations, in order not to swell uselessly the already long list of spurious species. In a number of cases Dr. Meyer has observed and recorded precisely what I have long known to be the fact, — that oftentimes from two to five of Conrad's species are mere variations, easily recognized as such when the rich material is seen on the spot and in numerous localities. That Dr. Meyer has in all cases judged correctly, I am of course unprepared to say; but I emphatically hope that a critical revision of the tertiary and upper cretaceous fauna of the south-west will soon be made, with a view to what we have learned on the subject of evolution since Lea's and Conrad's time, and that the host of varieties now cumbering our tertiary check-lists in the guise of species will be reduced to something like a comprehensive view by a master hand. I doubt if there exists a finer opportunity for observing the evolution of marine species in tertiary times than is presented by the minutely differentiated formations of Mississippi and Louisiana.

E. W. HILGARD.

Berkeley, Cal., June 22.

The ginkgo-tree.

A large and remarkably fine specimen of Salisburia adiantifolia was in fruit on the Landreth estate, near Bristol, Penn., during September last, — an annual and by no means uncommon occurrence, according to the proprietors. WINTHROP E. STONE.

Mass. ag'l exp't station, July 6.