bones and sandstone nodules of the Suffolk .Bone-bed—an old Eocene clay furnishing the so-called coprolites, crabs, etc.

The Rev. J. Gunn speaks of the "*stone*-bed" at Sutton in a recent letter to this Magazine. It is better to keep "stone-bed" for the Norfolk area, and to speak of the "Suffolk *bone*-bed," since their identity is not proved. Mr. Roper's collection is no doubt interesting, but Mr. Prestwich's discovery of Mammalian remains beneath the Coralline Crag needs no confirmation. In 1862 I worked in the Suffolk bone-bed in that position, and, in two separate papers, in 1865, had pointed out the fact of its occurrence with Mammalian and other remains, at the base of both Crags, three years previously to Mr. Prestwich's recent paper. One would suppose that this relation of the beds in question should be now an accepted fact, and I therefore cannot regard it as "a singular coincidence" that Mr. Roper obtained Mammalia from Sutton.

A cast of the Mastodon tooth noted in this communication has been placed by me in the British Museum. It is intended to figure and describe it fully elsewhere.

Mr. Baker's fine collection also contains another (making three specimens known) premolar of the upper jaw of my *Hyæna antiqua*.

NOTICES OF MEMOIRS.

I.—The Centenary of Wm. Smith's Birth.

W. SMITH, born March 23, 1769. Died Aug. 28, 1839.

"If in the pride of our present strength we are disposed to forget our origin, our very speech would bewray us; for we use the language which he taught us in the infancy of our science."

—Sedgwick, on presenting the Wollaston Medal to W. Smith.

IN March last (within a few days of the hundredth anniversary of Smith's birth) a lecture was delivered at the Royal Institution, Bath, on "Wm. Smith, the Father of English Geology, during his residence near Bath," by W. Stephen Mitchell, LL.B., F.L.S., F.G.S.[1] The object of the lecture was to revive the memory of William Smith in Bath,[2] and to call out all local reminiscences. We especially select for notice the sketch of the growth of his geological ideas.

The Lecturer pointed out that the sources of information were—

1. The memoir of W. Smith, by Prof. Phillips, his nephew.
2. The address of Sedgwick in announcing the award of the Wollaston medal.
3. Reminiscences of early life written by Smith himself, some of which are printed by Fitton in Phil. Mag. 1833, p. 38, etc.

[1] The notice of the Lecture has been purposely delayed as it was anticipated that further local information might have been added. With the exception, however, of some dates obtained by Mr. Mitchell from the minute-book of the Coal Canal Company, this hope has not been realised.

[2] Since this was put in type, we hear that the Committee have agreed to place a tablet on the walls of the Institution in Bath, to commemorate Smith's connection with that city.

4. A Paper by Farey (Smith's Boswell), Phil. Mag., March, 1818.
5. Obituary Notice in Geol. Journal.

It is difficult to make these agree in the matter of dates. Mr. Mitchell believes the reminiscences printed in Phil. Mag. 1833, are most trustworthy, as they were written by Smith himself in 1804. Although Smith was present when Sedgwick gave his address, and the facts were supplied by himself, yet this was in 1831, and his memory in 1804, it is thought, was more likely to be accurate. Following then his own (1804) account of himself, it appears that after surveying and noticing the different kinds of ground in various parts of England at the age of 22, he settled in Somersetshire in 1791, at High Littleton, a village within a few miles of Bath. He says:—"The discoveries of *regularity in the strata* . . . . . chiefly originated in surveys of estates and collieries in Somersetshire, where I found at High Littleton the same red earth sunk through for coal."

His next observation was on the *dip* of the strata.

"My observations on the superposition and continuity of the strata were greatly extended in 1792; and in the following year (1793), by taking levels for the proposed Somersetshire canal, I proved the Red Marl, Lias, blue marl, and Inferior Oolite . . . . . to be generally inclined to the east." The Somersetshire Coal Canal Bill passed April 8, and received Royal assent April 17, 1794. In August, 1794, Mr. Palmer, Mr. Perkins, and "Mr. Smith, the surveyor" were appointed by the Canal Committee to make a tour through England, which extended as far north as Newcastle. This gave Smith an opportunity of confirming his views. The party returned to Bath, and on October 3, 1794, gave in their report.

The next quotation from William Smith's reminiscences is of importance,[1] as showing how Smith has recorded his *next step*, the identification of the strata from their organised contents.—The Somersetshire Coal Canal consists of a main line and a branch to Radstock, but with this branch William Smith had little to do. The main line runs from near High Littleton to Dundas aqueduct, where it joins the Kennet and Avon Canal; the entire length being little over ten miles. Tracing its course from High Littleton it passes for about three miles over New Red marl, then turning north-east, crosses a strip of Lias for about three quarters of a mile, and near Withy Ditch it first enters the Sands, known as Upper Lias Sands or Inferior Oolite Sands. It then meets the hills of Inferior Oolite near Dunkerton, and after again crossing a narrow valley of the Sands, it continues on the Inferior Oolite to Combehay. Here for about a quarter of a mile it lies on Fuller's earth; then from there to South Stoke is again on Inferior Oolite. At South Stoke there is a great change of level in the canal, and from here to the end of its course it is on the before-named Sands.

"For six years," writes William Smith, "I was resident engineer on the Somersetshire Coal Canal, which put my notions of coal stratification to the *test of excavation;* and I generally pointed out

[1] In the *Bath Chronicle* report of the lecture it is given in the wrong place, and thereby loses its chief interest.

to contractors and others, who came to undertake the work, what the various parts of the canal *would be* dug through. But the great similarity in the rocks of Oolite, on and near the end of the canal towards Bath, required more than superficial observation to determine whether those hills were not composed of one, two, or even three of those rocks, as by the distinctions of some parts seemed to appear. These doubts were at length removed by more particular attention to the site of the organised fossils which I had long collected. *This discovery* of a mode of identifying the strata by the organized fossils respectively imbedded therein, the sharpness of those in their primitive sites, contrasted with the same fossils rounded and water worn in gravel, led to the most important distinctions," p. 40. Phil. Mag. 1833.

"The superintendence and execution of the canal I had before surveyed confirmed the notions previously formed of the strata; and the canal *excavations*, and the new quarries opened, produced organized fossils for the identification of several strata which could not otherwise have been distinguished" (p. 42).

This seems to fix on the valley between Dunkerton and Dundas as the *place* of Smith's discovery, Now as to its date. Sedgwick speaks of his having succeeded as early as 1791 in identifying strata by means of their fossils. In the minute book of the Canal Committee under date July, 1795, is an order to Bennett and Smith to stake out the Dunkerton portion of the canal. Advertisements in the "Bath Chronicle" of the period state that the committee will be ready to receive contracts after June 2nd, 1795. Smith remained in the employ of the company till June 5th, 1799. Assuming that the excavations in the Oolites to which he alludes were made early in the course of the work, his discovery cannot well be put earlier than 1796.

In 1791 he had perhaps noticed a difference between the fossils of the Lias and those of the Coal strata.

Everybody knows that it was in June, 1799, his first table of the order of British strata was drawn up. There were four works published in which the principles of "strata identified" were made known before Smith published anything himself, as shown in this table.

His Own Publications.	Publications of Others.
1799. MS. table of strata.	
1801. Prospectus of work never published.	
1806.	Farey. Phil. Mag., 1806, p. 44.
1811.	Farey. Derbyshire.
1811.	Parkinson. Geol. Soc., vol. I., Trans.
1813.	Townsend's Moses.
1815. Memoir to map.	
1816. "Strata identified."	
1817. Organized fossils.	

Mr. Mitchell traces the gradual spread of Smith's notions and the modification of them held in more recent times, but this, though very well in a popular lecture is too well known to need a place here. We must also, for want of space, omit the interesting notice of the

employment of William Smith by the Bath Town Council, on the failure of the supply in the hot springs in 1812. As early as 1808, a minute relating to this subject may be seen in the Corporation books.

The connection of Wm. Smith with Bath during the development of his geological ideas is thus summarized.

The examination of the district between High Littleton and BATH first led him to suppose a regularity in the succession of *all* the strata: the planning of the Somersetshire Coal Canal near BATH was the cause of the tour through England which enabled him to confirm his supposition: the difficulty in distinguishing "the Oolitic rocks on and near the end of the canal towards BATH" led him to "the *discovery* of a mode of identifying the strata by the organized fossils respectively imbedded therein."

The *first* collection of fossils stratigraphically arranged was made by him at Cottage Crescent, BATH.

The *first* table of the order of the strata was drawn up by him at Pulteney Street, BATH.

The *first* geological map known is his map of the district of BATH.

The *first* geological map of England was coloured by him while living near BATH.

The *first* announcement of the publication of a geological map of England, was his "prospectus" dated from Midford, BATH.

The *first* introduction of his discovery to public notice was through the friends he made in BATH.

II.—THE METAMORPHISM OF ROCKS.

By the CHEVALIER CRESCENZO MONTAGNA.

[Nouvelle Théorie du Métamorphisme des Roches fondée sur les phénomènes de fossilisation des Animaux et des Plantes de tous les Âges Géologiques. 3 Plates. Naples, 1869. pp. 127. London: Trübner and Co.]

THE term Metamorphic is usually applied to rocks whose original structure has been obscured. Contact with igneous rocks in a molten state was first taught by Hutton, and has been generally accepted as the principal cause.

But there are many forces, both chemical and physical, which tend to produce change in rocks, and it has been well said that all rocks are in a metamorphic condition, since all have suffered some changes subsequent to their formation, and changes they are continually undergoing. Professor Montagna takes this comprehensive view of the subject, and regards all rocks as metamorphic.

Allowing the means and causes which continually modify the crust of the earth to have been always the same, he considers the difference in rocks of similar origin to result in general from a longer series of metamorphic actions. From Tertiary strata downwards there are metamorphoses more or less profound; and the author discusses these changes from the evidence furnished by the fossil remains, whether of plants or animals. This mode of treating the subject he considers more positive than if the evidence were

derived solely from lithological characters, as the recent and unchanged forms of life may very readily be compared with the fossil forms, and their structure and composition is of a more definite character.

The work is divided into seven articles. Some of the principal theories of metamorphism are first pointed out and discussed; the alteration by heat of gneiss and other rocks exclusively termed metamorphic is objected to. When, as is sometimes the case, the stratification is apparent, and the character uniform, of beds hundreds of metres in thickness, the evidence seems to the author at once opposed to the igneous theory. A very elevated temperature would in places have destroyed every trace of stratification, while the change would be gradual, fading away from the point of contact with the igneous rock. To account for the uniform character we should have to suppose that the mass was entirely surrounded by molten material. The author points out the slight facility with which the majority of rocks conduct heat.

Several instances are quoted where rocks, undoubtedly of sedimentary origin, have originally been taken for igneous and eruptive rocks. It is also mentioned that volcanic lavas may, by atmospheric influence, be decomposed into clays, and undergo the same transmutations as the aqueous rocks.

The petrifaction of organic remains teaches us that the particles composing rocks do not remain inert; they indicate molecular changes.

Some space is devoted to the changes that are evidenced by mollusca. Many instances of replacement, both entire and partial, are noticed. It is evident in general that this substitution must have proceeded atom by atom.

In many instances the shell has been more or less removed without being replaced; but the author remarks that, during his long researches, he has in no instance observed the shell entirely dissolved in such a manner as to allow the shock to be heard of the nucleus inside the cavity. Thus occasionally new matter may fill these cavities, and so replace the shell in its general form, without replacing the intimate structure.

The most metamorphosed rocks have undergone the greatest amount of chemical action, or a repetition of metamorphic actions. In the earlier stages the changes were in a great measure confined to the organic remains, and these seem to have suffered much, so that in the more altered rocks they are greatly changed, or even destroyed.

Crystallisation appears to be the last stage of metamorphism,—it often destroys the organic remains.

Professor Montagna, however, announces his discovery, in granite, of vegetable remains, consisting of portions of *Lepidodendron* identical with species found in the Coal-measures; also of *Lepidodendron sexangulare* in a compact serpentine, and in certain porphyries. Vegetable remains are also cited as occurring in syenite. About seven-tenths of the numerous specimens of granite and granitic rocks examined by him prove their aqueous and stratified origin, by yielding plant-remains, which are more evident the finer the grain

of the granite. He remarks that these vegetable remains forbid the idea of heat being the agent in producing the metamorphism of the rocks. And he is confirmed in the opinion expressed in his "Generazione della Terra," that granite has been formed solid on the surface of the globe.

All the serpentines he has observed have yielded fossil plants, as *Lepidodendron*, *Asterophyllites*, *Stigmaria*, etc.

Serpentine and ophiolitic rocks of schistose or massive texture show their metamorphic origin in another way; they have been detected graduating into clay.

The author has concluded that metamorphism results from molecular changes. "The chemical changes that take place in a sedimentary rock, and also the formation of a crystalline structure, which we have recognized as the more frequent and remarkable the longer the metamorphic action has continued, are themselves only molecular movements produced by particular combinations and decompositions due to the nature of the elements."

The production of these changes he concedes to electricity.

"There is nothing but electricity which, among the forces known only by their effects, could produce all the phenomena of which we have spoken; we know no metamorphic phenomenon which it could not explain."

The origin of lodes may also, he thinks, be explained by electrodynamic forces.

Finally he remarks on the constancy and long duration of certain plants being opposed to the metamorphic views of Darwin, and concludes by proposing a new classification of the older rocks in reference to the amount of metamorphism they have undergone.

The three plates illustrate fossil plants from several rocks generally supposed to be eruptive or azoic.

REVIEWS.

I.—The Production of the Precious Metals: or, Statistical Notices of the Principal Gold and Silver Producing Regions of the World, Etc. By W. P. Blake, Commissioner from the State of California to the Paris Exposition of 1867. New York: Putnam and Son. London: Trübner and Co. 1869.

THIS valuable report, prepared by Mr. Blake at the request of the United States Commission, contains, in as compact a form as such a subject admits of, descriptive and statistical notices of the chief gold and silver producing regions of the world. It differs from the admirable work of Mr. Phillips, published in 1867, in treating less of the methods adopted in the extraction of the precious metals from their ores than of the yield and extent of resource of each country in this particular. The noble metals are considered in succession, and they are discussed, each in turn, in respect to the localities producing them, the statistics of their yield in most cases