by a simultaneous gliding of its whole mass, as believed by de Saussure. All these laws, deduced from a first, but attentive, study of the phenomena of the glaciers, were, at that time, — excepting that of the moraines, — new for science. They were expounded by me, and illustrated by diagrams, at the meeting of the geological society of France, in session at Porrentruy, the same summer of 1838; and I had the great satisfaction of seeing them fully confirmed by the subsequent observations of Agassiz and others, which furnished the precise numerical data then wanting for their complete elucidation. This paper, however, though duly mentioned in the proceedings of the geological society (*Bulletin*, vol. ix. p. 407), was not printed, owing to a protracted illness of its author in the winter following. But on the occasion of a claim by Prof. J. D. Forbes to the discovery of the laminated, or ribboned, structure of the ice, the portion relative to this subject was printed, and the whole manuscript, on a motion of Agassiz, was deposited, by a formal vote, as a voucher, in the archives of the Society of natural sciences of Neuchatel, the original draft being now in my hands. If I mention this circumstance, it is because the regrettable omission of the publication of my paper was the occasion of the unfortunate misunderstanding which estranged two such men as Agassiz and Forbes, and which I feel bound, in a measure, to explain."

The manuscript referred to in the latter part of this citation was sent to the Society of natural sciences of Neuchatel early in 1883, was read at the session of the society on the 12th of April, 1883, and published in its *Bulletin* of the same year. I have a copy of the published paper, which I received from the secretary of the Neuchatel society. It is in French, as first written, and its title page, and also the cover, bears the heading, 'Observations sur les glaciers des Alpes en 1838, par M. Arnold Guyot.' I had thus, in Guyot's memoir of Agassiz, and this publication by the Society of natural sciences of Neuchatel, the fullest authority for my statements, and also, in this and other ways, abundant reason for confidence in Professor Guyot. Moreover, his memoir of Agassiz bears evidence throughout that his friendship for Agassiz, as I know from long and intimate intercourse with him, was, to the end, that of a brother.

In the same memoir, Guyot says of Venetz and Charpentier — names mentioned by Mr. Marcou — and of Agassiz's great results:

"If to Venetz and Charpentier belongs the honor of having first proved the transportation of the Swiss erratic bowlders by the agency of ice, and the existence of great glaciers formerly extending to the Jura, to Agassiz we must accord the merit of having given to these facts their full significance; of having brought them before the world at large, and having made the glacial question, as it were, the order of the day. By his sagacity he found glacial action where it was never suspected before, pointed it out to the astonished and unbelieving English geologists on their own soil; found it in North America; traced it with undoubted evidence in the temperate regions of South America; and believed, though with hardly sufficient reason, that he had seen it on the vast plains of the Amazon. He proved the phenomena to be well-nigh universal." Thus Guyot does justice to his friend, and recognizes the earlier work of Venetz and Charpentier.

My academic memoir of Guyot closes with the following sentence: "As fellow-students, we have special reason to admire in Guyot — as he wrote of Humboldt — 'that ardent, devoted, disinterested love of nature, which seemed, like a breath of life, to pervade all his acts; that deep feeling of reverence for truth, so manifest in him, which leaves no room for selfish motives in the pursuit of knowledge, and finds its highest reward in the possession of truth itself.'" I know this to be a just tribute.

Mr. Marcou's remark condemnatory of Professor Agassiz's 'successor at Harvard college,' for "having denied, *in toto*, in a publication founded by Agassiz, — 'The memoirs of the Museum of comparative zoölogy,' — his [Agassiz's] great discovery of the 'ice age,' but having, more than that, ignored him altogether as the discoverer of the existence of ancient glaciers in the British Dominions, in New England and New York, in Brazil, in the Straits of Magellan, and in Chili," is essentially groundless. 'The memoirs of the museum,' referred to, contain, among its volumes, a work entitled 'The climatic changes of later geological time, by J. D. Whitney,' and this is the only ground presented by Mr. Marcou for the charge he makes. Mr. Whitney's work opposes accepted views on ancient glacier distribution, and therein opposes Agassiz, and nearly all geologists living; but he has not a word of disparagement for Agassiz, and gives no just cause of personal complaint. Mr. Marcou's charge against Mr. Alexander Agassiz has no other foundation, and is not true to the views he holds, and has always held, with regard to his father's work and discoveries connected with glaciers and the 'ice-age.' The memoirs of the museum of comparative zoölogy, founded by Mr. Alexander Agassiz, and not by his father, has been for some time sustained, and the museum work carried on, with the grandly generous outlay on Mr. Agassiz's part of several hundred thousand dollars; and he has never made the stipulation, which the objector seems to require, that the publications should contain nothing in opposition to his own, or his father's opinions.

JAMES D. DANA.

New Haven, Aug. 11.

Lacustrine deposits of Montana.

The examination of the Gallatin valley in Montana, by the writer, under the supervision of Dr. F. V. Hayden, during the summer of 1885, has developed some points of general interest in relation to the old lake basins of that region. Dr. Hayden was the first to demonstrate the fact that the western country, during the tertiary period, was covered to a greater or less extent with lakes, the waters of which, as the tertiary period progressed, gradually changed from brackish to fresh; until in pliocene time there were numerous fresh-water lakes scattered all over the area of the west, from the Mississippi valley to the Pacific coast.

The first of the basins described by Dr. Hayden was the one lying east of the Rocky Mountains, and extending from the Niobrara River to an unknown distance south of the Platte River. He estimated that this lake must have occupied an area of from 100,000 to 150,000 square miles. To the beds deposited in this lake the name of the Loup Fork group was given; and they were found to shade imperceptibly into an upper group, to which he gave the name of Post-Pliocene, the lower strata having been

referred to the pliocene from a study of the abundant vertebrate remains found in them.

In 1871 the writer accompanied Dr. Hayden's expedition of that year from Utah across the Snake River plains, through Idaho to Montana. Old lake-beds were found filling many of the valleys,—the expansions of all the more important rivers and many of their tributaries having once been lakes. The lacustrine deposits consisted mainly of sands, arenaceous clays, and what were called 'marls.' They were recognized to be precisely like the beds of the Loup Fork group, generally light colored, white, creamy yellow, or ashy gray, and were referred by Dr. Hayden to the pliocene, from their lithological characters. He supposed that the lakes dated back to the pliocene, and that the waters gradually subsided during quaternary times. Specimens of the rocks were collected, in 1871 and 1872, and deposited in the Smithsonian institution. The only fossils obtained in 1871 were a fragment of the jaw of Anchitherium agreste, associated with a helix. Pliocene fossils were found by Dana and Grinnell, in 1874, in a basin on a branch of Smith's River in Montana, but the beds from which they were obtained were only fifty feet in thickness, and differ from the beds of the other lacustrine areas in the mountains. The data as to the age of these supposed pliocene deposits is therefore meagre. Some facts of rather recent discovery, however, seem to indicate that possibly their age, and their contemporaneity with the original Loup Fork beds and the post pliocene of Hayden, may eventually be established by the study of the lithological characteristics of the various basins. At any rate, certain lines of investigation are suggested that promise interesting results.

Somewhat more than a year ago Mr. George P. Merrill, of the national museum, informed me that in arranging the 'pliocene marls' and sands that I had collected in 1871, he was struck with their peculiar appearance; and upon subjecting them to a microscopic examination, he had found them to be composed mainly of volcanic material, several of them, in fact, being wholly composed of volcanic or pumiceous glass. These specimens were from some of the valleys in the upper branches of the Jefferson River. Although some of the coarser strata of the deposits were recognized in 1871 as being of volcanic origin, that the peculiar ashy gray, drab, and cream-colored beds so characteristic of the lacustrine areas were of a similar origin, was first demonstrated by Mr. Merrill's examinations. This discovery gave additional interest to the study of the Gallatin valley lacustrine area, which has been our field of study for the past two seasons.

The specimens collected in the summer of 1885 have also been examined, and they reveal the fact that the so-called marls and sands are composed largely of pumiceous glass, which was in all probability ejected into the air from volcanic vents, and deposited in the quiet waters of the lake. The character of the beds is such that they are very readily eroded and broken down, which probably accounts for the removal of so enormous a mass from the central portions of the valley. How great the thickness of the original deposit was, it is impossible to say exactly; still, the remnants on the south east side of the basin, near Bozeman, represent a thickness of at least eight hundred to a thousand feet. Only the eastern side of the valley has as yet been re-examined, and the beds are so generally concealed along the edge of the mountains that it is difficult to obtain a connected section in detail: the general section, however, has been determined. As in the case of the Loup Fork section, near the mountains, and in the lake-basins of other portions of Montana, there is a progression from calcareous beds up through loosely coherent sands to conglomerates, which cap the series. Creamy-white limestones with veins of quartz or chalcedony are the lowest rocks of the lake series in the Gallatin valley; and above them are light yellowish-gray, marly-looking sands, distinctly stratified. They are highly calcareous, but, after treatment with hydrochloric acid, the residue is found to be mainly made up of particles of glass. In the central portion of the section near Bozeman, the beds are composed almost purely of pumiceous glass, while the upper portions show a mingling of particles of crystalline rocks with the glass. The crystalline particles were evidently derived from the mountains near by, when they formed the shore of the lake. The pumiceous particles in the Gallatin valley specimens are sharp and angular, and show no evidence of attrition. The conclusion seems inevitable that this material was thrown into the air from some volcanic vent or vents, perhaps in repeated showers, and deposited in comparatively quiet waters. As the lake became more and more filled up, there appears to have been more agitation in its waters, and particles worn from the shores were mingled with the volcanic materials. That the latter was not carried in by water, seems probable, for the central portions of the beds are almost, if not entirely, made up of glass alone; and moreover, the finely comminuted condition of the particles, and their homogeneity in close proximity to the shore, confirm the view that they are wind-carried. The general resemblance of the Montana sections to those of the Loup Fork region led me to look up in the national museum some of the Loup Fork fossils collected by Dr. Hayden from 1856 to 1857, and described by Dr. Leidy. Sufficient material for microscopic examination was found adhering to many of the bones, and, in nearly every case, pumiceous particles were recognized in the sand. Specimens sent to the writer within the last three months, from several localities in northern and north-western Nebraska, and from north-western Kansas, have also contained similar volcanic glass. Mr. G. P. Merrill, in the 'Proceedings of the national museum for 1885' (p. 99–100), has described volcanic dust from southern Nebraska. Dr. M. E. Wadsworth (*Science*, vi. p. 63) describes similar material from south-east of the Black Hills in Dakota; and Prof. J. E. Todd discovered, in 1885, in eastern and north eastern Nebraska, beds of siliceous material, which were identified by Mr. J. S. Diller as being composed largely of volcanic glass (*Science*, vii. p. 373). We find, therefore, that not only is there a resemblance in appearance and in the order of succession between the Loup Fork beds and the lacustrine strata of Montana, but that in both, volcanic dust or pumiceous glass enters largely into their composition; and it is suggested that future investigations may possibly lead to a determination of their age through the careful study of this volcanic material.

The fresh-water tertiary formations east of the Rocky Mountains, and even in the mountains, have been supposed to differ from those in the west (in Idaho, Nevada, and Oregon), where the accumulation of volcanic sediments in the old lake-basins has been recognized by Newberry, King, Russell, Gilbert, and

others. Will we not, therefore, have to cut down very materially the great length of time generally believed to have elapsed in this region from the beginning of this lacustrine period to the present time, when we find that a great portion of the sediment that once filled the lakes is due, not to the products of erosion, as has hitherto been supposed, but to repeated showers of volcanic dust? Again, do not these volcanic materials, which must have fallen in showers over a large extent of country,—accumulating in some cases in beds forty to ninety feet thick,—account for the perfect preservation of the vertebrate remains which characterize the formations in so many parts of the west; and is there not also suggested one possible cause for the extinction of some of the many groups of animals which have at present no descendants in this region, and whose only remains are the bony fragments found in these lacustrine deposits?

A. C. PEALE.

U. S. geological survey.

Carnivorous prairie dogs.—Carnivorous orioles.

The statement of R. W. Shufeldt that his pair of young prairie dogs took kindly to a meat diet (*Science*, viii. p. 102) attracted my attention and interest, for it recalled to my mind an experience of my own in the summer of 1838. Having a pair of the marmots at this moment under observation here, I determined to try them with a piece of raw beef, and the eagerness with which they *plunged* at it (for their avidity cannot be characterized by any milder word) was certainly something very astonishing. Their ordinary vegetable food they take *quietly*, but the beef seemed to set them frantic. They acted as though they were famishing,—they seized it so fiercely, fighting with one another for it, and hastening back to ask for more. And so it has continued. Their owner fears to feed them with it exclusively, but gives them more or less daily, and the contrast between their eagerness for the meat and their quiet consumption of vegetables is a very instructive lesson. Their stomachs, out on the plains, always hold vegetable contents and nothing else. This was doubtless the first piece of meat ever tasted by either of these. Whence this craving appetite?

The experience of 1838 to which I referred was this: That was in the earlier days of my 'natural history,' three years before my first ichthyological paper was written. I had taken three young Baltimore orioles from their nest, but feared that I should lose them, for they refused every variety of food I offered them. At that time I was collecting birds zealously, and was skinning several of them daily. As I was preparing a specimen, one of the young orioles was sitting on my table, very stupid indeed, head drawn in, not life enough to utter a sound, thoroughly dumpish. Without knowing why, I picked up a bit of the bird's flesh and offered it to him. To my great surprise he swallowed it on the instant, and roused himself at once. That one mouthful had done him so much good that he wanted more. I took him on my finger and fed him piece after piece, till his throat was swelled out like an over-fed chicken's crop, and I feared to give him more. He settled himself down with great satisfaction, and went to sleep. I fed his brother and sister in the same way; and from that time till they were fully grown they had not a mouthful of food except the flesh of the birds I was skinning. Their eagerness for the meat was extreme. They learned the bird-skinning business to perfection. As soon as they saw me prepared for work, they all gathered about the specimen, ravenous for meat, and I almost always commenced to skin my bird, with an oriole sitting on each hand, and one on the specimen itself, and with three little heads down over the abdomen, where the first cut was to be made (they knew the point well enough); and the instant I opened the skin, in went three bills, digging and tearing fiercely for their food, and continuing at it as I continued my work, till their appetites were satisfied.

I do not know that this fact concerning the Baltimore oriole has ever been reported. I recollect mentioning it to Mr. Audubon, but it was after his account of the species had been published.

W. O. AYRES.

New London, Conn., Aug. 11.

Flooding the Sahara.

In our own country an evaporation of two feet per year is a small figure, and twice that amount has been recorded in some cases; so that it would seem to be safe to assume that it would exceed the latter value in the north of Africa. Taking Mr. LeConte's figures (*Science*, vol. viii. p. 35), and an evaporation of *two* feet per year, and the cubic feet evaporated, on an area of 3,100 square miles would be $2 \times 864.-230 \times 10^5$ cubic feet $= 1{,}728{,}460 \times 10^5$ cubic feet per year. But the inflow, according to his assumptions, would be $1{,}262{,}277 \times 10^5$ cubic feet per year; so that at the rate of two feet of evaporation per year, the amount evaporated would be 1.3 times the amount of the inflow. In other words, at the rate of inflow assumed, the depression to be flooded would *never* be so far filled as to make a surface of 3,100 square miles; and if the evaporation be four feet per year, the inflow would necessarily be nearly three times that assumed by Mr. LeConte.

DE VOLSON WOOD.

Hoboken, Aug. 14.

Barometer exposure.

The discussions in *Science* relating to the effect of high winds upon the indications of a barometer in a room, have been highly interesting. I only desire at this time to present a few facts that bear upon the problem, and to correct a few misconceptions. No one that has attempted making a fire in a very cold room, on a very windy day, with a refractory chimney in the fore ground, can be easily convinced that there is much of a draft up a cold chimney, even with a hurricane. Even if there were such draft, the air must flow in through all the cracks, especially on the windward side, and equilibrium would thus be kept up. It should be noted also that the wind does not blow steadily, but rather in gusts; consequently there can be no such thing as a permanent lower pressure inside than outside a room, but a momentary depression by a gust would be relieved almost immediately by the lull.

This is shown beautifully by a barograph properly arranged. All references will be to a barograph inclosed in a tight glass case, such as has been adopted by Mr. Hough of Albany. The fluctuations are so rapid that they cannot be seen on a sheet carried at the rate of one to two inches per day, but only upon