oval lens lies close against the hypodermis, and can be strongly stained with haematoxylin. From the inner surface of the lens depend a cluster of prismatic cells, with nuclei in their bases, or ends away from the lens. These cells fill up the interior of the eye, and are enclosed in an envelope, which is fibrous, pigmented, and nucleated. The fibres probably are, in part at least, ramifications of the eye-nerve; the envelope is separated from the inner cells (so-called *glasskörper*) by a limiting membrane. These eyes conform, therefore, in their structure, with the known type of annelidan eyes. The three cephalic eyes are embedded in the brain. Their most remarkable peculiarity is the extension of the envelope of the eyes over the lenses, where it is much thickened. Each eye has three lenses (in P. pictus), but otherwise is similar in structure to the lateral eyes. Three pear-shaped vesicles lie beside the eyes: these Meyer believes to be probably otocysts. The digestive tract has five divisions: 1°, the mouth cavity, is a rather long cylindrical tube; 2°, the pharynx, extends in many windings and folds to the end of the fifth body-segment; it is quite muscular, and has numerous peculiar glands opening into it; these two parts appear to correspond to the fore-gut, while 3°, the oesophagus, seems rather a portion of the mid-gut, since it is lined with ciliated epithelium; 4°, the largest division or stomach proper, which has two ventrally placed glandular coeca at its anterior end; the coeca are lined with an epithelium composed of two distinct kinds of cylinder cells; the stomach has an external wall of fibrous and connective tissue, within which is a close network of large capillaries, which gradually becomes more and more irregular posteriorly; the epithelium over the capillaries is ciliated, but over each mesh there is a single cell, which extends down between the vessels, and itself forms a complete glandular bag, and represents a hitherto unknown type of cell-form; 5°, the end-gut, is very short. The vascular system is well developed, and is described in detail. A short account of the body cavity is given; the structure of the segmental organs was not elucidated. The sexual organs have been accurately described by Quatrefages and Claparède.

C. S. MINOT.

THE GLACIAL THEORY BEFORE THE PHILADELPHIA ACADEMY.

AT the meeting of the Academy of natural sciences of Philadelphia, Feb. 13, Prof. Angelo Heilprin, referring to the subject of glaciation, stated that in his opinion the vast ice-sheet which is generally supposed to have covered, during the great 'ice age,' a considerable portion of the northern region of the European and North American continents, could not have had its origin, as is maintained by most geologists, in a polar ice-cap; since it may be reasonably doubted whether any accumulation of snow and ice in the far north could ever have attained a magnitude (in height) sufficient to have propelled a glacier with an estimated thickness of several thousands of feet, to a distance of hundreds of miles, and up mountain-slopes to an elevation of five or six thousand feet.

The height of such snow-accumulation must necessarily depend upon two circumstances: 1°, the quantity of aqueous precipitation; and, 2°, the upper limit in the atmosphere to which clouds may attain. It is well known that as a rule clouds rise highest in the regions of highest temperatures, — the equatorial, — where the vapor absorption by the atmosphere is greatest; and, for a similar reason, higher in summer than in winter. The minimum rise will therefore take place in the polar regions, and necessarily during the polar winter. High (discharge) clouds in the extreme north are stated by arctic explorers to be a rarity, and hence precipitation in the form of snow must be restricted to a comparatively low atmospheric zone.

No great accumulation of snow can take place above this zone, which must consequently be of the height of the ice-cap. As a matter of fact, the officers of the late arctic expedition under Sir George Nares observed that the crests of the greater elevations were devoid of snow, and that in the winter-months there was altogether, even in the low lands, very little precipitation, heavy precipitation beginning only with the spring-months. The greatest snow-clad elevation in Greenland is Washington Land, supposed to be 6,000 feet, which gives origin to the great Humboldt glacier. Although this peak is completely buried in snow (of undetermined thickness), it may be safely doubted whether, unless with a warmer climate, snow of any great thickness could possibly accumulate on a summit of much greater height. If not, the elevation, in the opinion of the speaker, was entirely inadequate to account for the phenomenon of glacial propulsion southward to the extent required by geologists.

Prof. H. Carvill Lewis remarked, that, notwithstanding the difficulties in the way of a theoretical explanation, the fact of a great continuous glacier at the time of maximum glaciation seemed clearly indicated, at least in America, by the numerous observations recently made. He described the extent of the glacier in America, as indicated by its terminal moraine, and stated that the close similarity of its phenomena at distant portions of its southern edge indicated a continuous ice-sheet. The continuous motion of its upper portion is shown by the uniform direction of glacial striae upon elevated points. Thus the south-west direction of the striae upon the mountain-tops of northeastern Pennsylvania was identical with that upon the Overlook Mountain of the Catskills and that of the Laurentian of Canada. The striae at lower elevations conformed more or less to the valleys, and did not indicate the general movement of the ice. The thickness of the glacier increased northward, the rate of increase diminishing as its source is approached. This latter point has not heretofore been appreciated, although observed some time ago by Dr. Hayes in the case of the Greenland glacier.

Recent observations by the speaker in Pennsylvania had shown the glacier to be 800 feet thick at a point five miles north of its extreme southern edge, and 2,000 feet thick at a point eight miles from its edge, while it was only about 3,100 feet thick one hundred miles farther north-east, and about 5,000 feet thick three hundred miles back from its edge. The amount of erosion it caused upon rock surfaces was in some degree a measure of its thickness, being far greater in Canada, even upon the hard Laurentian granites of that region, than in Pennsylvania, where even soft rocks were but slightly eroded.

The present thickness of the glacier in central Greenland was considered, and the magnitude of certain icebergs detached from it given. A friend of the speaker had within a few months seen a floating iceberg near the coast of Newfoundland which stood 800 feet above the water by measurement, and may have been therefore nearly a mile in depth. Dr. Hayes saw an iceberg aground in water nearly half a mile deep.

That the great glacier flowed up steep inclines, was abundantly proven by recent observations of the speaker in Pennsylvania. He instanced the striae

covering the north flank of the Kittatinny Mountain; and a bowlder of limestone perched on the summit, which, within a distance of three miles, had been carried up eight hundred feet of vertical distance.

Referring to a paper recently published by Mr. W. J. McGee, who found difficulties similar to those of Professor Heilprin in the assumption of a polar ice-cap of great thickness, and who imagined the glacier to increase by additions to its outer rim, Professor Lewis held, that the single fact of the transportation by the glacier of far-travelled bowlders to its terminal moraine was a fatal objection to any such hypothesis. Nor did he believe that the hypothesis adopted by Professor Dana and others, of a great elevation of land in the north, was a probable one. The facts now in the possession of geologists do not indicate such a great and local upheaval as required by that hypothesis.

An explanation therefore must still be sought for the southward flow of a continuous ice-sheet, — a flow in some regions up-hill. The action of gravity was certainly not sufficient. Even in the case of the downward flow of the steeply inclined Swiss glaciers, it had been shown that gravity was more than counterbalanced by friction of the sides and bottom, and those glaciers moved by reason of an inherent moving power of the molecules of the ice. It was probable that a similar action occurred in the great continental glacier. He suggested, therefore, a hypothesis which, while preserving the unity of the glacier, as indicated by observed facts, neither assumed an unreasonable land-elevation in polar regions, nor required a thickness of ice so great as to be open to the objections of the last speaker. He suggested that the ice-cap flowed south simply because it flowed toward a source of heat. Such flow does not depend upon gravity, but would occur in a flat field of ice, or possibly even up a slight incline toward a warmer temperature. Upon this hypothesis the ice need not to have been more than a few times its present thickness in Greenland to account for all existing phenomena.

AN EARLY STATEMENT OF THE DEFLECTIVE EFFECT OF THE EARTH'S ROTATION.

A CORRECT knowledge of the deflective effect of the earth's rotation on the motion of bodies on its surface is generally accounted the result of studies made within the last twenty-five years. First in 1856, and more fully in 1859, Mr. William Ferrel of Nashville, Tenn., now of Washington, made the general statement, that, "in whatever direction a body moves on the surface of the earth, there is a force arising from the earth's rotation which deflects it to the right in the northern hemisphere, but to the left in the southern" (*Math. monthly*, 1859, i. 307); and gave, by a rigorous analytical treatment of the question, a quantitative measure of this force, showing that it depended on the sine of the latitude of the body, but not at all on the direction of its motion. A similar but less comprehensive result was arrived at about the same time by Babinet and others (*Comptes rendus*, xlix. 1859); and since then the subject has been treated by many writers, among whom may be mentioned Buff, Finger, Guldberg and Mohn, and Sprung. It has, however, also been disputed by some authors, as Bertrand and Benoni, who erroneously hold to the old idea, first suggested by Hadley (1735), and recalled (it would seem independently) by De Luc (1779), Dalton (1793), and Dove (1835), that the deflective effect is greatest on motions in the meridian and nothing on east-and-west lines; and this incorrect view is but slowly disappearing from the text-books in general use.

It is the object of this note to call attention to an early statement of the law of deflection, that has never, so far as I can learn, received due credit. In 1843 Mr. Charles Tracy, now of New York, read a paper 'On the rotary action of storms' before the Utica (N. Y.) society of natural history; this was published in the American journal of science (xlv. 1843, 65–72), and the paragraphs quoted below are taken from it. It will readily be perceived that this explanation is far in advance of Dove's; although it lacks the consideration of the effect of centrifugal force and of the preservation of areas, to be a full statement of the matter. Mr. Tracy thought, in accordance with Espy's theories, that there must exist "a qualified central tendency of the air, in both the general storms and the smaller tornadoes" (p. 67); and in order to develop a uniform rotary movement in these centripetal winds, he looked to "the forces generated by the earth's diurnal revolution" (p. 66). In every storm, "the incoming air may be regarded as a succession of rings taken off the surrounding atmosphere, and moving slowly at first, but swifter as they proceed towards the centre." In virtue of the law of deviation, every ring "begins to revolve when far from the centre, turns more and more as it draws near it, and finally as it gathers about the central spot all its forces are resolved into a simple whirl" (p. 69). The law of deviation is illustrated by appropriate figures for the two hemispheres, and is explained as follows. (Its *direct* application to the tornado and water-spout is probably incorrect, as Mr. Ferrel has shown.) "The relative motions of the parts of a small circular space on the earth's surface, by reason of the diurnal revolution, are precisely what they would be if the same circular space revolved upon an axis passing through its centre parallel to the axis of the globe. If such space be regarded as a plane revolving about such supposed axis, then the relative motions of its parts are the same as if the plane revolved about its centre upon an axis perpendicular to the plane itself; with this modification, that an entire revolution on the axis perpendicular to the plane would not be accomplished in twenty-four hours. Such plane daily performs such part of a full revolution about such perpendicular axis as the sine of the latitude of its centre is of radius. The plane itself — the field over which a storm or a tornado or a water-spout is forming — is in the condition of a whirling table. Hence the tendency to rotary action in every quarter of the storm is equal, and all the forces which propel the air toward the centre co-operate in harmony to cause the revolution" (p. 72). The special value of this statement lies in the proof that motions in all directions are deflected equally; but on account of the omissions above named only one-half of the total deflective force is accounted for. W. M. DAVIS.

LETTERS TO THE EDITOR.

'Mother of petre' and 'mother of vinegar.'

CHEMISTS were not a little interested a few years since by the discovery, first announced by Alexander Muller in Germany, and afterwards by Schloesing and Muntz in France, that the formation of saltpetre in nature, and of other nitric compounds as well, is in some way connected with the presence and action of a living 'ferment,' much in the same way that the formation of alcohol in the brew-house or distil-