movement on a slope of 4 to 5 degrees is 5·23 mm. per hour, or 125·1 mm. per day. Herr Seeland left the pegs and stones where they were, and laid down other marks for future measurements.

LIEUT. WISSMANN, who has already done so much good exploring work in the Congo region, started in November last on a fresh expedition, from Luluaburg, the station on the River Lulua, an affluent of the Kasai. Wissmann goes first to the junction of the Lubi with the Sankuru, the great southern tributary of the Congo. Thence he will endeavour to push northwards and explore the unknown country in which the Lulongo, the Chuapa, and the Lomami take their sources. He will then seek to reach Nyangwé, when he will make up his mind either to proceed northwards to the Muta Nzigé, or south to explore the Lanji, the Lukuga, and the Upper Lualaba.

THE paper at Monday's meeting of the Royal Geographical Society was by Mr. J. T. Wills, on the region between the Nile and the Congo. It was a summary of all that we know of the region, and places us in a position to appreciate the value of any exploring work which may be done by Mr. Stanley. It deals succinctly with all recent explorations of the Upper Nile region, and with the intervening country between that and the Middle Congo. The valuable work of Dr. Junker, as well as that of Emin Pasha, receives special prominence. Mr. Wills rightly dismisses the Shari hypothesis in connexion with the Welle-Makua, and insists on the identity of the Makua and Mobangi. The Mobangi is known to be a waterway not inferior to the main Congo for practical purposes; deep, never less than 600 yards wide, even in February, when the Kuta Makua certainly (and it too apparently) is at its lowest level; and navigable at all times from Stanley Pool 650 miles thence straight north-north-east to lat. 4° 20′ N. beyond the limit which the Congo State, by private treaty with Germany, has placed to its future "sphere of operations," and beyond the limits which the French will probably occupy if they win in their dispute with the Congo State as to which of the two shall not operate in the Mobangi basin. It is then found to turn sharply to the east, flowing from the east through a gap it has cut in a line of quartz and red clay hills 1000 feet high, hills which may be continuation of the hilly watershed between the Makua at Ali Kobo and the sources of the Ngala. One would expects rapids at such a place, but there is only a good current and some awkward rocks; after reconnoitering in a boat, Mr. Grenfell got the *Peace* through easily, in February. Where we know the Kuta Makua next, they are placid and colossal; the Shinko at Marra is still 90 yards wide, 20 to 35 feet deep in October, and only 1980 feet above the sea. The average fall thence to Stanley Pool (1070 feet above the sea) is by this only some 9 inches to the mile, and the main Congo appears to nearly maintain this slope up to Bangala, beyond the Mobangi mouth.

BIOLOGICAL NOTES

INJURIOUS FUNGI IN CALIFORNIA.—The following facts recorded by Prof. W. G. Farlow are not without interest in Europe: *Nicotiana glauca*, abundant in Mexico, attracts attention by its pleasing foliage and graceful habit; it is a native of Buenos Ayres, but is acclimatised in Mexico. Within the last few years it has escaped from cultivation in California, and is now a common weed by the roadsides. At San Diego Prof. Farlow noticed that the leaves were badly attacked by a fungus which formed large, grayish-black spots on both sides of the leaves. Examination proved it to be *Peronospora hyoscyami*, De Bary, which was first found on *Hyoscyamus niger*, L., in Europe, where it does not appear to be at all common. Since it is well known that the species of Peronospora attack different species of flowering plants which belong to the same natural order, it is much to be feared that the disease which now attacks *N. glauca* may sooner or later extend to the cultivated tobacco, which belongs to the same genus. If this were to happen, the injury to the tobacco would be very great, since, by causing large spots on the leaves to rot, they would become worthless for manufacturing purposes. The question of the possible spread of the disease is one of importance, for it would be a very serious thing if it were to reach the great tobacco-growing regions of States like Virginia.

FERTILISATION OF CASSIA MARILANDICA.—The relation of insects to flowers continues to be a question of profound interest, but Mr. Meehan thinks that the dependence of a plant on insect aid is rather an indication that, instead of any material aid to its race being gained, its race is nearly run; he thinks that the opposite assumption has been an injury to the study of the main questions on fertilisation, and that the statements of Darwin and Asa Gray do not warrant the generalisations that have been drawn from them. In *C. marilandica* the phenomena attending pollen-formation are curious and apparently little known. The stamens are arranged in different sets. There are three beneath the pistil—the two lateral ones are very strong and equal the pistil in length, the central one immediately beneath the pistil is as long as those on each side, but more slender. Immediately above the pistil are four stamens, with short stout filaments, the anthers being perfectly formed and nearly as long as in the lower set. Above are three petaloid stamens. All the stamens have long black anthers, full of pollen, but which seems never to burst the anther cases. The only opening is at the apex, and this opening is covered by a membrane—never opening except by insect agency. As soon as the flower expands it is freely visited by humble-bees, and, as their loaded thighs evidence, for the pollen. To collect this they alight on the anthers of the long and lower stamens, as on a platform, make an opening in the apex of each of the four shorter ones, and then rifle them of their contents. A mass of plants containing eighty-eight flower-stems was watched on July 30, and the same lot for an hour on August 6, but no attempt was seen to be made by the bees to get the pollen from the longer anthers, or to use them in any way but as a platform. It would be very difficult for the bees to stand anywhere so as to have power to pierce the apical membranes of the longer stamens. When the flowers matured, and the anthers were ready to fall, they were examined, the four short ones were empty sacs, the three lower ones were full of pollen. These latter served no visible object to the flower or its insect visitors. While, however, no pollen could be detected on the stigmatic surfaces, still three out of every twelve flowers yielded a pod, and panicles of flowers covered so as to prevent egress of insects, neither produced fruit nor did a single anther open at its apex. In this case it would appear as if the fertilisation depended on the accident of the extracted pollen escaping from the insect to the stigma, and yet to an ordinary observer this plant would seem one specially arranged for cross-fertilisation. (Proc. Acad. Nat. Sci. Phil. 1886, p. 314.)

VARIATIONS IN THE NERVE-SUPPLY OF THE LUMBRICALES MUSCLES IN THE HAND AND FOOT, WITH SOME OBSERVATIONS ON THE PERFORATING FLEXORS.—Dr. H. St. John Brooks has lately investigated the subject of the varieties in the nerve-supply of the lumbricales. He finds—(1) Discrepancies in the statements of English and Continental anatomists. All these writers appear to be in error about the normal or commonest arrangement of the nerves to these muscles in the foot, and they appear never to have noticed a *double* supply to the third lumbrical in the hand. (2) Varieties of innervation that the author has observed in man, with an account of the nerve-supply in the orang, gibbon, and macaque monkey. He has discovered nerves entering the deep surface of the second (or indicial) lumbrical muscle in both hand and foot; these nerves, he believes, have never before been described: the latter, however, has been seen by Prof. D. J. Cunningham in the foot of a negro, and is recorded by him in his notes (as yet unpublished) of the anatomy of the negro foot. The following statistical table is compiled from the author's notes:—

Table of Variations in the Innervation of Lumbrical Muscles

HAND

	Cases
First and second by median; third and fourth by deep ulnar	9
Third by median and deep ulnar (others as before) ...	6
Second and third by deep ulnar	1
First, second, and third by median (deep dissection not carried out)	2
Total	18

FOOT

First by internal plantar; second, third, and fourth by deep external plantar	8

In the orang, gibbon, and macaque, the second lumbrical of the foot was supplied as in the above table. (3) Prof. Cunningham (*Challenger* Reports, vol. xvi.) has shown that, in Thylacinus

and Cuscus, the lumbricals of the manus are all supplied on their superficial surface; a similar arrangement is found in the pes of the fox-bat; here, however, the deep external plantar also furnishes twigs to the two outer lumbricales. (4) It appears probable from these facts that the lumbricals were all originally supplied on their superficial surface: the deep nerve (ulnar in hand, external plantar in foot) is, on this hypothesis, gradually displacing the superficial (median; internal plantar). This invasion of the deep nerve has advanced further (in the case of the lumbricals) in the human foot than in the hand. The reverse is the case with the innervation of the short muscles of the pollex and hallux. (5) There is a general correspondence between the innervation of a particular lumbrical muscle and that belly of the long perforating flexor of which it is a part; this fact is best made out in the case of the first or indicial lumbrical of the hand and the indicial belly of the flexor perforans, which are both supplied by the median; it is also seen in the fourth lumbrical and the belly of the long flexor ending in the tendon to the little finger (both by ulnar); also in the third lumbrical and annular belly (both of which have typically a double nerve-supply). In the foot and leg this part of the investigation presents special difficulties, which have, however, in a measure been overcome by minute dissections of the posterior tibial nerve and its branches, conducted under water. (*Dublin University Reports.*)

ON CERTAIN MODERN DEVELOPMENTS OF GRAHAM'S IDEAS CONCERNING THE CONSTITUTION OF MATTER[1]

I.

THERE is a certain fitness in our selecting this place to do honour to-night to the memory of Thomas Graham. For was in the chemical laboratory of this Institution that Graham carried out, upwards of half a century ago, the experimental investigations which culminated in his memorable discovery of the law connecting the rate of movement of a gas with its density. This law, combined with that of Boyle, which connects the volume of a gas with its pressure, and with the law of Charles, which expresses the relations of the volumes of gases to heat, has done more to give precision to our knowledge of the constitution of matter than all the speculations of twenty centuries of schoolmen.

Graham was made Professor of Chemistry in the Andersonian Institution in 1830, and it was from here that he gave to the world his classical paper "On the Law of the Diffusion of Gases," read before the Royal Society of Edinburgh, December 19, 1831. I am fully conscious that my only claim to be regarded as worthy to pronounce this eulogium of Graham arises from the circumstance that I also have had the good fortune to hold the Lectureship of Chemistry in this place; and with forerunners like Birkbeck, Gregory, and Graham, I may well be proud of an honourable and distinguished ancestry. This association with the Andersonian Institution naturally quickened my interest in Graham and his works, and my frequent opportunities of conversation with the late Dr. James Young, of Kelly, who for so many years was its President, and who was, as we all know, also one of Graham's discoveries, and for a long time, both here and in London, one of his most trusted assistants, enabled me to learn much of Graham's personal character and mode of work. On the occasion of the gift of Brodie's fine statue of Graham to the city by Dr. Young it fell to my lot to prepare the short biographical notice of my distinguished predecessor, which, with other papers relating to the matter, is, I understand, deposited in the archives of your Corporation. And I may be pardoned, perhaps, for recalling with what mingled feelings of pride and trepidation I set myself to the execution of that task.

In the preface to the admirable reprint of Graham's papers which we also owe to the filial piety of Dr. Young, the late Dr. Angus Smith has indicated in precise and even luminous language Graham's position in that chain of thinkers which includes Leucippus, Lucretius, Newton, and Dalton. Indeed, of all Angus Smith's papers with which I am acquainted there is none, to my thinking, more charming than this little introductory essay of a dozen octavo pages, in which, with unwonted perspicacity, he has defined Graham's place in the history of speculative philosophy. Angus Smith has here crystallised out, as it were, the thoughts of a life-time of literary research and meditation. Probably, no man—certainly no contemporary of Graham's—was better fitted by knowledge and by sympathy to form a sound critical estimate of such a position than the biographer of John Dalton. Angus Smith's mind was simply steeped in the old Hellenic philosophy. To him even Kapila was more than a name, and the atomic systems of India matters of more than conjecture or of passing interest. There was much in Smith's intellectual nature to make such inquiries congenial to him. With all his leaning towards objective science he had a Highlander's love of the mystical and a Lowlander's passion for metaphysics. And yet nothing is more admirable than the manner in which, in this essay, these qualities and this wealth of learning are subordinated and held in check, and nothing more striking than the way in which, in a few graphic strokes, done with a master hand, lightly yet firmly, with a consciousness of power and a sense of restraint, Graham's place in the evolution of the atomic philosophy is set forth.

It is here claimed for Graham that he was a true descendant of the early Greeks, and that to him belonged as of right the mantle of Leucippus. Atoms and eternal motion were as much fixed articles of his creed as they were of that of Heraclitus. But with no one of the older Greeks was Graham's thought more in harmony than with that of Leucippus. He, with his wider knowledge of the so-called "elemental" forms of matter, and of the persistency with which the specific properties which we associate with our "elements" are retained, could yet share with the old Greek his conceptions of the essential oneness of matter. It was with Graham, as Smith says of Leucippus, that "the action of the atom as one substance taking various forms by combinations unlimited, was enough to account for all the phenomena of the world. By separation and union, with constant motion, all things could be done."

In one respect Graham's position as an atomist is unique: no man before him had dedicated his life to the study of atoms and atomic motion. These fundamental ideas are intertwined to make up, so to say, the silver thread which runs through the work of forty years. They were the dominant conceptions of his life. Even in his earliest paper, published when he was just twenty-one, in which he treats of the absorption of gases by liquids, we are able to detect in the phraseology employed that his mind had been already permeated by the notion of atomic movement. That he should be familiar, even at this time, with the conception of atoms in the Daltonian sense is hardly surprising when we remember that he had already come under the influence of Thomas Thomson, whose place in the history of science is probably that of the first great exponent of Dalton's theory of chemical combination. But the idea of motion was never with Dalton an integral part of his theory, nor, in so far as it was necessary as serving to explain the phenomena of chemical union, was it held by Thomson. And this is the more remarkable when we remember that Dalton had discovered for himself the fact of the molecular mobility of a gas, and that his first glimpses of the truth of his great law were obtained by the study of chemical combination among gases. Graham was doubtless cognisant, in a general way, of the speculations of the early Greeks, but there is no evidence in any of his writings, nor has anything been preserved in the reminiscences of his friends and contemporaries, to indicate that he was knowingly influenced by them.

This continuity of idea is indeed the most striking characteristic of Graham's labours; all his work seemed to centralise round this fundamental conception of atomic motion. "In all his work," says Smith, "we find him steadily thinking on the ultimate composition of bodies; he searches after it in following the molecules of gases when diffusing; these he watches as they flow into a vacuum or into other gases, and observes carefully as they pass through tubes, noting the effect of weight and of composition upon them in transpiration. He follows them as they enter into liquids and pass out, and as they are absorbed or dissolved by colloid bodies, such as caoutchouc: he attentively inquires if they are absorbed by metals in a similar manner, and finds the remotest analogies, which, by their boldness, compel one to stop reading and to think if they be really possible. He follows gases at last into metallic combination, and the lightest of them all he makes into a compound with one of the heavier metals, chasing it finally through various lurking-places until he brings it into an alloy and the form of a medal, and puts upon it the stamp of the Mint. Indeed he is scarcely satisfied even with this, and he finds in bodies from stellar places—in meteoric iron—this same metallic hydrogenium which he draws out from its long prison in the form of a gas. . . If we examine his work on Salts and on Solutions we have a similar train of thought. One

[1] The Triennial "Graham Lecture," given in the Hall of the Andersonian Institution, Glasgow, on March 16, by Prof. T. E. Thorpe, F.R.S.