

origins of the various methods; the physiologist from whom education has borrowed the historical principle says that "the history of the individual is a blurred recapitulation of the history of the race."

Too exact a recapitulation is wasteful of time and deadens the intellect. The recapitulation must be a blurred one; the barriers between the various branches of mathematics must be broken down, and the pupil given freedom to select for any problem whatever tool he finds most appropriate.

In Paper 16 Mr. Durell drives home this principle. The freedom to treat a problem by Euclid's method, by Descartes', or by Monge's, by the principle of duality or by that of continuity, gives to the pupil a breadth of view and to the subject a unity otherwise unattainable. It reduces the multitude of properties of geometrical figures to a small number of greater generalisations which the mind can carry without effort. And it effects a saving of time, which makes possible a much further advance in mathematics than is now customary.

Mr. Durell rightly reduces to small compass the Euclidean treatment of conics, but he retains conics as the chief material to which the various methods are to be applied. His course might be further improved by the substitution in some cases of other material, such as an occasional higher algebraic curve, a transcendental curve, or a surface.

#### *The Postulates of Geometry.*

Mr. Carson (Paper 15) pleads for more system in the treatment of elementary geometry, in order that the pupil may gain a better grasp of the subject and have time to pursue his studies further. Mr. Carson would assume as postulates all the geometrical properties which can be looked upon as "intuitive," and build a system of reasoned geometry upon these; a suggestion which deserves serious consideration. The elaboration of this idea must involve some preliminary discussion of the nature of intuition. Intuition varies greatly from individual to individual; that "things equal to the same thing are equal to one another" is not an intuition to every child (see Branford's "Principles of Mathematical Education"); and, on the other hand, to an occasional genius results are intuitive which involve prolonged investigation for the average mathematician. Intuitions depend upon experience, and differ according to the experience of the individual.

It will clearly be necessary to give precision to each particular property which is to be assumed as an intuition. One valuable method of giving such precision is strangely repugnant to Mr. Carson, I mean that of numerical illustration. This method has real value, not only for these intuitions, but also for ensuring the comprehension of a property of which the proof is to follow. Nevertheless, when worked out Mr. Carson's scheme would probably differ little from some courses now in use.

Mr. Carson's main thesis is that if the inclusion of mathematics in the school curriculum is to be upheld, its study must be justified as an end in itself, and not by any consideration of utility. This view is best judged by the conclusions to which it leads him. One such conclusion is that the study is essential for girls as well as for boys; perhaps if Miss Burstall's excellent discussion of that topic in a recent number of *The Mathematical Gazette* had been available at the time when Mr. Carson wrote this paper, he might have modified his views.

We have already referred to Mr. Carson's criterion of the content of the mathematical course—"mathematics for its own sake." To most of us beauty is closely connected with utility; there are on the high road of progress just as many and as lovely views

to be seen as in Mr. Carson's bypaths. For many of us, also, the high road provides bread and butter along with beauty; at the present day the view is all too prevalent that real work and beauty are incompatible.

But really Mr. Carson is barely half in earnest. He is constantly falling into some utilitarian justification for his teaching, and then pulling himself up short. And the programme he sketches is excellent, chiefly because he keeps so close to the concrete and to utility.

#### *Examinations.*

In recent years there has been much discussion of the value of literary examinations, some holding them to be the only true criterion of a pupil's ability, others holding them entirely harmful. The truth would appear to lie between these extremes. On the one hand, no literary examination can tell us much of the character of a boy, and there are subjects in which training is the great element, and knowledge so small an element that any attempt to examine would spoil the value of the subject. There are, on the other hand, many subjects in which examination has real value—provided it is properly conducted.

An examining body cannot escape the responsibility of influencing schools, whether for good or ill. If the examiner is ignorant of the schools his influence will be bad; he must in some way be put in close touch with the school. He must also not be a mere hack, but have a fresh interest in the subject and some knowledge of educational principles. With that granted, there is ground for hope that his influence on the schools will be good. Another thing of much value is difficult to get, namely, the criticism of the business man who has no expert knowledge of the subject but a real knowledge of the kind of boy he wants in his business. I remember Prof. Henrici's modest account of his early mathematical development as teacher in a technical college. The business committee wanted certain things done which seemed impossible to the young professor with his academic views. But he agreed to try, and speedily he concluded that the business men had been perfectly right.

Messrs. Macaulay and Greenstreet (Paper 14) discuss the scholarship examinations on which the universities select entrance scholars. The discussion concerns Cambridge chiefly, and the authors make a strong case for their view that the universities are not sufficiently acquainted with the conditions of the schools and that more weight should be attached to the opinions of the schoolmasters who prepare the boys for the examinations. The authors deserve all sympathy in their desire that pupils should not waste time in exploring bypaths and in the acquisition of excessive skill in manipulation, but should push on along the main road. Some of their suggestions, however, scarcely carry conviction. Consider, for instance, their disapproval of the graphical method in statics, a method of such value for giving a grasp of principle. Take, again, their view that a boy should sit still and watch his master draw algebraic graphs without drawing them himself.

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#### *BIOLOGICAL PAPERS FROM PRAGUE.*

PROF. HLAVA (Bull. Internat. Acad. Sci., Prague, xv. Ann.) has found, in the blood of children infected with measles, oval or rod-like bodies, which he regards as probably of protozoan nature. In a blood-smear from another infected child (who also exhibited severe anæmia due to the presence of numerous whip-worms in the intestine),



sickle-shaped bodies were present in the red corpuscles. These bodies could not be found in the blood of this child on the following day, but there occurred, in the plasma, ovoid bodies, which, according to Prof. Hlava, were similar to *Leishmania*. In the accompanying figure, however, only a single nucleus is shown in each cell, whereas two nuclei are present in *Leishmania*.

J. Hořejší (Bull. Internat. Acad. Sci., Prague, xv. Ann.) records observations on the symbiotic union of a cyanophycean alga (*Anabæna*) with the roots of *Cycas revoluta*. The alga, which enters a root through the lenticel-system, passes into the meristematic apical tissue, retarding the activity of the latter, inducing dichotomy and the eventual production upon the root of a coral-like outgrowth. The advantages to the two organisms concerned are probably mutual; the root derives from the alga its nitrogenous products, whereas the alga takes up from the root a certain part of its host's products of assimilation. In the same bulletin Dr. B. Némec traces the stages of degeneration of the nuclei in the cells which form the sieve-tubes in *Euphorbia*, *Ricinus*, &c.

The biology and physiology of a species of dodder (*Cuscuta gronowii*), parasitic on willows, have been investigated by Dr. K. Spisar (Bull. Internat. Acad. Sci., Prague, xv. Ann.). He found that seedlings would wind round organic or inorganic supports of varying thickness, the contact-stimulus being very strong, contact with a suspended thread being sufficient to bring about the reaction. The zone in which the response reaches its maximum is in or near the growing zone. During the formation of haustoria, which is not dependent either on light or on the want of food, growth ceases, and the circumnutation movements are lost, but reappear in two or three days. This dodder is not very fastidious in regard to its host, and may even be "parasitic" on itself. The tissues remaining in the haustorial zone, when the rest of the dodder has been torn off its host, give rise to adventitious buds, and thus regenerate the parasite. The purple-red colour depends on the influence of light; at any rate, it was soon lost in the dark. In the absence of a suitable food-plant the axis of the dodder (which is green in the seedling) does not assume the usual purple colour.

#### PALÆOLITHIC MAN IN NEW JERSEY.<sup>1</sup>

SINCE Dr. C. C. Abbott's discovery of Palæolithic implements in the river-deposits of Trenton, New Jersey, nearly forty years ago, the valley of the Delaware has continually attracted the attention of students of early man in North America. This region lies immediately south of the southern limit of the ice-sheet which extended over the greater part of the continent during the Glacial epoch, and it is covered by a thick stratum of boulder clay, with associated gravels, through which the existing rivers have cut their channels. The Trenton gravels occupy the valley excavated by the Delaware, and therefore represent a period later than that of the maximum glaciation, though their constitution suggests that they date back to a time before glacial conditions had completely passed away. Over the Trenton gravels are spread yellow sands and loam, which Dr. J. B. Woodworth regards as Post-glacial; and there is also a thin superficial covering of black soil. All these three deposits yield evidence of man, and for more than twenty years they have been systematically searched and studied by Mr. Ernest Volk. His work has been done under the general direction of Prof. F. W.

<sup>1</sup> "The Archaeology of the Delaware Valley." By Ernest Volk. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, vol. v. (Cambridge, Mass., 1911.)

Putnam, for the Peabody Museum of Harvard University, and an exhaustive, well-illustrated report of his results has now been published by the Museum.

From Mr. Volk's researches, it appears that all the remains found in the surface soil and the pits and graves dug through it are those of the Indians who were displaced by the first European settlers. Numerous human skeletons were obtained, most of them buried in a crouching posture, with the knees drawn up towards the body, as well shown in several photographs.

Traces of man in the underlying yellow sand and loam are rarer than in the black soil. Charcoal and pebbles broken by fire are found, but there is no pottery, and all the stone implements are of argillite. Some of the latter are obviously spear-heads, others are borers, and some are rudely made with a jagged cutting edge. Mr. Volk was fortunate enough to discover a few human skeletons undoubtedly of the same age, but the bones were too much decomposed for preservation, and merely showed that the people were strongly built.

Discoveries in the Trenton gravel, with its intercalated clays and sands, are still rarer. Mr. Volk notes chipped pieces of quartz and certain quartzite pebbles, which he regards as having been artificially broken. He also records fragments of a human cranium, and part of a human femur, which both he and Dr. A. Hrdlička consider to have been cut and worked by man. In the same deposits were found identifiable bones of the musk-ox and the elk.

Both Mr. Volk and the Peabody Museum are to be congratulated on the painstaking thoroughness of this interesting investigation, which it is to be hoped may be continued. In these days of overcrowded libraries, however, we must add a word of protest as to the undigested state in which the report is issued. It may be of moment to the Peabody Museum to know that Mr. Volk did not work on Sundays or Washington's birthday, and was continually interrupted by rain, snow, ill-health, and "errands in town"; but these and innumerable other trivialities lengthen the text to an inordinate extent, while a large proportion of the 125 plates might well have been omitted without detracting from the value of the volume.

A. S. W.

#### RHEINBERG'S MICRO-SPECTRA METHOD OF COLOUR PHOTOGRAPHY.

THE special features of the micro-spectra method of colour photography are, first, that by its means pictures absolutely faithful in colour, tone, and texture are obtainable by means purely optical without the intervention of any artificial colouring matter whatsoever, and, secondly, that it is a one-plate process involving nothing more than everyday black and white photography. A single negative is taken on a panchromatic plate, a lantern slide is made from it and placed in the position of the negative, white light is projected through the apparatus, and the picture after slight adjustment, flashes out in its true colours.

The theory of the process is a simple one. It consists in producing by optical means a surface composed of hundreds of complete but very narrow spectra, lying next to one another, the spectra being so close together as to render the individual colours indistinguishable to the unaided eye, so that the surface appears to be white. The photographic positive is used as a mask to block out or weaken those colours which are not wanted, the remainder combining to form the picture.

The surface, composed of these contiguous narrow spectra, is produced by allowing white light to fall