SCIENCE

FRIDAY, FEBRUARY 24, 1888.

WE CALLED ATTENTION a few weeks ago to the beginnings of a zoölogical garden at Washington. It now appears that plans for a similar undertaking have been in progress for some time in Boston, and are now made public in a correspondence between the park commissioners of that city and the Society of Natural History. Although only preliminary steps have yet been taken, the outcome appears to be that the park commissioners have agreed to place in reserve, and lease the society on a nominal rental for a long term of years, several pieces of land under their control, to be developed, under the auspices of the society, as natural-history gardens and aquaria, if the friends of the society will raise a fund of two hundred thousand dollars as a foundation for the enterprise. The society proposes to interest the general public in the matter by creating a new body of members, to be called 'garden members,' paying a certain annual sum for the support of the enterprise, and in return presumably receiving certain entrance privileges. In their reply to the proposal made by the Natural History Society, the park commissioners call attention to the peculiar situation of Boston, in that its territory is greatly divided by bodies of water and marsh, and its dry land by rocky ridges, causing the city to extend itself in a very irregular manner. This prevents the possibility of finding any one piece of land large enough for the proposed natural-history park, and leads the commissioners to suggest to the society the advisability of occupying several distinct pieces of land; so that the plan as developed includes a diversified but unwatered portion of Franklin Park, next the future pleasuring-ground of Boston, a section of the park below Jamaica Pond, and a salt-water basin, perhaps a quarter of a mile long, at City Point, South Boston. Such a division has never before, we believe, been attempted in a zoölogical garden, but, though obviously requiring a larger staff to operate it, has some advantages which should not be overlooked. It is thus possible to obtain for aquatic animals places specially suited to them, and to select ground of a very varied character for other parts of the garden without feeling dependent upon a great water-supply; while the establishment of the large marine aquaria at the very edge of the harbor has obvious advantages. Moreover, it brings all the citizens into near proximity to some part of the ground occupied. Another distinct feature in the plan is a most commendable one, though its advantages are not so apparent on financial as on educational grounds. The committee points out that the society has long developed its museum with the distinct purpose of making it auxiliary to the general scheme of education in the State, and within a recent time has given special attention to exhibiting the animals, plants, and minerals of New England, believing that its position as the leading natural-history society of this group of States imposes such a duty upon it. This same idea it would carry out in the proposed garden by making it in an especial way a reproduction of the true indigenous fauna of New England. For it is to be borne in mind, say the memorialists, "that with the increase of population, and the concomitant decrease of the indigenous wild animals; above all, with the modern excessive growth of city life, — the percentage of city children (and hence of all) who may ever hope to see, and still less to observe at their leisure, the living objects of their native State or country, is rapidly growing less. At the same time the importance of such observation and study, instead of decreasing in like proportion, is greatly enhanced. To the country boy it is of comparatively little moment whether he observes this bird or plant, or that, since he has usually definite ideas of all, drawn from frequent observation of many. But to the city lad it is of the utmost consequence that he shall be able to correct his less definite ideas — formed for the most part by hearsay, by books, or by pictures — by observation of the object itself." The enterprise now plainly depends on the public spirit of the citizens of Boston. It is the natural and proper outcome of the admirable park system of that city. The Natural History Society has had the plan in view for twenty years, and believes the time is now ripe for developing it. Surely no such scheme has ever been proposed in this country under more favorable circumstances, or with the promise of so powerful and substantial support. That the park commissioners perceive this, is evident from the readiness of their response to the application of the society's committee, and we shall look with confidence to a generous response from a city that has already done so much for science and education.

THE MOST IMPORTANT QUESTION discussed by the Department of Superintendence of the National Educational Association at its meeting at Washington last week was, 'How and to what extent can manual training be ingrafted in the public-school system?' It occupied the entire morning of the first day's session; and after the reading, by Mr. Charles H. Ham of Chicago, of a very thoughtful and eloquent paper, the discussion was taken up by a number of gentlemen, some of them the most prominent and influential educators of the country. Of all who participated in the discussion, only one, Mr. Marble of Worcester, — a gentleman whose idiosyncrasies on this subject we have lately criticised (*Science*, No. 257), — opposed manual training, he even going entirely beyond the limits of the question at issue in order to ventilate his views. The reports of the meeting which reach us go to prove that our previous judgment, that Mr. Marble knows nothing about manual training or the argument for it, was correct. We regret to understand, however, that at Washington he surpassed his previous efforts, and considerably exceeded the bounds of courtesy in his treatment of those who favor manual training. The consciousness that one stands alone in the wrong of so great a question as this, must be irritating, but it can hardly be offered as an excuse for the conduct in question. Argument by invective is becoming far too common in this country, and it is our duty to protest most emphatically against its introduction into educational discussions. The advance of a great educational movement is not to be checked by abusing either it or those who regard it with favor, and it was this abuse, without a line of argument, which made up Mr. Marble's fifty-minute harangue. President Butler, Dr. Belfield, and Mr. Newell very easily and briefly showed how entirely aside from the question it all was. The result of the discussion was the appointment of a committee of seven to draw up a course of study in manual training, and to report at the next meeting.

THE MISSISSIPPI PROBLEM.

THE improvement of the Mississippi River, on a large scale and systematic plan, enjoyed, from its inception to the last session of the Forty-eighth Congress, a most enthusiastic support. From the outset, the theories proposed as the basis of the work undertaken have been criticised and contested, but for a considerable time no opposition was directed to the constructions actually undertaken.

Happily all who had addressed themselves to the problem had been, so far as concerns the works in the bed of the river, substantially in accord as to the projects for the immediate application of the appropriations, while differing somewhat as to the reasons for

the work recommended, and still more as to the results to be expected of them. In such a state of affairs, the work could properly be continued; since the concurrent opinion of all as to the work to be done would probably be right, though of the discordant reasons and diverse expectations of individuals, some, of course, must be wrong.

At the beginning of the session above referred to, a strong and determined opposition developed to one of the principal features of the work proposed. It was stated that the revetment of caving banks was unnecessary and wasteful, since the object of that work, the cessation of caving, would result from the contraction-works, or those designed to concentrate the water over the shoals.

Some of the most active champions of the improvement and of the commission by which it was being carried on, announced the discovery that this commission had effected an insidious and dangerous change in its original plan, by virtue of which the objectionable feature of bank-revetment had been introduced or made more prominent. It is without the present line of argument to contest this statement, several refutations of which have appeared in print. The issue is now squarely made between revetment and anti-revetment theories, and must be met on its merits. It makes no difference, in the decision of the question, whether the Mississippi River Commission have changed front on it or not; except, perhaps, that if they have done so, it has been in the light of four years' experience, which in itself would be a strong argument in favor of their later views.

The two theories are so antagonistic that compromise is scarcely possible. The revetment or protection theory makes prevention of caving by means of this class of work one of the prime causes of the improved condition of the river: the anti-revetment theory predicts the cessation of caving as a result of the contraction-works. The one would stop the deterioration of the channel, and cut off one of the principal causes of impaired navigation, preliminary to or concurrent with the effort to improve the channel: the other would attempt to remove the effect, while leaving the cause in full operation.

The hypothesis on which the anti-revetment theory is based is very simple. It is assumed that the ability of flowing water to carry suspended sediment is directly proportional to its velocity; that at any given velocity it can carry a certain normal quantity, refuses more, and is not content with less; that if undercharged it takes up the deficit from the adjacent bed, producing scour and caving; if overcharged it drops the surplus on the spot, causing a fill. A corollary of this is, that if the channel can be so regulated that the velocity will be uniform throughout its whole extent, and always bear the proper ratio to the supply of sediment, there will be no scour or fill in the bed or on the banks of the stream; the sediment supplied by tributaries will be carried without loss or gain to the sea; the deterioration of the channel will cease; the bars, having been removed, cannot re-form; and the problem is solved.

As evidenced by their practice, engineers are overwhelmingly in favor of ideas the reverse of these. Many civil engineers have addressed themselves to the problem in the interest of individuals or corporations. No case is known where any of them have proposed any remedy for a caving bank, except a direct protection of some kind. When called upon to induce a scour along a bank, as in some cases of important landings, they have, strangely enough, successfully employed for that purpose the very means now proposed to prevent the same thing.

Such proponderance of professional opinion would be accepted in any question of law or medicine. In matters of engineering, however, the public demand not only that we shall be agreed, but that they shall be convinced. It is therefore necessary to further argue the question, and for the same reason the argument must be addressed, not to the profession alone, but to the public as well.

It is not proposed to test the hypothesis by any of the well-ascertained facts of the river's regimen. Thus no argument will be founded on the facts that by hypothesis the proportion of sediment should increase from the bottom to the surface, as does the velocity, whereas the increase is from surface to bottom; that the sediment should be greatest at the thread of swiftest water, and diminish toward either bank, as does the velocity, while, on the contrary, it is sensibly equal all the way across, and as often in excess on the slow as on the swift side; that a greater proportion of sediment should always be carried at a higher than at a lower stage, the reverse having been again and again observed; or that the rate of caving should be least when that proportion is greatest, which rarely or never happens. Nor will any attempt be made to weaken the force of this doctrine by pointing out any of the well-established causes of caving, such as outflow of ground-water, eddies, or whirls, and wash of wind or steamboat waves, which, being independent of the velocity, will survive any regulation of it which may be effected.

Inquiry will be made as to the applicability of this theory to the problem in consideration, or, in other words, whether the conditions under which the hypothesis is claimed to be effective can be produced in the Mississippi River. Should it be found that these conditions can be produced, the truth or falsity of the hypothesis could be quickly decided by trial. On the other hand, should it appear that the conditions precedent cannot be realized, the truth or falsity of the theory is immaterial.

The actual velocities or rates of current are, in the river's present state, any thing but uniform. Their distribution may be illustrated by the motion of the wheels of a cart driven over a crooked road. On a straight stretch, the wheels revolve with equal velocity. If a turn to the left be made, the right wheel is accelerated and the left retarded, and the reverse in case of a turn to the other side. If the curve be sufficiently short, the inside wheel stops; while, if still more abrupt, it must turn backward. Add to this that the top of each wheel moves faster than the bottom, and the motion of the water of the Mississippi and like streams is completely illustrated.

The channel of the Mississippi River is just such a road, and the relative velocity of its current at any point of its course may be readily predicated from the above analogy. The depth is always roughly proportional to the velocity. The highest velocity and greatest depths coincide on the concave sides of the bends, corresponding to the outside wheel on a curve, and it is here that the caving banks are found. On the convex side, deposits of sediment from the retarded currents are constantly being made, the accretions nearly, though not quite, keeping pace with the recession of the caving line opposite.

A word now as to the location and operation of the contraction-works, which are the means to be employed to bring about the required conditions. At every flood the river builds up its principal shoals, so that the bottom is as high as the surface of the water at the lowest stage. Low waters, such as now occur, would be impossible but for the fact that the river, in falling, cuts a channel for itself through these barriers. Were these natural channels suitable and sufficient for navigation, river improvement would be without its strongest claim to public support. They are unsuitable by reason of the uncertainty when and where they will form, and their frequent tortuousness. When they are deficient, it is usually by reason of a division of effort whereby two or more small channels are formed by an expenditure of the work which would suffice for a single one of sufficient size.

Above and on these shoals the contraction-works are to be placed. Their effect will be to localize and accelerate the natural channel cutting, but not to increase the amount of energy so expended. The amount of material scoured from the shoal nearly or quite equals each year the amount deposited on it. Otherwise the river would shut itself up. If so little as one per cent of the material deposited in a year on any shoal remained there permanently, the shoal would be raised perceptibly each year, and, within the recorded history of the river, should have become a dam as high as the banks, to turn the river out over the country. The regulated river, flowing through the contraction-works, can remove from the shoal each year but a small excess of material over what is deposited on it, and this for a limited period only: ultimately it can not, and by our hypothesis must not, carry away any excess.

It appears from the foregoing that the aggregate amount of material scoured from any shoal will not be sensibly changed by the contraction-works. The amount passing through in suspension cannot be affected at all: hence the total amount in suspension in the bend below will not differ. That the volume of water discharged will not be affected, it is scarcely necessary to argue. These two quantities unchanged, their quotient, which is the degree of satura-

tion, cannot be modified by the contraction-works: for their effect on the distribution of velocities in the bend below, it is only necessary to point to the portion of the river below Baton Rouge. Here the conditions prescribed for a regularized river obtain in greater perfection than can possibly be realized on the river above. Yet in this ideal stream the distribution of velocities follows the cart-wheel analogy as closely as anywhere else.

To sum up, the effect of the contraction-works on a shoal, upon the conditions existing in the bend below, is simply nothing, — nothing as to the distribution of velocities, and nothing as to the amount of sediment carried.

In the face of this conclusion, the changes required by our hypothesis, before it agrees to stop the caving, are quite discouraging. It asks nothing less than the complete reversal of present conditions. It requires that the restraint of a fundamental hydraulic law be removed, so that the water may move at the same velocity at bottom and surface. It demands that the rapid currents along the caving banks be checked, and the sluggish ones on the other side quickened; that sediment shall be deposited in places whence it is now removed, and removed from those where it is now deposited. These revolutions of the river's regimen, as results of works at a distant point, and which have, as has been shown, no effect upon the conditions to be changed, are severally and equally impossible. The greatest actual velocity will be found, as now, in front of the caving bank. If the lesser velocity at the contraction-works be sufficient to produce scour there, the greater velocity at the point of caving must also scour and the caving continue. If the velocity along the caving bank correspond to saturation, so as to prevent caving, the lesser velocity on the shoal must allow deposits, and navigation will be injured.

The disparity in velocities is utilized by steamboats, the down boats being assisted by the rapid currents in the bends, while the up boats take advantage of the slack water on the other side. Uniform motion all the way across would retard the former preceptibly, and the latter fifty per cent. It is now difficult to get up stream enough pieces to accommodate the down-stream traffic. With uniform motion, it would be impossible. Navigation will suffer by the most cautious bestowal of such benefits.

A more general view leads to the same result as the local one. Suppose the channel to have been regularized from Cairo to Baton Rouge as completely as it now is below the latter point. In this conduit, the water supplied by its tributaries is to flow under the conditions that it shall always have the normal charge of sediment due to the velocity, and that it shall neither erode the channel nor make any deposits therein. No sediment being derived from action on the bed, the supply must come entirely from the tributaries.

The tributaries differ widely in their turbidity. The Missouri is the largest silt contributor, furnishing much more than all the others together. After it, but still classed as muddy, come the small streams on the east side above Memphis, the Arkansas and the Red. The Ohio, St. Francis, White, and Yazoo are comparatively clear. If our regularized channel be adapted in size to carry Ohio water without scour or fill, deposits must result when the Missouri predominates. If the channel be such that Missouri water can be carried without loss or gain of sediment, scour and caving must be expected when the supply is mainly from the Ohio. If a mean be taken, the scour and fill will alternately occur, which is simply a relapse into the present difficulties. No natural adjustment by mixture is possible, since the streams named have drainage areas lying in widely different latitudes, and it is rarely that their rises or floods are co-incident.

Suppose, again, that the corrected channel just below Cairo is filled to a certain level with just the right mixture of Ohio and Missouri water, having the normal charge of sediment due to its velocity, and carrying it without loss or gain. A slight rise comes out of the Ohio. Bringing an insufficient supply of sediment, it reduces the degree of saturation in the trunk stream. In order that scour and caving may not begin, this addition of water must be accompanied by a decrease of velocity and a rise of surface. If the rise, on the other hand, comes from the Missouri, the case is reversed, and, in order to prevent deposits and shoals, the velocity must be increased without a corresponding rise in surface. To realize either set of conditions requires an inverse ratio between velocity and slope, which is a blow at the fundamental law of the universe, that of gravitation. These contradictory requirements are repeated all along the river's course. The Forked Deer, Obion, and Wolf Rivers must produce an effect on the main stream directly the reverse of the St. Francis; the Arkansas, of the White; and the Yazoo, of the Red. The velocity of the river must conform to the supply of sediment, or the hypothesis will be violated. The supply of sediment is fortuitous: hence chance must take the place of hydraulic laws in controlling the flow of the water.

There never has been a day in the known history of the river when caving was not in progress. The amount of sediment requisite to produce normal saturation and prevent caving must therefore be greater than the river has ever before carried. The demand is, that the river be made muddier, and kept so. How as to supply? Of the present contributions, a considerable part is to be cut off by the cessation of caving and scour, which are promised as results of the improvement. The tributaries remain; but of these, the only one worth considering, the Missouri, is already under improvement. The result of that improvement, if successful, will be a fixation of its bed, and a large reduction of its output of sediment. The maintenance of even the present supply of sediment in the trunk stream involves the degradation of the tributary. If the Mississippi is to be improved on such principles, the regulation of the Missouri must be stopped at once.

We see, that, while the demand for sediment is increased, the supply is largely reduced. A scheme of improvement, the vital feature of which is the production and maintenance of increased muddiness, promises as its results changes which must largely reduce the muddiness. Surely this is necromancy on a large scale.

The saturation hypothesis, whether true or false, and following it the anti-revetment theory and plan of improvement based thereon, must be entirely rejected so far as the Mississippi River is concerned; because the conditions under which it is claimed to act cannot be produced or maintained; because uniformity of velocity in any cross-section, or from one section to another, is impossible, either in natural or regulated channel; because the volume of water which controls the velocity, and the supply of sediment, the two factors which determine the saturation, are now practically independent, and in a regulated channel become absolutely so, thus making the combination of the two to produce normal saturation a matter of chance and not of law; finally and principally, because the hypothesis contradicts and defeats itself in that it requires an increased supply of sediment to produce results which, if realized, must make this supply a constantly decreasing quantity.

If the caving of banks is to be stopped, it must be done by means outside of the contraction-works, since the latter cannot produce the slightest diminution of caving. That they will greatly increase it, may be strongly argued both from theory and experience; but such is beyond the present purpose. SMITH S. LEACH.

MENTAL SCIENCE.

A Second Laura Bridgman.

THE recently issued report of the Perkins Institution for the Blind, where Laura Bridgman has spent fifty years of her life, adds another most interesting and promising record to the accounts of persons afflicted with this double infirmity. The number of persons deprived of both sight and hearing is larger than is commonly supposed, and gives no sanction to the common belief that the loss of one sense insures an unusually strong development of the others. From a psychological point of view, the value of such cases depends, first and chiefly, on the age at which the senses were lost, those cases being the most suggestive and valuable in which the loss is earliest; secondly, upon the degree of blindness and deafness, as well as the rapidity with which these senses lose their function, the most instructive inferences being deducible from cases in which the loss is total; and, thirdly, from the completeness and accuracy of the record of the person's capabilities and achievements at the various periods of life, and especially during early childhood. In all these respects the case of Laura Bridgman is a most phenomenal one. Her life-history is to the psychologist most fruitful of hints and suggestions, throwing clear light upon questions otherwise