will, in the course of time, come to us through the work of successive 'Balfour students.'

The sum already subscribed in England is more than sufficient to provide for the Balfour studentship: but a memorial to such a man and for such objects should be international; and we are glad to learn that a representative committee of American naturalists, with Mr. Alexander Agassiz at its head, is being organized for the purpose of obtaining subscriptions to the Balfour fund. Few scientific men in this country are in a position to contribute large sums; but we trust that all American biologists will give something, whether they be investigators, teachers, or students. A general subscription from naturalists on this side of the Atlantic would be a most graceful testimony to the esteem in which Balfour's character and work are held by us; and would at the same time express our approval of the idea to make the monument of an eminent scientist not a bronze or marble statue, but a permanent endowment for the advancement of knowledge.

REARING OYSTERS FROM ARTIFICIALLY IMPREGNATED EGGS.

DURING the past three years the writer has been engaged upon the investigation of this subject, with the view of reaching some practical results which would be available in the hands of oyster-culturists. Until last year his efforts under the auspices of the U.S. fish commission had been comparatively fruitless and unsatisfactory. In July and August last, in association with Col. M. McDonald, the experimental work was resumed at St. Jerome's Creek, St. Mary's County, Maryland. Col. McDonald devised a simple combination of glass apparatus, consisting of a series of jars connected together with rubber tubing, somewhat in the manner of a series of Wolff's bottles, with an open glass aquarium at a higher level as a feeder, or reservoir, while the last jar of the series discharged into a similar cylindrical aquarium standing on the floor. The sea-water introduced into this contrivance was carefully filtered through cotton-wool, to remove all sediment and foreign organisms. The circulation was maintained in this contrivance by baling the water from the lower into the upper aquarium; the water passing continually through the intervening series of jars, which were, in effect, simply enlarged portions of the siphon-tube passing from the upper to the lower aquarium. No difficulty was experienced in keeping the water in this apparatus fresh and sweet without renewal.

On the 23d of July a batch of oyster-eggs was introduced into this apparatus, impregnated by a method to be hereafter described. On the 24th, and just about twenty-four hours after impregnation had taken place, an inspection of the transparent sides of the jars and aquaria was made; and to our great surprise we found immense numbers of embryos with the valves of the larval shell covering the sides of the body, and adherent to the inner surfaces of the glass vessels. In some places upwards of twenty-five might have been counted to the square inch. Every available part of the surface of the vessels was, however, more or less affected by these affixed embryos. Some of the jars were then taken from the closed circuit, and a continuous current passed through them, which it was found did not dislodge the embryos; but in two to three days more it was found that most had died or been detached, even in the portion of the apparatus not affected by a continuous current of fresh sea-water. The gratifying result which we had anticipated at the beginning of our experiment was, however, not realized, except in so far as it determined that fixation of the embryos took place at an early period under favorable conditions, or in about twenty-four hours, and that they might be reared from artificially fertilized ova. Efforts to repeat our first successful experiment failed, owing, probably, to the high temperature then prevailing.

The next advance made was when the writer hit upon a physical test by means of which the sexes of the spawning adults can be instantly determined by the most ignorant person. It was found, that if the ova were squeezed from the ovary, and dropped into sea-water in a glass dish resting on a dark ground, they would break up into a distinctly granular cloud; while the milt would not so readily break up, but would tend to mix slowly with the water as a milky substance, the particles of which were not perceptible to the naked eye, and, if stirred about in the water, would not break up at once, but be drawn out into wisps and streaks resembling in miniature cirrus or mare's-tail clouds. This test was an infallible guide; so much so, that a pocket-lens was found to be of no advantage, as we had formerly supposed. We also found, that if the eggs did not separate at once, when dropped into the water, they were not so mature as they should be.

Another important improvement was also in-

troduced by the writer for extracting the eggs and milt from the adults for spawning purposes. This consisted in applying essentially the same method for the extraction of the eggs as is used in spawning fish artificially; thereby avoiding the admixture of foreign matters, and fragments of the other tissues of the animal, such as occurs when the ovary is cut out, and chopped up into fragments in water. A very little experience will enable a person to find the ovary or spermary on the sides of the body of the animal when one valve is removed. Removing the mantle below and in front of the heart-chamber, its principal ducts will be exposed; and these may be traced backwards on either side of the ventral process of the body-mass to below the muscle, where the process juts into the suprabranchial chamber with its apex reaching to the commencement of the cloaca. When the spawn is abundant, the ducts are usually gorged, and look like prominent veins distended with a creamy substance.

To remove the generative products without cutting or lacerating the reproductive organs, one should be provided with a medicine-dropper or short pipette with a curved tip and a compressible rubber bulb at top. With the curved point of the pipette, the ducts of the reproductive organ are gently and firmly stroked in the direction of the external opening from before backwards. This, if properly done, will force out the eggs or the milt in a stream from the genital opening of the same side; when the pipette may be applied to suck up the extruded spawn, and drop it into water without the admixture of any deleterious foreign matters whatever. If the soft parts of the oyster have been left attached to the one valve, which I have found to be most convenient in practice, the other side of the animal may be treated in the same way, as the reproductive organ has an opening on either side of the body. To do this the head end of the animal, next the hinge, is simply thrown back over the adductor, the mantle cut open, and the spawn pressed out of the ducts of the under side as before.

By the foregoing method, which is much neater and more cleanly than any other, the best spawn is obtained; and it is often possible to impregnate fully ninety per cent of the eggs taken. When eggs so treated are placed under the microscope, comparatively few injured ones will be observed; at any rate, the result will be vastly more satisfactory than if the animal is crushed or chopped up in order to get the spawn. Many billions of eggs might be fertilized in a day by this plan.

As a result of the experience with the fixation of the embryos resulting from the artificially fertilized eggs, as described at the outset, it was determined to investigate the mode of fixation to learn if there was any uniformity about it. I now believe that the fixation of the fry is accomplished by the border of the larval mantle, the existence of byssal organs being doubtful. The oldest larval shells of artificially reared embryos have the hinges of the valves truncated and without beaks or umbos; while the fry on the eve of conversion into spat has a distinct beak to each of its valves, which projects anteriorly beyond the hinge-line. The valves, at this time, are very ventricose, quite symmetrical, and similar to Pisidium in form, or in the most marked contrast, in respect of shape, with the irregularity of the older spat and adult.

When a large number of very young natural spat is examined on their attachments, it will be found, that in every case the apex of the umbo of both the valves of the larval shell are turned towards the left if the hinge end is directed towards the north. It is therefore clear, that when the young attach themselves, they do so constantly by one and invariably the same side. Upon examining spat which has just begun to form a shelly attachment, we find this to begin at the border of the larval shell, and to grow outwards; the hinge being continued for a time laterally or on a line with that of the larval shell. We may also note, that the distal free border of the lower valve is the only part of the fry shell which comes into direct contact with the object to which attachment occurs; and that the hinge end of the larval or fry shell is directed somewhat upwards, the line of junction of the valves having at first formed an angle of nearly thirty degrees with the plane of the surface to which fixation occurred. This condition of things is so invariable that it may be regarded as universally the case. How does the fixation occur? A byssus at most would only serve for temporary anchorage; and we find, that as soon as the first calcareous deposits are formed to build the asymmetrical valves of the spat, the lower valve of the latter is for the first time glued down by the conchioline or periostracum covering it externally, and that it often continues to be so affixed until it is nearly two inches in diameter. After this the lower valve of the spat becomes free, and the free margin of the shell begins to be bent upwards. The valves of the symmetrical fry are also laminar and homogeneous in microscopic structure; while the very first layers of

calcic carbonate deposited to form the spat shell are prismatic and of a wholly different microscopic appearance from that of the fry. The facts presented above prove beyond a doubt, that it is the mantle border of the fry which is the effective agent in achieving firm fixation, whatever may be the importance of a temporary or larval byssus.

This was an interesting and important point to determine, on account of its practical relation to the artificial rearing of the American oyster (Ostraea virginica). But with the foregoing comparatively meagre results we may say, that our success in the artificial culture has ended; and, were it not for the highly encouraging recent reports from France, our efforts might have rested here. The stimulus which has provoked the investigations recently undertaken abroad was, however, probably Dr. W. K. Brooks's success with the American oyster in 1879, and his demonstration of its unisexuality.

The remarkable success of M. Bouchon-Brandely in rearing spat from the artificially fertilized ova of O. angulata at Verdon in France, as reported in the *Annals and magazine of natural history* for October, 1882, and his still later reports to the minister of marine of France in the *Journal officiel de la république française*, are of the greatest moment as applied to practical oyster-culture. M. Brandely, after determining that O. angulata was unisexual like the American species, conceived the idea of rearing the spawn by artificial means. In order to do this, two adjoining oyster claires, or ponds, fed by the tides were arranged at Verdon; the one acting as a reservoir from which the fresh sea-water (brackish) was drawn through a tube, provided with a filter consisting of a sponge at either end, into the lower experimental claire. The water percolated out of the latter through a bed of fine sand; in this way the embryonized ova placed in this pond were kept from escaping. Fertilized eggs were then put into the experimental pond from day to day, while a number of collectors, or tiles, were at once submerged in the same. In somewhat more than a month, success had attended his experiments; and in the course of further experiment still greater success was attained when about four thousand spat had been found affixed to a single tile under circumstances which admitted of no doubt as to their having been the product of the artificially impregnated eggs placed in confinement in their vicinity. It was found, moreover, that the artificially fertilized eggs had actually developed into spat in the closed claire a month before any had made their appearance on the thousands of tiles placed on the natural banks in the Gironde.

From a personal investigation of the anatomy of O. angulata, we can affirm that it is remarkably similar to O. virginica in the structure of the generative organs, and that there is no reason why as great success should not attend the culture of that species by the same apparently very practicable means. It remains to be seen, however, what proportion of the artificially reared spat will reach the adult condition. With an abiding faith, however, in the final achievement of the solution of the question of the artificial culture of the American oyster, which will soon become a positive necessity to its culture, I think it not improbable that another season's work will conclude the required preliminary research, and realize for us all the success we could hope for.

J. A. Ryder.

THE MAPPEMONDE OF SEBASTIAN CABOT.

The library of Harvard College, in Gore Hall, has recently been enriched with a photographic facsimile of the large map of the world in the national library in Paris, known as the map of Sebastian Cabot. This interesting memorial was discovered in Germany about the year 1844, in the house of a Bavarian curate, and, through the good offices of M. de Martius, was in that year purchased for the Paris library. It is a large elliptical *mappemonde*, engraved on copper, 1 m. 48 cm. in width, 1 m. 11 cm. in height. Along each side of the map, that is to say, outside the circle, is a table 30 cm. in width; the first, on the left, inscribed at the head, Tabula Prima, and that on the right, Tabula Secunda. On these tables are seventeen *legendes*, or inscriptions, in duplicate, — that is to say, in Spanish and in Latin, — printed, and pasted on the map. Each legend in Latin immediately follows the Spanish original, and bears the same number. Besides these seventeen inscriptions, there are five others in Spanish which have no Latin *exemplairs*.

This ancient map, composed, as we shall see farther on, in the year 1544, while Cabot was yet living in Spain, contains geographical delineations of discoveries down to about that period. In representing the north-east coast of our continent, Newfoundland is laid down as a group of islands; and we easily recognize the river and bay of St. Lawrence,