fibre, which is undergoing fatty degeneration. At p. 217 he mentions rusty brown granular pigment in muscular fibrils, which have lost their striæ, and in the atrophied muscles of a stump after amputation.

I hope to resume the subject in some future number of the Microscopical Journal.

On the Actinophrys Sol. By J. Weston, Esq., H.E.I.C.

Having during the last two or three months met with a plentiful supply of *Actinophrys Sol*, and fortunately also a most unusual deficiency of professional calls upon my time, I have been enabled to pay these little creatures considerable attention, not, I hope, quite fruitlessly, since the description I am about to give of some of their peculiar habits will, I think, be novel.

I would premise, that as my knowledge of the microscope is in its infancy (something less than two years old), my observations will be confined mostly to *what I have actually seen* and shown to some of my friends, leaving deductions to older hands and abler heads.

I regret that I shall have to call in question the correctness of descriptions given by previous writers; but as I "pin my faith on no man's sleeve," and have rather a method of looking and thinking for myself, I shall fearlessly state what the instrument has revealed, much of which differs so materially from a Paper on the same creature in the 1st volume of the Journal, that I am led to imagine the writer and myself have been observing a different species.

In the first place, then, as there appears to be doubt about the existence of a valvular opening, I have had some thousands of these animalcules under my observation, and have never met with a specimen where the valve was absent. It is best distinguished when about the edge of the *seeming disc*, and so far as my observations go, is never still night nor day; being slowly, but without cessation, as it were, protruded, occupying from ten to seventy or eighty seconds in its development, and then, like the bursting of a vesicle, rapidly and totally subsiding; for an instant it has utterly disappeared, only to be again as gradually and as certainly reproduced. Should that side of the creature, where the valve is placed, be turned from the observer, *the effects* of the contraction are distinctly seen, although the valve itself is not, for at the instant of its burst-

ing and closure, some half-a-dozen or more of the tentacles, *situated on or about it*, which have been gradually thrust from their normal position by the act of its protrusion, now rapidly approach each other with a jerk-like motion, caused by the sudden bringing together of their bases.

With one-eighth of an inch objective I have been led to imagine the valve to be formed of a double layer of the external hyaloid membrane, the edges of which appear to adhere to each other tenaciously, notwithstanding the growing distension from within, until the force becomes so great that the lips, as they may be called, suddenly separate, apparently to give vent to some gaseous product, and at this moment there is, as I have stated, enough seen to induce the belief in the existence of a double lip-like valve, *perhaps the organ of respiration.* A rough sketch,* Pl. IX., fig. 6 *c.*, shows the valve distended. The power employed was two-thirds objective, and No. 2 eye-piece of Smith and Beck.

The mode of feeding in the *Actinophrys Sol* has not, I think, been accurately given. That the tentacles possess some other power than that of mere prehension appears to me evident, because nearly every creature of moderate, and sometimes immoderate size, which strikes against them, is at once, for a time, rendered immovable; when a Rotifer, in crossing the field with velocity, strikes against an object, the rotatory organ is frequently seen quickly to suspend its operation, the more particularly should its cilia strike the cilia of another animalcule; frequently no notice whatever appears to be taken of the shock, except a sudden change in its course; not so, however, with the victim to the *Actinophrys Sol*, on the instant of contact with whose tentacles it appears paralyzed.

In some cases the prisoner is held for some seconds on the exact spot where it struck, and then, without any visible means, becomes *attracted* towards the body of the *A. Sol*, gliding slowly down the tentacle until it is jammed between its base and a neighbouring one. In another instance (in the same creature) instead of the prisoner being arrested on or near the extremity of the tentacle at which it strikes, it is shot down to the base with extreme rapidity, to occupy the same position as in the former case. In a third it would seem as if the appetite of the *Actinophrys* were sated, or that the prisoner was not approved of, for after remaining stunned, sometimes for a few seconds, four or five, sometimes much longer, ciliary motion (of a Vorticella, for instance) is feebly commenced internally, not with sufficient energy to produce motion, but, as

* We are unable to obtain the assistance of an artist here, or the sketches should not have been *rough*.

if a return to vitality were being effected by struggles; shortly it is seen to glide off the tentacle (as if this appendage possessed the power both of appropriation and rejection), and frequently, with but little sign of recovered life, it slowly floats out of the field.

We have now arrived at the point where the intended food is fixed, the next process is as follows: from the margin of the body of the *Actinophrys* a thin pellucid membrane is projected, up the side of the creature destined for food, which proceeds rapidly, but almost imperceptibly, to surround one side of it; a similar membrane springs sometimes also from the *Actinophrys*, but more frequently from the tentacle on its other side; these amalgamate on the outer surface of the prisoner, which is thus enclosed in a sac, composed of what I take to be the extended outer vesicle of the *Actinophrys*. This vesicle gradually contracts, or rather seems to return by elasticity to its original position, and the food thus becomes pressed within the body, there to become digested.

Often before the engulphing was complete, I have seen the return of ciliary movement in the victim, which, when large, exhibits powerful efforts to free itself. This ciliary movement continues long after its total immersion in the body of its devourer, and ultimately ceases as its substance seems to be dissolved.

In no one instance have I ever seen that crossing of the tentacles described by Kolliker, as one of the means of preventing an escape, but, as I before said, I may have been watching a different species. In many instances I have seen half-a-dozen or more prisoners attracted to the tentacles of an individual, each gradually absorbed, and although thus busily occupied, *no cessation of the action of the valve takes place.* The *Actinophrys* itself appears as if possessed of the most complete stability; nothing seems to move it, a free Vorticella, almost as large as itself, or a Rotifer of equal dimensions, dashes against it, producing scarcely a sign of motion, although the force of the concussion would lead one to expect the little creature would be forcibly driven from its position. Does this stability arise from its *spherical figure*, and the hold thus given to it by the numerous tentacles arising from its entire periphery?

Fig. 6 *a* of the sketch is intended to show a *Chætonotus larus*, engulphed; *b*, *b*, *b*, three Rotifers fixed between the tentacles; *c*, the valve. Power used, 2-3rds objective, No. 2 eye-piece.

Fig. 7 *a* represents a large Vorticella, seized and surrounded

by the outer membrane, previous to being drawn into the body as food. Power used 1-8th objective, No. 1 eye-piece.

Fig. 3 is my best drawing with the camera lucida; which, bad as it is, will, I hope, show, *a*, *a*, two Vorticellæ enclosed within the vesicle. To obtain this, with my untrained manipulation of the camera, I had to raise the stand of the microscope a foot from the table. The power used was 2-3rds objective, and No. 2 eye-piece. A very few minutes sufficed to engulph these larger morsels.

With regard to the reproduction of the species, I can positively affirm that self-division is one mode, for I may say I have witnessed it a hundred times, and shown it to others. The first time it came under my observation was late in the afternoon, early in the month of August last; division had commenced before the object came into view, but in less than an hour it was complete. The observing of this act by a more experienced microscopist than myself would, I have little doubt, set at rest the question as to whether or no the envelope of the *Actinophrys Sol* was cellular. I watched this division proceed, as in fig. 4, which was sketched about half an hour after first seen. First was noticed a deep depression above and below, not far from the centre of the body; this, as it increased, threw the tentacles across each other, in a manner similar to that described by Kölliker, when in the act of enclosing an object of prey; this crossing, however, in the act of self-division would appear to be only the necessary consequence of the depressions alluded to in the sketch, and the position into which the outer membrane (in which the tentacles are inserted) is drawn. As division proceeded, the two animalcules steadily, but rather quickly, increased the distance between them, until the connecting medium was apparently a long membranous neck, which, to my unpractised eye, appeared composed first of four, then three, then two, irregular lines of cells (possessing no nuclei), which ultimately diminished into a single cord, composed of three simple cells, elongated like the links of a chain, this becoming gradually more attenuated, until the exact moment of its division could not be seen. All this latter portion of the process was rather rapidly performed, that is, from the first formation of the rows of cells, to the time of what I supposed to be the final separation, occupied only about a quarter of an hour.

At this time *only the margin* of each *Actinophrys* was left in the field, so rapidly had they receded from each other; so that, to watch further, I had to shift from one to the other; this, however, could only be done for a very short time, as they got out of an easy line of observation, which made it necessary

I should confine myself to one, and I selected the larger of the two. Attached to the side of this I could perceive two of the cells which had previously formed the connection, and on the loose edge of the outer was a floating faint line, the broken thread; this, together with the cells, gradually contracted towards the body, and only a few minutes were necessary to draw the whole into the body of the *Actinophrys*, which then appeared as perfect an animal as I had seen. During the whole of the process, the valve of each, situated at nearly opposite extremes, was in constant action, and each creature was busily employed seizing its food.

On the following morning I had several specimens in a cage, one of which I observed *slightly* indented on its opposite sides. I wrote to a microscopic friend to come to my bungalow (only about two hundred yards separated from his), but before despatching the note I took another look, and found division progressing so rapidly, that I fixed the cage and carried the instruments to him.

Precisely the same proceedings occurred that I have already described, except that the connecting chain, previous to separation, remained to the last, broader, consisting of five or six rows of cells. I have since had so many opportunities of witnessing the same circumstances, that I have written down self-division in the *Actinophrys Sol, as a fact.*

That other modes of multiplication occur is, also, I consider, undoubted, otherwise how are to be accounted for the clusters of them in their infancy, frequently met with so minute as to render a $\frac{1}{4}$ inch necessary to identify them positively; minute, however, as they are in this stage, the valve is still to be easily recognised when the eye has become accustomed to its motion.

With regard to the production of these clusters of young I have a curious occurrence to register. I have observed, and that by no means unfrequently, see fig. 5 *b*, *b*, a thin pellicle protruded from the edge of the *Actinophrys*, sometimes forming a single, large irregular-shaped sac, generally two, as in the figure, and in one instance, three. The first time this came under my observation I supposed the cover of the cage was pressing too hard upon the specimen, and was crushing it, for shortly both cells simultaneously burst at their outer margin, giving exit to a considerable mucous discharge, much resembling (only of less consistence), the discharge seen on the bursting of pollen; this discharge diffused itself gradually in the water of the cage, and steadily disappeared (in eight minutes) on dilution. Immediately after the bursting of these cells I was surprised to see them contract; this changed my opinion regarding the supposed pressure of the cover, and

I soon became satisfied it was a natural phenomenon, for with the same slow and steady motion by which all the food is drawn in, and in the same manner as the connecting medium of self-division, after separation, so were the burst cells drawn towards the *Actinophrys*, ultimately disappearing in its substance. I kept this creature under the microscope nearly the whole day, and watched it constantly, feeding it as in all other cases.

Naturally expectant of a repetition of this proceeding, I had soon the satisfaction of seeing it (for I had on some occasions thirty or forty specimens in the cage at once), and have watched the process as I have described upwards of a dozen times.

Does this emitted fluid contain the germ of future generations?

In Buffon's 'Histoire Naturelle' he says that nature gives to the *Actinophrys Sol* a mouth and an anus at opposite sides of the body. These I have never seen, nor anything that leads to a conclusion of their existing, for the food is admitted into the body exactly at the base of the tentacle against which it strikes; so also are the excrementitious portions of the food passed out at any spot where circumstances appear to force them. This latter process I have frequently seen; in one specimen twice, in less than half an hour, at different spots.

In watching the digestion of a Rotifer, it occurred to me to see a dark body, composed apparently of the case, remain for some hours in the same spot, and then gradually approach the side, as if for expulsion, but while waiting for this to take place, an opening in another part occurred, and excrement was voided in quantity; this voided matter lies amongst the base of the tentacles, while the opening through which it has passed closes, and then, with the same stealthy motion I have before described, it is apparently driven along the tentacles (as if by repulsion) beyond their extremities, finally disappearing in the surrounding medium.

I am aware that Pritchard gives the *Actinophrys Sol* "a flat, pancake form," p. 554, but this I look on as an error. If the cover of the cage in which the specimen is confined be gradually and dexterously raised a little, with a 2-3rd objective, and No. 2 eye-piece, the animalcule may be made to take a rolling motion, owing to the increased depth of water, and its spherical form distinctly traced; moreover, correct focussing with the higher powers will give the very points of the tentacles standing erect, which, by *focussing down*, may be traced to their bases, while, during the progress, the points

and sides of others come plainly into view with the *rising* of the globe.

With an 1-8th objective I can distinctly see granules in constant motion in the body of the *Actinophrys*, similar to those always found in the points of the *Closterium Lunula*. Apropos to this, a microscopic observer here remarked to me, a short time since, that these granules, in the hyaline globules at the points of the *C. Lunula*, are dependent for their position in the globule *on gravity*, being always found, when observed through the compound body, in *the upper portion* of the field. Repeated observations of my own confirm this, which has not, I think, been hitherto noticed.

In conclusion, I have much to regret that my attempted description of the actions of the *Actinophrys Sol* is sadly deficient in a most essential point, viz., the absence of any measurement of the objects. Microscopists are, as yet, but few and far between in India, and there is not a micrometer here; even the instruments furnished lately by Smith and Beck for the use of the Government hospitals are deficient in this essential, added to which is the distressing circumstance, that we are so far from the manufacturers that what could be procured in London in a few hours, or at most a few days, I have been waiting for with the greatest anxiety since October, 1854, in which month I sent an order for them.

Sept. 10th. Since writing the above I have had another case of self-division, which presented some novel circumstances.

I had been observing a specimen which was an unusually large one, when visitors interrupted me. At the end of an hour or so, on returning to my table, I found that division had proceeded almost to completion, for the two were each partly out of the field. I was using Smith and Beck's $\frac{1}{4}$ inch. For a time I observed them to become stationary, which is not usual at this stage, but I was greatly surprised presently; a *reflex action* commenced, and instead of separation, they rapidly approached each other by the contraction or elasticity of the neck or chain. Not only did they close upon each other, but the smaller specimen overlapped the larger with full one-third of its body, and thus they remained still for about two minutes, giving me hopes I should be able to confirm Kölliker's description of amalgamation; but here I was disappointed, for again they parted, the same chain appeared to elongate, and that so rapidly, that in about five minutes they were perfectly divided, and both out of the field.

Again I followed the larger specimen, because within it

could be seen a large green oval substance, approaching to the outer edge as if for expulsion. This occurred in about half an hour, but in a manner perfectly distinct from any I had before seen. In this case the egg-shaped substance, fully one-fourth as large as the *Actinophrys*, was pushed through the integuments, retaining its perfect figure, and giving to the whole object much of the form of a dumb-bell crystal, only that the one portion was smaller than the other. Suddenly, as if from distension, the envelope of the ejected substance burst, the ovoid figure was instantly dispelled, the greenish matter of which it consisted spread about similarly to the excrementitious ejections, and quickly disappeared.

Does this remarkable oval figure support the supposition of the cellular substance of the *A. Sol*?

In other words, was it a single cell distended with fæcal matter?

Was the conjunction of the two partially divided specimens accidental, or had it ought to do with gemmation?*

* The following letter accompanied the above interesting paper:—

" DEAR SIR, " *Bangalore, Sept.* 10, 1855.

" I hope you will find the enclosed worthy a place in the 'Journal.' It strikes me that we are yet in our earliest stages of knowledge of the *Actinophrys Sol*. Each specimen I look at shows me something more that I have seen before, and the difficulty of developing the cause of its motions appears to me greater the further I go. I have seen a specimen this morning fixed in a fork of the plant, as it were in an angle, thus *forcibly work itself out;* but by what means I could not distinguish. The valve was posterior in its progress; has this anything to do with it when under such fixed positions? In this case the body of the *Actinophrys* was forced forwards, so as to leave the tentacles as it were trailing behind against the sides of the angle out of which it forced itself. It has, at the moment of my writing, been four hours in an open space, feeding voraciously, but not moving. Indeed, it has not gone beyond the field of the $\frac{1}{4}$-inch, since it took up the position.

" I have a curiosity for a future occasion, in the shape of a Rotifer hitherto unknown, with a forked foot *and a tail*. I was fortunate in getting a brother officer to take a better sketch for me than I could do myself. I fancy it allied to *Hydatina*.

" If I can in any manner be of service in India, I shall be most happy.

" I remain, dear Sir, very truly yours,

" *To Dr. Lankester*, " J. WESTON."

&c. &c.