

PRESENT STATUS OF LONGITUDINAL DIVISION IN HYDRA

ROBERT L. ROUDABUSH

DEPARTMENT OF ZOÖLOGY AND ENTOMOLOGY, IOWA STATE COLLEGE, AMES, IOWA

Longitudinal division in *Hydra* has long been considered a method of reproduction, but it was admitted that it was rare in occurrence. The author wishes to point out works which show that the process is merely one of regulation and not of reproduction, and to substantiate this view with some of his own experience.

Several authors have described longitudinal division, Trembley (1744) probably being the first; but it should be noted that Baker, working at the same time as the Swiss priest, also noted this phenomenon. Jennings (1883) records a similar process as do also Koelitz (1909) and Ross (1914). These last three authors have merely described the process of division and have not entered greatly into discussion of it. Trembley noted that the division could be instigated by cutting the oral end of the animal.

Marshall (1882) found that if the anterior end of a hydra were partially split in two, each half became a distinct anterior end. The body then began to separate slowly into two parts, the division taking place at the angle between the two oral ends until the two parts became completely separated. King (1901) repeated the experiment in a large number of cases with practically the same result. The work of these men and others shows beyond a doubt that hydra can be stimulated to divide longitudinally.

Morgan, in his memorable book on regeneration, quotes von Kennel as asking the questions, "Can accidental injuries account for the result (viz. for the division in *Lumbriculus*, planarians, and starfish), since how few starfish are there with regenerating arms in comparison with the enormous number of uninjured individuals? Should we not rather look for the external stimuli that have initiated the process of self-division?"

Morgan gives his own opinion on the subject when he says, "Hydra appear rarely, if at all, to divide by a cross-division, and, although one or two cases of longitudinal division have been described, it is not improbable that they have been started by the accidental splitting of the oral end." More recently Hegner (1931) states that the longitudinal

division is the result of the animal's readjustment to release itself from an abnormal condition.

During the writer's recent work on regeneration (Roudabush, 1933), it was his privilege to make a series of observations which will lend some evidence toward the views of von Kennel, Morgan and Hegner. It was noted that during the process of turning hydra inside out, a number of individuals were torn at the anterior end, and since these were not useful for the problem then at hand, they were isolated in other culture dishes and examined at intervals to note just what would be the outcome of such injury. A large number of these injured specimens regenerated into normal individuals while a smaller percentage was found to develop two anterior ends and eventually complete the division. Thus a large number of dividing specimens was seen and all were begun by some injury inflicted on the anterior end. No notes were kept on these discarded animals, so no relationship can be definitely drawn between the number injured and the number showing division.

More recently a good stock of animals was secured for the purpose of obtaining a percentage relationship between those which showed division and those which did not. Both *Pelmatohydra oligactis* (Pallas) and *Hydra vulgaris* Pallas were used in this experiment. The animals were cut, or rather torn, through the mouth to a distance just posterior to the base of the tentacles. The distance was practically the same for every specimen so as to eliminate the possibility that some would have greater stimulus than others to divide. These animals, after having been cut, were placed in small dishes and examined daily until all the apparent injuries had healed. Those with two oral ends and slightly divided bodies were judged to show longitudinal division. These criteria were chosen merely because if such a condition were found in nature the specimen would be promptly judged to be undergoing division. The author realizes that some of these may never have completed the division either because of depression ensuing or because of the absorption of one of the anterior ends, but it still remains true that such specimens if found would have been considered to show division.

Sixteen and nine-tenths per cent of the animals treated as described showed the evidence of division. This percentage, doubtless, would have been much higher had the animals been torn farther down the body. (It should be noted that 11 per cent of the hydras which did not show division had an increase in the number of tentacles; most of them increasing only by one, but several by two.) This percentage may vary with hydras taken from different conditions because their ability to regenerate depends upon their past history. The fact that the percentage is low does not affect its significance.

The literature itself is evidence to the fact that longitudinal division occurs very rarely or at least it is rarely recorded. The facts discussed above show why this should be. If a number of hydras should happen to become injured at their anterior ends, only about 17 per cent of this number would regenerate two oral ends and undergo division. Of this 17 per cent, only a very few would ever fall into the hands of a scientific observer and so the number of records necessarily would be low. These records would also be lowered if the number of injured hydras were by any means kept low.

The foregoing statements are offered as an answer to von Kennel's first question. As to his second, let us consider how hydras could become injured in nature in such a manner as to cause division.

Since it is the mouth which is primarily involved, is it not conceivable that, should the animal attempt to take in pieces of food—worms or crustaceans—which are too large, this act would tear its mouth and thus instigate—at least in some cases—the division?

The author has seen such activity both in aquaria and in animals taken from their native pools. One case is of particular interest since it was watched through nearly the entire process.

While examining newly caught hydras one day, it was noted that one was attempting to swallow a worm which was nearly as large as the hydra itself. The worm, needless to say, was still struggling even though it was half inside the hydra. The worm was pushing against the side of the mouth of the hydra, as if in an effort to pry itself free. Other duties made it necessary to set these animals aside for a short time and when they were again observed the worm had in some manner released itself and in the process had split the hydra through the mouth. As the observation continued, the hydra developed two oral ends and showed typically longitudinal division as described above.

Since this answers von Kennel's question, and shows that the division can be caused by an external stimulus rather than by an internal condition, it is highly probable that it is a process of regeneration or regulation rather than one of reproduction.

SUMMARY

1. It is concluded that longitudinal division in *Hydra* is not a reproductive process but is one of regeneration.
2. Longitudinal division is stimulated by the tearing of the hydra's mouth.
3. About 17 per cent of those animals torn undergo division; the remainder merely heal the cut.

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Roudabush, Robert L. 1934. "PRESENT STATUS OF LONGITUDINAL DIVISION IN HYDRA." *The Biological bulletin* 66, 326–329.

<https://doi.org/10.2307/1537385>.

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