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ABRAHAM TREMBLEY, INFLUENCES ON HIS LIFE, AND HIS CONTRIBUTIONS TO BIOLOGY

BY

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(Compiled and edited by H.M. LENHOFF[1])
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The Trembleys were of French origin. The record begins with a direct ancestor of Abraham, one Hector Trembley, who lived at Charlier in Lyonnais in or about the XVth century. Hector's Grandson, Louis, founded the Genevese family. It was presumably to avoid persecution as a protestant that he left France, though his departure took place during the reign of Henry II, who at first gave support to the Reformation; the massacre of St. Bartholomew did not occur until 20 years later. Louis arrived in Geneva in 1552 . . . .

[THE ESCALADE]

[Because this symposium is timed to coincide with the annual celebration of the Escalade, a major event in the history of Geneva, and one which continues to be important to the Geneva Trembleys today, it seems appropriate to include Baker's account of the origins of this unique holiday.]

The most spectacular single event in the history of Geneva, the famous "Escalade", occurred exactly 50 years after the establishment of the Trembleys in Geneva, and one of them fought in the streets in defence of the city on the occasion. Ever since the thirteenth century the rulers of Savoy had threatened the independence of Geneva. Never did they come nearer to success than on the night of 11th/12th December 1602 (by the old Julian calendar). The Genevese had been assured that Savoy would scrupulously respect the treaty of peace between the two countries, but the forces of the Duke were assembled for a surprise attack by night. The blackened scaling-ladders, which may still be seen with other relics of the occasion at the Musée d'Art et

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[1] These excerpts are taken verbatim from *Abraham Trembley of Geneva* (1952), by the late John R. Baker, with permission of his widow, Mrs. Liena Baker, and the Edward Arnold & Co., London.

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d'Histoire at Geneva, were erected against the city wall with the utmost secrecy, at what is now the northern end of the Place Neuve, at the bottom of the Rampe de la Treille. The Savoyard soldiers, with blackened cuirasses, succeeded in entering the city unobserved. When the alarm was at last given, the citizens rushed half-clothed to the support of the guard. The assailants were outnumbered and their retreat cut off by a successful cannon-shot that broke the ladders. An attempt to force the near-by city-gate was foiled by a common soldier, who had the presence of mind to lower the portcullis in the nick of time. The Savoyards outside, fired upon by a volley of grape-shot from the walls, retreated in disorder. The city was saved.

On the 12th of December 1672, exactly seventy years afterwards to the day, the members of the Trembley family — now one of the largest in the city — met together and signed the following statement:—

"We, the undersigned, having assembled today in the house of Monsieur Pierre Trembley, to rejoice together at the happy deliverance that it pleased God to grant to our fathers and to this state against the enterprise of His Highness of Savoy, seventy years ago, and to render thanks to the Supreme Being, promise that so long as it shall please this Divine Goodness to allow us to live, we shall assemble every year, at about this date, at the house of one of us, to continue to render the same thanks to God and to rejoice with one another in our family, praying him to continue his blessings on our state and on our families; we promise also to educate our successors in this same determination as long as it shall please God to leave us in this world."

Two and three-quarters centuries have passed since then; many distinguished Trembleys, Abraham among them, have come and gone; and still every member of the family signs the pledge, and in December, whenever it is possible, they still assemble for the same purpose as their ancestors . . . .

[BIRTH OF ABRAHAM TREMBLEY]

On the 3rd of September . . . 1710, Abraham Trembley was born at Geneva . . . . (The date of his birth was unfortunately given as 1700 in Cuvier's *Histoire des sciences naturelles,* though in *Le règne animal* it is given correctly. The error has been repeated in nearly every book that mentions the date of Trembley's birth.) . . . .

[TREMBLEY'S EDUCATION]

[His father] intended that Abraham should enter the Church, and the young man studied at the Academy that had been founded by Calvin. Abraham's chief interest at this time was in mathematics, and he was fortunate in his teachers. By a curious arrangement the Chair in this subject was held by two men, Cramer and Calandrini, who

alternated in their professorial functions and were thus free during half their time to travel or improve their minds as they thought fit. On account of their affection for one another and their alternation in office, these two distinguished mathematicians and physicists were nicknamed Castor and Pollux. Abraham came chiefly under the influence of Calandrini. He addressed himself to the infinitesimal calculus and in 1731, at the age of 20 or 21, successfully defended his thesis on this subject.

Abraham now turned for a time to the study of theology, in preparation for his intended career; but his health was enfeebled by an attack of small-pox and he doubted whether he would have the physical strength necessary for the life of a minister of religion. He realized that his father had not sufficient wealth to provide indefinitely for himself as well as his two brothers and four sisters, and he therefore looked around for means of rendering himself independent. He decided to go to Holland as a tutor . . . .

[THE DUTCH CONNECTION]

It must have been his father's connexions with Holland that turned Abraham's mind in the direction of that country. On arrival there in 1733, at the age of 22, he took up the post of tutor in the family of Count Wassenaar; but circumstances of which we know nothing soon brought this employment to a close. The young man supported himself by giving lessons in belles-lettres and philosophy. His circumstances were for some years extremely hard, but he resolved on no account to return to Geneva to become a burden on his family . . . .

[COUNT BENTINCK AND SORGVLIET]

[Most] . . . influential on Trembley's career . . . was William Bentinck, whose father, a Dutchman, had acted as confidential adviser to William of Orange and was created Earl of Portland in the year of William's accession to the throne of Great Britain and Ireland. The Hon. William Bentinck — or Count Bentinck, for he held this title of the Holy Roman Empire — was the Earl's second son. He lived at The Hague with his younger brother, Charles. He was a Curator of the University of Leiden and it was probably in this capacity that he first met Trembley. He must have formed a very high opinion of the young man, for he determined to secure his services as tutor to his two boys, though the latter were as yet too young to receive instruction. Towards the end of 1736 Trembley was taken into Bentinck's household at the mansion of Sorgvliet, situated about a mile and a half from the centre of The Hague . . . . It is difficult to imagine Trembley's feelings in passing at a step from poverty to an environment of extreme magnificence . . . .

It was here that Trembley was to carry out his most famous scientific researches. His first residence, however, was not prolonged. Having no immediate need for a tutor to his own children, Bentinck permitted Trembley to go for a time into the service of the former's father-in-law, Count d'Aldembourg (or Aldenburg). The young man therefore left Holland in 1737 and spent nearly two years at Varel in Oldenburg, as tutor to the Count's nephew, the Prince of Hesse-Homburg . . . . It was at Varel, early in 1739, that Trembley began to undertake biological research. His mind was turned in this direction by reading the early volumes of Réaumur's *Mémoires pour servir à l'histoire des insectes.* He found here a scientific outlook that was in accord with his own character. Réaumur was one who observed accurately, described simply what he saw, and avoided hypothesis. Trembley was fascinated. Now, at the age of 28, he began to investigate nature for himself. . . .

Count Bentinck's two sons had now reached the age at which they needed a tutor, and Trembley was recalled from Varel. He re-entered Sorgvliet in October 1739 . . . . Apart from a couple of visits to London, this was to be his home for the next eight years — the years which, for science, were the most fertile of his life.

During the following spring he turned his attention once more to the animals of fresh water, and in June 1740 discovered the "polyp" that was to bring him fame . . . .

[THE RÉAUMUR, TREMBLEY, BONNET TRIO]

He had left at Geneva a relative, Charles Bonnet, with whom he corresponded. The exact relationship is uncertain, but Trembley regarded Bonnet as his cousin. The latter, 10 years his junior, was already in correspondence with Réaumur on biological subjects . . . . On 26th September 1740, Trembley wrote his first letter to Réaumur . . . . Thus started a correspondence of extraordinary interest that lasted for 17 years and only ended with Réaumur's death.

It is hardly possible to exaggerate the great French naturalist's influence on Trembley. He lavished help, encouragement, and affection upon him. It was nearly 9 years from the beginning of the correspondence when they first met, but this did not interfere with the establishment of a close friendship between the tutor and the famous scientist, 27 years his senior . . . .

"I am above all intent on following Réaumur." So Trembley wrote in his first letter to Bonnet from Sorgvliet. It was the key to his life. Réaumur, like Trembley, started his career as a mathematician. He passed on to become a physicist, a technologist in various useful arts, including metallurgy and ceramics, and a natural historian; in all these capacities he did work of outstanding importance. His biological researches seem to have been prompted by a reaction against the purely systematic approach to nature that occupies a good deal of space in the writings of Ray — against mere lists of species with descriptions of dead specimens attached. Réaumur wanted to know how animals

lived — what their habits were, how they nourished themselves, how they reproduced, developed, and underwent metamorphosis; he wanted to study them not only as they occurred in nature, but also under the conditions of controlled experiment. He was a student, in fact, of processes. If Trembley eventually surpassed him in this field of study, the older man had opened up that field and given him the utmost encouragement and support in its cultivation.

It was not only in this respect, however, but in another, still more important, that Trembley followed Réaumur. Modern science exists because there have been and still are men who find nature intrinsically interesting and therefore devote their lives to the study of it. So long as the outlook of investigators was purely practical — so long as botany was a mere aid to pharmacy — science was not yet born. Réaumur lived at the time when man was making one of the greatest advances he has ever made, by realizing that science must be studied independently of its practical applications, as a subject in its own right. More than any other man, perhaps, Réaumur revealed to the civilized world the intrinsic interest of the lower animals. His influence was profound. People began to take to the study of obscure organisms as a matter of course, simply on the ground that they were interesting. That spirit has been and remains the basis of scientific advance. The applications of science flourish because they no longer interfere with the free development of the fundamental knowledge on which they depend. Réaumur was a first-rate technologist, but he played an important rôle in the establishment of science as an independent entity. To Trembley it never occurred that science exists simply for the sake of its practical applications: if someone had persuaded him to believe that, he would have been sterile and biology would have suffered as a result. Had he lived a century sooner, his talents as an investigator would probably have found no outlet. The development of a scientific atmosphere, in which a Trembley could flourish, required the active participation of men endowed with very original minds and forceful personalities. Réaumur was one of these . . . .

Réaumur, Trembley and Bonnet form a distinctive trio in XVIIIth century biology. They were in continuous touch by correspondence, and Trembley and Bonnet were intimate friends. The two younger men owed almost everything to the French naturalist at the outset of their careers, and neither of them achieved distinction over so wide a field as he. Trembley, however, was the greatest of the three as an observer: his discoveries, though far less diverse, were more important than any made by Réaumur in biology . . . .

[TREMBLEY'S CONTRIBUTIONS]

To discuss Trembley's selection of problems in biology, his approach to them, and his technique, it is best to start by presenting his actual achievement in summary form. The following were his chief discoveries:—

He was the first serious student of the asexual reproduction of animals by budding, the first to prove by rigorous experiment that the process is in fact asexual, and the first to discover that budding of new individuals occurs in any animals other than hydra (in Polyzoa and Annelida).

He was the first to show that certain animals can be artificially multiplied by division, the first to make permanent grafts of animal tissues, and the first to make a single individual by grafting two animals together.

He discovered that Protozoa multiply by division, and form colonies when the division is not quite complete; he was the first to witness true cell-division (in the multiplication of a single-celled alga).

He described some of the salient physical characters of protoplasm, 101 years before Dujardin.

He was the first to describe the anatomy of the Polyzoan individual. The general recognition of the animal nature of Polyzoa and sessile coelenterates was largely due to him.

Beyond this he made a large number of lesser discoveries, all of which have been described in the earlier chapters of this book. It suffices here to recall his work on reproduction, colony-formation, and tube-building in rotifers, and his confirmation of Bonnet's proof of the reality of parthenogenesis. He was the discoverer of the following genera (in the sense that he was the first to publish descriptions of species belonging to them):— *Stentor, Epistylis, Zoothamnium, Chlorohydra, Lophopus.*

It has been said already in the earlier chapters, and it must be said again now, that it was not possible in Trembley's time for him or anyone else to recognize the full significance of some of his discoveries. When he discovered that Protozoa multiply by division, no one had yet attempted to separate these animals into a single group with that name. When he discovered cell-division in *Synedra,* no one yet knew that *Synedra* represented a cell. When he described the physical characteristics of the protoplasm of hydra, neither he nor anyone else had yet guessed that there might be a fundamental living substance that occurred in all organisms. When he exposed the animal nature of Polyzoa and sessile coelenterates, he did not fully understand — or at any rate did not stress — the wide separation of these two groups. The full significance of his other discoveries was, however, apparent in his own time.

[TREMBLEY'S APPROACHES TO THE STUDY OF LIVING ORGANISMS]

A list of his discoveries shows at once that he was above all a student of *processes.* The only large exception to this was his investigation of the anatomy of *Lophopus.* In the rest of his work he was nearly always watching and recording the unfolding of events with the passage of time: his outlook was essentially dynamic. In concentrating mainly on the organisms of fresh water he was probably influenced partly by the knowledge

that these were less well known than terrestrial ones, and partly by their ready availability in the ditches, fish-ponds and rivulet of Sorgvliet. It was particularly characteristic of him that he focused his attention with immense energy on a limited field at any one time. He recognized, however, the advantages of studying corresponding processes in different species. "I find", he wrote, "that the Experiments I make upon Insects of one Species, facilitate in several respects those I have to make upon others; and that these last often throw a new light upon Observations and Experiments already made". In the selection of his field of study he was prepared to let chance play its proper part. He had nothing of the dilettante in him; but when he saw that chance had presented him with a problem of particular interest, he switched over to its investigation, and planned the necessary observations and experiments with thoroughness. The planning of his experiments on regeneration in hydra will serve as a model for all time. In this, as in so many of his investigations, he had very little indeed in the work of others to serve as a guide, yet he made nearly every experiment that could give interesting results: the only important exception is that he did not investigate the reversal of polarity.

Trembley has sometimes been called the father of experimental zoology, but it seems unlikely that he would have approved of this name, or even understood what it was intended to convey. It never entered his head that there might be a particular branch or subdivision of zoology to which the experimental approach was restricted: he used experiments as a matter of course whenever they would help to solve the particular problem that he had set himself, but he had no intention to divide the science in an arbitrary way on the basis of the methods of investigation adopted.

[INSTRUMENTS AND TECHNIQUES]

He had no inclination towards elaborate instruments. He used a hand-lens and a simple microscope; the latter consisted of a single lens of short focus held in a jointed support. It is true that in one place, in describing his study of vorticellids, he refers to the "lenses" of the microscope, but nowhere in his writings is there any definite statement that he used the compound instrument.

In his work on hydra Trembley used some very novel techniques. One was vital dyeing, a method that had never previously been tried; another was a curious kind of injection-technique, in which the colouring-matter (a partly digested *Polycelis*) was forced through the cavities of the body by means of the muscular movements of the animal itself . . . . It was by this method that he proved the hollowness of the tentacles and the continuity of their cavities with the "stomach" or main coelenteron. Injection had already been used in biological microtechnique by the Dutch anatomist Ruysch, who used it in a manner that more nearly resembles the modern techniques . . . .

[ACCURACY, THE HALLMARK OF TREMBLEY'S WORK]

The accuracy of his observations is perhaps the most striking feature of Trembley's work. One can read his writings today not simply for their historical interest, but to get reliable information: the student can learn biology and the history of biology at the same time. There is only one class of readers that will be disappointed — those who like to read old works of natural history for the pleasure of laughing at the errors contained in them. For in Trembley's publications on his discoveries in biology there are very few errors; so few indeed, that a complete list of [those errors regarding hydra] (apart from absolute trivialities) will be given here:—

(1) He thought that the tentacles might act as suckers by developing temporary dimples.

(2) He seems to have thought that the aperture at the base of the body is a relic of its attachment to the parent.

(3) He did not clearly express the existence of the two *layers* in the body-wall that are nowadays called ectoderm and endoderm, though he knew that the two *surfaces* were different in structure.

(4) He did not distinguish clearly between the nematocysts of the ectoderm and the carotene granules of the endoderm.

(5) He thought that the carotene granules are permanent. (They are nowadays said to disappear on prolonged starvation.)

(6) He seems to have thought that all the food that is absorbed passes into the carotene granules.

(7) He was inclined to think that the development of what we now know to be testes might represent a disease.

(8) He considered that after "reversal" or snipping into small fragments, the outer surface of the body could take on the function of the inner, and *vice versa* . . . .

[RESEARCHES ON OTHER ANIMALS]

"With regard to the polyps with horns [hydra], I could say quite bodly, 'See'. With regard to those in the form of bouquets and funnels [colonial vorticellids and *Stentor*], it is important that I should be able to say, 'Monsieur de Réaumur has seen'." So wrote Trembley in the year after the publication of his *Mémoires.* There can be no doubt of the justice of the sentiment expressed, for most of the researches that he had been carrying out on other animals were more difficult technically, and therefore harder to confirm, than those on hydra.

Although his study of hydra is better known, it is arguable that some of the other researches undertaken at Sorgvliet during the years 1741 to 1746 were even more important. He devoted himself to the microscopical animals of fresh water. It is characteristic of him that he studied a few species only, in detail. These species were the following:—

CILIATA
- *Stentor* spp.
- *Epistylis anastatica*
- *Carchesium polypinum*
- *Zoothamnium arbuscula*

ROTIFERA
- *Sinantherina socialis*
- *Floscularia ringens*

POLYZOA
- *Lophopus crystallinus*

OLIGOCHAETA
- *Stylaria* sp.

Trembley's discoveries may be briefly summarized as follows:—

CILIATA. — He discovered multiplication and colony-formation by division. The multiplication of Protozoa had never previously been described. (It must, however, be borne in mind that almost exactly a century was to elapse before these organisms were to be separated off as an independent group and given the name Protozoa.)

ROTIFERA. — He discovered the remarkable process of colony-formation in *Sinantherina.* His work on the reproduction of this animal was far ahead of his time. He also studied the curious process of tube-building by *Floscularia.* It is an extraordinary fact that his contributions to the study of rotifers have been entirely overlooked by the authorities . . . .

POLYZOA. — He discovered the Phylactolaemata and was the first to describe the anatomy of the individual in any Polyzoon. He was the first to describe reproduction by budding in this group. The realization that Polyzoa and sessile coelenterates are animals was largely due to his work on *Lophopus.*

OLIGOCHAETA. — He was the first to describe reproduction by budding in this group.

Until Trembley discovered reproduction by budding in Polyzoa and Oligochaeta, it had never been seen in any animal other than hydra . . . .

[TREMBLEY HONORED]

Trembley was elected a Fellow of the Royal Society on 19th May 1743, and was awarded its Copley Medal in the same year. The award was made "for his experiments on the Polypus"; it was announced by the President on 30th November. Trembley was undisturbed by the fame that had descended so suddenly upon him and preserved the simple modesty that was a fundamental part of his character . . . .

[TREMBLEY'S LEGACY]

It is not easy today to recapture the sense of utter amazement caused by Trembley's discoveries on hydra. Some people went so far as to announce that they would not believe the facts even if they saw them for themselves. "Apparently", wrote Trembley in a letter to Réaumur, "these gentlemen have some cherished system that they are frightened of disturbing." Even Réaumur, as we have seen, could scarcely believe his own eyes when he had performed the experiments for himself. He wrote to Trembley, "Sir, polyps are for you a stock of inexhaustible marvels: no insect has ever deserved better to be studied, and there will not be, or at least there has not been up till now, any insect that has been so well observed." Bonnet wrote to him, "The hydra of the poets is no longer anything in comparison with yours, and the hero who delivered the world of it had not, in my opinion, a juster claim to be celebrated, than the observer to whom we owe so many prodigies."

. . . Abraham Trembley [died] on 12th May 1784, at the age of 73 years.

POSTSCRIPT

The preceding short excerpts from John R. Baker's scholarly biography of Abraham Trembley, while giving a flavor of Abraham Trembley the man, and his contributions to biology, does justice neither to Dr. Baker nor to Abraham Trembley. Trembley's contributions, interests and influences extend far beyond his research on hydra, and Dr. Baker researches and writes elegantly about the multifaceted life of this eighteenth century renaissance man. Trembley was a philosopher and an educator. He was a tutor/companion to royalty of Holland and England. He became heavily involved in the politics of Geneva. In addition to his classic *Mémoires* on his researches on hydra, he wrote books on his system of educating children, on politics, on religion, and on moral philosophy. Hence, for you to get a taste of the breadth of interests and the stature of this important figure among eighteenth century biologists, I can but recommend that you read *Abraham Trembley of Geneva* (Edward Arnold & Co., London, 1952) by John R. Baker. The chapters are:

1. Background
2. Early Researches
3. Hydra: History of the Researches
4. Hydra: Structure and Movements: Relation to Environment: Feeding and Digestion
5. Hydra: Reproduction under Natural Conditions: Regeneration and Grafting
6. Researches on Other Animals, 1741-1746
7. A Decade of Travel, 1747-1757
8. Scientific Activities After 1757
9. Scientific Method
10. Education
11. Politics
12. Religion and Moral Philosophy