Arch. Sc. Genève	Vol. 38	Fasc. 3	pp. 335-344	1985

ABRAHAM TREMBLEY'S INFLUENCE ON THE DEVELOPMENT OF THE AQUATIC MICROSCOPE

BY

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INTRODUCTION

Any discussion touching on the history of scientific discoveries would not be complete without a consideration of the instruments employed in making those discoveries. In this article, therefore, I will: (1) point out the kinds of microscopes used by Abraham Trembley both in the period during which he made his classic discoveries on hydra, and afterwards; and (2) provide information which suggests that the aquatic microscope was developed in response to the excitement created by the announcement of Trembley's discoveries on the fresh-water hydra.

Let me begin, however, with my more general message, which is: the study of scientific ideas should go hand and hand with the study of scientific instruments. For what would scientists be without instruments? What would they do? Can you imagine Abraham Trembley without his microscope? Can you imagine science progressing without instruments?

We all are aware, for example, of how the invention of the telescope transformed astronomy, how the use of the barometer changed our ideas about the atmosphere, how the microscope has become indispensable for the study of the natural sciences, and so on and so on. The point I wish to make, however, is that the study of scientific instruments is requisite for a complete study of the history of science.

For us, curators of museums of science, instruments are extremely important. I am in complete agreement with my colleague, Dr. Gerard Turner, Curator at the Museum of the History of Science, Oxford, who wrote (Turner, 1980, p. 1):

> Some historians of science like to describe themselves as intellectual historians, seeing as their proper study the development of concepts in man's attempt to explain the material universe. I do not, of course, dispute the value of this study. What is unfortunate is the imbalance that I see in the history of science brought about through the failure to recognize the potential of the study of scientific instruments, which are, after all, ideas made brass.

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Thus, for my contribution to this symposium, I would like to provide the views of a museum curator on Trembley and the microscope in the hope that they will give the scientists and historians of science among you a more complete appreciation of the influence of Abraham Trembley on the advancement of the biological sciences.

MICROSCOPES OF ABRAHAM TREMBLEY

Although Trembley mentions using a magnifying glass (*loupe*) and a microscope a number of times in his *Mémoires* (Trembley, 1744a), he never gives us any details about those instruments. I am not aware of his having described the microscope that he used in any of his letters to Réaumur, Bonnet, Folkes, or others; perhaps further study of Trembley's letters may reveal such information.

The first time that Trembley describes a microscope in his published writings is in an article on colony formation in protozoa ("bouquet polyps") presented in English in the *Philosophical Transactions* of the Royal Society of London (Trembley, 1744b). Trembley says in the last paragraph of this article that he has "... hardly been able to observe any of the several facts above-mentioned without the assistance of the Microscope" and he describes succinctly the apparatus that he used at the time, but no illustration is given.

In the French version of Needham's book on the microscope (Needham, 1747), however, an illustration of Trembley's microscope (Figure 1) and a detailed legend for that figure are provided along with a translation back into French of Trembley's article that originally had appeared in the *Philosophical Transactions* of 1744 cited above.

The figure legend from the French version of Needham's book as rendered in English by John Baker (1952, pp. 172-173) is reprinted here:

> "Fig. 6 [Figure 1] represents the apparatus necessary for the easy and continuous observation of a bouquet-polyp. In the glass A is the end of a peacock's feather, *b, c, d,* bent at *c*; its extremities are held firmly against opposite sides of the glass through the elasticity of the feather. On one end of the feather a barb is left; this is long enough to allow the attachment at *d* of a stalk of aquatic horse-tail, on which is a polyp; the latter is very close to the side of the glass, so that one can observe it easily with a lens of short focus, such as *e.* This lens is screwed into a ring provided with an extension *f g* carrying at its extremity a ball, which fits into a socket and forms a knee-piece. There are also knee-pieces at *h* and *i.* By means of these one can move the lens in every direction and bring it conveniently near the object. The foot, *i k,* is sunk into the edge of the window-sill on which the glass stands. The daylight that enters by the window may suffice for the observation of the object in the glass by the naked eye or with the magnifying glass; but when one wishes to observe with a lens of short focus, it is necessary to shut out the daylight and put a candle behind the glass, with its flame at the height of the object. The lens can easily remain in front of the object for several consecutive days without being disturbed, so that in order to observe the progress of the polyp, one has only to set the candle behind the glass from time to time, and put the eye to the lens."

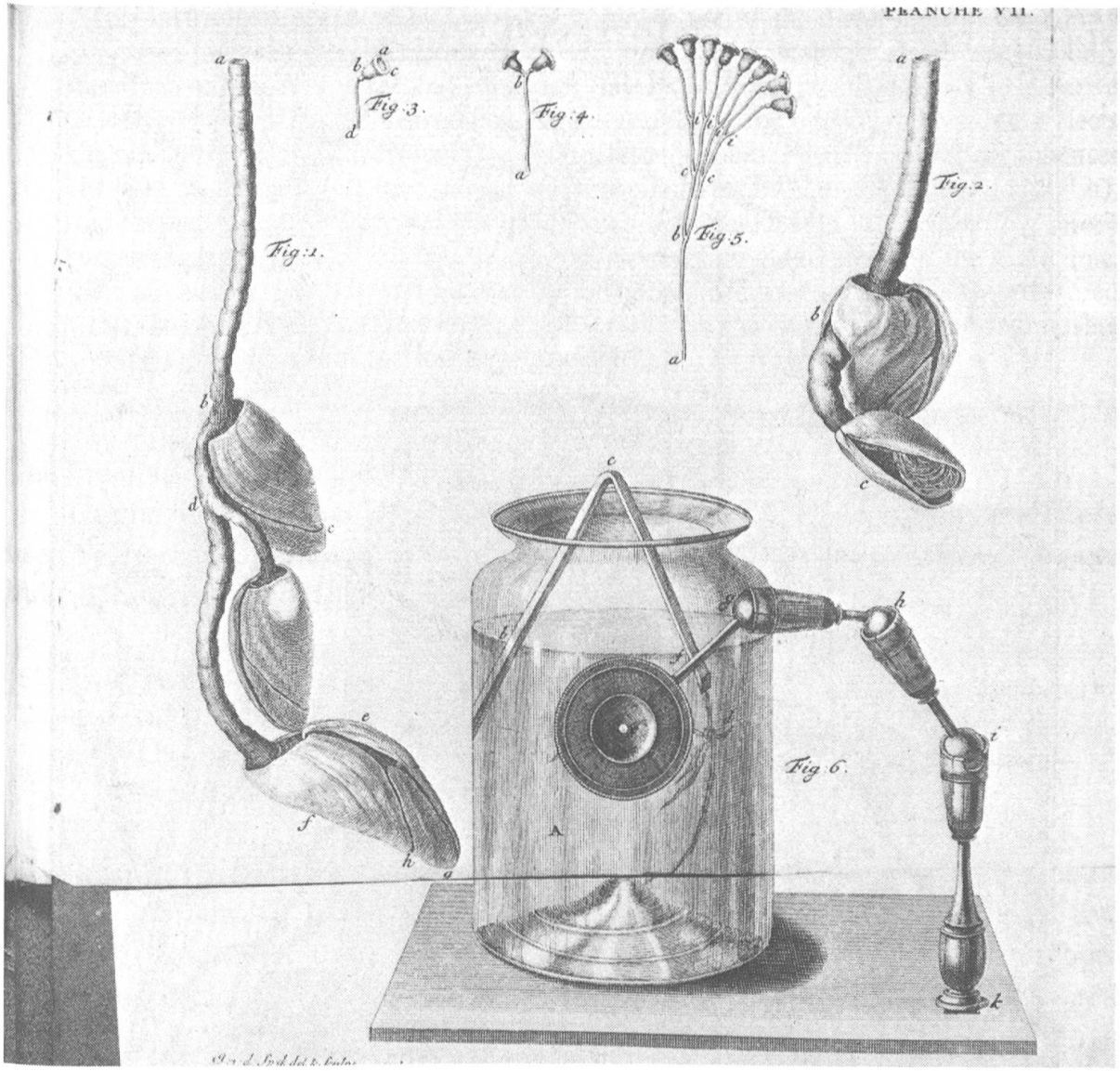

FIGURE 1. — The microscope used by Abraham Trembley in the study of the "bouquet polyps", as described in Needham (1747).

Another engraving of this same instrument, presented in Figure 2, is taken from the marvelous book by Ledermüller (Ledermüller, 1762-1763).

Still another version of the same figure, with some modifications, is also provided in the German translation of Trembley's *Mémoires* (Goeze, 1775), which also includes a compilation of several other of Trembley's scientific contributions.

This microscope for the study of the "bouquet polyps" is lost. Did Trembley use it while he made his classic discoveries on hydra? Perhaps yes, perhaps no; the question remains unanswered.

John Baker goes on to mention that Trembley also tried using a solar microscope for some of his studies on protozoans (Baker, 1952, pp. 173-174):

FIGURE 2. — The "bouquet polyps" microscope of Abraham Trembley as described in Ledermüller (1762-1763).

> "This instrument, invented by Lieberkühn, makes use of the direct light of the sun to project an image on to a screen in a darkened room. The improved form of it was carefully described and figured in the 2nd edition of Baker's *Microscope made easy* a year or two before Trembley tried the instrument. An adjustable mirror outside the window reflects the sunlight through an aperture in the shutter into the room. There is a lens that condenses the light on to the object (not too exactly, if the latter is alive, or the heat would kill it), and the image is thrown by a single lens of 1/2-inch focal length (or less) on to a screen placed far enough away to allow several people to observe the image at the same time. This instrument was not well adapted to Trembley's needs, since it could only be used while the sun was shining; and he regarded it rather as a means of producing an amusing spectacle than as a tool for scientific research".

The Trembley's solar microscope is also lost.

For the moment, what I have described is about what we know of the microscopes used by Trembley. We know much more, however, about the microscopes that were built because of the influence of his work.

INFLUENCE OF TREMBLEY'S WORK ON THE DEVELOPMENT OF THE AQUATIC MICROSCOPE

Most of the papers presented in the morning session of this symposium point out the importance of Trembley's work to the evolution of experimental biology. You should also know that it was of great importance to the evolution of the microscope. To fully appreciate this influence, we first have to look at the impact of Trembley's discoveries on the English scientific scene.

On the continent, Trembley's discoveries on the hydra were first presented to the Paris Academy of Sciences by Réaumur who received, in December 1740, some hydras sent by Trembley from Holland. They first appeared in print in the preface of the sixth volume of Réaumur's *Mémoires* on the insects (Réaumur, 1742). In this preface, Réaumur assure us that he repeated must of Trembley's experiments with the same results. In England, word of Trembley's findings was brought to the Royal Society via letters from Buffon and Bentinck, and were first published in the Society's *Transactions* in the form of a brief reference to the paper read before the Society on November 18, 1742 by J. F. Gronovius (Grovonius, 1742). As a footnote to the Gronovius communication, reference is made to the earlier letters, Buffon's on July 18, 1741 to Martin Folkes, and Bentinck's to Folkes of September 15, 1741; both mention Trembley's discovery of regeneration. The paper of Trembley himself (Trembley, 1743) was published in the *Transactions* in the beginning of 1743.

In this same year, 1743, Henry Baker published a book (Baker, 1743a) on Trembley's experiments on hydra and added a chapter on these experiments in the second

edition of his popular book *The Microscope Made Easy* (Baker, 1743b); this book ran into many editions, and was translated into Dutch and French.

In 1744, one year after Henry Baker, Trembley's classic *Mémoires* appeared, and in the following year, the Englishman T. Needham (Needham, 1745) published his book on new microscopical discoveries, which also mentions Trembley's discoveries on hydra. It was the French edition of Needham's book (Needham, 1747) that had an engraving of Trembley's microscope.

As John Baker wrote, "It is not easy today to recapture the sense of utter amazement caused by Trembley's discoveries on hydra (Baker, 1952, p. 43)." Even such contemporary literary greats as Fielding, Smollet, Goldsmith and Voltaire were aware of Trembley's discoveries, and commented upon them in their writings.

During this period there was no microscope built expressly for studies of aquatic organisms. The best microscope then available was the one made by John Cuff (1708-1772) of London under the instigation and the direction of Henry Baker (1698-1774).

This microscope made by John Cuff in 1743, had for the first time in the history of the microscope, a true stage but it was not an aquatic microscope in the sense that it was built, as the other microscopes of the time, for all kinds of observations. The first aquatic microscope (Figure 3), that is, one made expressly and solely for observing specimens contained in a liquid medium, appeared in 1752. This instrument was also made by John Cuff, but this time under the direction of John Ellis (1710-1776), who describes it in his book on the corallines (Ellis, 1755).

It is my contention that Ellis, who often mentions Trembley in his book, was greatly influenced by Trembley's work with aquatic creatures. Further, it was the result of Trembley's impact on Ellis and on other scientists in England, where microscopical studies on aquatic organisms had become very fashionable, that led Ellis to design the aquatic microscope.

To complete the story, this first aquatic microscope of Ellis and Cuff was shortly followed in 1758 by an improved model, again made by Cuff. This model (Figure 5) is shown in a engraving in a book by George Adams (Adams, 1771). We know that Abraham Trembley possessed one of these microscopes; it was donated to the University of Geneva in 1916 by his great grandson, Guillaume Trembley, and belongs now to the Musée d'Histoire des Sciences of Geneva (Figure 4).

In conclusion, the creation of the aquatic microscope is a fine example of the interaction between scientific ideas of the time and the construction of scientific instruments. As Gerard Turner wrote, "scientific instruments are, after all, ideas made brass."

ACKNOWLEDGEMENTS

I thank Ms. France Campbell and Professor Howard Lenhoff for their suggestions in translating my paper into English.

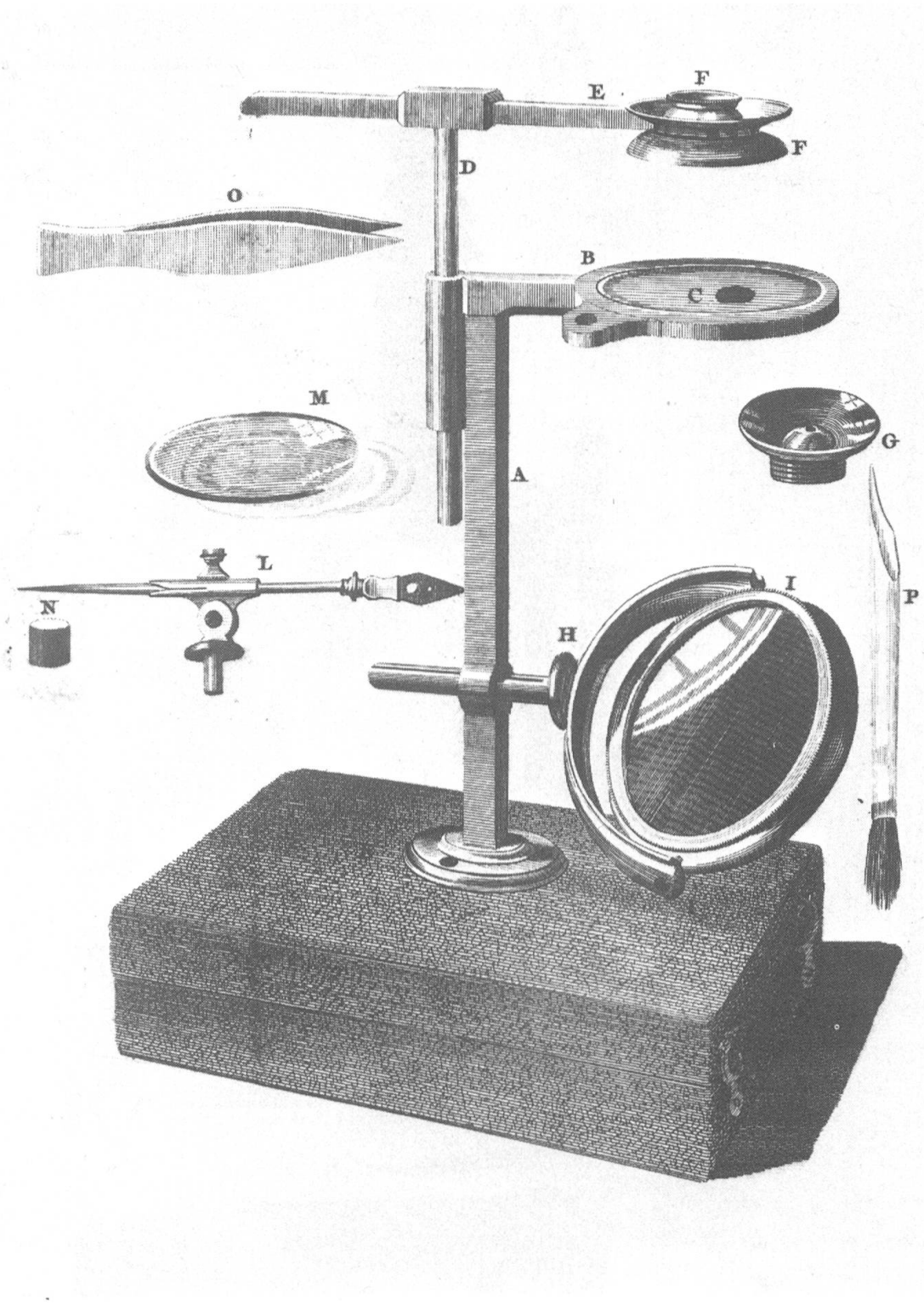

FIGURE 3. — The first aquatic microscope of Ellis and Cuff, as described by Ellis (1755).

FIGURE. 4. — The only microscope used by Trembley which has survived. It is signed "I. Cuff, Londini, Inv. & Fec." (Musée d'Histoire des Sciences, Geneva, inv. 10).

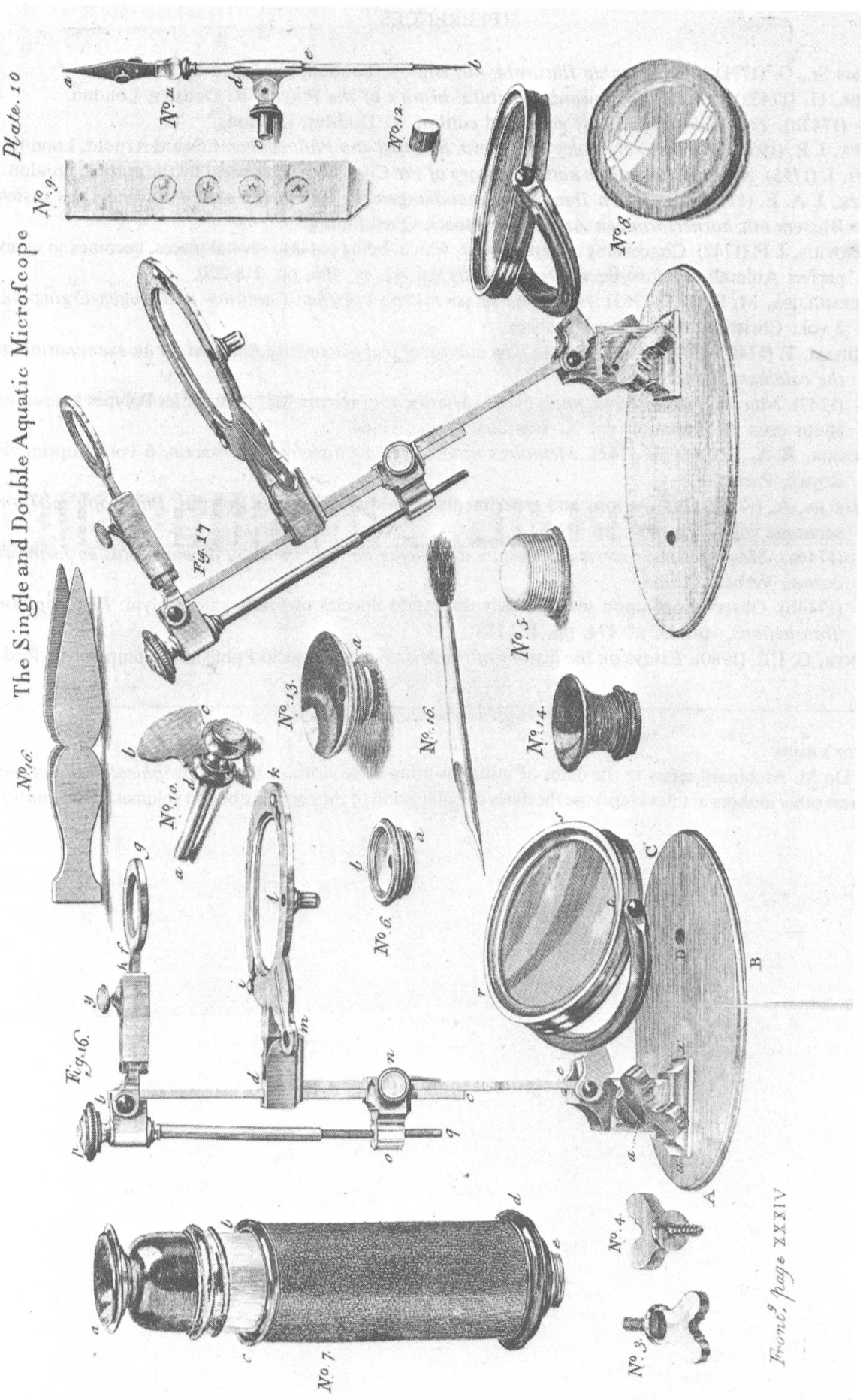

FIGURE 5. — The improved model of the Ellis aquatic microscope, as described by George Adams (1771), and similar to the one which belonged to Trembley.

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Editor's note:

Dr. M. Archinard refers to the dates of initial printing of sections of the *Philosophical Transactions,* whereas other authors in this volume use the dates of publication of the complete bound volumes of the journal.