



Chapitre de livre

2007

Published version

Open Access

This is the published version of the publication, made available in accordance with the publisher's policy.

Abraham Trembley's impact on the construction of microscopes

Ratcliff, Marc; Fournier, Marian

How to cite

RATCLIFF, Marc, FOURNIER, Marian. Abraham Trembley's impact on the construction of microscopes. In: From Makers to Users. Microscopes, Markets. and Scientific Practices in the Seventeenth and Eighteenth Centuries. D. Generali & M.J. Ratcliff (Ed.). Firenze : Leo S. Olschki Editore, 2007. p. 92–112. (Biblioteca dell'edizione nazionale delle opere di Antonio Vallisneri)

This publication URL: <https://archive-ouverte.unige.ch/unige:37204>

BIBLIOTECA
DELL'EDIZIONE NAZIONALE
DELLE OPERE DI ANTONIO VALLISNERI

3

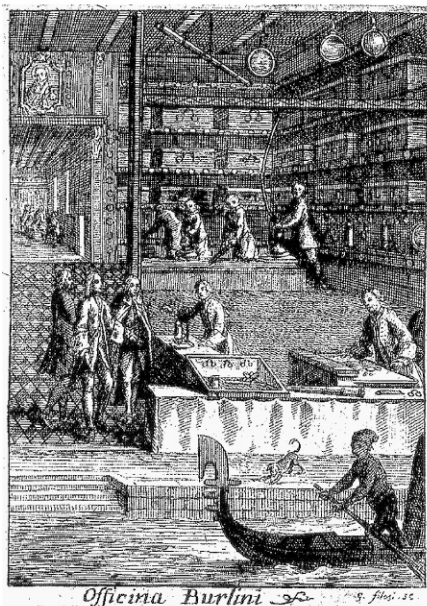
FROM MAKERS TO USERS

Microscopes, Markets, and Scientific Practices
in the Seventeenth and Eighteenth Centuries

DAGLI ARTIGIANI AI NATURALISTI

Microscopi, offerta dei mercati e pratiche scientifiche
nei secoli XVII e XVIII

edited by DARIO GENERALI and MARC J. RATCLIFF



LEO S. OLSCHKI EDITORE
MMVI

MARC J. RATCLIFF - MARIAN FOURNIER

ABRAHAM TREMBLEY'S IMPACT
ON THE CONSTRUCTION OF MICROSCOPES*

Abstract – Famous for his discovery on hydra, Abraham Trembley was also much interested in the devices he used for his scientific investigation. Particularly, he conceived instruments that could best fill the needs of his research, among them, microscopes. When in London in 1745, he got in touch with the instrument maker John Cuff and asked him to build a microscope with an eyepiece that could move in all directions. In other words, Trembley invented aquatic movement and Cuff made the instrument for him. However, Trembley never claimed his invention, therefore we used a contextual approach to reconstruct this story. We investigated his relationships with the world of practitioners, his role as an agent for buying instruments for his patron William Bentinck, and, through his unknown correspondence with Martin Folkes P.R.S., we could identify his authorship with certainty. As a consequence, the microscope he invented is the ancestor of the so-called Cuff-Ellis microscope, that originated in Trembley's model.

INTRODUCTION

The Geneva scholar Abraham Trembley (1710-1784) is famous for his discovery of the regeneration of the polyp, on which he experimented during the early 1740s.¹ For these experiments and observations he used at

* We thank the *Royal Society* of London, the *Archives de l'Académie des Sciences de Paris*, the *Bibliothèque Publique et Universitaire*, the *Musée d'histoire des sciences* in Geneva, the *Archives of the University Library* in Leiden, and Mr. Jacques Trembley in Geneva for allowing us to quote from manuscript sources in their collections. Figure 1 is reproduced courtesy Bibliothèque Publique et Universitaire, Geneva; Figures 2, 3 and 4 are Courtesy Musée d'histoire des sciences, Geneva. This research was funded by the Swiss Science Foundation, no. 100011-105719.

¹ For a biography of Trembley, see J.R. BAKER, *Abraham Trembley, Scientist and Philosopher 1710-1784*, London, Arnold, 1952.

least one microscope with several lenses, as he wrote in his major publication, the *Mémoires pour servir à l'histoire d'un genre de polypes d'eau douce à bras en forme de corne*, published in Leiden in 1744.² Yet, although historians of science have discussed his experimental skills at great length,³ there are several dimensions of Trembley's scholarly activity that remain unexplored. It has recently been shown that he was a master in para-experimentation – mainly the care for, preservation and preparation of animals – which allowed him to draw a demarcation between the field of experimental natural history and physics.⁴ Among the various issues left to explore, Trembley's relationship with a particular sort of scientific practice, that is the difficult-to-access world of instrument makers, has not yet been discussed. Clearly, the microscope was an important instrument to him and indeed, in 1747, he published a paper in the *Philosophical Transactions* where he supplied the illustration of an articulated lens – a simple microscope – used for the observations of polyps (Fig. 1). This particular instrument, known to be produced by the Leiden instrument maker Musschenbroek for Trembley,⁵ was emblematic of the latter's work on polyps during the 1740s, although it has been recently shown that Trembley did not use it for hydrae, but for microscopic animalcules.⁶ For these investigations Trembley used the full resources of experimental natural history. This simple microscope, known as *porte-loupe*, was in fact conceived by Trembley and produced by Musschenbroek, who described this instrument in his sale catalogue of 1748 as a microscope invented by Mr. Trembley for observing polyps.⁷

² A. TREMBLEY, *Mémoires, pour servir à l'histoire d'un genre de polypes d'eau douce, à bras en forme de cornes*, Leide, Luzac, 1744, pp. XIV, 77-78.

³ On Trembley's experimental skills see J.R. BAKER, *Trembley...*, cit., pp. 170-187; M. BUCAGLIA, *The Rhetoric of Proof and Persuasion utilized by Abraham Trembley*, in *From Trembley's Polyps to New Directions in Research on Hydra*, edited by Howard M. Lenhoff and Paul Tardent, «Archives des Sciences Genève», 38(3), 1985, pp. 305-319. S.G. LENHOFF-H.M. LENHOFF, *Hydra and the Birth of Experimental Biology 1744*, Pacific Grove, CA, The Boxwood Press, 1986, pp. 14, 20; V.P. DAWSON, *Trembley's Experiment of Turning the Polyp inside out and the Influence of Dutch Science*, in *From Trembley's Polyps...*, cit., pp. 321-334; ID., *Nature's Enigma, the Problem of the Polyp in the Letters of Bonnet, Trembley and Réaumur*, Philadelphia, American Philosophical Society, 1987, pp. 86-88, 183-184.

⁴ See on this M.J. RATCLIFF, *Abraham Trembley's Strategy of Generosity and the Scope of Celebrity in the Mid-Eighteenth Century*, «Isis», 95(4), 2004, 555-575.

⁵ J.N.S. ALLAMAND, *Avertissement du traducteur*, in J.T. NEEDHAM, *Nouvelles découvertes faites avec le microscope*, Leide, 1747, p. 2.

⁶ See M.J. RATCLIFF, *Forms Shaped by Functions? Using, Improving and Conceiving Microscopes during the 1740s*, in *Who needs scientific instruments?*, edited by Bart Grob and Hans Hooijmaijers, Leiden, Museum Boerhaave, 2006, pp. 235-244.

⁷ *Catalogus multarum Machinarum Physicarum, Mathematicarum, Anatomicarum, et Chirurgicarum*, Leiden, 1748, pp. 10-11.

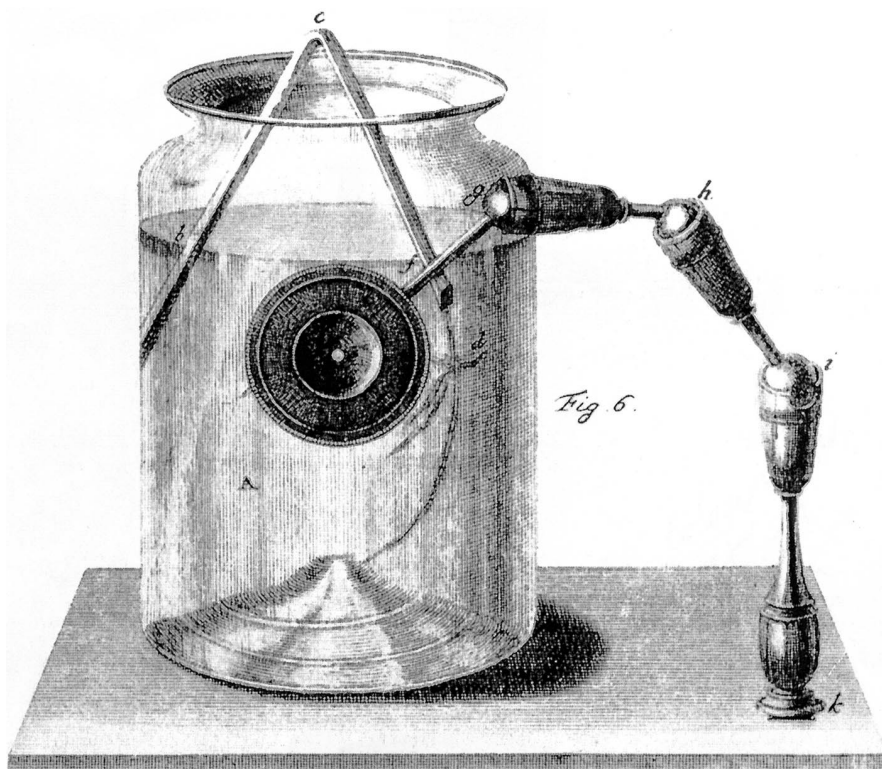


Fig. 1. Trembley Porte-loupe.

In this paper, we shall take the *porte-loupe* as a clue to Trembley's larger activities as a creator of scientific instruments. Aiming at a better understanding of the interaction between scholars and instrument makers, we shall bring evidence that Trembley positively influenced the development of the microscope during the eighteenth century. His impact was actually much stronger than one would expect just on the basis supplied by the *porte-loupe*, as revealed by unpublished manuscript sources. We adopted a contextual approach to discuss more in depth Trembley's impact on instrument making. First we will see how he cared for his network of instrument makers, then we shall examine his role as an agent and con-

gicarum quae venunt et fabregiunt a Joanne van Musschenbroek, Leydae [1748], item 148: 'Simile [= Microscopium] sed simplex a Do. Trembley pro polypis observandis inventum, cum tribus lentibus'.

noisseur buying and sending instruments to his patron and friends on the Continent. Eventually, we shall discuss Trembley's design for a microscope very different from the *porte-loupe*, which allowed better observation of small aquatic organisms. This latter activity, the conception of a microscope, is very much consistent with Trembley's high degree of expertise in instruments.

From the time of Clay and Court's classic *History of the microscope*, historians of science agree that the relationship between the creation and making of microscopes up to the mid-eighteenth century may be summarized as follows. In the seventeenth century, ideas regarding the construction of microscopes circulated in Europe. British practitioners took hold of many of these ideas and embodied them into production, sometimes claiming that a microscope was of their own invention. James Wilson claiming authorship of the screw-barrel microscope is a good example.⁸ Indeed, British makers were very clever at bringing to perfection ideas and models invented elsewhere. From the numerous examples from the second half of the seventeenth century we mention: the screw-barrel and the slideholder by Campani, the focusing adjustment by Homberg, the screw-barrel microscope by Campani and Hartsoeker, new combinations of lenses by Fabri and Divini, the field-lens by Francesco Fontana and Johann Wiesel, the movable body and the plane mirror by Hertel.⁹ This situation persisted until the beginning of the eighteenth century. From the 1720s onwards, the historiography has described British makers as being almost out of the influence of the Continent. Indeed, from the mid 1730s, we notice a striking increase in the production of microscopes in London, concurrent with a sharp increase in the market of scientific instruments. At this time Scarlett, Martin, Adams, Cuff, and many others made microscopes. Usually, one episode occurring during this expansive period is remembered that provides the only acknowledged trace of influence of the Continent. In 1738, during the English leg of his grand tour of Europe, the German MD Johann Nathaniel Lieberkühn (1711-1756) demonstrated the concave

⁸ J. WILSON, *The Description and Manner of Using a Late Invented Set of Small Pocket-Microscopes*, «Philosophical Transactions», 23(281), 1702, pp. 1241-1247.

⁹ See J. BENNETT, *Malpighi and the Microscope*, in *Marcello Malpighi Anatomist and Physician*, edited by Domenico Bertoloni Meli, Firenze, Olschki, 1997, pp. 68-70; S. BEDINI, *Seventeenth century Italian Compound Microscopes*, «Physis», 5, 1963, pp. 416, 421; R.S. CLAY-T.H. COURT, *The History of the Microscope Compiled from Original Instruments and Documents*, London, Griffin, 1932 (Reprint London, Holland Press, 1975), pp. 21-22, 41, 106-107; A. POLLARD, *The Mechanical Construction of the Microscope from a Historical Stand-Point*, 1922, pp. 337-341.

mirror which carries his name before certain craftsmen and members of the Royal Society, as well as two new microscopes: the solar microscope and the simple microscope for opaque objects.¹⁰ A few years later improved versions of these microscopes were being sold by Cuff and by other British manufacturers.

The usual historiographic presentation continues with the impact of Henry Baker FRS and John Ellis FRS on the construction of the microscope. In winter 1743 Baker worked on crystals, using a microscope, a work that had a «lasting effect on the construction of microscope»,¹¹ because he asked Cuff to make a microscope of a new shape that eliminated problems with manipulating the specimens which he had encountered with the classic Culpeper-type microscope.¹² Cuff (or Baker?) found a solution and the result was the modern shape of the Cuff microscope, made of brass, which allowed for easier handling of objects and steadier focusing, thereby extending the range of microscopic observation.

In this paper we will argue that, besides the German Lieberkühn and the Englishman Baker, also the Genevan Trembley had important ideas to offer John Cuff concerning the construction of microscopes. In other words: the influence of the Continent on British instrument making was greater than has hitherto been realised.

TREMBLEY'S NETWORK OF INSTRUMENT MAKERS

Far from being a naive and apolitical fellow enclosed in his Calvinism and spending his time in observing polyps, as certain historians have described him,¹³ Trembley was essentially a man of relations and of interaction. For him it was essential not only to keep good relationships with his network, but he used to work in close connection with practitioners. For example, manuscript evidence clearly shows how he managed the work of engravers of the plates for his *Mémoires*. Towards the end of April

¹⁰ R.S. CLAY-T.H. COURT, *The History of the Microscope...*, cit., p. 189.

¹¹ G. L'E. TURNER, *Henry Baker F.R.S., Founder of the Bakerian Lecture*, «Notes and Records of the Royal Society of London», 29(1), 1974, p. 63.

¹² ID., *Henry Baker...*, cit., p. 63; A. POLLARD, *The Mechanical Construction...*, cit., p. 343.

¹³ M. JACOB, *The Radical Enlightenment Pantheist, Freemasons and Republicans*, London and Boston, Allen & Unwin, 1981, p. 202.

1743 Bentinck invited, probably at Trembley's request, the famous engraver Jan Wandelaar for dinner, together with Pierre Lyonet, who had previously made some drawings of the polyps. With reference to this occasion, Trembley wrote to Martin Folkes, P.R.S.:

I'm preparing polyps for him in my Cabinet, in most of the circumstances he must represent them. I'll teach him a small lesson on the history of these animals, and I'll give him polyps to have them in front of him while working.¹⁴

The drawings Lyonet had made earlier were also to be given to Wandelaar. Thus, as regards the drawings, which were considered museum pieces, Trembley took the precaution not only to meet the artist personally, but he also showed him prepared polyps and even planned to give him some animals, so as to accustom the engraver with his subject.

We have no reason to think that Trembley proceeded in a much different way with instrument makers. In Holland, Trembley met a number of instrument makers, among them Jan van Musschenbroek (1687-1748), famous for running a workshop of optical and mathematical instruments that he inherited from his grandfather. It is not clear exactly when Trembley met Musschenbroek. But their meeting most probably resulted from the connection between Bentinck and his former tutor s'Gravesande, who worked very closely with Jan van Musschenbroek over the expansion of the Leiden Cabinet of Physics. Trembley's first mention of Musschenbroek indicates that he already knew him by then: after a visit to Cuff in London, to whom he gave suggestions for improving a microscope, Trembley wrote to Bentinck in July 1745: «If [Cuff] carries that out successfully, I'll take one, and I will inform myself if Mr. Musschenbroek and our Dutch friends want one of those».¹⁵ The clues showing that he meant Jan van Musschenbroek the instrument maker, and not his younger brother Petrus (1692-1761), a professor in physics at the Universities of Duisburg and Utrecht, are contextual: everything in the passage concerns microscopes and workshops. Not until six months later is there evidence that Trembley knew Musschenbroek personally: in a short note he mentioned that he went to Musschenbroek's workshop in Leiden at the beginning of 1746.¹⁶ Prob-

¹⁴ Trembley to Folkes, 23 April 1743, Archives of the Royal Society, Ms Folkes 250, Fol 3, f. 65v (hereafter Ms Folkes). Our translation from the original French. Wandelaar dismissed the proposal for he was already committed to a work for the anatomist Bernhard Siegfried Albinus.

¹⁵ Trembley to Bentinck, 1st July 1745, British Library, Ms Eg. 1726, f. 23 (hereafter BL Eg).

¹⁶ A. TREMBLEY, *Concerning the Light caused by Quicksilver shaken in a Glass Tube, proceeding from Electricity*, «Philosophical Transactions», 44(478), 1746, pp. 58-60: 59.

ably Trembley knew him much earlier, but evidence is lacking for this. Musschenbroek was enthusiastic about Trembley's *porte-loupe*, as acknowledged by their mutual friend Allamand: «as soon as this skilful artist acknowledged its utility, he took great care in making them».¹⁷ Apparently Musschenbroek began to make this practical optical device directly after he had seen the instrument.

Trembley owned a thermometer made by a prominent Dutch maker, Hendrik Prins, at least from the summer 1740.¹⁸ Most probably he bought the thermometer at Prins's workshop in Amsterdam and met the man there. Trembley's correspondence contains a surprising piece of information about Prins. In 1745, in connection with a solar microscope made in London for Bentinck, Trembley wrote: «One settles the inclination of the mirror through a machine almost like that of the microscope by Prins».¹⁹ This microscope by Prins was perhaps a *unica*, for Prins is not known for making optical devices.²⁰ Trembley's relationship with Dutch practitioners was not limited solely to instrument makers. Indeed, for the observation and conservation of polyps, he had soon special glass jars after his own design made in a factory.²¹ Later, he also asked Folkes for «glasses which broke», the latter looked for them in a London glass factory.²² Therefore, we may conclude that Trembley was also well in touch with the world of glassmakers.

Trembley's first visit to England in summer 1745 provides us with a wealth of evidence about his relationship with British instrument makers. As preceptor of Count Bentinck's two children, Trembley was sent with them on their first visit to their grandmother, Lady Portland. Bentinck, who shared with Trembley a deep interest in natural history and in scien-

¹⁷ J.N.S. ALLAMAND, *Avertissement...*, cit., p. 2.

¹⁸ Trembley to Réaumur, 26 September 1740, in M. TREMBLEY-M. GUYÉNOT (eds.), *Correspondance inédite entre Réaumur et Abraham Trembley*, Genève, Georg, 1943, p. 6.

¹⁹ Trembley to Bentinck, 7 July 1745, BL Eg. 1726, f. 26v.

²⁰ There is a telescope signed by Prins in the collections of the Museum Boerhaave, so he did produce other optical devices, but presumably only rarely. It would be interesting here to investigate the relationship of Prins with Celsius who was at Leyden around 1735, and who gave Lieberkühn the idea for the solar microscope. He could have given it also to Prins.

²¹ Bonnet to Trembley, 24th March 1741, in V.P. DAWSON, *Nature's Enigma...*, cit., p. 201. Trembley to Folkes, 2 July 1743, Royal Society, Ms Folkes 250, Fol 2, f. 43.

²² Folkes to Trembley, March or April 1746, (hereafter Ms Trembley) copies of letters preserved by Mr Jacques Trembley. These glass drops that exploded when touched were probably Prince Rupert's drops. On this see L. BRODSLEY-C. FRANK-J.W. STEEDS, *Prince Rupert's Drops*, «Notes and Records of the Royal Society of London», 41(1), 1986, pp. 1-26.

tific instruments, asked him to get and buy several instruments at various London instrument makers. The man who helped Trembley to meet both scholars and makers in London was Martin Folkes, President of the Royal Society, with whom he corresponded from early 1743. A month before Trembley's arrival in London, Folkes alluded to all the visits he should pay to the London instrument makers, where, he thought, Trembley could find some pieces useful for his experiments and observations.²³ Trembley arrived in London on the 22nd of June and already paid a visit to Folkes on the 24th.²⁴ Only one week later both went to Cuff to buy a microscope for Bentinck.²⁵ Trembley actually bought two solar microscopes. On 5th July 1745 he wrote to Bentinck: «I got and paid your and your brother's solar microscopes. Each is 3 guineas. They are made of brass. I'm much satisfied with them».²⁶ Trembley's interest in instruments was far too strong to be limited to microscopes. Indeed, other optical devices such as telescopes, also fell under his competence. From 1745 to 1750 he bought six telescopes for Bentinck and his friends, and one more for his personal use. At the workshop of James Short, he bought in July 1745 a 7-inch telescope for a Mr. Malin. Before choosing this telescope, Trembley had compared it with similar pieces, less expensive and made in other workshops, which shows that he was in touch with more makers than those directly mentioned in his letters. Later, in January 1748, when the war for the Succession of Austria, which had strongly limited communication between Austria and France and England, seemed to reach its end, Trembley continued to send instruments. At that time Bentinck acted as an intermediate agent for friends. Trembley was asked to send him four telescopes, most probably from Short; these were for the Prince of Wolfenanthel, Mr. de Bathiani, Mr. de Gastheim and the Abbott Guasco, at four Guineas each.²⁷ Early 1750, back in London, Trembley sent to Bentinck another small telescope.²⁸ In March 1750 he had returned to Holland, and he brought with him another telescope made in London.²⁹ This time, at last, it was for himself.

²³ Folkes to Trembley, 19 May 1745: «J'espère entre autres choses qu'en vous voyant, que vous pourrez trouver ici, parmi nos ouvriers quelques machines qui pourraient vous servir dans vos expériences, pour observer dans des conditions favorables ces petits objets qui vous fournissent des observations si intéressantes».

²⁴ Trembley to Bentinck, 24 June 1745, BL Eg. 1726, ff. 18-19.

²⁵ Trembley to Bentinck, 1st July 1745, BL Eg. 1726, f. 23.

²⁶ Trembley to Bentinck, 5 July 1745, BL Eg. 1726, f. 25.

²⁷ Trembley to Bentinck, 8 February 1748, BL Eg. 1726, f. 67v.

²⁸ Trembley to Bentinck, 18 January 1750, BL Eg. 1726, f. 114.

²⁹ Trembley to Bentinck, 3 March 1750, BL Eg. 1726, f. 121v.

Other sources allow us to complete the picture. When in London in summer 1748, Allamand wrote to Bentinck to express his satisfaction with Trembley, who had guided him through the London scholarly and practitioners' milieu. In one day, Allamand and Trembley discussed with the mathematician Abraham Moivre, then met the physician Robert Mead, stopped at Harrison's workshop before ending at a meeting of the Royal Society. There Folkes showed Allamand some lenses made by Huygens, a gift from Bentinck to the Society. «There is no famous maker», wrote Allamand, «which he missed to introduce me. I owe to several of them specific ideas touching perfection as regards mechanical works, which would still seem impossible to realize in practice for me, had I not seen what they are able to do».³⁰ The two guys paid visits to George Graham, to Gowin Knight and to John Harrison, but James Short was absent when they arrived at his door. Therefore Trembley was in touch with numerous instrument makers in Holland as well as in England, and it appears that he was especially keen to meet the best practitioners.

Some of the above data show that Trembley's network of makers served as a reservoir for finding instruments to send to Holland. Actually this was part of an important role Trembley played that touches upon wider relationships between London and the Continent. Up to 1748 the War for the Succession of Austria considerably hindered the dealings between England and many countries on the Continent. As a middleman, Trembley worked mainly for William Bentinck and his brother Charles, but also for several friends who had asked him for specific objects. Of the six telescopes he sent to Holland, only one was for Bentinck and five were for other people. Another type of instrument Trembley took care to send were watches, especially the very good pieces made by Graham, whom he met, thanks to Folkes on 30th August 1745. Earlier, Folkes had served as an intermediary for Bentinck when buying watches from Graham,³¹ but from 1745 Trembley took over that duty.³² Also, in July 1745, he was asked by Bentinck to buy magnets, and may have visited Go-

³⁰ Allamand to Bentinck, Kensington, 2 August 1748, Genève, Bibliothèque Publique et Universitaire, Fonds Trembley 6, env. 3, f. 596.

³¹ Folkes to Trembley, 19 April 1743, Ms Trembley: «Monsieur Graham, qui est un de ces derniers, me prie, avec ses très humbles compliments à Monsr. de Bentinck, de lui faire savoir qu'il travaille à achever les 2 montres qu'il lui a commandées et qu'elles lui seront envoyées aussitôt qu'il le pourra».

³² Trembley to Bentinck, 11 December 1747, BL Eg. 1726, f. 63.

win Knight to do so.³³ Knight was a physician who had found a method to make strong artificial magnets, and some years later Trembley did know him.³⁴

Actually, Trembley did not limit his activities to sending instruments. In early 1750, through Trembley's mediation, Réaumur sent his book on an incubator for chicken eggs and thermometers to Charles Lennox, second Duke of Richmond.³⁵ Books, bought or given for Bentinck were also frequently on the road to Holland. Two other examples show that, although there is no trace of being paid for his services, Trembley was really instrumental as an agent. Early 1748, he drew up a list of copperplate engravings collected in some British cabinets for the Dutch clerk Fagel, an influential man in Holland.³⁶ Also, in spring 1750, he bought for the French antiquarian Claude Gros de Boze the whole cabinet of medals from Henry Herbert, 9th Earl of Pembroke.³⁷ Thus, with reference to the wider relations between England and the Continent during the Succession, people like Trembley helped the exchange of scientific ideas, instruments and books to continue in times of war.

To come back to his interest in microscopes, among the commissions Trembley carried out for other people, he bought or lent sets of lenses for microscopes, at least from July 1745 onward. Indeed, when in London in summer 1745 Trembley asked Bentinck to give his set of lenses to Gerard van Swieten.³⁸ Bentinck looked for these in Trembley's room at Sorgvliet but did not find them and, for further precision, Trembley specified in a subsequent letter that the lenses were «wrapped into a paper, which is an advertisement of the instrument maker Cuff».³⁹ The origin of this set remains hypothetical. Before travelling to London, Trembley's only acknowledged link with British makers was indirect, through Folkes from whom he received a microscope in May 1743. As Folkes was close to Cuff,

³³ Trembley to Bentinck, 24 July 1745, BL Eg. 1726, f. 30.

³⁴ Trembley to Bentinck, 9 August 1748, BL Eg. 1726, f. 94.

³⁵ Réaumur to Trembley, 8 November 1749, in *Correspondance Réaumur-Trembley...*, cit., p. 329.

³⁶ Trembley to Bentinck, 22 January 1748, BL Eg. 1726, f. 66. On Fagel, and especially his bad relationship with the friend of Trembley, Pierre Lyonet, see W.H. VAN SETERS, *Pierre Lyonet 1706-1789*, La Haye, Martinus Nijhoff, 1962.

³⁷ Trembley to Réaumur, 24 June 1750, in *Correspondance Réaumur-Trembley...*, cit., p. 343.

³⁸ Trembley to Bentinck, 24 June 1745, BL Eg. 1726, f. 19. There was also a set to give to Mr Reisehack, but the letter is not clear whether or not Reisehack was an agent for van Swieten.

³⁹ Trembley to Bentinck, 18 July 1745, BL Eg. 1726, f. 27v.

to the point that he tried early in 1744, yet failed, to make him a Fellow of the Royal Society,⁴⁰ it is probable that Trembley received Cuff's advertisement and possibly also lenses made by Cuff, through Folkes.

Later, Trembley continued to order sets of lenses, probably from Cuff. From the time he was in London in 1749 to his European travels in 1753, he sent at least four sets of six lenses to Paris to Réaumur and other people.⁴¹ In autumn 1749, Trembley had lent two of his *porte-loupes* to Réaumur, with which he and a few colleagues repeated Needham's and Buffon's microscopical observations. For the observations, Trembley also lent his two sets of lenses (of unknown provenance, but probably from Cuff), which Réaumur bought in spring 1750.⁴² While the sock and ball system was easy to make and even cheap in Paris,⁴³ good lenses were probably more difficult or expensive to get there. Indeed, Réaumur insisted several times that Trembley met with facilities to get good lenses in London.⁴⁴ We do not know if it was Cuff to whom he turned as supplier of lenses, but for sure, Trembley asked for the best work, and indeed a set of six lenses cost 20 French *livres*.

All those examples show quite clearly that Trembley felt happy performing services for other people. The network brought him the real pleasure of sharing knowledge with the practitioners. On this ground Trembley cultivated a second function complementary to that of the middleman, he developed his own expertise in instruments, both to assess the goodness and value of an instrument, and to improve it when necessary. Such a desire for expertise infers that Trembley could easily adopt the position of a student, even in small things. He reported in summer 1745 that some people were preparing a «bell gear», probably chimes, for Bentinck's apart-

⁴⁰ Archives of the Royal Society, Cert I, 252; A06562. Cuff's certificate was signed by Egmont; M[artin] Folkes; F[rancis] Wollaston; H[enry] Baker; Crom[we]ll Mortimer; Ja[mes] Parsons; James West; Hen[ry] Stuart Stevens; Hen[ry] Miles. But Cuff was «Ballotted and rejected 19 April 1744».

⁴¹ Réaumur to Trembley, 8 November 1749; 22 May 1753, in *Correspondance Réaumur-Trembley...*, cit., pp. 328, 370.

⁴² Réaumur to Trembley, 26 May 1750; 27 June 1750, in *Correspondance Réaumur-Trembley...*, cit., pp. 341, 343. The microscopical observations with Trembley's lenses were published anonymously as *Lettres à un américain* (1752), a three volume book by abbé Lignac who attacked Buffon's and Needham's microscopical observations and almost spontaneist theories.

⁴³ Réaumur to Trembley, 8 November 1749, 10 January 1750, in *Correspondance Réaumur-Trembley...*, cit., pp. 328-329, 334.

⁴⁴ Réaumur to Trembley, 20 November 1749, in *Correspondance Réaumur-Trembley...*, cit., p. 332.

ments and dining room. So as to be up with the latest «advances», Trembley had taken private lessons with a bell master to learn how to balance the bells, and, he added: «I'm observing all the bells I can find». ⁴⁵ Becoming an expert also required both a practical and theoretical interest in instruments. Several letters report some of Short's methods and projects for new telescopes. In July 1745, Short was working on a 12-foot reflecting telescope and Trembley noticed the maker's method for polishing mirrors, with the help of a copper basin and metallic portions of an arc of circle, both of 24 feet. ⁴⁶ Whenever he came back to London, Trembley used to visit Short and other makers. In November and December 1748 he thrice visited Short, and informed Bentinck that the former was working on increasing the power of a telescope without increasing its length, thanks to a larger mirror. ⁴⁷

All this social and instrumental knowledge was very useful with respect to the improvement of microscopes, which was one of the means Trembley exploited between 1740 and 1746 with the intention to refine his experiments and observations.

TREMBLEY'S DEALINGS WITH JOHN CUFF

Even before he met him, Martin Folkes clearly expected that Trembley would have something constructive to suggest as regards the improvement of the microscope. In October 1744, when he heard that Trembley would come to England, he wrote to him: «Recently, we had much pleasure here with the microscope, and this urged craftsmen to improve this instrument. The insight you shall give us will perhaps allow us to add some facilities, which no one thought about». ⁴⁸ Once Trembley had arrived in London in the early summer of 1745, he went almost immediately to Cuff's workshop in Fleet Street. After his visit, Trembley wrote to Bentinck:

I found at Cuff's a microscope he devised, about which I was much satisfied. I made suggestions for him to improve it. He's going to try. If he manages, this mi-

⁴⁵ Trembley to Bentinck, 30 August 1745, BL Eg. 1726, f. 40v.

⁴⁶ Trembley to Bentinck, 7 July 1745, BL Eg. 1726, f. 26v.

⁴⁷ Trembley to Bentinck, 12 November 1748, BL Eg. 1726, f. 101; 28 November 1748, BL Eg. 1726, f. 105; 9 December 1748, BL Eg. 1726, f. 107.

⁴⁸ Folkes to Trembley, 26 October 1744, Ms Trembley: «On s'est beaucoup plu ici, depuis quelque temps au microscope et cela a fait songer les ouvriers à perfectionner cet instrument; les lumières que vous pourrez donner nous mettront peut-être en état d'y ajouter quelques commodités auxquelles on n'a pas encore pensé».

croscope will not take a lot of place; it will be a simple or double as for convenience: the lenses will be the same as those I put to my *porte-loupes*, and the body of the double microscope will even be adapted to the *porte-loupe*.⁴⁹

So Cuff, who had a reputation of working quickly,⁵⁰ started working with the ideas handed to him and two months later, on the 1st September, Trembley wrote to Bentinck «my microscope is going well, I hope it will be achieved within 15 days».⁵¹

Trembley's involvement with the microscope made according to his suggestions continued through the next year. At the end of 1745, Trembley ordered with Cuff a similar microscope for his friend and compatriot Jean-Nicholas-Sébastien Allamand,⁵² who, along with Bentinck, Isaac Sacrelaire and Pierre Lyonet, had participated in the repetition of Trembley's experiments on the regeneration of the polyp. The microscope was made according to Trembley's suggestions. Around early spring 1746, Folkes wrote to Trembley that Cuff had assured him that he was working on Allamand's microscope without loosing time and that he would take good care to satisfy him.⁵³ Actually, things were not going so well, for in July Folkes wrote that he felt much ashamed that Cuff had not finished the instrument. By way of excuse, Cuff told he had lost workers and therefore could not fill the order.⁵⁴ It appeared in December 1746 that Cuff had shown a bad lack of taste. According to Folkes,⁵⁵ after many reminders and telling Cuff off, Folkes had after a long delay given the microscope up, having first compelled Cuff to apologize. Consequently Cuff had become a bit scared or ashamed and therefore shrank from telling him that he had finally finished the microscope. As Cuff had met a «gentleman who liked the microscope» he sold it. Even worse, Cuff had since built a second, similar, microscope and a Dutch guy, named Burnan, had bought it. This disturbing portrayal of Cuff actually matches with other disagreeable traits in Cuff's character

⁴⁹ Trembley to Bentinck, 1st July 1745, BL Eg. 1726, f. 23.

⁵⁰ G. L'E. TURNER, *Baker...*, cit., p. 64.

⁵¹ Trembley to Bentinck, 1st September 1745, BL Eg. 1726, f. 42v.

⁵² Allamand did own an aquatic microscope made by Cuff. The auction catalogue of his estate *Catalogus... physische, mathematische en werktuiglijke instrumenten...* J.N.S. Allamand, 1788 lists at no. 90: «Een fraaije Engelsche Microscoop, door Cuff met al zyn toebehooren, in een sagryn doosje en zyn houten voet».

⁵³ Folkes to Trembley, March or April 1746, Ms Trembley.

⁵⁴ Folkes to Trembley, 16 July 1746, Ms Trembley.

⁵⁵ Folkes to Trembley, 10 December 1746, Ms Trembley.

and reputation,⁵⁶ and there is no reason to doubt Folkes' version of the facts. However, as Folkes had also written in the same letter that he saw at Cuff's all the pieces of a third instrument which Cuff could assemble within 15 days, he wrote to Trembley:

I thought that those pieces matched well what he did for you, yet I could easily be mistaken as it is two years ago, when I saw this microscope.⁵⁷ If you want to give orders or have other makers working, I'll try to have the work done. [Cuff] is much convinced of the advantages of this microscope thanks to the changes you made on his first plan. He had a drawing made of it, which, with time going, he intends to engrave.⁵⁸

Trembley reacted quickly, and asked for the microscope in hand to be completed and sent to him as soon as possible for Allamand and, by the end of January 1747, the microscope was ready.

After this somewhat awkward incident, there is nothing more involving Cuff in Trembley's correspondence. Nevertheless this episode sheds an intriguing light on Cuff's career which was characterized by instability. It is possible that Folkes no longer trusted Cuff, or in other words, stopped to support him in one way or another.

The microscope in question, made by Cuff, based on suggestions proffered by Trembley, was a so-called aquatic microscope. We shall return to it presently. Meanwhile we also note that Folkes encouraged not only Trembley to proffer suggestions to Cuff, but the latter was also asked to write to Trembley as to sketch out the problems he met to build a microscope according to Trembley's ideas: «Still, he met with some difficulties on the double microscope which I advised him to send you a description by letter. I wish he did this».⁵⁹

⁵⁶ Clay and Court described Cuff as instable (G. L'E. TURNER, *Baker...*, cit., p. 64). See also E.G.R. TAYLOR, *The Mathematical Practitioners of Hanoverian England 1714-1840*, Cambridge, Cambridge University Press, 1966.

⁵⁷ This passage is difficult to interpret, because Folkes's use of French does not respect the regular syntax: «mais je puis aisément me tromper comme il y a deux ans, et que je n'ai que simplement vu ce microscope».

⁵⁸ Folkes to Trembley, 10 December 1746, Ms Trembley.

⁵⁹ Folkes to Trembley, 16 July 1746, Ms Trembley.

TREMBLEY'S MICROSCOPES

What microscopes did Trembley use for his investigations? In the early stages of his research, he probably used a thread-counter.⁶⁰ He certainly also tried or used the (solar) microscope by Prins, and he used any other microscope which Bentinck acquired through his relationship with Dutch and British makers.⁶¹ Trembley had actually tried before 1745 the solar microscope to observe the polyp.⁶² Although it produced a nice spectacle, he did not consider it as a heuristic instrument by contrast with double and simple microscopes.⁶³ Apart from a solar microscope, Trembley apparently did not, as was the practice of other scholars, use a number of different microscopes for his observations until June 1743. In May 1743 Folkes sent him a pocket microscope as a gift: «it is only a small microscope recently invented and made here. Perhaps its only advantage is to be portative».⁶⁴ In Trembley's letter of acknowledgment, there is nothing allowing the identification of that microscope, except that he said it was «extremely handy» and the lenses were «excellent».⁶⁵ Trembley added he would repeat all his previous observations with this microscope.⁶⁶ Although there is no direct evidence, a series of coincidences makes it probable that this microscope was made by Cuff. Indeed, Trembley owned an advertisement by Cuff, in which he had wrapped a set of lenses. Also, in February 1743 Cuff published pamphlets describing five microscopes: the old Culpeper tripod, the Wilson pocket microscope, the Wilson screw-barrel on a stand, the recently developed solar microscope and a microscope for opaque objects. This latter was a microscope with lieberkuhn lenses and it was announced by Cuff as a recent development. That was only some months

⁶⁰ Mr. Jacques Trembley in Geneva owns a box that belonged to Abraham Trembley, which contains a wooden thread-counter (personal communication).

⁶¹ He owned at least two telescopes (Trembley to Bentinck, 7 July 1745, BL Eg. 1726, f. 26v), at least one microscope, perhaps the one by Prins, a solar microscope bought in London, probably a double by Cuff, another one made by or belonging to Mr. Jan Noppen. Much later, in 1766, Bentinck still owned the *porte-loupe*. A letter from Trembley to Bentinck (18 March 1766, BL Eg. 1726, f. 329) took it for granted that the latter owned this instrument: «vous laisserés toujours [cet animal] au foier d'une lentille du microscope, au moien du porte-loupe».

⁶² Trembley to Réaumur, 18 February 1745, in *Correspondance Réaumur-Trembley...*, cit., p. 229.

⁶³ Trembley to Réaumur, 18 February 1745, *ibid.*, p. 229.

⁶⁴ Folkes to Trembley, 2 May 1743, Ms Trembley.

⁶⁵ Trembley to Folkes, 31 May 1743, Ms Folkes 250, Fol 2, f. 17v.

⁶⁶ Trembley to Folkes, 31 May 1743, Ms Folkes 250, Fol 2, f. 17v.

before Folkes sent Trembley the microscope that was «recently invented and made here». Nevertheless, other makers, such as Lindsay, also patented microscopes at this time.⁶⁷

The best-known microscope employed by Trembley is the *porte-loupe*, a simple lens attached to an articulated arm, a description of which was published by Trembley in the *Philosophical Transactions* of 1747. This instrument was not mentioned in the correspondence with Folkes. In April 1743, at Folkes' request, Trembley explained his use of the microscope:

I use the microscope double or simple according to my needs. When the object must be in a concave glass in the water, I always use the double microscope; but when I just need it in a drop of water, I put it on a glass plate, which I fit to the simple microscope. The latter seems to me much handier in various respects. In order to avoid the illusion which the lenses produce sometimes, I observe the same object at different times, and with different lenses. First with three or four magnifying glasses of a different power, and eventually with most lenses of the microscope.⁶⁸

Consequently, there is no evidence that Trembley used his famous *porte-loupe* for the observations in the 1744 book. It is possible that the interchangeable lenses of Cuff's microscope were used to build it. When he visited Cuff in July 1745 Trembley saw a set of lenses which he identified as similar to those he used for his *porte-loupe*.⁶⁹ That suggests that the *porte-loupe* was built between June 1744 and July 1745. He certainly used it in the experiments on dividing polyps performed between 1745 and 1747.⁷⁰

Finally, Trembley also had an example of the aquatic microscope that Cuff developed from a design of his own according to suggestions made by Trembley. Cuff did finish the microscope for Trembley he was working on

⁶⁷ George Lindsay acquired early in 1743 a patent for a simple microscope. This instrument was known in London as the 'snuff-box microscope'. Lindsay described the microscope in a pamphlet entitled *An explanation of the mechanisms and uses of the general portable microscope, as invented and made 1728, and patented 1743*. The advantage of this model was (according to the inventor) that the magnifiers were closer to the eye, it gave a larger angle of vision, and shifting the lenses and objects was done without screwing the lenses in or out, as they were mounted in a slider.

⁶⁸ Trembley to Folkes, 12 April 1743, Ms Folkes 250, Fol 3, f. 52v.

⁶⁹ Trembley to Bentinck, 1st July 1745, BL Eg. 1726, f. 23.

⁷⁰ See J. BAKER, *Abraham Trembley...*, cit., pp. 172-173, and M.J. RATCLIFF, *Forms Shaped by Functions?...*, cit.

in September 1745⁷¹ and doubtless Trembley took it with him when he went back to Den Haag. It is now conserved at the *Musée d'histoire des sciences* in Geneva (Fig. 2).⁷²

In Den Haag he must have shown it to his acquaintances. Certainly this new microscope became known in the Low Countries as the microscope after «the invention of Mr. Trembley». The question is, what was this invention of Trembley's exactly. We can find some clues. The instrument could be used as «a simple or double [microscope] as for convenience». Using one instrument both for simple lenses and a compound optical tube had until then only been applied by Edmund Culpeper in a sophisticated version of his famous screw-barrel microscope. In this instrument a tube, containing an eyepiece was screwed over the simple lens, so that both parts together formed a compound tube. The same arrangement was used by Cuff for Trembley's microscope: «the lenses will be the same as those I put to my *porte-loupe*, the body of the double microscope will even be adapted to the *porte-loupe*». But in this case the optical tube contained besides an eyepiece also a field-lens. So the combination of a simple microscope and a compound microscope in one instrument was not original.

A very different clue comes from a comment by Trembley on the solar microscope he bought for Bentinck: «I'll see if I can try it and find any sort



Fig. 2. Trembley's microscope made by Cuff. MHS Genève, no. 10.

⁷¹ Folkes to Trembley, 13 February 1746, Ms Trembley.

⁷² See for a description M. ARCHINARD, *Le microscope d'Abraham Trembley*, «Musées de Genève», 253, March 1985, pp. 3-9.

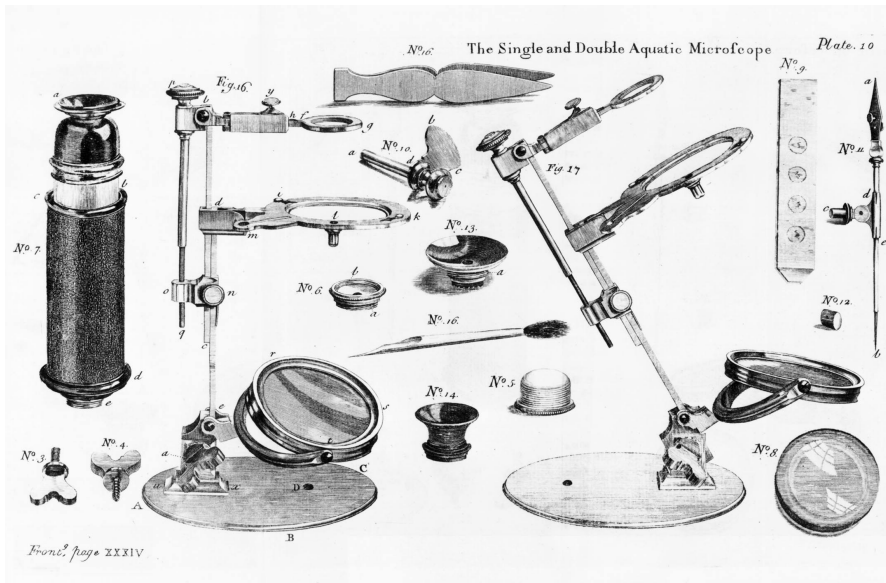


Fig. 3. Trembley/Cuff aquatic microscope by George Adams.

of means to improve it. I'm not absolutely satisfied with the way one places the object. I would like to fit more easily simple glass plates with drop of water». ⁷³ This passage shows that Trembley was anxious to investigate water samples without being hampered by the construction of his instrument when putting the sample before the lens. The finished instrument (Fig. 3) ⁷⁴ is fitted with the same double pillar as Cuff's famous compound microscope, it can be fitted with both simple lenses and a compound tube and it has a relatively large glass stage. But most importantly, it has aquatic movement. This means that the optical part of the instrument could be moved to the right and to the left, forwards and backwards in the plane parallel to the specimen. This in fact is very helpful when studying water samples full of living organisms. So, it is tempting to think that this – aquatic movement – is Trembley's contribution to Cuff's new microscope.

⁷³ Trembley to Bentinck, 5 July 1745, BL Eg. 1726, f. 25.

⁷⁴ First published in G. ADAMS, *Micrographia Illustrata*, London, 1771, fourth edition.

AFTERMATH

Cuff did not acknowledge Trembley's contributions in any detail at all, except for one thing. A note in the Musschenbroek archives describing the new microscope reads:

The Description of the Aquatic Microscope I have not yet drawn out it being a Microscope I have sold only in a private manner and till lately I made to it many alterations, now being pretty compleet I shall finish a drawing and Copper plate begun of it soon as possible, Sr. The Use of the ring to screw the lenses in wch. is thicker than ye other is for conveniency of viewing Opake Objects with ye Lens set in the center of the Silver Mirror this is to be screw'd underneath, and the depth of the Ring admits of the double microscope to be screw'd over it, this improvement was made by the desire of Mr. Trembley to which Gentleman I am obliged to for some useful alteration in this Microscope.⁷⁵

This little note is undated and unsigned, yet, from the wording, it would seem that the author was John Cuff. As to a possible date, in the above quoted note it says «I shall finish a drawing» and in Folkes' letter of 10 December 1746 he mentions that Cuff has «had a drawing made of it». It is therefore tempting to think that the note was written some time during 1746. Perhaps early in the year as Jan van Musschenbroek already offered this microscope to Arnout Vosmaer in a letter dated 16 March 1746. After informing him about various types of microscopes he had for sale Musschenbroek concluded that he had also 'a new set invented by Mr. Trembley for aquatic objects' for sale, which cost 72 guilders.⁷⁶ So, Musschenbroek must have been in contact with Trembley and in all likelihood also with Cuff in the preceding months to be able to make this offer. Perhaps Cuff sent him the above quoted note in the course of an exchange of information concerning the retail of the Trembley microscope. This letter offers an appealing aside. Musschenbroek had addressed his letter to Vosmaer in Rotterdam, but the letter was forwarded to the instrument maker Edward Scarlett in London, with whom Vosmaer presumably was staying (or lodging). Only three weeks earlier, on 13 February 1746 (24 February 1746 new style), Folkes had written to Trembley that Cuff had sold one of the aquatic microscopes to someone from Rotterdam.⁷⁷ This someone could have been Vosmaer.

⁷⁵ Archives University Library Leiden, BPL 240, 67 II.

⁷⁶ Archives University Library Leiden, BPL 246.

⁷⁷ Folkes to Trembley, 13 February 1746, Ms Trembley.

In the above quoted note, Cuff acknowledges Trembley as the person responsible for the two separate lens holders with which the microscope is supplied, one thicker than the other. The thicker one of the two is used with the lieberkuhns. But, as the author of the note indicates, Trembley offered more suggestions.

The aquatic microscopes most often encountered are mostly derivations from the simple microscope which Cuff made for John Ellis in the early 1750s, perhaps during the summer 1752.⁷⁸ This microscope, for which the name «aquatic microscope» was coined in 1755,⁷⁹ was much simpler, but the large stage was unaltered. The Trembley/Cuff aquatic microscope was illustrated for the first time in 1771 in the fourth edition of George Adams' *Micrographia illustrata*. That is rather surprising as Cuff, through Baker, usually quickly published plates of his new instruments. A possible explanation for this untypical conduct could be that, after Cuff failed to become a fellow of the Royal Society in 1744, and after the incident with Allamand's microscope, he lost his reputation. Indeed he went bankrupt in 1750⁸⁰ – and bankruptcy, in England, usually lead to a trial as it was considered a crime. Later, in 1758 Baker loaned him 20 pounds but it seems that Cuff could not recover his business. Nevertheless, from 1745 onwards, Cuff certainly made quite a number of the Trembley microscopes. Apart from the five mentioned in the correspondence of Trembley, there are two specimens in the Science Museum in London.⁸¹ Both are signed and bear serial numbers: 31 and 34.

Allamand, for whom the microscope was ordered that caused so much bother between Folkes and Trembley on the one hand and Cuff on the other hand, admired the instrument very much. In the preface to Needham's *Nouvelles découvertes* he wrote:

[the] microscope of the new invention of Mr. Cuff in London [...] surpasses in all respects those that have been in use up to now. One can turn them into simple

⁷⁸ J. ELLIS, *An Essay towards a Natural History of the Corallines*, London, 1755, Introduction p. VIII, plate 39. Cuff made changes in the microscope for Ellis before August 1752, see *ibid.*, (French transl. 1756, p. 3): in August 1752, «à l'aide d'un microscope fait par Mr. Cuff, & que j'avois rendu propre à l'usage auquel je le destinois, j'eus l'occasion d'examiner dans l'eau même de la Mer ces Corallines».

⁷⁹ J. ELLIS, *Natural History of the Corallines...*, cit., p. 120.

⁸⁰ G. L'E. TURNER, *Baker...*, cit., p. 64.

⁸¹ B. BRACEGIRDLE, *A Catalogue of the Microscopy Collections at The Science Museum*, London, CD-Rom, 2005.

or compound [microscopes] without any difficulty, all their movements work with great facility and accuracy, and that without it being necessary to remove the object one is examining, whether it is opaque, transparent, solid or fluid. I do not doubt that when these microscopes are generally known, they will add to enlarging the number of microscopic discoveries because of the ease with which anyone can handle them.⁸²

The Trembley microscope enjoyed some popularity in the Low Countries. Jan van Musschenbroek's assistant Jan Paauw copied this microscope and sold it with his own signature. In the instruction manual which he provided with the microscope he acknowl-

edged that the design came from Cuff, whom he deemed to be the best maker of microscopes of the time. But he also brought about some changes to the microscope: notably the screw connecting the two parts of the focusing mechanism was fitted by Paauw with a knob at the bottom of the screw rather than to the top, as Cuff did.⁸³

CONCLUSION

The contextual approach we adopted in this paper allowed us to show that the influence of Continental scholars on British instrument making

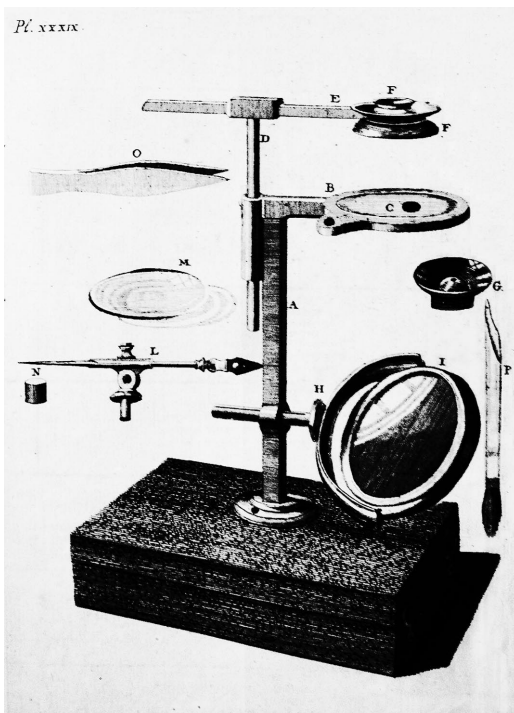


Fig. 4. The so-called Cuff-Ellis microscope, originated in Trembley's model.

⁸² J.N.S. ALLAMAND, *Avertissement...*, cit., p. 2.

⁸³ M. FOURNIER, *Early Microscopes A Descriptive Catalogue*, Leiden, 2003, no. 156, 157, 158, 159.

was greater than hitherto realised. We could link together three sorts of activities through which Trembley developed his interest in instrument-making. He kept up a network of instrument makers both in the Low Countries and in London. He was an agent and an expert as regards instruments for Bentinck and other scholars. And most of all, he looked for the best instrumental means to reshape his experimental research on living organisms. Thus his contribution to the development of the microscope was twofold. Thanks to his discovery of the polyp and his exciting investigations upon this organism, microscopy received a new impetus, and as a result the simple microscope, or *porte-loupe*, was further developed. This general story has been told in some detail in a number of studies. But, it now appears through a detailed analysis of Trembley's correspondence with Martin Folkes and William Bentinck that Trembley's impact was also more unique. Indeed, while the credit for the invention of the aquatic microscope is usually linked with John Ellis, the evidence we bring forward in this paper showed that it actually originated from the meeting between Trembley and Cuff in 1745. Therefore Trembley's influence on the construction of the microscope was much greater than usually acknowledged. The more so as aquatic movement was not reserved for single-lens microscopes after the simplified design developed by Cuff for John Ellis in 1752, but was also widely applied in compound microscopes throughout the second half of the eighteenth century.