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Re-visiting The Ridiculed Rival of Leeuwenhoek: Louis Joblot (1645 - 1723)

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Abstract

Louis Joblot published one of the first manuals of microscopy in 1718, just a few years before both he and Leeuwenhoek died. It contained Joblot's microscope designs and his extensive observations on microorganisms including experiments on spontaneous generation. Joblot's work and his observations have often been overlooked, misdated, and denigrated. This is due to attention given to a few apparently fanciful drawings of microorganisms, and the identification of his work as appearing in a posthumous 1754 edition. The second edition not only placed Joblot's work as decades after Leeuwenhoek's death, but was also expanded by the publisher to include unattributed material from famous sources. Here an attempt is made to shine a light on Joblot's work and bring it out of Leeuwenhoek's shadow.

Keywords: history of protistology; miscroscopy; infusoria; spontaneous generation; scientific illustration; *Paramecium*

Introduction

A contemporary of Antonie van Leeuwenhoek (1645-1723), but 13 years younger, Louis Joblot (1645-1723) was a "Professor of Mathematics and Perspective" at the Royal Academy of Painting and Sculpture in Paris. He was an accomplished physicist. Before turning to microscopy, he had published extensively on magnetism, and optics (Joblot 1701, 1702a,b, 1703a,b, Joblot 1704). Today Joblot is known by some as a pioneer microscopist, and the first to have authored a monograph on protists. It was in 1718 that Louis Joblot published, at his own expense, his treatise. It was the first monographic work on protists and the first treatise that contained both methods for the construction of microscopes and original observations of microorganisms (Ratcliff 2009). In 1718 when his treatise appeared, Joblot was 73 and Leeuwenhoek 86 years old. They both died in 1723, just a few years after the appearance of Joblot's treatise. There is no evidence that the two ever communicated. There is no mention of Joblot in any of Leeuwenhoek's letters. Leeuwenhoek was likely ignorant of Joblot's treatise as it appeared when Leeuwenhoek was 86 years old and

suffering from poor eyesight. On the other hand, Joblot was well aware of Leeuwenhoek's work. Joblot mentions Leeuwenhoek in his treatise with regard to the fact that Leeuwenhoek stated that using his microscope, the image of the object examined is reversed (Joblot 1718). Thus, Joblot knew of Leeuwenhoek and it is likely that Joblot's microscopical investigations were inspired by Leeuwenhoek's discoveries

Leeuwenhoek is commonly acknowledged as the first to have observed protists and bacteria. However, there are distinct opinions as to his role in the development of protistology. Many have declared or acknowledged Leeuwenhoek to be the "Father of Protozoology" (e.g., Corliss 2002; Dobell 1923). However, according to Becking (1924) Leeuwenhoek was an 'immortal dilettant' and not the founder of any discipline. His view is based on the fact that Leeuwenhoek's observations were known mainly through the 114 letters published by the Royal Society. The letters addressed a large variety of topics, often within a letter. He did not produce a coherent singular work that could be considered as the foundational piece of a field of study. Here the case will be made for considering Louis Joblot as another founder of protistology, an active promoter of microscopy, and the study of microorganisms, bringing him out from the shadow of Leeuwenhoek.

Louis Joblot was described by Dobell (1932) as the only other protozoologist of Leeuwenhoek's period because Joblot produced the first treatise on protists containing descriptions of many new forms. However, Dobell also dismissed Joblot as an imitator of Leeuwenhoek. Perhaps most importantly, Joblot is known for conducting the first experiments on spontaneous generation employing heat sterilization. In these experiments, he examined the development of protists in boiled and untreated media as well subsequent colonizations (e.g., Dobell 1923). Joblot's experiments have been used literally as a textbook example of an early experiment in microbiology (Wheelis 2008) but omitted entirely in some histories of spontaneous generation and microbes (Summers 2009). Joblot's treatise was also very unusual in its time as it prominently featured detailed technical illustrations allowing exact reproduction of several different microscopes (Jardine 2016). Joblot is also credited with technical contributions to microscopy in introducing the diaphragm (Nelson 1900) a rotating stage (Mayall 1886) and even special containers to allow transport of small volumes of cultures (Ratcliff 2004).

On the negative side, Louis Joblot has been ridiculed for his depictions of protists beginning early on (i.e., Boureau-Deslandes 1736), and continuing nearly to the present day (Ford 2010). In addition, Joblot has long been miss-cited with his observations and illustrations attributed only to a 1754 edition of his book published 21 years after his death in 1723 (e.g., Dujardin 1841; Müller 1773,

1786). The publication date of the 1754 edition casts Joblot as a post-Leeuwenhoek microscopist, rather than his contemporary. Furthermore, in the 1754 edition, the publisher added very well known material from Robert Hooke and others without any attribution leading to Joblot to be accused of copying illustrations of others without attribution. These matters are likely responsible for the fact that Joblot has remained in Leeuwenhoek's shadow for over 300 years. Here, the reader will be presented with new viewpoints with regard to Joblot's contributions. First Joblot's treatise will be briefly described and his illustrations of microscopic organisms presented in their entirety. Then the contentious, ridiculed, figures will be given special attention. Joblot's often-neglected contribution to the controversy of spontaneous generation will be described. Finally, the complicated publication history of Joblot's work will be laid out. In the interests of brevity, no extensive translations of Joblot's texts, or account of the life of Louis Joblot will be given; interested readers may consult Lechevalier's excellent account (in free access) and the several sources he cited (Lechevalier 1976). These will reveal that, sadly, almost nothing is known of Joblot's life other than dates of birth, death, and employment at the Royal Academy of Painting and Sculpture.

Joblot's Treatise

Joblot titled his treatise "*Descriptions et usages de plusieurs nouveaux microscopes, tant simples que composez : avec de nouvelles observations faites sur une multitude innombrable d'insectes, et d'autres animaux de diverses especes, qui naissent dans des liqueurs préparées, & dans celles qui ne le sont point*" (Descriptions and uses of several new microscopes, both simple and compound, with new observations on an innumerable multitude of insects and other animals in treated solutions and untreated solutions).The work was composed of two volumes, separately numbered, but bound together. The first volume, of 78 pages of text and 22 plates, consists largely of the presentation of detailed plans of microscopes (e.g., Fig. 1). The second volume, of 96 pages of text and 12 plates, contained his observations of microscopic organisms in various solutions both 'simple' (nothing added) and 'manipulated' (plant material added). The title of Joblot's book, and the order in which material was presented, reflected the primacy he gave to microscopy. In his preface he promoted the potential value of microscopy to various fields of endeavor. In the first volume he gave not only his designs for new microscopes, but also instructions on how to make inexpensive alterations to existing microscopes to improve performance.

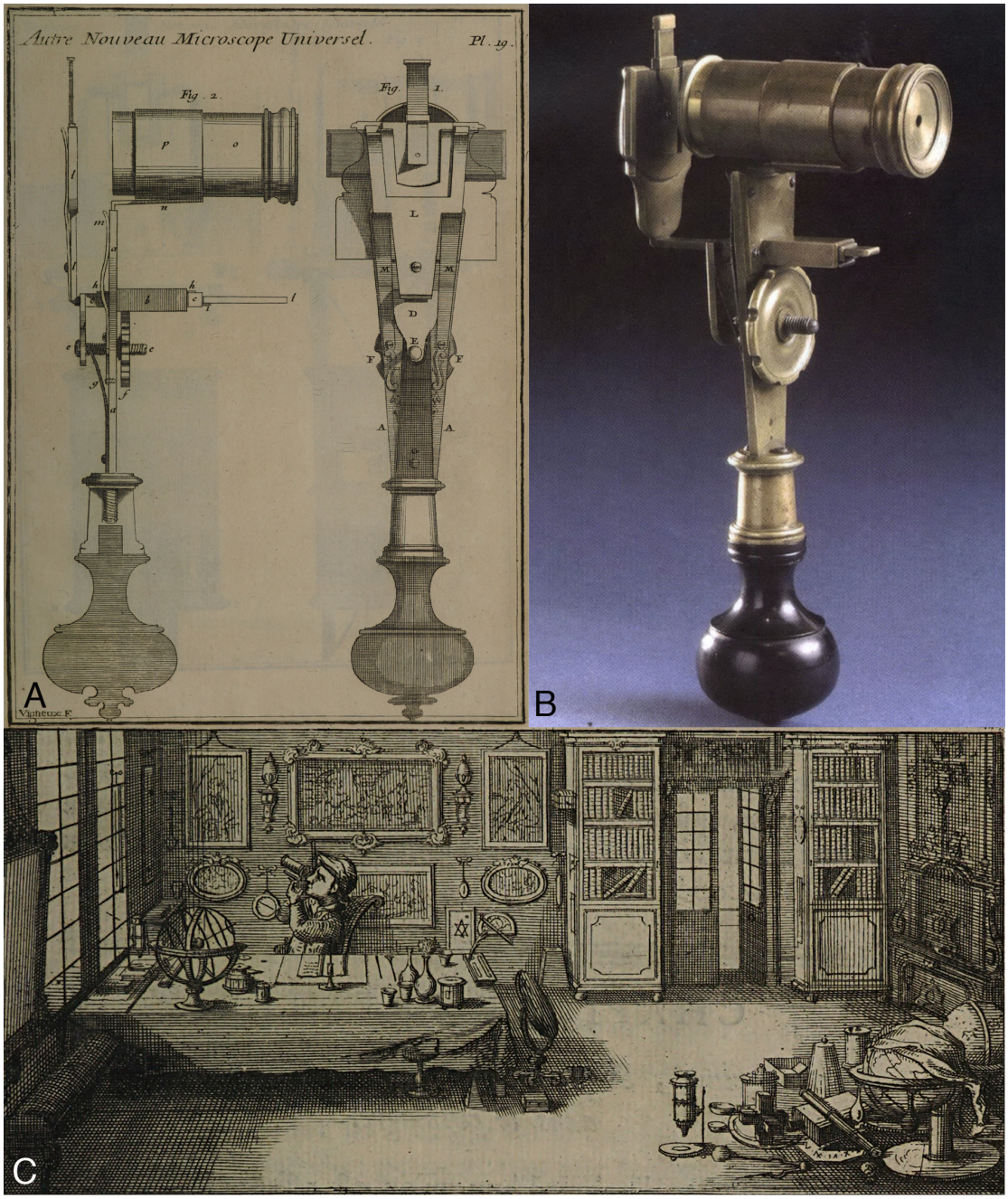


Figure 1. Joblot's microscopes. **A.** A new microscope design, in profile and head-on, and the components of the microscope. The details given allowed construction of the microscope by suppliers of telescopes and navigation instruments. **B.** Another new design for a hand held microscope with an ergonomic handle, photograph of the microscope held by the Musée des Confluences (from Jacomy 2011). **C.** An engraving, from the title page of the second volume on his observations of microorganisms, reputedly shows Joblot holding one of his hand-held microscopes up to the window in his laboratory.

Before examining Joblot's illustrations of microorganisms, it is important to know what he wished to convey with his drawings. In the preface to his book, he described the second part as a sort of journal of his observations to which is added his conjectures as to the nature of the very small animals. Thus, there is good reason to assume that both his texts and his drawings probably included some amount of conjecture. He states that to distinguish and describe the multitude of different types he saw he gave them names of common shapes, objects and animals that they most resembled such as ovals, bagpipes, kidney, tufted chicken, funnel, etc. The following figures include all of Joblot's illustrations of microorganisms. Most of the organisms are difficult to attribute to currently known forms. However, many were identified by Ehrenberg (1838) as either a recognizable illustration of certain previously described species, or as an illustration of a previously unknown species. Ehrenberg attributed to Joblot the illustration and text description of 24 recognizable species. Of the 24, 15 were considered as new species by Ehrenberg. To put the numbers 24 and 15 in perspective, Ehrenberg attributed to Leeuwenhoek the descriptions or first observations of 24 species.

Below are shown the 12 plates of Joblot's illustrations, in Figures 2, 3, and 4. The plates contain, in total, 236 drawings of microorganisms and inanimate objects. The actual size of each plate in the 1718 book is about 25 x 18 cm. In the plates, the depictions identified as first illustrations of a species by Ehrenberg (1838) are designated her by asteriks. It should be noted that Ehrenberg referred not only to Joblot's illustrations but also to his text descriptions. Also, while both Müller (1786) and Dujardin (1841) cited Joblot's text descriptions and figures, they both dated his observations as 1754 thus often not as first descriptions. Consequently their citations are not noted. Joblot's descriptions and illustrations were also cited in the English version of Linné's System of Nature (Linné 1802), based on Müller (1786), but again the citations were to the 1754 edition.

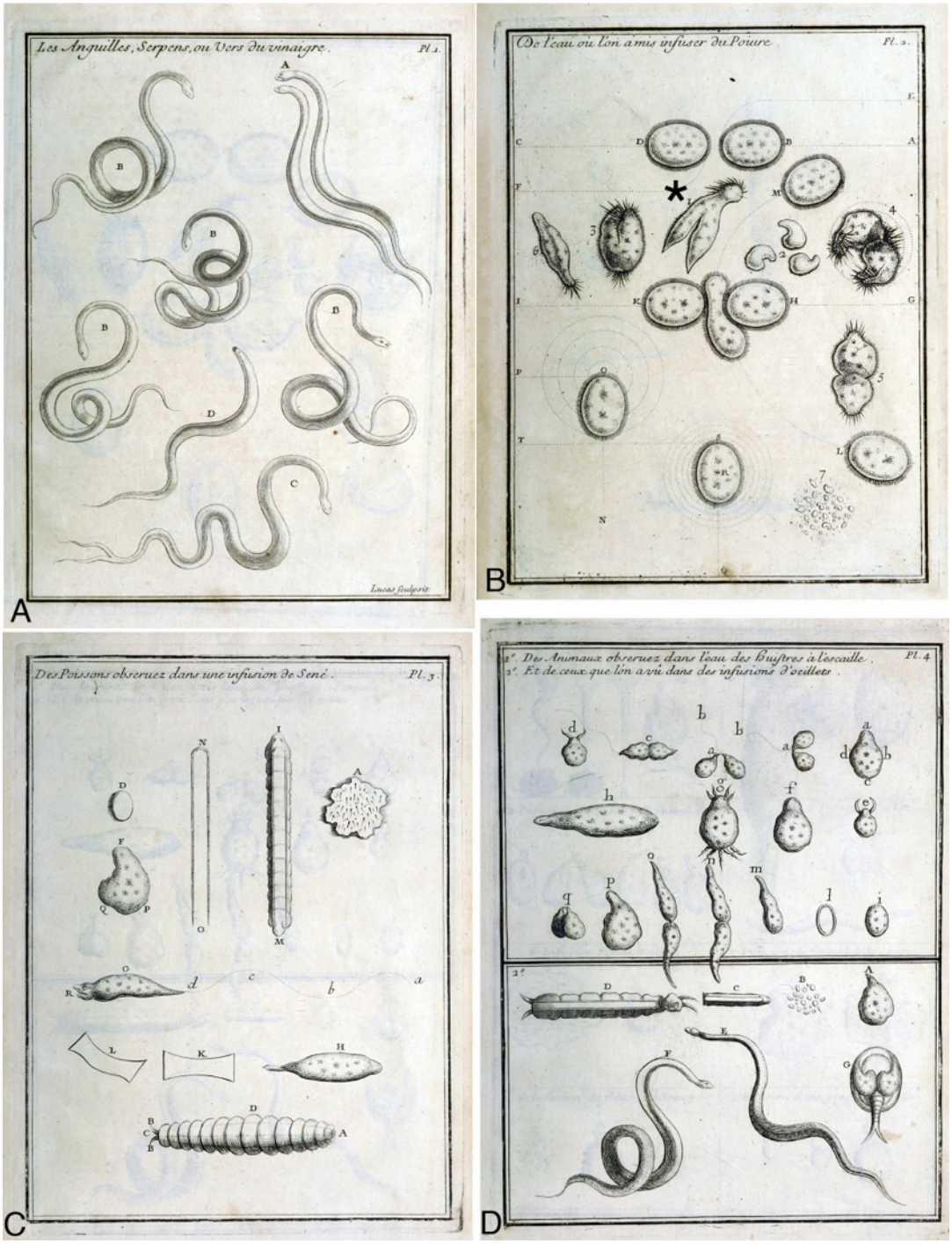


Figure 2. Plates 1-4. **A**. The *top left plate* show 'eels' found in various types of vinegar. Inclusion of eyes and a mouth in the drawings damaged Joblot's reputation. **B.** The *top right plate* shows microorganisms found in infusions of peppercorns. In the plate, the depiction labeled '*' was credited by Ehrenberg (1838) as the first depiction of the species he called *Oxytricha pellionella*, now known as *Tachysoma pellionellum* (Müller, 1773) Borror, 1972. The same drawing is also reputed to show a stage of conjugation (Baker 1953). **C**. The *bottom left plate* shows items and organisms from an infusion of séné, a small flowering plant. **D.** The *bottom right plate* shows forms from the mantle cavity of oysters (top half), all described as 'baby oysters' and forms found in infusions of oeillets, another flowering plant.

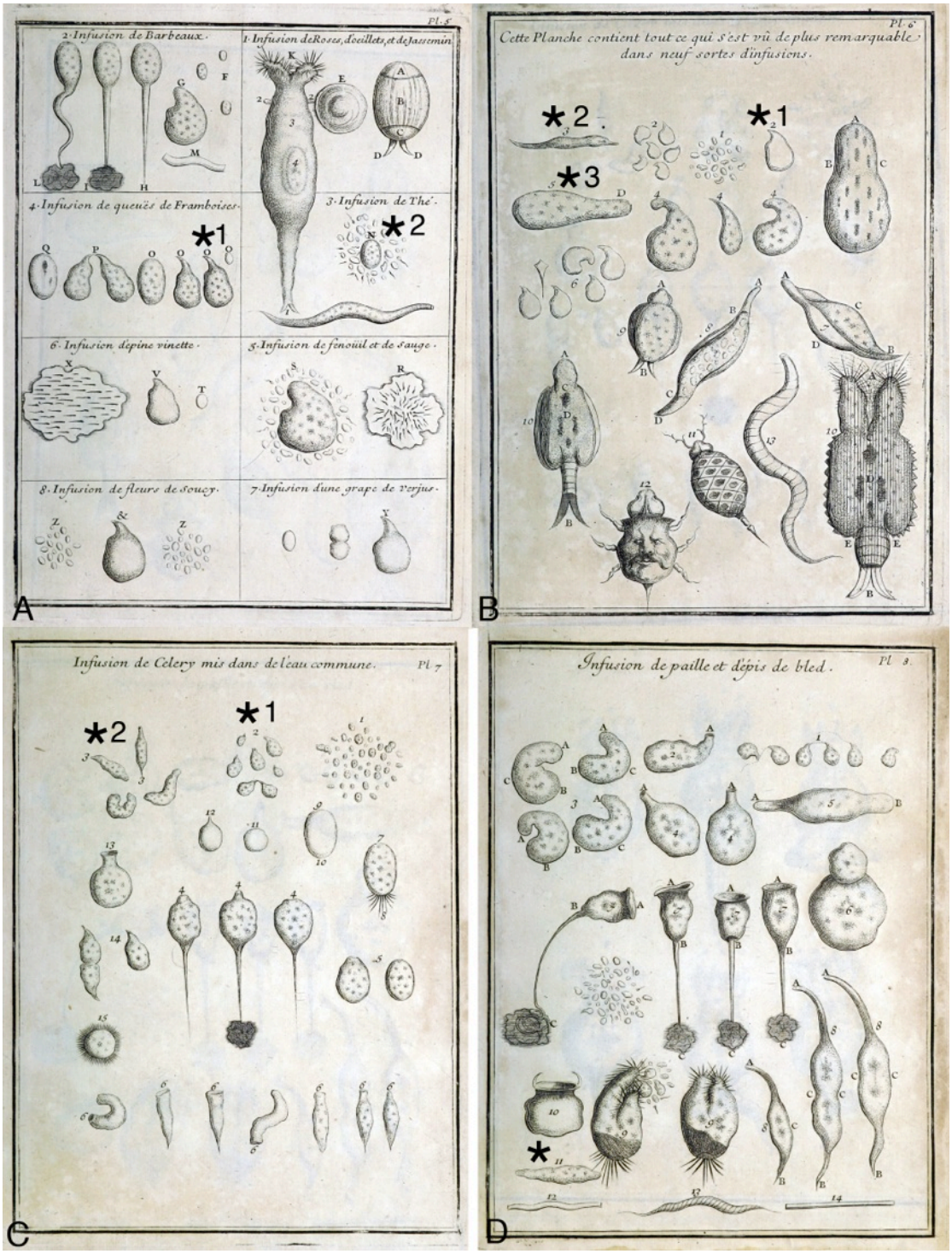


Figure 3. Plates 5-8. **A.** The *top left plate* shows microorganisms found in infusions of a variety of vegetable matter. The label *1 on the drawing labeled 3 indicates the illustration noted by Ehrenberg (1838) as part of the original description of *Cyclidium glaucoma*. The *2 on fig. 4 indicates that the illustration was noted as part of the original description of *Glaucoma scintillans*. **B.** The *top right plate* shows 'the most remarkable' organisms found in a variety of infusions. It includes an illustration that would become famous, the aquatic animal with a mask of a human face on its back (drawing labeled 12 in the plate), damaging Joblot's reputation. The illustrations 2, 3 and 5 labeled *1, *2, *3,

indicate the illustrations that were noted by Ehrenberg (1838) as part of the original descriptions of, respectively, *Trachelius anas*, *Trachelius lamella*, and *Enchelys pupa*. **C.** The *bottom left plate* shows organisms found in an infusion of celery. The labels *1 and *2 on the drawings labeled 2 and 3 indicate that they were noted by Ehrenberg (1838) as part of the original descriptions of, respectively, *Trichode pyrum* and *Trachelius trichophorus*. **D.** The *bottom right plate* show organisms found in infusion of hay and wheat. The figure labeled with an * was noted by Ehrenberg as the first depiction of *Amphileptus anser*.

Figure 4. Plates 9-12. **A.** The *top left plate* depicts "aquatic pomegranates, crowned and bearded", now known as rotifers. **B.** The *top right plate* show the organisms found in infusions of oak wood. Drawing in plate labeled 6 and 15, noted here *1, *2, were credited by Ehrenberg as the first depictions of, respectively, *Uroleptus piscis* and *Euplotes charon*. The drawing below the illustration 8, marked A-C-B, was named the slipper by Joblot, and would later be ridiculed. **C.** The bottom left plate shows the organisms observed in infusions of oak bark, probably all rotifers. **D.** The *bottom right*

plate shows organisms found in infusions of fresh oak bark. All of the organisms labeled A to Y were credited by Ehrenberg to be the first depictions of *Spirostomum ambiguum*.

Joblot's Most Ridiculed Illustrations

As mentioned above, Joblot's illustrations of the organisms he observed have long been derided, damaging his reputation as an early observer of microorganisms. Joblot was said to have had an over active imagination (e.g., Boureau-Deslandes 1736). Dujardin (1841) stated that several figures were so bizarre and fantastic that they no doubt discredited the use of the microscope. According to Saville Kent (1880-1881), Joblot *"... was unfortunately led, through his possession of a more than ordinarily romantic imagination, to embellish very considerably his descriptions and drawings of the various types observed, these latter being in many instances moulded by his facile pen into the similitude of satyrs's heads and other monstrosities having no existence in the plain and solid ground of fact*." Particular attention has been drawn to the three drawings shown in Figure 5: Joblot's illustrations of vinegar eels, now known as the nematode *Turbatrix aceti*, the aquatic animal with a mask of a human face on its back which came to be known as the satyr, and the slipper, now known as the ciliate *Paramecium*. The three figures were all derisively commented upon by Entz (1888), a few years after Saville Kent.

Figure 5. The most ridiculed illustrations of Joblot. The left panel is a vinegar eel from Plate 1, shown with eyes and a mouth. The middle panel shows the aquatic animal with a mask of a human face on its back from Plate 6. The right panel shows the organism Joblot named the slipper, now recognized as *Paramecium* from Plate 10.

The vinegar eel was given as an example of a fantastic creature by Calkins (1910). However, in all fairness, Joblot's text states that he did not actually observe them to have mouths and eyes but included these features in his illustrations as his observations of their behavior led him to believe that they likely existed. It should be mentioned that Robert Hooke (1665) appears to have been the first to provide an illustration of vinegar eels and in describing his illustration (1665, plate 25, fig. 3) remarked on zones on the body, which might

be gills. Unlike Joblot, Hooke's suppositions concerning the gills of vinegar eels were not mocked.

Probably the illustration that did the most damage to Joblot's reputation is the aquatic animal with the mask of a human face on its back. It attracted comments early on (e.g., Anon. 1719). Baker (1742), in recommending Joblot's treatise, appears to have been the first to call attention to the illustration as "an exact satyr's face". Hill (1752) in an essay mocked "a certain French writer who says there is the figure of a satyr's face". Despite Saville Kent's assertion (above), there was only one organism described as having a human face on its back. Joblot states that he was amazed by the sight and saw it only once and never found it again, nor another like it. Obviously, the existence of a microorganism with a feature so closely resembling a human face is unlikely. One likely fanciful figure out of the hundreds can perhaps be forgiven.

Joblot's illustrations have been very harshly denigrated, termed caricatures relative to those of Leeuwenhoek (e.g. Ford 1985; Ford 2010). However, it should be recalled that Leeuwenhoek's drawings were the work of professional draughtsmen who drew what they saw through the microscope (i.e., Leeuwenhoek 1703, 1705). The drawings accompanying Leeuwenhoek's letters were then used by engravers employed by the Royal Society to make the engravings published in the *Philosophical Transactions of the Royal Society* (Dobell 1932). Unlike Leeuwenhoek, Joblot's illustrations of hundreds of forms were all based on his own drawings and most of the plates (the exceptions are the signed plates 1 and 12), he engraved himself.

Joblot's illustration of a microorganism with the shape of a slipper was according to Entz (1888) likely to have been based on his own slipper. While derided, the 'slipper' has remained a popular common name for *Paramecium* and the resemblance even shown as in Figure 6, the first figure in Wichterman's seminal book *Paramecium* (Wichterman 1953). Thus, Joblot's illustration of an organism resembling a slipper does not today appear to be the result of, in the words of Saville Kent, "*a more than ordinarily romantic imagination"*.

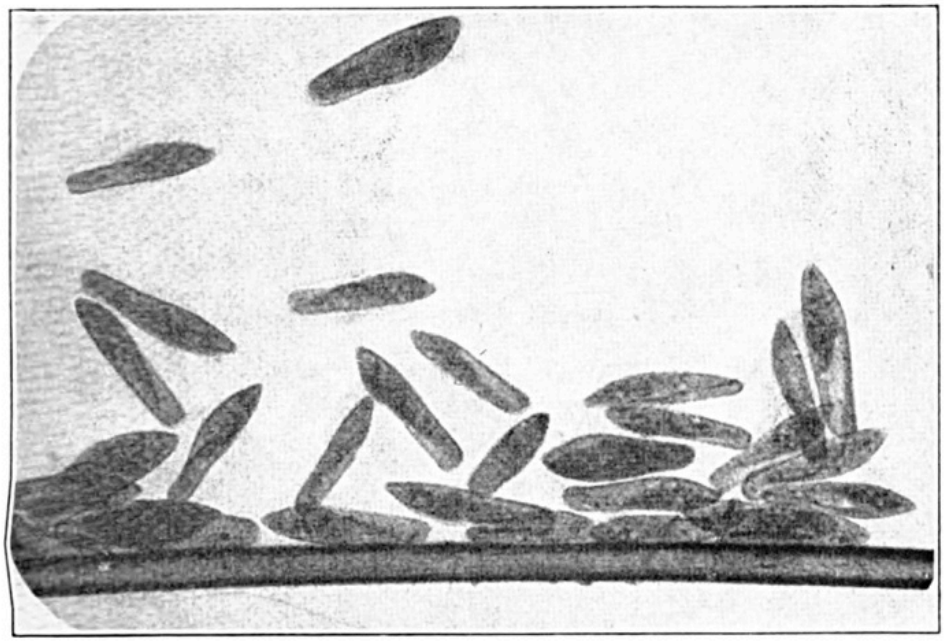


FIG. 1. Living specimens of *Paramecium caudatum* photographed next to a hair from author's head. Note how closely the paramecium to the right resembles the shape of a lady's slipper. (Wichterman)

Figure 6. The first illustration in Wichterman's book on *Paramecium*. He pointed out the resemblance of *Paramecium caudatum*, when orientated in a certain fashion, to a lady's slipper (Wichterman 1953).

Joblot and spontaneous generation

Louis Joblot, in the preface to his treatise, drew special attention to his observations and experiment with regard to the question of the factors governing the appearance of microorganisms in his 'infusions'. He stated that his observations argue against a production of living organisms attributable simply to putrefaction, or inanimate matter. In his treatise, he showed that infusions of material from different plants contained different forms of microorganisms. Joblot hypothesized that the microorganisms found in his infusions originated from 'eggs' deposited on the plant material, with different 'eggs' deposited on different plants, as well as 'eggs' circulating in the air. Joblot's text concerning his experiment examining these possibilities is given below (translation of the original text from Lechavalier 1976)

> *"On the 13th of October, I boiled similar fresh hay in ordinary water for more than a quarter of an hour. I then placed an equal quantity in two vessels of about the same size. I sealed one right away even before it has cooled down: in the other one, which I had left open, I saw animals at the end of a few days but not in the infusion which had been sealed. I kept it sealed a considerable amount of time in order to find some living insect, if any should grow, but finding none, I left it open and after a few days I observed some. From this, one*

should understand that these animals were born from the eggs distributed in the air since those which would have been encountered on the hay had been completely ruined by boiling water."

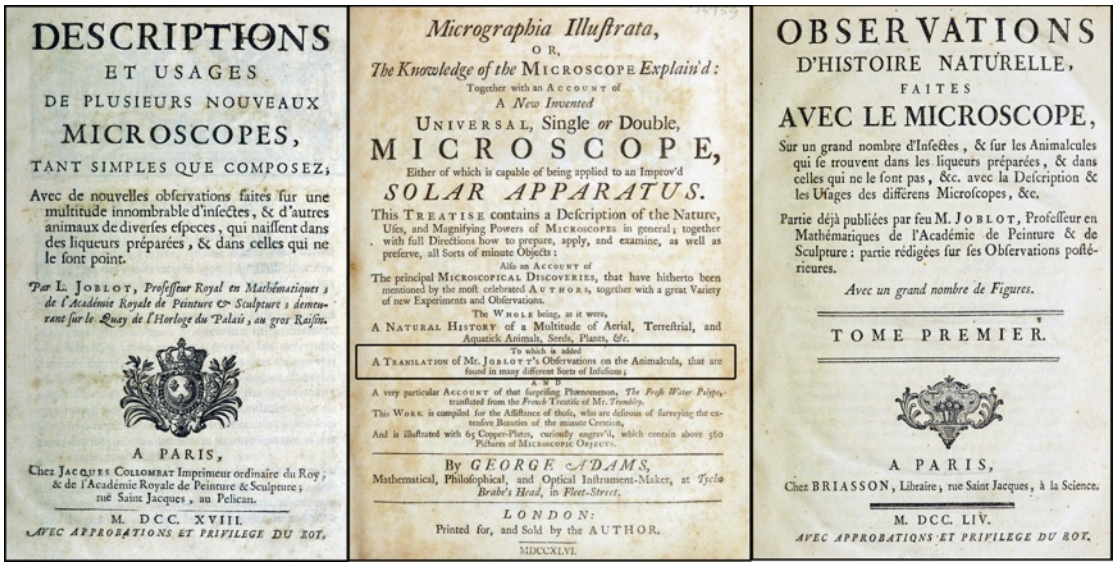
Joblot established that boiling sterilized plant material. Further, exposure to open air sufficed to allow the once sterilized hay solution to become populated by microorganisms. Joblot, while the first to demonstrate inoculation of microbes by simple exposure to air, he was not the first to propose it. That honor goes to Leeuwenhoek. According to Dobell (1932), Leeuwenhoek was inspired by Redi's famous demonstration of the effects of covering meat with regard to the appearance of maggots and flies (Redi 1668). However, Leeuwenhoek failed in his attempt to demonstrate a development of microbial populations through exposure to open air. In 1680, he examined sealing, or leaving open, solutions in vials without heating them beforehand. Leeuwenhoek found that with time animacules appeared in both (Dobell 1932).

Joblot's and or Leeuwenhoek's experiments would later be replicated by Needham, without any mention of Joblot or Leeuwenhoek. Needham purported to show that microbial populations appeared in corked containers of previously heated blood solutions (Needham 1748). The question was finally laid to rest when Spallanzini showed that spontaneous generation of protists did not occur if containers were hermetically sealed (Spallanzini 1765).

The role accorded to the work of Louis Joblot in the fall of spontaneous generation varies considerably among accounts. Some omit any mention (e.g., Farley 1974; Summers 2009). However, many do acknowledge that the experiments described in Joblot's treatise represented an important and oft-neglected advance (e.g., Dobell 1923; Doetsch 1976; Drews 2000).

The Tangled Publication History of Joblot's Work

Louis Joblot's work appeared in print in three publications (Fig. 7). The first was the original, self-published, version of 1718. Many years later, some of Joblot's observations were translated, and a selection of his illustrations of microorganisms, were included in George Adam's *Micrographia Illustrata*. It was a popular guide to microscopy published in 1746 in English. This work included text and illustrations from both Joblot "on the animalcules found in many different sorts of infusions", and from Trembley on "the freshwater polype". Finally, in 1754, some 21 years after Joblot's death, a new, very different, edition of Joblot's treatise was published with a great deal of extra material added by the publisher.


DESCRIPTIONS
ET USAGES
DE PLUSIEURS NOUVEAUX
MICROSCOPES,
TANT SIMPLES QUE COMPOSEZ;
Avec de nouvelles observations faites sur une multitude innombrable d'insectes, & d'autres animaux de diverses especes, qui naissent dans des liqueurs préparées, & dans celles qui ne le sont point.
Par L. JOBLOT, Professeur Royal en Mathématiques, de l'Académie Royale de Peinture & Sculpture, demeurant sur le Quay de l'Horloge du Palais, au gros Raisin.
A PARIS,
Chez JACQUES COLOMBAT Imprimeur ordinaire du Roy, & de l'Académie Royale de Peinture & Sculpture, rue Saint Jacques, au Pelican.
M. DCC. XVIII.
AVEC APPROBATIONS ET PRIVILEGE DU ROY.
Micrographia Illustrata,
OR,
The Knowledge of the MICROSCOPE Explain'd:
Together with an ACCOUNT of
A New Invented
UNIVERSAL, Single or Double,
MICROSCOPE,
Either of which is capable of being applied to an Improv'd
SOLAR APPARATUS.
This TREATISE contains a Description of the Nature, Uses, and Magnifying Powers of MICROSCOPES in general; together with full Directions how to prepare, apply, and examine, as well as preserve, all Sorts of minute Objects:
Also an ACCOUNT of
The principal MICROSCOPICAL DISCOVERIES, that have hitherto been mentioned by the most celebrated AUTHORS, together with a great Variety of new Experiments and Observations.
The WHOLE being, as it were,
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To which is added
A TRANSLATION of Mr. JOBLOT's Observations on the Animalcula, that are found in many different Sorts of Infusions;
AND
A very particular ACCOUNT of that surprising Phænomenon, The Fresh Water Polype, translated from the French Treatise of Mr. Trembley.
This WORK is compiled for the Assistance of those, who are desirous of surveying the extensive Beauties of the minute Creation,
And is illustrated with 65 Copper-Plates, curiously engrav'd, which contain above 560 Pictures of MICROSCOPIC OBJECTS.
By GEORGE ADAMS,
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OBSERVATIONS
D'HISTOIRE NATURELLE,
FAITES
AVEC LE MICROSCOPE,
Sur un grand nombre d'Insectes, & sur les Animalcules qui se trouvent dans les liqueurs préparées, & dans celles qui ne le font pas, &c. avec la Description & les Usages des différens Microscopes, &c.
Partie déjà publiées par feu M. JOBLOT, Professeur en Mathématiques de l'Académie de Peinture & de Sculpture: partie rédigées sur ses Observations postérieures.
Avec un grand nombre de Figures.
TOME PREMIER.
A PARIS,
Chez BRIASSON, Libraire, rue Saint Jacques, à la Science.
M. DCC. LIV.
AVEC APPROBATIONS ET PRIVILEGE DU ROY.

Figure 7. Publications of Louis Joblot's Observations and Illustrations from 1718 to 1754. The left panel shows the cover of Joblot's 1718 treatise. Note the primacy given in the title to 'descriptions and uses of several new microscopes'. The middle panel shows the cover of Adams' 1746 *Micrographia Illustrata*, a popular book on microscopy, which included translations of some of Joblot's observations and illustrations of microorganisms (indicated within the added square). The right panel shows the title page of the 1754 re-edition of Joblot's treatise. It included material added on insects, plants, and mineral salts and was published 21 years after Joblot's death. Note the primacy in the title given to 'observations of natural history' rather than microscopy.

The publications of Joblot's work in 1740's and 1750's, long after his death, rather than increasing his renown, likely diminished his reputation, primarily because later workers commonly mis-dated his work. The "second edition" of his treatise, and the reproduction of Joblot's texts and illustrations in Adams' book, firmly placed Joblot's observations in the post-Leeuwenhoek period rather than as one of the early microscopists. Mistakenly attributing the 1754 edition as resulting from an action by Joblot himself has yielded some rather odd citations. Ford (2000) for example, gives Joblot's years of birth and death (1723), with the title and year of 1718 treatise, and then remarkably states "*He followed it by Observations d'histoire naturelle, faites avec le microscope [etc] 2 volumes (1754-55), Paris*" thus attributing the publication of the work actively to Joblot 21 years post mortem. Another is Entz (1888) crediting Joblot with having observed a heliozoan in 1712 but only publishing the observation a full 39 years later. Also, by the 1740's popular works on microscopic marvels with detailed illustrations had appeared (e.g. Baker 1742; Adams 1746) and Joblot's work from decades earlier appeared quaint in comparison.

A change in the reception of Joblot's work in the years separating the two editions is evident from a comparison of the reviews in the *Journal des Sçavans* of

the 1754 edition (Anon. 1755) compared to the review of the 1718 edition (Anon. 1719). In the early review (Anon. 1719) of 13 pages, several pages are devoted to Joblot's microscopes. The organism with a mask of a human face on its back is mentioned, but not mocked. Joblot's experiments on the effects of heating media on the development of aquatic microorganisms are described in detail along with his conclusions concerning microbial colonization as resulting from open exposure to air. Interestingly, Leeuwenhoek is not mentioned. In contrast, the review of the 'new edition' (Anon. 1755) of 3.5 pages, states that animalcules have been known since Leeuwenhoek and Hartsoeket. The review points out that material and illustrations from the work of Hooke and Grew are included without attribution. Joblot's illustrations are described as showing a multitude of beings that would surprise the most developed imagination, and the statement is made that Joblot saw an infinity of things no one else has ever seen, singling out the organism with a mask of a human face on it back. Also in contrast to the 1719 review, Joblot's experiments and conclusions concerning the prevention of the development of microorganisms by boiling infusions are said to have been disproven years ago by J.T. Needham (1748) who purported to show the reality of spontaneous generation.

The amount of material in the 1754 edition attribution taken from the works of Robert Hooke (1665) Nehmiah Grew (1682) and Henry Baker (1742) was actually substantial. The reproduction, for example, of Hooke's illustration of louse has led to an accusation of plagiarism in recent years (i.e., Oliver 2005). The material copied from Baker was on mineral salts and included an exact copy of Baker's plate 14. As Baker's book dates from well after the death of Joblot, there can be no doubt that the blame for the plagiarized nature of the 'new' material added to the 1754 edition lies with the publisher.

Notably, the publisher also changed the title (Fig. 7) giving primacy to microscopical observations, rather than microscopes: "*Observations d'Histoire Naturelle Faites Avec Le Microscope, sur un grand nombre d'insectes, & sur les animalcules qui se trouve dans les liquers préparés, & dans celles qui ne le font pas, & avec la Description & Usages des différens Microscope, etc*.". What would motivate a publisher to reprint Joblot's 36-year-old treatise but add material on insects, plants and mineral salts from old but well-known works? Likely it was the appearance in 1754 of a French edition of Henry Baker's "*The Microscope Made Easy*", a true best seller of the time (Turner 1974). According to Gottdenker (1979), Baker obviously had modeled his book after Joblot's 1718 treatise. By 1754, *The Microscope Made Easy* had already gone through 4 editions in English and contained much material on insects, plant structure, and mineral salts.

While Joblot's work was published in two editions in France, it likely became only widely known beginning in 1746 when his observations on microscopic

organisms were translated into English and appeared with some of his illustrations in George Adam's controversial yet popular book "*Micrographia Illustrata*" (Fig. 7). The Adams' book appears to have been quite popular as it went through 4 editions, with the last edition printed in 1771. The history of the book is mixed up with that of Henry Baker's *The Microscope Made Easy*. Adams was accused of copying large parts of Baker's book, and publishing a book largely to sell his own microscopes (see Dolan 2019). Nonetheless the two books co-existed and both went through several editions. In Adams' book, only a small sample of Joblot's illustrations are given. Unfortunately for Joblot's reputation, the few samples provided prominently included two of his most ridiculed illustrations, the vinegar eel and the satyr masked organism. Thus, the most widely known illustrations of Joblot were probably those in the Adams book, which included contentious figures.

A note on the supposed discovery of the contractile vacuole

The discovery of the contractile vacuole has been repeatedly attributed to Louis Joblot. Both the original 1718 treatise has been cited as containing a description of what is now known as a contractual vacuole (e.g., Woodruff 1937; Wichterman 1953) as well as the 1754 edition (e.g., Calkins 1910). Unfortunately, none of the citing articles give any details as to where the description might be found. Patterson (1980) stated that a critical reading of Joblot 1718 fails to support the existence of a first observation. The only texts which might be construed as perhaps referring to an organelle now known as the contractile vacuole are mentions of an apparent beating heart in several organisms, but in agreement with Patterson (1980), none are clearly identifiable today as describing a contractile vacuole in a ciliate.

Conclusions

Hopefully shown here is that Louis Joblot was much more than an imitator of Leeuwenhoek. Joblot conducted the first controlled experiments to examine the effects of heating media on the subsequent development of microbial populations. Dobell described the experiments as truly extraordinary for their time (Dobell 1923). While Leeuwenhoek never shared his microscopes, Joblot was a promoter of microscopy, providing designs of microscopes, and instructions for their use. Joblot's observations and illustrations have been treated as belonging to the 1750's rather than Leeuwenhoek's era. Dismissed by some later workers such as Saville Kent and Dobell, Joblot's microorganisms were carefully catalogued by others such as O.F. Müller, C.G. Ehrenberg, F. Dujardin and O. Bütschli. Joblot freely admitted to naming the microorganisms he observed with names of known organisms and objects, many of which such as bagpipes, slipper, and crested chicken, appear fanciful today. Some of his

illustrations were indeed embellished, as he stated, to show what he thought likely existed such as eyes and mouths of vinegar eels. On the whole, Louis Joblot should be remembered as a pioneer microscopist who made important contributions to protistology.

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