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THE *HISTORIA PISCIUM* (1686)

by

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SUMMARY

In 1686, just as Newton was preparing for the publication of the *Principia*, the *Historia Piscium* was being printed under the auspices of The Royal Society. The *Historia Piscium* was a work begun by Francis Willughby (1635–1672, F.R.S. 1663), completed by John Ray (1627–1705, F.R.S. 1667) and brought into print with the financial support of The Royal Society. The text and illustrations of the *Historia Piscium* reflect the 17th-century origins of the enterprise: Ray's quest to recover the knowledge and language lost in the Fall, and The Royal Society's support for establishing a reformed natural history of fish through publication. Ray's biblical belief in the corruption of human language and knowledge led him to reform natural history through 'characteristic marks'. He sought to define, classify and depict fishes through their external features, which when matched up, would yield the same nature, and thus allow humans to identify and give a name to a fish. The Royal Society helped Ray's task by confirming the validity or uselessness of a given author on the subject, suggesting other authorities and sources for illustrations, organizing the printing, checking the corrections and paying for the cost of the printing. Subscriptions were sought for the illustrations and the inscriptions of subscribers reflect the Society's concern to promote its institutional identity and its supporters. Some Fellows of the Society also helped Ray with identities and classification of fishes, and changes were made in response to suggestions and objections of other Fellows. Without the intellectual and financial support of the Society, especially Pepys, Lister and Robinson, the *Historia Piscium* would not have been published in the way that it was. Despite the subscription, however, the *Historia Piscium* was a costly venture, largely due to its lavish illustrations, and the subsequent flop of sales of the book meant that The Royal Society faced serious financial problems. This is perhaps the main reason why it could not meet the cost of publishing Newton's *Principia*.

INTRODUCTION

Before embarking on the Grand Tour of Europe, John Ray (1627–1705, F.R.S. 1667) and Francis Willughby (1635–1672, F.R.S. 1663) agreed to reform the study of natural history, Ray undertaking to study the plants, and Willughby the animal kingdom of birds, fishes and insects. They travelled extensively through Europe from 1662,

collecting specimens, attending and recording dissections, purchasing books and pictures, and finally returning to England in the spring of 1666.[1] During the winter of the same year both Ray and Willughby worked on tables of plants and animals requested by John Wilkins for his *Essay towards a real character and philosophical language* (1668). Willughby died on 3 July 1672, and in an act of friendship and obligation, Ray completed and published the work begun by Willughby—the *Ornithologiae libri tres* (1676; English edition, 1678) and the *Historia Piscium* (March 1686). Both works were handsomely illustrated with engravings, a feat that could not have been achieved then without some substantial subvention—Willughby's widow paid for the illustrations for the *Ornithology*, while members of The Royal Society subscribed to the engraved plates in the *Historia Piscium*.

The *Ornithology* and the *Historia Piscium* are similar in form and approach, though the latter has the unique distinction of nearly bringing The Royal Society to financial destruction, and has often been blamed for the failure of the Society to meet the cost of printing Newton's *Principia* the following year. There is, of course, more to the *Historia Piscium* than remaining an ignominious footnote to the *Principia*. Georges Cuvier, for instance, saw the *Historia Piscium* as marking a 'happy epoch' that ushered in the beginning of modern ichthyology.[2] Indeed, the *Historia Piscium* seems to differ markedly from the works of natural history of the previous century by emphasizing morphology and rejecting mythical and fantastic descriptions. Yet, as I argue in this paper, the *Historia Piscium* was a product of 17th-century England in two fundamental ways. First, Ray's approach was guided by a biblical belief in the corruption of human knowledge and language generally held among his peers at the time. Second, the book would not have been published in the way that it was without the crucial support of The Royal Society.

The *Historia Piscium* consists of two parts: the text, printed in Oxford by John Hall and supervised by John Fell, the Bishop of Oxford (figure 1); and the illustrations with a separate title page, *Icthyographia* (i.e. pictures or descriptions of fishes), printed in London.[3] The two parts were frequently bound together. For both the text and images, Ray drew heavily on works by others: Hippolytus Salviani's *Aquatilium Animalium Historiae* (1554), Guillaume Rondelet's *De Piscibus Marinis* (1554), Conrad Gessner's *Historiae Animalium* (1551–87), Ulisse Aldrovandi's *De Piscibus libri v* (1613), Pierre Bellon's *De Aquatilibus* (1551), Carolus Clusius's *Exoticorum Libri Decem* (1609), Stephanus Schonevelde's *Icthyologia* (1624), the *Historiae rerum naturalium Brasiliae* (1648) by Willem Piso and Georg Marcgraf, and a volume of pictures of waterfowl and fishes drawn by Leonard Baltner, a fisherman from Strasbourg, purchased by Willughby during the Grand Tour.[4]

FRANCISCI WILLUGHBEII Armig.

DE

HISTORIA PISCIUM

LIBRI QUATUOR,

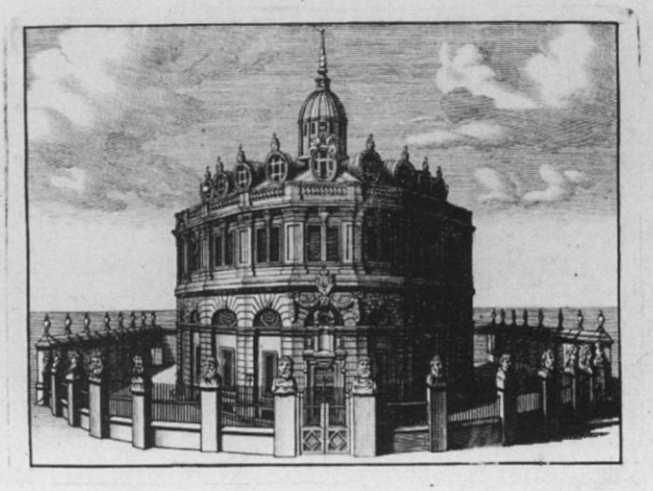
Juſſu & Sumptibus SOCIETATIS REGIÆ LONDINENSIS editi.

In quibus non tantum *De Piſcibus* in genere agitur, Sed & ſpecies omnes, tum ab aliis traditæ, tum novæ & nondum editæ bene multæ, naturæ ductum ſervante Methodo diſpoſitæ, accurate deſcribuntur.

Earumque effigies, quotquot haberi potuere, vel ad vivum delineatæ, vel ad optima exemplaria impreſſæ; Artifici manu elegantiſſime in Æs inciſæ, ad deſcriptiones illuſtrandas exhibentur. Cum Appendice Hiſtorias & Obſervationes in ſupplementum Operis collatas complectente.

TOTUM OPUS

Recognovit, Coaptavit, Supplevit,
Librum etiam primum & ſecundum integros adjecit
JOHANNES RAIUS e Societate REGIA.



OXONII,
E THEATRO SHELDONIANO, *Anno Dom.* 1686.

Figure 1. Title page of *Historia Piscium*.

RAY'S PROJECT

Ray explained that as with the *Ornithology*, the *Historia Piscium* was not a *pandect*, a collection of everything ever written about a given animal, be it true, false or dubious, as in Conrad Gessner's *Historiae*; nor was it an *epitome*, a short-cut guide to such compilations. Instead, Ray was hoping to offer a newly reformed natural history of fishes. According to Ray, the major problem natural history had suffered was the 'multiplication of species'. This problem arose because vague or incomplete descriptions of the same animal had been taken to refer to several different animals. Ray wanted to ensure that descriptions of external features were specific and distinct enough to describe a species properly and adequately—these descriptions he called 'characteristic' marks or notes (*Historia Piscium*, Appendix, p. 28).[5]

The search for characteristic marks guided Ray's definition and classification of fishes as well as his choice of illustrations. Departing from the traditional definition of fishes as aquatic animals, or any animal living in water, Ray defined fishes descriptively, as having hairless skin and fins, lacking feet and being unable to live freely or long without water. Because of this narrower definition based on external features, some creatures traditionally treated as fishes were excluded. For instance, the hippopotamus and the crocodile were both rejected by Ray because they have feet and can live outside water. On the other hand, it also meant that Ray defined cetaceans such as whales as fishes too, despite acknowledging that their internal structure resembled viviparous quadrupeds. Albeit large, whales have a smooth skin without hair, do not have feet but have fins and cannot breathe outside water; therefore they must be counted as fishes (*Historia Piscium*, pp. 1–2).

Similarly, Ray emphasized the importance of external features for classification and deliberately altered Willughby's classification by habitat commonly used by 16th-century authors such as Pierre Belon. Ray opposed classification by habitat because it separated species which, by external form, should be grouped together; moreover, habitat of a fish could change within the course of a lifespan of a fish such as salmon. Instead, Ray offered a morphological division—fishes were first divided into three classes: cetaceous, cartilaginous and bony. Cartilaginous fishes were further divided into long or broad; bony fishes into truncated or long. Bony, truncated fishes were then subdivided into those with no pelvic fins or with pelvic fins; then further into whether the pelvic fins were soft-rayed or spiny; or if they were accompanied by three, two or one dorsal fins. This series of subdivision according to external features was meant to facilitate identification—rather than having to match up every feature, such as the shape, size, number and colour of fins, gills, spots and eyes with every entry, one could follow the table through major features such as the shape of the body and number of fins to look up a much smaller group of entries for identification. Although Ray does discuss in general the parts of the fish, its anatomy, motion and generation in the first book, the remainder of the *Historia Piscium* is dedicated to describing the morphology of species of fishes.

It is this strong emphasis on morphology that marks the difference between the *Historia Piscium* and earlier works. Sixteenth-century authors on fishes such as

Rondelet or Gessner were writing within the tradition of the *materia medica*, and showed a good deal of interest in the medicinal uses of fishes, including how to catch them and prepare them for food or for medicine. Gessner, in particular, went further and gathered all that was written about a particular animal by any author, ancient or modern. In contrast, Ray's aim was to produce a book by which people could identify and name a fish correctly through characteristic marks.

Ray's choice of pictures was also guided by a concern to establish characteristic marks. Ray thought that Willughby had at times been over-meticulous in his descriptions, paying too much attention to individual details. This would not do because, as Ray put it, 'Nature doth not in all Individuals, (perhaps not in any two) serve exactly the same spots or strokes.'[6] The characteristic marks were features common to a species, not unique to an individual. Thus we find Ray similarly rejecting some of Baltner's pictures because they were 'an accidental or a monstrous variety' and thus not a constant species.[7] This also explains why the *Historia Piscium* is devoid of pictures of monsters or prodigies such as the monkfish, so popular in the 16th century.

Ray of course had other reasons for discarding certain illustrations. For instance, he rejected Bontius's illustrations as 'heathenish' and not matching the textual description, which in turn were already described by Marggrave or Nieuhoff.[8] Whether they matched the textual description was another important touchstone for illustrations.[9] For instance, '*Mustela vulgaris*', called Sea Loche in Chester, is described as a bony, non-depressed fish, three-quarters of a foot in length with a flat head. Ray thought that this was the same fish as the Sorghe Marina of Venice reported by Gessner, because Gessner's verbal description matched the description of the Sea Loche in every respect. Ray, however, rejected Gessner's picture for the Sorghe Marina because it did not match the description. What is noteworthy is that instead of then just discarding Gessner's illustration, Ray tried to find out if it might represent another fish, and concluded that it best matched the mullet called Lumpen in Antwerp.[10] Textual description and visual illustration may well not match each other, but this did not mean that one kind of description was privileged over another. Ray treated textual description and visual illustration of past authors as equally referring to a possibly real fish.

In the text and images, then, Ray was trying to establish characteristic marks of species of fishes. This enterprise, I believe, reflects certain beliefs that Ray shared with his contemporaries. As already mentioned, Ray created 'Tables' for John Wilkins's *Essay* towards a real character, which aimed to construct a universal language based on a proper knowledge of nature. Wilkins's project of a universal language was based on the belief that as a curse on humans for their arrogance as signified in the Tower of Babel, the tongues of peoples had become confused, so that instead of the one language that Adam spoke, there were now hundreds more.[11] This meant that although humans were capable of forming mental notions of things, when expressing these notions the curse of Babel made different nations assign different arbitrary sounds to them and thus created confusion.[12] The curse was to be overcome by a construction of a universal language based on a table that properly expressed the natural order and

relations between things. Each thing or notion was to have a mark or name assigned to it according to its respective nature, and this mark was to signify things, not words.[13] For Wilkins, mythical creatures did not have a place in this scheme because they were 'bare names'—have no counterpart in things; they may at best be treated as 'individuals'.[14] Precisely because Wilkins aspired to a universal language, however, individuals, bound to particular places or times, were not included in his scheme.[15]

Ray himself had earlier encountered a bewildering variety of dialects in his travels through England. His works on words reflect his concern to clear up this linguistic confusion.[16] To Ray, the problem of language and method of studying nature had in fact arisen from the same origin. Dispelling the multiplication of species was about dispelling confusion of words: people had given several names to the same fish because their descriptions had become confused. It is why Ray dealt with nomenclature and descriptions of past authors—he could then point out and rectify the confusion of tongues of the time. Ray's natural history was thus about re-establishing a proper connection between words and things. As with Wilkins, his natural history was to be of some generality, not of individuals. Thus monstrous varieties, such as the monkfish (*Squatina*) lost their place in the study of fishes and individual details were ignored.

Although Ray does not doubt that God had given a primeval language to humans before the Fall, he nevertheless believes that even if they had not been given the language, they would still have been able to construct one by tackling nature with diligence.[17] This ability to form words, and thus language, on the foundation of things is one that Ray seems to believe humans possessed even after the Fall. What humans cannot grasp after the Fall, however, is the essence of things. Thus essential marks or attributes cannot be known for certain either. Ray insists that all post-lapsarian knowledge begins with and is based on knowledge of the particulars through the senses. The human mind compares and examines the similarities and differences between individual objects and then gives a name to those that agree in certain qualities. This is how universals or general concepts, which do not exist in nature, are formed. It is uncertain, however, if qualities or attributes perceived by the senses are those that make up the 'essential' characteristics of things, and thus there is also some uncertainty as to whether general concepts formed from such attributes constitute knowledge of essences. However, Ray believes that it is likely that those that agree in many attributes agree in [their] nature also.[18] Hence Ray's concentration on morphology—external attributes which when matched up, would allow readers to identify and give a name to a fish. Defining things through an aggregate of attributes or 'accidents' in the absence of essential definitions is a strategy that can be traced back to Aristotle and was used often by early modern authors of natural history.[19]

Yet Ray's *Historia Piscium* was starkly different from a project like Gessner's natural history in which the purpose was to praise God through the *copia* of meanings and names of animals created by God.[20] The *copia* that symbolized the munificent Creation of God was now seen as a result of the curse of Babel. Ray's task was to recover the correct relationship between words and things through characteristic marks. Biblical belief in the corruption of human language and knowledge had led Ray to define, classify and depict a fish through external features, which when matched

up, would yield the same nature and thus allow humans to identify and give a name to a fish. As Ray's own controversies with Bachmann or Tournefort over classification of plants indicate,[21] there was, however, a considerable divergence of opinion over which of the attributes were 'characteristic' or to be privileged for distinguishing species. For the natural history of fishes, Ray was fortunate enough to have the support of the Fellows of The Royal Society.

The publication of the *Historia Piscium*

On 25 February 1684/5, Tancred Robinson reported to The Royal Society that Ray had finished the *Historia Piscium*. John Fell, the Bishop of Oxford, originally agreed to finance the publication at Oxford, provided that the Society undertook to purchase 100 copies, but by 25 March, the Society decided to print 'at their own charge' the entire work. A committee consisting of Samuel Peyps, Martin Lister, Robinson, Richard Waller, Edward Tyson, Ray, Abraham Hill and Francis Aston was set up to oversee the publication. Despite the fact that the draft was evidently 'ready' for publication, the next ten months saw the revision, correction and supplement of the work with the help of the Fellows of The Royal Society. This was especially the case with the illustrations.[22]

The Society almost immediately drew Ray's attention to the *Anatomy of Phocaena* by Tyson (Council and Committee member), as well as works of other authors, in order to supplement the section on cetaceous fishes, which Ray conceded was far from perfect.[23] Ray also reported the absence of a picture of a unicorn-fish, expressing doubt over the merit of the one that could be found in the *Histoire generale des Antilles* of Jean Baptist du Tertre (1667–71).[24] The Society replied that the work was of little authority and its picture of the unicorn-fish 'false'.[25] The Society also took steps to search other pictures that might be useful: Henry Hunt was asked to 'roll off' figures from some plates of fishes engraved for Wilkins.[26]

Individual Fellows also assisted Ray's project. Plot, Lister and Robinson, for instance, helped to establish the true identity of a fish named 'rotele' by Baltner. Ray's letter on this subject was read at the Society's meeting.[27] After much consultation, Robinson and Ray decided that it was the same fish as the finscale known to Plot and as the rudde by Lister.[28] Lister further helped Ray with the classification of orbes.[29] Lister also oversaw the arrangements for printing, deciding on the exact number of copies and agreeing on the price of engravings.[30] Robinson seems to have been involved more in the day-to-day supervision of the work, as he proudly declared that he managed to catch the engravers in time to make improvements. He also drew Ray's attention to various other books on fish.[31] The additions and corrections were large enough by November 1685 that the Council decided to have a separate Appendix to incorporate them.[32]

Although it is not possible at present to establish a precise chronology, enough material has survived to give us a sense of the process of printing the illustrations by the Society.[33] First, pictures from which engravings were to be taken were assembled. Figures cut out of Salviani's *Aquatilium Animalium Historiae*, watercolours purchased

by Willughby, sketches by others and Baltner formed these originals and were put together roughly in groups.[34] These were then sent to the engravers. A comparison of the originals and the final printed plates suggests that the figures were faithfully copied and engraved, mostly without names of fishes at first, but sometimes with names of subscribers. By the end of May 1685, the printing of the plates had begun, and The Royal Society decided to ask for subscriptions at the rate of one guinea a plate in order to defray the cost of printing the illustrations.[35] On 24 June , proofs of six plates were produced for inspection by the Society. On 8 July, further plates that had been 'ingraved in Oxford' were shown at the Society's meeting.[36] The reference to Oxford is somewhat puzzling, because none of the engravers I have been able to identify, including Paul van Somer II, who engraved the title page, seems to have been based there.

By 30 November 1685, all the figures were ready, 'ordered and completed by the great care of Dr Lister' and were exhibited with 60 sheets of the text at the Society's meeting.[37] This may well be the stage when the names of fishes were decided on, names of subscribers were corrected, instructions to add figures of fishes were written in and more subscribers' names were inserted.[38] This seems to fit with the subscription of Sir Richard Bulkeley as a Fellow of the Society at plate D1, elected only on 25 November 1685.[39] In January of the following year, the names of fishes were being checked, and then Ray wrote to Robinson thrice more in the same month for further corrections.[40] It may be around this time that some of the plates were renumbered and two fishes erased from a plate.[41] The index and errata were compiled in February 1686, but as late as 10 March 1686, Ray requested to make amendments and additions to the plates.[42] The Society ordered Halley to ensure that the corrections had been done by Hunt, but amending the Index was possibly forgotten, as it ended up out of step with the final order of illustrations.[43] Since they do not turn up at the earlier stages of the proof, the crosses indicating new fish must have been added right at the end.

About 65, a third of the plates (over 100 fish) bear these crosses. The provenance of these can be traced to sketches by Baltner and James Frasier, as well as the dried specimens in the Society's museum.[44] A comparison with the originals at Nottingham further suggests that not all of those bearing the crosses were newly pictured fishes, however. Nor were all of those without these press figures derived from other printed works, although many of them can be traced to the illustrations of Salviani, Rondelet, Gessner and Schonevelde. The marking of new figures of fishes with crosses thus seems to have been done almost as an afterthought, and not terribly rigorously. It may perhaps be a response to Plot's objection against the pictures not being all taken from life.[45] Ray himself was not so concerned, it seems, whether they were taken from life or not, since even for his own work on plants he rejected the phrase 'taken from the life', because most of the descriptions, he said, were taken out of books.[46]

Although Ray was aware that as representations, pictures could be deceiving, fictitious or over-adorned by artists,[47] Ray was very pleased with the pictures in the *Historia Piscium*. They excelled in number, elegance and truth, or—as he explained—in their conformity with the archetype of a fish or with a fish itself.[48] He even believed (rather optimistically, as it turned out) that the 'beauty and elegancy' of the engravings would attract buyers.[49]

By April 1686, the book was ready. Although it bears Willughby's name, his notes on fishes were not accessible to Ray for most of the time. Although Ray is rightly credited with the bulk of the work that went into the *Historia Piscium*, as Ray himself acknowledged, Robinson and Lister contributed much to it. During the process of printing the *Historia Piscium*, The Royal Society confirmed the validity or uselessness of an author, suggested other authorities, looked for other pictures, and organized the printing and checked the corrections to the illustrations. Society Fellows helped Ray with identities and classification of fishes, and changes were made in response to suggestions and objections of the Fellows of the Society.[50] In other words, without the intellectual and financial support of the Society, the *Historia Piscium* would not have been published in the way that it was. The venture was to cost the Society dearly, however.

The illustrations and the subscribers

Ray and his contemporaries lived in the aftermath of Basilius Besler's *Hortus Eystettentis* (1613), an extraordinary volume of large, exquisitely engraved (and often lusciously coloured) pictures of plants from the gardens of the Prince Bishop of Eichstätt. It proudly demonstrated what could be achieved in copper engraving, given a generous and substantial support from a patron. It was admired for its beauty and envied for the generosity of the patron. It was unlikely, however, that there would be another such generous patron. Instead, some illustrations were printed through subscription by a group of people.[51] Robert Plot's *The natural history of Oxfordshire* (Oxford, 1677) and *The natural history of Staffordshire* (1686) contained tables and maps that were gratefully dedicated to local worthies or patrons who had subscribed to the plates. In 1680, the *Plantarum Historiae Universalis Oxoniensis Pars Secunda* by Robert Morison, the Professor of Botany at Oxford, was published. This contained over 100 tables of engraved figures of plants, each with the name and coat of arms of the subscriber. The names were roughly ordered by social and political importance, followed by numerous fellow physicians, fellow Fellows of the College of Physicians and members of the Apothecaries' Guild. The list included Robert Boyle and John Evelyn, though neither was described as a Fellow of The Royal Society. The way subscribers to Morison's illustrations are ordered and described reflects the extent of Morison's own connection as well as his self-image as a physician and Fellow of the College of Physicians.

In contrast, the only institutional affiliation of the subscribers that is spelt out in the *Historia Pisicum* was, unsuprisingly, that of The Royal Society. The *Icthyographia* contained 187 plates, including 10 plates in the Appendix. Eighty plates bore the name of Samuel Pepys (figures 4 and 5). In November 1685, the Council had decided to use the £50 Pepys had laid out towards the cost of the *Historia Piscium* for engraving 50 plates. By the time the text of the dedication was fixed, the number had increased to 60 plates, but Pepys ended up paying £63 and 80 plates carried his name.[52] Sixty-nine other individuals subscribed to 74 plates,[53] so 24 plates in the main section and nine

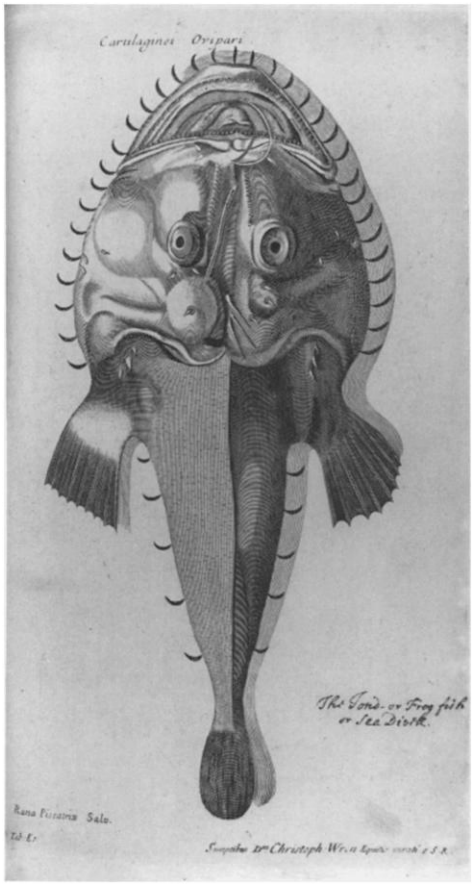


Figure 2. *Rana piscatrix* Salv. The pond- or frog fish or sea diver. Sumptibus D^ni^ Christop: Wren Equitis aurati e S.R. Tab. E1, plate 22.

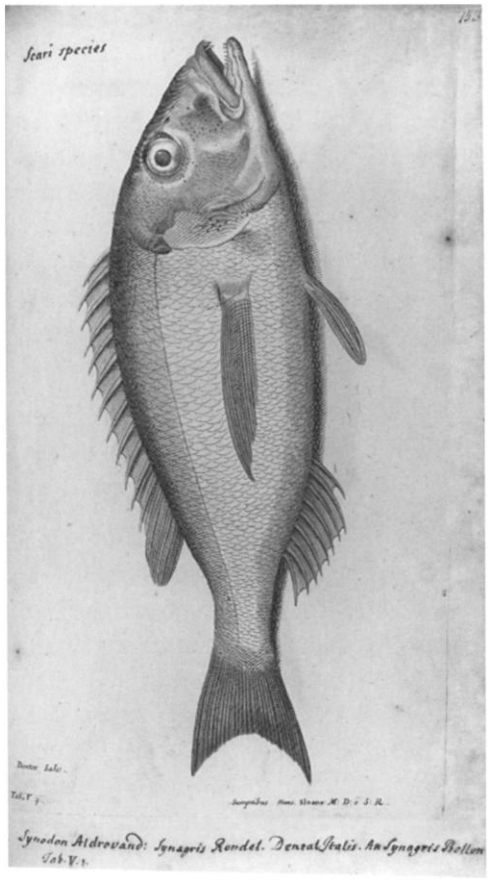


Figure 3. *Synodon aldrovand synagris* Rondel. *Scari* sp. Sumptibus Hans Sloane M.D. e S.R. Tab. V.1., plate 153.

plates in the Appendix were not subscribed. Of the total of 70 subscribers (including Pepys), 45 were Royal Society Fellows, 25 were non-Fellows. The subscribers from The Royal Society included those with official positions in 1685—the president (Pepys), the treasurer (Hill), the secretaries (Gale, Aston, Plot, Musgrave, Robinson and Hoskyns) and other Council members (Flamsteed (figure 6), Herbert, Evelyn (figure 7), Haynes, Lister, Meredith, Tyson, Henshaw, Bulkely, Wych, and Wren (figure 2). Notable absences include Halley, Hooke and William Perry (Fellow of Trinity College, Cambridge, and Council member in 1685), though perhaps Hooke, as curator and the bête noir of Lister, was not expected to contribute.[54] Similarly, Halley was then Clerk to the Society, not a Fellow. On the other hand, some of those Fellows who have been classified as more or less 'inactive' in the 1680s by Michael Hunter proved their worth by at least subscribing to one plate (Thomas Firmin, Hugh Chamberlain, Alexander Stanhope,[55] Richard Beaumont, Andrew Birch, Walter Mills, James Mounson, Henry Paman and John Lowther). Hunter counts about 75 Fellows

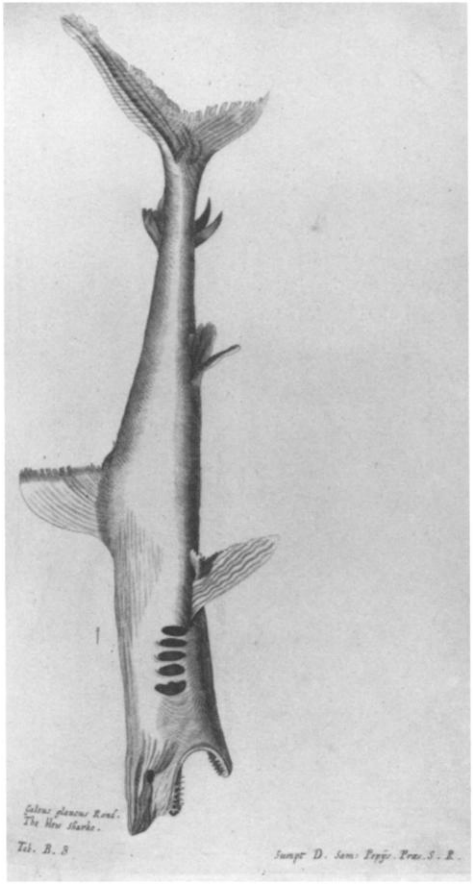


Figure 4. *Galeus glaucus* Rond. The blewe sharke. Sumptibus D. Sam. Pepys, Praes.R.S. Tab. B.8., plate 70.

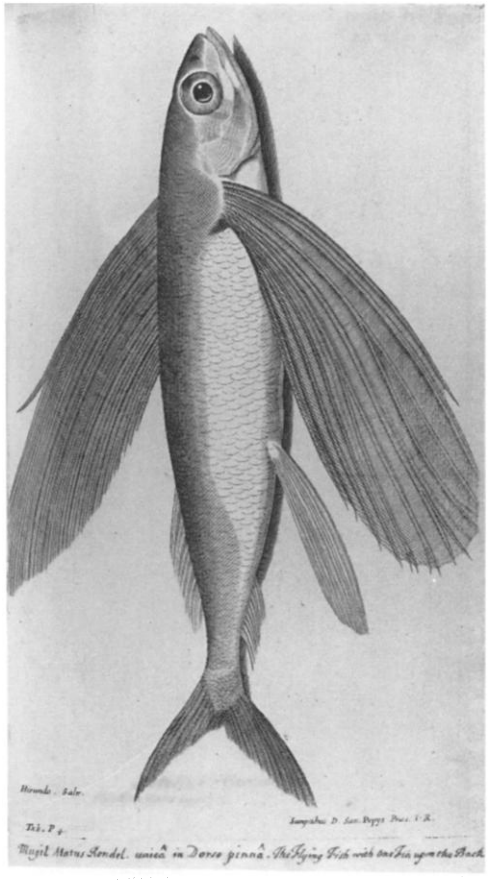


Figure 5. *Migul Alatus* rondel. unica in Dorso pinna. Flying fish with one fin upon the back. Sumptibus Sam. Pepys, Praes.R.S. Tab. P.4., plate 109.

as active in 1685 out of a total of 141 Fellows (including 21 Foreign Members). If we discount the eight 'inactive' Fellows from the 45 Fellows who subscribed to the plates of the *Historia Piscium*, it means that about half of the active Fellows of The Royal Society had subscribed to the plates. Although several Fellows belonged to other institutions, such as the Royal College of Physicians or Oxbridge colleges, such affiliations were not inscribed, while peerages of Fellows were.

The 25 subscribers who were not Fellows of The Royal Society included the following: Arthur Rawdon (d. 1695), second Baronet of Moira; John Knatchbull (d. 1696), Baronet of Mersham; Richard Coote (1636–1701), Baronet of Coloony; Metcalf Robinson, Baronet of Newby, and his nephew, William Robinson; Sir Francis Rolle; Sir Walter Young; Sir Robert Clayton (1629–1707), merchant, politician and benefactor to Christ's Hospital and St Thomas' Hospital; gentlemen by the names of Robert Davies, Metcalf Weddall, Henry Squire, Roger Belwood, Thomas Lechmere, Richard Thompson, William Gore, Hugh Willoughby and James Hamilton; John

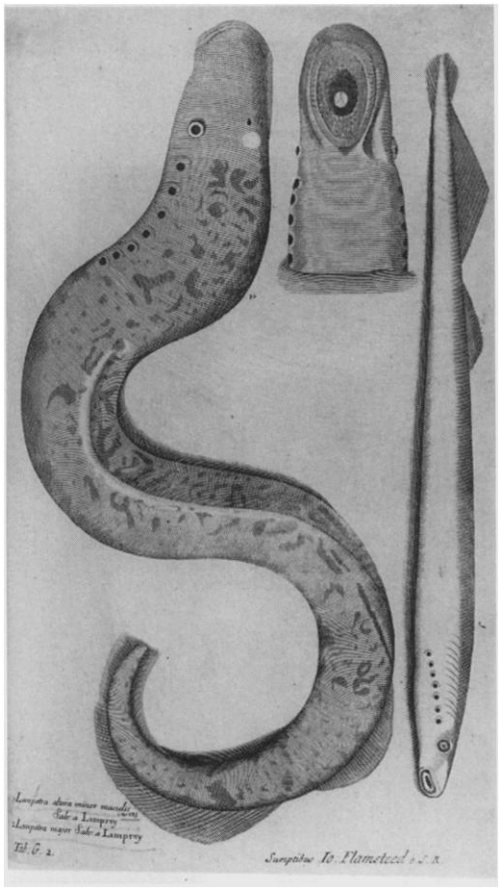


Figure 6. *Lampetra altera minor maculis* Salv. A lamprey (right). *Lampetra major* Salv. A lamprey (left). Sumptibus Io Flamsteed. Tab. G.2., plate 33.

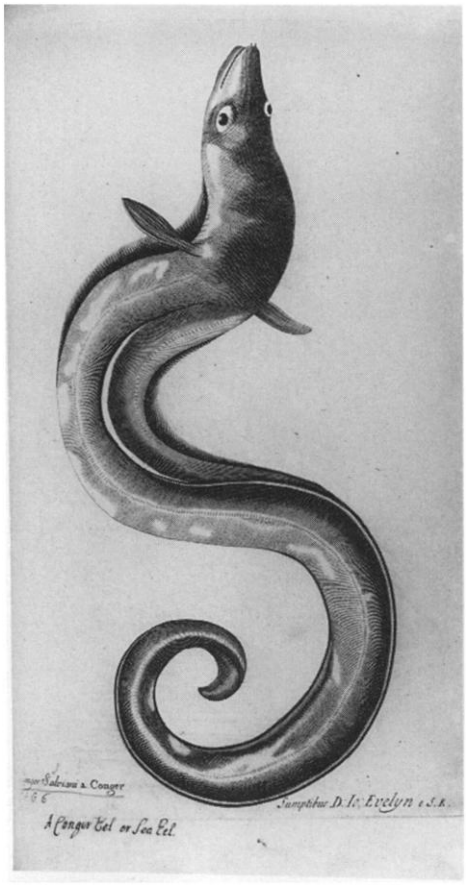


Figure 7. *Conger Salviani*. Conger or sea eel. Sumptibus D. Io. Evelyn e S.R. Tab. G.6., plate 37.

Fell, the Bishop of Oxford (1625–1685), who undertook the printing of the text of the *Historia Piscium* at Oxford; and Samuel Fuller (1635–1700), later Dean of Lincoln. There were also a few physicians: William Denton (1605–1691); Francis Bernard (1627–1698); Fernando Mendes (d. 1724), Royal Physician; and Leonard Plukenet (1642–1706). The first three were Fellows of the College of Physicians, an institutional affiliation not listed in the subscription. Henry Plumtree and Daniel Price are listed without any qualification or rank.[55] Ray had personal connections with at least two of them, Sir Francis Rolle and Plukenet. Social rank and higher degrees were the only ways in which the 25 non-Fellows are described, and again, affiliation with other institutions is ignored. Overall, the impression created by the list of subscribers is a strong focus on The Royal Society—its Fellows and its supporters, who were mostly of good social standing or qualification.

Unlike Plot's subscribers, there seems to be little evidence for an explicit or coherent policy as to who subscribed to which plate. Nor does the order in which the subscribers

appear, as in Morison's case, seem to be deliberate. For the proof of plate I1 of the *Historia Piscium*, the subscription in handwriting reads 'sumptibus Gulielmi Payne ~~Theologi Londoniensis~~ e SR',[57] but in the printed version, Edward Haynes's name appears instead—Payne's name appears on the next plate, I2, and on I20. These changes, however, may well have derived from simple errors or were a result of reordering, and seem unlikely to amount to any deliberate policy, although the deletion of Payne's identity as a London theologian may confirm the emphasis attached to the Fellowship of the Society. It is most likely that the names were inscribed as the proofs were being prepared and as the subscriptions were coming in.

In 1685, 121 guineas were collected from 42 individuals, including Pepys who gave 60 guineas, and Boyle, Needham and Gale who gave two guineas each (Wych and Payne are recorded as having given only one guinea each).[58] By Michaelmas 1687, the names of Tyson, Willoughby and Mounson were recorded as subscribing, in addition to the £29 11s 6d collected by Henry Hunt, presumably from the remaining 27 subscribers whose names appeared in the *Icthyographia*. The amount of just under £163 was thus gathered, but fell well short of the final cost. Perhaps the review of outstanding Fellowship fees in the spring of 1686 was occasioned by the sense of financial urgency resulting from this project.

From the accounts of The Royal Society, it seems that at least 18 artists were involved in the engraving of the illustrations. At present, not all of them have been identified, but the following 16 engravers charged the Society for engraving the plates: Collins, Barnford, Skilman, John Parry, Bouche, Merlier, Norton, Bird, Croxall, Moll, Pierce Tempest (d. 1717, active in London since 1670), Paul van Somer II (1649–1694), Johannes Drappentier (a Dutch engraver active in London between 1674 and 1700), and probably William Elder (who also cut Ray's portrait in the *Stirpium Europaearum Sylloge*, 1694), William Faithorne Jr (1656–1710) and William Sherwin (1645–1711).[59] Some of them (Elder, Bouche, Moll and Bird) also charged for engraving words, while the names of Holmes and Greenhill appear exclusively in relation to engraving words.[60] Their bills run from October to December1685, and most of them charged by the plate, whose cost varied between five shillings and 20 shillings per plate, 12 or 15 shillings per plate being the most common. The variation of charges may reflect the number of fish on each plate, and one artist, Moll, charged by the number of fishes. The most expensive plate was naturally the frontispiece, for which Paul van Somer charged £4. Van Somer also engraved 13 other plates. The engraver who contributed the largest number of plates was Croxall, with 58 plates. The engraving of plates cost about £89 and the lettering about £28, making a total of £117.[61] By April 1686, the cost of engraving the plates rose to £232 11s 7d. Together with the cost of paper (£45 15s), printing the Index (£6 6s 6d), printing the text (£51 16s 6d) and of Henry Hunt's engraving (£7 10s), the full cost came to £360.[62]

The printers were instructed to print 500 copies, but the cost of production was calculated on the basis of 480 copies, allowing for some imperfect copies, and came to 15 shillings per book. With additional charges for the printing either on good paper or cheaper paper, the Society set the price at £1 0s 8d (worst paper) and £1 3s (best paper) for subscribers and £1 5s (worst paper) and £1 8s (best paper) for non-subscribers.

The Society then set about distributing the copies. Ray was sent 20 gratis copies. On 19 May 1686, at the same time as resolving to print Newton's *Principia*, the Society ordered copies of the *Historia Piscium* to Malpighi, Hevelius, Leeuwenhoeck and Bayle.[63] Pepys, whose generous support had been crucial for the illustrations, was given five copies with a special dedication copy bound in 'Turkey Leather' (30 June 1686).[64] Efforts were made to get booksellers to take on copies with up to one shilling's profit (28 July 1686). By February 1686/7, it was clear that the bulk remained unsold, as the Council ordered Hooke to negotiate a deal with an Amsterdam bookseller to take on 400 copies at 25 shillings each, two fifths to be paid in money and the rest in kind (9 February 1686/7).[65] The *Historia Piscium* was frequently used by the Society in lieu of cash; thus Halley and Hooke were offered 50 copies of the book in lieu of £50 salary[66] and Papin (December 1687) was given four copies as a mark of gratitude for his service to the Society. In November 1689, the Society sent a bound copy to the Bodleian Library and asked Plot to sell six copies. By the spring of 1690, the Society tried to get Samuel Smith, the bookseller, to take 40 copies for a profit of 2s 6d or 100 copies for five shillings (5 March 1689/90). A larger profit margin for a larger number of copies suggests that the Society was keen to get rid of a large number of copies. Between 1688 and 1772 the Society received £111 1s 5 d. for the sale of the *Historia Piscium*.[67]

The cost of printing the *Historia Piscium* and the subsequent flop of sales confirms the hazards of publishing large books with many engraved illustrations. Ray clearly believed in the value of pictures—a good picture was capable of conveying a clearer and true idea of a thing more speedily and pleasantly than lengthy verbal descriptions could. On reviewing Plukenet's *Phytographia* (1691–92), Ray praised its illustrations on the 'two only qualities' of a perfect cut, namely beauty and exact similitude.[68] Yet his own *Historia Plantarum*, prepared around the same time as the *Historia Piscium*, was not illustrated. Ray in fact had wavered over whether to include figures or not in his *Historia Plantarum*; he first seems to have been happy to do without them, until others had pointed out that a history of plants without figures would be like 'a book of geography without maps'.[69] He also seems to have thought of a compromise—a book without illustrations, but including references to other books in which the best figures could be found. However, he decided that that such a book could still prove costly to the reader who could not expect to possess all those books referred to and would have to purchase the other books. Ray's *Historia Plantarum* was published under the auspices of The Royal Society, with subscription, but without illustrations. Ray's friends had insisted that his illustrations had to be engraved in copper, not woodcuts[70] and Morison's work on plants had of course appeared by then. Ray would have had to match the illustrations in quality and quantity, and that would have been too costly. A much more active and substantial support was needed from a patron before illustrations that met the standards of the time could be produced.

The lavishly illustrated *Historia Piscium* was thus a rather remarkable publication. Its text and illustration reflect the 17th-century origins of the enterprise: Ray's quest to recover knowledge and language lost in the Fall, and The Royal Society's active support for establishing a reformed natural history of fishes through publication. The publication of the *Historia Piscium* was coming to an end when Newton's

Principia was being prepared for publication. Financially, the Society could not provide the cost of printing the *Principia*, and thus asked Halley to take over. Such a decision, however, was neither a gesture of meanness or condescension. Indeed, it was more common for The Royal Society not to provide funds for works they wished to have published under their auspices.[71] What is significant is the great interest the Society took, in one way or another, to harness the medium of print in order to establish and promote studies of nature of its Fellows.[72]

ACKNOWLEDGEMENT

In memory of Jeremy Maule, Trinity College, Cambridge, colleague, scholar and teacher.

NOTES

1 For the details of the trip, see C. Raven, *John Ray naturalist: his life and works*, pp. 123–138 (Cambridge University Press, 1950). For Ray's letters, I cite from E. Lankester (ed.), *The correspondence of John Ray* (London, The Ray Society, 1848) and Robert W. T. Gunther (ed.), *Further correspondence of John Ray* (London, The Ray Society, 1928) [cited hereafter as 'Corr' and 'FC', respectively].

2 G. Cuvier, *Historical portrait of the progress of ichthyology, from its origins to our own time* (tr. A.J. Simpson), p. 73 (Baltimore and London, Johns Hopkins Press, 1995).

3 This was a fairly common practice at the time. For a list of books printed under the auspices of The Royal Society, see C.A. Rivington, 'Early printers of the Royal Society 1663–1708', *Notes Rec. R. Soc. Lond.* **39**, 1–28 (1984). Geoffrey Keynes, *John Ray: a bibliography*, pp. 65–72 (London, Faber and Faber, 1951).

4 On 24 March 1685, Ray sent on to Tancred Robinson Baltner's pictures (FC, p. 287), which now cannot be found in the Middleton Collection at Nottingham University Library. Other copies of Baltner's work are discussed in R. Allgayer, 'Un naturaliste et son oeuvre oubliés, Léonard Baldner (1612–1694)', *Revue Française Aquarologie*, Suppl. 1, 1–12, which I have been unable to consult.

5 See Francis Willughby, *Ornithology* (London, J. Martyn, 1678), fol. A3r. A. J. Cain, 'John Ray on "accidents"', *Arch. Nat. Hist.* **23**, 343–368 (1996), argues how Ray's idea of 'accidents' remained largely Aristotelian and static. In 1674, Ray had already explained to The Royal Society how mistaking 'accidents' for these characteristic marks had led to the multiplication of plant species, whose numbers he believed to have been fixed at creation. 14 December 1674, Royal Society Register Book (Copy) vol. 4, 38–46.

6 Willughby, *op. cit.*, note 5, fol. A3r.

7 Ray to Tancred Robinson, 1 April 1685, FC, p.143.

8 Ray to Robinson, 14 September 1685, FC, p. 153; fishes from East India by Nieuhoff, however, were deemed imperfect, and discussion of them was kept in the Appendix, as suggested by Robinson (12 May 1685), FC, p. 146. On 29 April 1685 (FC, p. 145) Ray had also rejected pictures from an unspecified book of designs (possibly Adrian Collaert's prints, now in Nottingham University Library, Mi LM 25, items 82–114).

9 Ray recorded this objection to a pencil drawing of an oxyrhyncos in Mi LM 25, item 192.

10 *Historia Piscium,* pp. 121f. Baltner's '*Mustela vulgaris*' is probably the modern five-bearded rocking (*Ciliata mustela*); the Sorghe Marina of Venice the three-bearded rocking (*Gaidropsarus mediterraneus*). I owe these identifications to Alwyne Wheeler.

11 J. Wilkins, *An essay towards a real character and a philosophical language*, p. 1 (London, L.S. Gellibrand and J. Martyn, 1668). For universal languages and the confusion of tongues, see J. Bennett and S. Mandelbrote, *The Garden, the Ark, the Tower, the Temple. Biblical metaphors of knowledge in early modern Europe*, pp. 103–133 (Oxford, Museum of the History of Science in association with the Bodleian Library, 1998).

12 'That conceit which men have in their minds concerning a horse or tree is the notion or mental image of that beast or natural thing, of such a nature, shape and use. The names given to these in several languages are such arbitrary sounds or words, as Nations of men have agreed upon, either casually or designedly, to express their mental notions of them. The Written word is the figure or picture of that sound. So that if men should generally consent upon the same way or manner of expression as they do agree in the same notion, we should then be freed from the curse in the confusion of tongues, with all the unhappy consequences of it.' Wilkins, *op. cit.*, note 11, p. 20.

13 *Ibid.*, p. 21.

14 *Ibid.*, p. 121.

15 *Ibid.*, p. 295. At best, individuals were to be described periphrastically.

16 See for instance, J. Ray, *Collection of English words* (London, H. Bruges, 1674).

17 J. Ray, *De variis plantarum methodis dissertatio brevis*, p. 1 (London, S. Smith and B. Walford, 1696).

18 'Cum ergo essentiae rerum nobis incognitae sint, notae generum essentiales a nobis certo sciri non possunt. Quae tamen plurimis attributis conveniunt ea naturâ convenire verisimile est.' *Ibid.* p. 5.

19 For Ray's Aristotelianism, see Cain, *op. cit.*, note 5. For the issue of accidents in an earlier case of natural history, see my article 'Leonhart Fuchs on the Importance of Pictures', *Journal of the History of Ideas* **58**, 403–427 (1997).

20 See Gessner, *Historia animalium*, vol. 1, β3v (1551), referring to Job 38, and his *Mithridates* (1555), a collection of the Lord's prayer in 22 different languages.

21 Raven, *op. cit.*, note 1, pp. 282–294.

22 Ray had only a list of where the best figures of a particular fish could be found in extant works. He was asked to submit this list by The Royal Society. Ray to Robinson, 13 March 1684/5 was read to the society on 18 March 1685, FC, p. 90.

23 Ray to Robinson, 13 March 1684/5, Corr, p. 164.

24 *Ibid.*

25 FC, p. 90.

26 Council Meeting on 18 March 1685, Birch, IV, 380.

27 Read at the Council Meeting on 8 April 1685, Birch, IV, 389.

28 See Ray to Robinson, 1 April 1685, FC, p. 142f.; 29 April 1685, Corr. p. 165; 12 May 1685, FC, p. 146. Note that at plate Q3, although the fish is described as *Euythrophthalmos* (red roach) on the plate, in the corrigenda it is called the *Rutilius latior* (broad roach) or the Rudde.

29 Raven, *op. cit.*, note 1, p. 353.

30 Council Meetings on 11 and 17 March 1685, Birch, IV, 373, 466.

31 Ray to Robinson, 8 September 1685, FC p. 150. Compare this with Ray's dissatisfaction with the engravers of the *Ornithology* because of the lack of supervision owing to distance, see Willughby, *op. cit.*, note 5, fol. (A4v). For the books sent by Robinson, see FC, pp. 145, 151f., 153f.

32 Council Meeting on 11 November 1685, Birch, IV, p. 428.

33 This can be partially reconstructed from Nottingham University Library Mi LM 25, though Baltner's pictures are not among the Nottingham collection (note 4). For details of the collection, see M.A. Welch, 'Francis Willoughby, F.R.S. (1636–1672)', *J. Soc. Bibliogr. Nat. Hist.* **6**, 73–85 (1972). Shaw Kinsley, Linacre College, Oxford, is completing a bibliographical

study of the production and circulation of the *Historia Piscium*, using surviving copies and taking into account the re-issuing of the book by Cromwell Mortimer in 1740 [1743], see also Keynes, *op. cit.*, note 3, p. 68.

34 See Mi LM 25, item 42 (picture of a mackerel) with an inscription 'tab M', was the basis for M4; item 50 (picture of a sorghe) with an inscription 'H', became H.2.1; see also items 77 and 177.

35 Meeting of 27 May 1684/5, Birch, IV, p. 402.

36 Meeting of 8 July 1685, Birch, IV, p. 414.

37 Birch, IV, p. 444.

38 Subscribers' names were corrected in Mi LM 25, item 166 (proof for L.1.1) and Mi LM 25, item 230 (proof for F8). For figures of fishes being added, see Mi LM 25, item 182; 'add the designe of the spotted Dorato' Mi LM 25, item 178. Item 180, which was the proof for N13, has the inscription, 'place the cataphractus of Brasil ex MSR' and the engraver's name 'Drappentier'. Item 184, proof for O3, has 'place here the square Acarauna of the museum e SR' and the name 'Norton'. For the engravers, see below.

39 Bulkeley may well have pledged his support earlier at the meeting of the Dublin Society. I owe this point to Professor M. Feingold.

40 FC, p. 289. Compare this with his attitude towards the proofs of the text on 12 May 1685, to Robinson, FC, p. 146.

41 See, for instance, the B plates, Mi LM 25, items 141 and 142. Note that Mi LM 25, item 233 (proof for B9) has seven fishes, without the names but with a handwritten inscription for Pepys, the first two of which disappear in most copies of B9 (for instance, in Pepy's dedication copy now at Magdalene College, Cambridge). They reappear, however, in Joseph Banks' copy (British Library, 457.e.10), with the names: (1) canis carcharias (of Gessner) and (2) Maltha (of Gessner and Rondelet). Those with the full seven figures of the illustrations seem to date from the 1743 edition.

42 FC, pp. 289, 94. Birch, IV, p. 464.

43 FC, p. 94. For instance the list of fishes in the Index for M plates is out of step with the illustrations themselves. Halley's supervisory role in the *Historia Piscium*, as well as the *Philosophical Transactions*, suggests that he was well equipped to oversee the printing of Newton's *Principia*. A. Cook, *Edmond Halley: charting the heavens and the seas* (Oxford, Clarendon Press, 1998), pp. 153–165.

44 For Frasier's pictures, see Raven, *op. cit.*, note 1, p. 353. For the pictures, see also Ray to Robinson, 13 March 84/5, Corr. p. 164. For a slightly dried specimen of a fish sent up from London, see Peter Dent to Ray, 15 February 1674, Corr. p. 15f. Those from the museum were not necessarily copies from Nathaniel Grew's published *Catalogue* of the museum (1681).

45 Dr Plot to Mr Aston, Oxford, 18 March 1684/5; Royal Society Letter Book, X, p. 54. FC, p. 90.

46 Ray to Robinson, 22 May 1685, FC, p.147.

47 Raven, *op. cit.*, note 1, p. 310.

48 'Superest tantum ut quibus in rebus hoc opus illi excellat paucis exponamus. Ea sunt vel Iconum multitudo, elegantia et veritas, seu cum Archetypis piscibusve ipsis conformitas, vel virorum eruditissimorum ad historiam symbolae, seu observationes et descriptiones piscum nondum editum collatae.' *Historia Piscium,* Preface, b1r.

49 Ray to Robinson, 14 September 1685, FC, p.154.

50 See Ray's acknowledgement in the Preface, *Historia Piscium*.

51 For subscription lists for printing the text of books, see F.J.G. Robinson and P.J. Wallis, *Book subscription lists: a revised guide* (Newcastle, H. Hill and Son, 1975). This, however, does not include subscription lists of illustrations. For the *Hortus Eystettensis*, see N. Barker, *Hortus Eystettensis: the Bishop's garden and Besler's magnificent book* (London, British Library, 1994).

52 Birch, IV, 428; *Historia Piscium,* Preface, b1r.

53 Needham, Wych, Boyle, Payne and Gale subscribed to two plates each.

54 For the conflict between Lister and Hooke, see S. Pumfrey, 'Ideas above his station: a social study of Hooke's curatorship of experiments', *History Sci.* **29**, 1–44 (1991) and 'Who did the work? Experimental philosophers and public demonstrators in Augustan England', *Br. J. History Sci.* **28**, 131–156 (1995). The subscribers' list may also reflect a growing rift in the society between naturalists and physicians on the one hand and mathematicians and natural philosophers on the other. I owe this insight to Professor M. Feingold, who kindly allowed me to read his 'Mathematicians and naturalists: Sir Isaac Newton and the Royal Society' in the forthcoming book *Isaac Newton's natural philosophy* (ed. J. Buchwald and I. B. Cohen) (Cambridge, MA, MIT Press, 2001).

55 Stanhope, however, was not listed as Fellow of the Society at plate G1.

56 Henry Plumtree may be the father of another Henry Plumtre, later President of the Royal College of Physicians. William Gore may be Esq. of Woodford, Robert Davies may be the Esq. of London, Kettelbaston and Preston (d. 1695), who married Elizabeth Harwood in 1682. J. Burke, *A genealogical and heraldic history of the landed gentry: or, commoners of Great Britain, Ireland, enjoying territorial possessions or high official work, but uninvested with heritable honours* (4 vols) (London, Henry Colburn, 1837–38).

57 Mi LM 25, item 157.

58 Though the final sum entered in the accounts was £130 1s 6d, falling short by about £2 of the original 121 guineas.

59 Royal Society Accounts on Lady Day 1686 and Michaelmas 1687. The bills of engravers account for only about 140 plates out of the final 187 plates. For the identified engravers, see U. Thieme and F. Becker (eds), *Allgemeine Lexikon der bildenden Künstler* (37 vols) (Leipzig, W. Engelmann, 1907–1950). William Faithorne Sr could be the father (1616–1691), who had painted the portrait of Ray, after which Elder had done an engraving, Keynes, *op.cit.*, note 3, p. 150.

60 Holmes charged 5 shillings for engraving 100 words on 12 November 1685 and Bird charged £2 for engraving 950 names on 30 November 1685.

61 Since some artists charged for both plates and lettering, it is difficult to provide precise figures.

62 FC, pp. 95f.

63 Birch, IV, p. 484.

64 This dedication copy, bound in red leather, survives in Magdalene College, Cambridge (PL 2713).

65 15 June 1687 Council Minutes Book (Copy). This ambitious proposal seems to have been unsuccessful, as only two copies of the *Historia Piscium* were sent to Holland in return for Henry van Rheede's *Hortus Malabaricus*. See also the Council minutes of 8 February 1687/8.

66 Council Meeting of 6 July 1687, Birch, IV, p. 545. Halley was offered a further 20 copies for delayed pay. Earlier, he was also offered £50 or 50 copies of the *Historia Pisicum* as an incentive to measure the circumference of the Earth, Birch IV, p. 491 (30 June 1686).

67 R.K. Blume, 'Remarks on the Royal Society's finances 1660–1768', *Notes Rec. R. Soc. Lond.* **13**, 100 (1958).

68 'Now a good *Figure* having this advantage of a verbal description that it conveys speedily to the mind with ease & pleasure a clearer & truer *Idea* of the thing delineated, then the understanding can with much labour & in a long time form to itself from a description, be it never so exact.... As for the *sculps* they recommend themselves to the perusal of all sorts, as well as for their beauty & elegancy, as for their exact similitude to the vegetables they were taken from or are intended to represent; which are the two only qualities requisite to the perfection of a cut.' FC, p. 99. Italics in original.

69 Ray to Robinson, 22 October 1684, Corr., pp.155f.

70 Ray to Robinson, 12 May 1685, FC, p.146. Cf. Halley's recommendation to Newton that his diagrams be done in woodcuts so that they could be inset with the text, I. B. Cohen, *Introduction to Newton's* 'Principia', p. 134, n. 20 (Cambridge University Press, 1971).

71 For the role of printing in the early history of The Royal Society, see Adrian Johns, *The nature of the book: print and knowledge in the making*, pp. 489f (Chicago University Press, 1998).

72 An earlier version of this paper was read at the conference, 'John Ray and his successors', organized by the John Ray Trust. I wish to thank the members of the audience, and in particular, Nigel Cooper, Alwyn Wheeler and Scott Mandelbrote, for their interest and help. I have also benefited from the comments of Professor Mordechai Feingold and Sir Alan Cook. I am responsible for errors and faults that remain in this paper.