Captured on paper: fish books, natural history and questions of demarcation in eighteenth-century Europe (ca. 1680–1820)

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CHAPTER 1

"This busie and inquisitive Age": Tradition and Reform in Seventeenth-Century Natural History

> We shall further add, that we have wholly omitted what we find in other Authors concerning *Homonymous* and *Synonymous* words, or the divers names of Birds, *Hieroglyphics*, *Emblems*, *Morals*, *Fables*, *Presages*, or ought else appertaining to *Divinity*, *Ethics*, *Grammar*, or any sort of Humane Learning: And present him [the reader] only what properly relates to their Natural History.[1]

In the preface of the *Ornithology* (London, 1678), English naturalist John Ray explained what the reader should expect to find in this natural history of birds. The principle aim of this work, which was the result of years of sustained study he had undertaken together with his late friend Francis Willughby, was to offer the reader accurate descriptions of species. In investigating living nature around them, they had thought long and hard about how best to demarcate one species from the other. The humanistic approach of studying nature, with its encyclopaedic emphasis on etymological origins and symbolic meanings, detracted from the stuff that natural history, according to Ray, should be made of: precise and unambiguous species descriptions. This was also the approach they had taken in describing plants, insects, and fish. Ray's remarks have been cited

[1] Francis Willughby, *The ornithology of Francis Willughby of Middleton in the county of Warwick Esq*, trans. and ed. John Ray (London: John Martyn, 1678), preface, sig. A6r. The book is an English translation from the Latin original: Francis Willughby, *Francisci Willughbeii De Middleton in agro Warwicensi, Armigeri, e Regia Societate, Ornithologiae libri tres*, ed. John Ray (London: John Martyn, 1676).

more than once by historians of science and of biblical scholarship to stress how Ray and Willughby challenged conventions and introduced either a new kind of natural history or a new kind of theology.[2] Ray's use of the adjective 'properly' certainly indicates that these naturalists were rethinking what precisely natural history was, what it was not, and what it ought to be. At the same time, this quotation not only expresses what should be different, but also says something about what should remain the same.

The aim of this chapter is twofold. First of all, it serves to give a general introduction into how natural history was done in the time that Willughby and Ray embarked on their studies of plants, birds and fish. By focussing both on the aims of investigating nature in the sixteenth and seventeenth centuries, and how this research was carried out in practice – through collecting, classifying, describing, and depicting – this chapter brings forward some of the key themes that will recur throughout this dissertation. Secondly, it caters to questions of continuity and change. It sets out to examine whether approaches to natural history in the late seventeenth century designated as 'new' were not altogether as different to the study of nature in the sixteenth century as they are sometimes made out to be, thus placing Ray's claim to novelty that opens this chapter in context.

Ray found himself to be living in a "busie and inquisitive Age".[3] Although he does not elaborate on what made the late seventeenth century so enthralling, several things come to mind. The British Isles had been stirred up by civil wars and regime changes. European powers were engaged in a series of battles, both on

[2] For citations of this passage in the context of natural history, see: Nathan Flis, "Francis Barlow, the King's Birds, and the Ornithology of Francis Willughby and John Ray," *Huntington Library Quarterly* 78, no. 2 (2015): 265; Stephen Jay Gould, *The Hedgehog, the Fox, and the Magister's Pox: Mending the Gap between Science and the Humanities* (Cambridge, Mass.: Harvard University Press, 2011), 47; Isabelle Charmantier, "Emblematics in Ornithology in the Sixteenth and Seventeenth Centuries," *Emblematica* 18 (2010): 102; Charles E. Raven, *John Ray Naturalist: His Life and Works* (Cambridge: Cambridge University Press, 1942), 309. For the context of theology, see: Kevin Killeen, *Biblical Scholarship, Science and Politics in Early Modern England: Thomas Browne the Thorny Place of Knowledge* (Farnham: Ashgate, 2009), 156; Peter Harrison, "Hermeneutics and Natural Knowledge in the Reformers," in *Nature and Scripture in the Abrahamic Religions*, vol. 1, eds. Scott Mandelbrote and Jitse M. van der Meer (Leiden: Brill, 2008), 354. John Hedley Brooke, "'Wise Men Nowadays Think Otherwise': John Ray, Natural Theology and the Meanings of Anthropocentrism," *Notes and Records of the Royal Society of London* 54, no. 2 (2000): 200; Peter Harrison, *The Bible, Protestantism, and the Rise of Natural Science* (Cambridge: Cambridge University Press, 1998), 269.

[3] Willughby, *Ornithology*, preface, sig. A2v.

their own territories and on those of their overseas conquests. This expansion was, to a large extent, driven by the companies that circumnavigated the globe, trading in spices as well as in the enslaved.[4] These commercial networks also shaped the study of natural knowledge.[5] Naturalists, already dizzied by the rapid pace of discovery in the late sixteenth century, found the early seventeenth marked by an inundation of specimens of plants and animals hitherto unknown to them. New philosophies were challenging received wisdom and ancient authorities, and devices had emerged with which one could study nature in ever-growing detail. These religious, political, economic and intellectual developments, which were of course closely connected,[6] may have well prompted Ray's characterization of his own time as a lively one.

The chapter begins with a concise history of how the study of natural history took shape in the sixteenth century. It discusses how the study of living nature became increasingly regarded as a topic worth studying for its own sake rather than a subset of other studies, like the liberal arts or medicine. The chapter then goes on to introduce Willughby and Ray. It describes how these Cambridge graduates carried out their study of nature together both during travels and at home, on what principles they based it upon, and how their collaboration ultimately led to the publication of the *Historia piscium* (Oxford, 1686). From here, the chapter proceeds to discuss how 'fish' were conceptualized in the sixteenth and seventeenth century respectively. It argues that, in the course of the seventeenth century, new frameworks emerged for the study of nature, in which classical organization principles were replaced – even if these shifts were neither immediate nor pervasive. Finally, the chapter discusses the textual and the visual depictions of the species in the *Historia piscium*, comparing their format and content to those appearing in earlier works of natural history so as to highlight both their similarities and differences.

[4] For the link between empire, commerce and the sudy of nature, see: Klaus Vogel, "European Expansion and Self-Definition," in Daston and Park, *Cambridge History of Science*, vol. 3, 818–840; Larry Stewart, "Global Pillage: Science, Commerce, and Empire," in Porter, *Cambridge History of Science*, vol. 4, 825–844.
[5] Harold J. Cook, *Matters of Exchange: Commerce, Medicine, and Science in the Dutch Golden Age* (New Haven: Yale University Press, 2007), 3–4.
[6] See, for example: Michael Hunter, *Science and Society in Restoration England* (Cambridge: Cambridge University Press, 1981).

Authors of Natural History

Who were these 'other authors' to whom Ray referred? The preface names Ulysse Aldrovandi (1522–1605) and Jan Jonston (1603–1675) alongside Gessner, while Ray and Willughby also drew on other Renaissance authors such as Guillaume Rondelet (1507–1566), Hippolyto Salviani (1514–1572), and Pierre Belon (1517–1564). In their turn, these authors took their place within a long and rich tradition of examining and describing nature. They were part of a generation of humanists that had started looking critically at classical and scholastic texts, and both commented on and amended them. Certainly, these naturalists differed in their emphases and approaches: when describing animals, for instance, Gessner was particularly interested in philological questions, whereas Aldrovandi's aim appears to have been to bring together all that had been written on a certain species.[7] As we will see, these Renaissance authors were nonetheless representative for the community of naturalists that was forming in the sixteenth century, when natural history began to take shape as a separate field of study.

The study of natural history stretched back to antiquity, and was commonly referred to as *historia naturalis*. The term *historia*, as Gianna Pomata and Nancy Siraisi have shown, had a range of connotations across various domains of knowledge in the early modern period, from civil history to law and from medicine to philology to natural philosophy.[8] In medicine and natural history, *historia* usually entailed the knowledge and description of particulars, and was considered distinct from *scientia*, which meant causal, certain, demonstrable and universal knowledge.[9] The term *historia naturalis* had become popular with Pliny the Elder, who had produced many volumes under this same title, in which he described the particulars of both natural phenomena and the products of human artifice.[10] He had been inspired by Aristotle's histories of animals.[11] Their

[7] Cf. in Laurent Pinon, *Livres de zoologie de la Renaissance: Une anthologie (1450–1700)* (Paris: Klincksieck, 1995), 84–85 and 104–105.
[8] Pomata and Siraisi, "Introduction," in *Historia: Empiricism and Erudition in Early Modern Europe*, eds. Gianna Pomata and Nancy G. Siraisi (Cambridge, Mass.: MIT Press, 2005), 1.
[9] Ibid., 3, 10.
[10] A translation is found in Pliny, *Natural History*, 10 vols, ed. and trans. H. Rackham (Cambridge, Mass.: Harvard University Press, 1938–1952).
[11] See for a translation: Aristotle, *Histories of Animals in Ten Books*, ed. and trans. Richard Cresswell (London: George Bell, 1878).

respective models of *historia* had different philosophical aims and implications, however: Pliny did not seek to offer a causal account for natural phenomena but solely described their particularities, while cause and purpose formed the central tenets of Aristotle's approach to nature.[12] Nonetheless, both of these schemes of knowledge were used alongside one another, and Aristotle and Pliny remained classical authors of consequence throughout the medieval and early modern period. Both their philosophies were taught at the universities alongside those of medieval thinkers.[13]

At the early modern universities, natural history did not constitute a separate discipline in and of itself. Rather, it was subsumed under the academic curriculum of the long-established faculties. It might be taught at the faculty of arts, for example as part of a philosophy course, or the higher faculty of medicine.[14] In the latter, for example, students were taught medical botany because knowledge of the properties of plants and herbs was useful for healing. Besides receiving some training in botany, students of medicine at some universities could also attend the dissections of animals, and occasionally humans, to learn more about anatomy.[15] From the sixteenth century onwards, however, students who had taken their degree in medicine began to abandon the examination of patients altogether, directing their attention to inspecting plants and animals instead.[16] Brian Ogilvie considers this as the period in which natural history was invented: when naturalists came to consider themselves as "practitioners of a discipline that, although related to medicine and natural philosophy, was distinct from both."[17]

[12] Ian Maclean, "White Crows, Graying Hair, and Eyelashes: Problems for Natural Historians in the Reception of Aristotelian Logic and Biology from Pomponazzi to Bacon," in Pomata and Siraisi, *Historia*, 154; on Pliny, see Karl A.E. Enenkel, "Die antike Vorgeschichte der Verankerung der Naturgeschichte in Politik und Religion: Plinius' Zoologie und der römische Imperialismus," in *Zoology in Early Modern Culture*: *Intersections of Science, Theology, Philology, and Political and Religious Education*, eds. Karl A.E. Enenkel and Paul J. Smith, 15–54.
[13] Ogilvie, *Science of Describing*, 89.
[14] A discussion of the curricula of early modern European universities can be found in: Laurence Brockliss, "Curricula," in *A History of the University in Europe,* vol. 2, *Universities in Early Modern Europe (1500–1800)*, ed. Hilde de Ridder-Symoens (Cambridge: Cambridge University Press, 1996), 563–620.
[15] Findlen, "Natural History," 445; by the end of the sixteenth century, Italy had distinct professorships for natural history, see: Paula Findlen, "The Formation of a Scientific Community: Natural History in Sixteenth-Century Italy," in *Natural Particulars: Nature and the Disciplines in Renaissance Europe*, eds. Anthony Grafton and Nancy Siraisi (Cambridge, Mass.: MIT Press, 1999), 370.
[16] Findlen, "Natural History," 459.
[17] Ogilvie, *Science of Describing*, 1.

In this development, the close communication between naturalists was key. Florike Egmond has argued that it was through the exchange of seeds and bulbs, preserved plants and animals, and visual and textual observations, that naturalists developed a communal sense of what aspects of nature were worth investigating.[18] An important apriori in these exchanges was that of reciprocity. According to the principle of *do ut des*, the recipient of a gift was obliged to return the favour, either by offering an object or observation in return or by acknowledging in some other way, for example by mentioning the name of the donor in one's publications.[19] As we will see further in the other chapters of this dissertation, these and other manifestations of an 'ethos of service'[20] – in the words of Anne Goldgar – continued to underpin exchanges between naturalists until well into the late eighteenth century.

In trying to understand nature, naturalists scoured a wide array of textual sources besides ancient texts, including travel accounts, lyric poetry, collections of recipes, agricultural treatises as well as tracts pertaining to hunting and fishing. At the same time, naturalists attached evermore weight to knowledge derived from direct observation. While assertions of eye-witnessing had carried authority from antiquity, they took in new vigour in the early modern period, with a range of terms to describe it.[21] The emphasis on 'autoptic authority' – the authority derived from *autopsia*, or 'seeing with one's own eyes' – grew in the sixteenth century, and was used by a wide range of people, from artisans to anatomists and beyond.[22] Pomata has shown how in the sixteenth century the plethora of words that denoted some type of observational practice (she mentions *observatio*, *experientia*, *experimentum*, *contemplatio*, *consideratio*, *consilia, curationes*, *autopsia*) converged in a common language.[23] The term *observatio* was firmly established as

[18] Florike Egmond, "European Exchanges and Communities," in *Worlds of Natural History*, eds. Helen Anne Curry, Nicholas Jardine, James Andrew Secord and Emma C. Spary (Cambridge: Cambridge University, 2019), 78.
[19] See also Elizabeth Yale, *Sociable Knowledge: Natural History and the Nation in Early Modern Britain* (Philadelphia: University of Pennsylvania Press, 2016), esp. chapter 2.
[20] Anne Goldgar, *Impolite Learning: Conduct and Community in the Republic of Letters, 1680–1750* (New Haven: Yale University Press, 1995), 51.
[21] Gianna Pomata, "*Praxis Historialis*: The Uses of *Historia* in Early Modern Medicine," in Pomata and Siraisi, *Historia*, 113.
[22] Smith, *Body of the Artisan*, 42.
[23] Gianna Pomata, "Observation Rising: Birth of an Epistemic Genre, 1500–1650," in *Histories of Scientific Observation*, ed. Lorraine Daston and Elizbeth Lunbeck (Chicago: Chicago University Press, 2011), esp. 65–69.

the vocabulary of experience in the course of the seventeenth century.[24] It could be applied in multiple ways: 'observation' could refer to the actual act of observing, or the (often written or drawn) report that was made of an observation.[25]

In the course of the sixteenth century, spaces were erected where nature could be examined with one's own eyes, from anatomical theatres to botanical gardens and cabinets of curiosities.[26] They formed, in the words of Ogilvie, the 'empirical substrate' for natural history.[27] In her influential work on early modern museums in Italy, Paula Findlen has shown both the range and depth of the collections that emerged in the sixteenth and seventeenth centuries, in sundry places and under different guises.[28] Collections were assembled by individuals of various stripes, from princes to apothecaries, and merchants to monarchs. The content of these collections was encyclopaedic in character, bringing together objects that were both natural (*naturalia*) and artificial (*artificialia*), as well as items that bridged these categories, such as painted nautilus shells or wrought coral. When Willughby, Ray and their travel company visited what appears to have been the collection of physician Felix Platter (1536–1614), one of Gessner's close collaborators, they witnessed a "[…] collection of rarities; among which […] many sorts of minerals, stones, dry'd fishes, *&c*. with their names written; a lamp with a brass globe, which, turned any way, would still keep in its right posture; lachrymal urns; painted books of quadrupeds, fishes and fowls; […]."[29] The description of Platter's collection is a good representation of the bandwidth of objects that one might encounter in cabinets of curiosities.

[24] Ibid.
[25] Dirk van Miert, "Introduction," in *Communicating Observations in Early Modern Letters (1500–1675): Epistolography and Epistemology in the Age of the Scientific Revolution*, ed. Dirk van Miert (London: The Warburg Institute, 2013), 3.
[26] Paula Findlen, "Anatomy Theaters, Botanical Gardens, and Natural History Collections," in Daston and Park, *Cambridge History of Science* vol. 3, 272–289.
[27] Ogilvie, *Science of Describing*, 42.
[28] An overview of the many terms used to denote these collections in the early modern period can be found in Findlen, *Possessing Nature*, 48–49.
[29] Philip Skippon, *An Account of a Journey Made Thro. Part of the Low Countries, Germany, Italy and France* (London: Churchill, 1732), 446; the painted books might have been what are now known as the Gessner-Platter albums held in the Special Collections Department of the Universiteitsbibliotheek Amsterdam (hereafter UBA), Amsterdam, hs. III C 22/23; for its recent discovery and its provenance, see Florike Egmond, "A Collection within a Collection: Rediscovered Animal Drawings from the Collections of Conrad Gessner and Felix Platter," *Journal for the History of Collections* 25, no. 2 (2013): 149–170.

Aquatic specimens seem to have held particular appeal to collectors. In the well-known depictions of cabinets of curiosities from the sixteenth and seventeenth centuries, such as that of Ferrante Imperato (*c.*1525–1615) in Naples and Ole Worm (1588–1655) in Copenhagen, we detect stuffed sharks dangling from the ceiling, inflated puffer fishes as well as scores of crayfish, crabs and shells. These species had the undeniable quality of being not subject to immediate decay. Marine creatures had, since Pliny, been considered to be more monstrous than those living on the land because the sea's fertility.[30] Aquatic specimens also may have carried particular value because they demonstrated certain mastery or dominion of the world under water, as James Delbourgo has argued: "[t]he aquatic collector paradoxically exhibited his piety by emulating divine power, creating conditions for vision into the watery part of the creation by raising its treasures from the depths. As the Creator's power could overturn nature's lawful order and turn land into sea, the collector's manifested itself by transforming aquatic creatures into dry curiosities."[31] While the incentives for collecting aquatic curiosities varied, these objects offered the opportunity to examine the wonders of the deep on dry land.

Nature was thus studied in many configurations. To cite Findlen, natural history in the sixteenth century "was a truly encyclopaedic science in which broad sectors of society participated, although not, at this point, as a unified group."[32] These encompassed, among others, philologists, philosophers, physicians, apothecaries, princes, artists and artisans, who probed natural history in, among other places, workshops, gardens, cabinets, and courts. Above, we have seen how Ogilvie has suggested how natural history was established as its own discipline, emancipated from medicine, during the mid-sixteenth century.[33] The statements of Ogilvie and Findlen form an interesting juxtaposition: while natural history gradually emerged as a field of inquiry in and of itself, recognized as such by its practitioners, these practitioners did not yet constitute a unified group.

[30] Marine creatures were also thought to be underdeveloped compared to their terrestrial counterparts. See: Sophia Hendrikx, "Monstrosities from the Sea: Taxonomy and Tradition in Conrad Gessner's (1516–1565) Discussion of Cetaceans and Sea-Monsters," *Anthropozoologica* 53, no. 11 (2018): 127–128.
[31] James Delbourgo, "Divers Things: Collecting the World Underwater," *History of Science* 49 no. 2 (2011): 153.
[32] Findlen, "Natural History," 435.
[33] Ogilvie, *Science of Describing*, 34.

For many of these new-fangled natural historians of the sixteenth century, description lay at the core of their endeavours. As Ogilvie has argued, while description had been an important part of *historia naturalis* since its inception, it truly became a topic of concern in the sixteenth century.[34] Naturalists pondered how to draw up species descriptions in such a way that it would be clear to both their correspondents and the readers of their books precisely what they had seen. Naturalists in the sixteenth century examined plants and animals for differences [*differentiae*] on the basis of which one species could be distinguished from the other. In this, they based themselves on the ancient, Aristotelian distinction of 'essential' and 'accidental' properties which, in practice, were liable to prove rather difficult to draw.[35] If, for example, two plants looked very much alike, but one produced larger or differently coloured flowers, did that mean that they constituted a separate species or were they variations of one and the same species? A definitive answer could not be given. Nonetheless, naturalists developed a communal approach to these questions by establishing a common vocabulary, as well as a (more or less) consistent format for describing species.[36]

We have seen, in broad strokes, how in the sixteenth century a wide range of people began to consider natural history as a topic worth studying for its own sake. This development was not necessarily reflected in the university curricula, as there were no formal requirements or qualifications for the study of natural history.[37] Thus, while early modern universities facilitated the study of nature as part of other courses, they were far from its exclusive locus. Both the people who examined nature, and the places where they did this, were multifarious. Because of the centrality of description to the aims of natural history, however, it is no wonder that it was mostly *authors* that were recognized as naturalists, rather than those who were engaged in the study of nature in a more practical sense or spent their time teaching rather than writing.[38] The constant comparison of observed animals and plants with written texts was one of the key elements in

[34] Ibid., 6.
[35] Ibid., 181.
[36] Ibid., 53.
[37] Ibid., 38.
[38] Findlen, *Possessing Nature*, 6.

the formation of Renaissance natural history. Even if books remained important sources for understanding nature, sixteenth-century naturalists began to compare the claims published in them with what they could observe around them.

"The hot pursuit of useful studies and designs"

When Willughby passed away after a short illness in 1672, his death came in the midst of "the hot pursuit of useful studies and designs", as Ray put it.[39] Willughby had indeed been a polymath, well versed not only in Cartesian philosophy, mathematics, chymystry and magnetism, but also competent in the study of plants, four-footed beasts, birds and fish.[40] In Ray he had found a kindred spirit. Ray, too, had taken to the study of a wide range of fields. He tutored in Greek and mathematics, but had developed a predilection for the study of natural history, which he considered, as we will see, as a perfect entry into contemplating God's endless wisdom.[41] Both Willughby and Ray immersed themselves in various branches of learning, their intellectual interests stretching from the movement of the heavens, to classical languages, to fish. Their enthusiasm for the natural world was shared by the other members of the Royal Society, which had been established in London in 1660 under a charter of King Charles II (1630–1685), and which foregrounded direct experience as the foundation for acquiring knowledge about nature. As we will see shortly, the Fellows of this Society would become closely involved in the publication of the *Historia piscium*.

The basis for the collaboration of Willughby and Ray was formed at the University of Cambridge. In 1644, Ray had been admitted to Trinity College as the son of a blacksmith in Black Notley, on a stipend. After completing his degree of Master of Arts in 1651, he stayed on as a lecturer and tutor, first of Greek and later in mathematics. During this time, he also developed his botanical interests, cataloguing the plants in the vicinity of Cambridge, and cultivating them in

[39] Willughby, *Ornithology*, preface, sig. A2v.
[40] He studied so much that his tutor thought "he should moderate his thirst for learning", see: William Poole, "The Willughby Library in the Time of Francis the Naturalist," in *Virtuoso by Nature: The Scientific Worlds of Francis Willughby (FRS)*, ed. Tim Birkhead (Leiden: Brill, 2016), 236.
[41] Ray's most influential physico-theological treatise, *The Wisdom of God Manifested in the Works of the Creation* (London: Samuel Smith, 1691) was reprinted in 1692, 1701 and 1704; it was translated in German, Dutch and French.

his garden.[42] Willughby, a descendant from a noble family, arrived at Trinity in 1652.[43] He enrolled in the undergraduate arts course, although his noble descent meant that, during Commons, he shared the table with the College's fellows rather than with his fellow students. Although it was quite uncommon for gentlemen to stay at the university for an extended period of time, Willughby went on to take a Master of Arts, all the while developing a particular interest in natural philosophy and natural history. It was probably in this context that he got to know Ray better; the latter's *Catalogus plantarum circa Cantabrigiam nascentium* (Cambridge, 1660) mentions him as a contributor.[44] As such, it was their first joint foray into the study of living nature, a collaboration that further developed in the decade to come.

In the early 1660s, both Willughby and Ray departed from Cambridge.[45] This did not mean they left their pursuit of the study of living nature; they would continue to meet fellow scholars at the recently founded Royal Society for the improving of natural knowledge in London. Given their sustained interest in studying the natural world, Willughby and Ray seemed suitable members, and they also knew several of the other Fellows from their days at Cambridge. Willughby's noble descent may have been a factor in gaining early entry to the Society in 1661, whereas Ray was accepted as a member in 1667.[46] The Society's chambers offered a congenial setting for men of certain standing interested in natural philosophy to exchange thoughts, ideas, and occasionally to perform experiments.[47] As we know, emphasis on first-hand observation alongside texts rose steadily from the early sixteenth century onwards; the Society, however, foregrounded direct, sensory experience of nature. This approach has been characterized as explicitly empirical; the Society's motto, *nullius in verba* (on the word of no one), reflects

[42] For Ray's years at Cambridge, see: Raven, *John Ray*, 21–110.
[43] For the history of the Willughby family, see: Cassandra Willoughby, *An Account of an Elizabethan Family: The Willoughbys of Wollaton by Cassandra Willoughby, 1670–1735*, ed. Jo Ann Hoeppner Moran Cruz in *Royal Historical Society Camden Fifth Series* 55 (2018): 67–258.
[44] Willughby's time at Cambridge is discussed in more detail in Richard Serjeantson, "The Education of Francis Willughby," in Birkhead, *Virtuoso by Nature*, 44–98.
[45] Raven, *John Ray*, 60–61.
[46] Johnston, "The Life and Domestic Context of Francis Willughby," 9 and Raven, *John Ray*, 46.
[47] A concise overview of early modern academies is given in Jürgen Renn and Florian Schmaltz, "Institutions and Knowledge Systems: Theoretical Perspectives," in *The Institutionalization of Science in Early Modern Europe*, eds. Mordechai Feingold and Giulia Giannini (Leiden: Brill, 2019), 292–296.

the commitment of the Fellows to questioning received wisdom, and examining everything with their own eyes.[48] They collected many observations on a wide range of topics, from which they hoped to distil general natural principles. In this, the Society owed much to the philosophical programme of Francis Bacon (1561–1626), even if its adherence to the latter's work was not absolute. Chapter 2 will delve into the historiography surrounding the Royal Society in much more detail than the present chapter allows, and will also look at its empirical project in more depth. This sketch of the Royal Society's aims is, however, sufficient to help address the wider, institutional context in which Ray and Willughby were pursuing their natural historical studies in the 1660s.

Willughby and Ray spent the larger part of this decade travelling. During their time at university, both had made several trips in England and Wales, during which they collected observations of plants, birds and fish but also made lists of words in several dialects. It appears that they made some sort of division of labour while undertaking these joint researches, with Ray focussing on the plants, and Willughby on the animals.[49] Their departure from Cambridge allowed them to embark on further travel and examine even more nature and culture. Willughby and Ray toured continental Europe between 1663 and 1666. They did so together with Nathaniel Bacon (1647–1676) and Philip Skippon (1641–1691), with whom they had become acquainted at Cambridge, and two servants. It is likely that the affluent Willughby and Bacon bore the brunt of the costs. After having reached Calais, the company set course to the Low Countries, from where they travelled through Germany, Switzerland, and Austria to the Italian Peninsula – after which the company returned home, except for Willughby, who ventured onwards to Spain.[50]

[48] That experience was not to be equated with objectivity is argued in Alexander Wragge-Morley, *Aesthetic Science: Representing Nature in the Royal Society of London, 1650–1720* (Chicago: Chicago University Press, 2020), 3–4.
[49] Sachiko Kusukawa, "The *Historia Piscium* (1686)," *Notes and Records of the Royal Society of London* 54, no. 2 (2000): 179.
[50] For a more detailed itinerary, see: Mark Greengrass, Daisy Hildyard, Christopher D. Preston and Paul J. Smith, "Science on the Move: Francis Willughby's Expeditions," in Birkhead, *Virtuoso by Nature*, 152–193.

Both Ray's and Skippon's accounts of these travels have appeared in print.[51] They demonstrate the travel company's devotion to recording everything they encountered, a devotion remarkable in its intensity, attention to detail and scope.[52] Besides notes about animals and plants, the journeying naturalists documented inscriptions on buildings, as well as local customs. Skippon wrote, for example, that during their visit to Rome, the travel company had climbed Trajan's Column, and recorded that it comprised 173 steps.[53] Thus, they found that the number of steps that the humanist scholar Alfonso Chacón (1530–1599) mentioned in his description of the column, namely 184, was incorrect.[54] The reports of Skippon and Ray likewise contain several accounts of the number of steps in various church towers.[55] While these kinds of reports may seem trivial, they are exemplary for their insistence on holding their own direct observations against those that were reported by earlier authors. Willughby and Ray applied this same meticulous attention to detail to natural history.

Their travels both within the British Isles and on the Continent were important opportunities for the examination of nature. Wales and the West Country, for example, they described birds, fishes and plants as well as visiting mines.[56] On the Continent, they visited the late Platter's collection in Basel,[57] whereas in Venice they called on "one *Rosachio*, a reputed astrologer" who "shew'd […] his collection of rarities, which were kept in pretty good order."[58] It was through natural historical specimens in such collections that Willughby and Ray could also catch a glimpse of species that were not native to Europe. They could make use, for example, of the Royal Society's Repository, which had drawn "together in one Room, the greatest part of all the several kinds of

[51] John Ray, *Observations Topographical, Moral and Physiological, Made in a Journey through Part of the Low-Countries, Germany, Italy and France* (London: John Martyn, 1673) and Skippon, *Journey* cited note 28; Willughby's account of the journey unfortunately appears no longer extant, though parts of it were subsumed in Ray's. Greengrass, Hildyard, Preston and Smith, "Science on the Move," 163.
[52] Greengrass, Hildyard, Preston and Smith, "Science on the Move," 160.
[53] Skippon, *Journey*, 653.
[54] Alfonso Chacón, *Historia iutruisque belli datici a Traiano Caesare gesti quae in columna euisdem Romae visuntur, collecta* (Rome: Franciscum Zanettum & Bartholomaeum Tosium socios, 1576), A1r.
[55] Ray, *Observations*, 81.
[56] Greengrass, Hildyard, Preston and Smith, "Science on the Move," 151.
[57] Skippon, *Journey*, 446.
[58] Ibid., 517.

things, that are scatter'd throughout the *Universe*."[59] The catalogue that natural historian and Fellow of the Royal Society Nehemiah Grew (1641–1712) drew up of this collection gives an idea of its contents, ranging from coins to 'humane rarities' and to animals, plants and minerals.[60] Ray explained that Willughby had planned "a Voyage into the *New World*", having already examined so many of the European animals, but he did not live to undertake it.[61] Since neither of them left the comfort of familiar European climes, their knowledge of faraway species came from other sources: from the aforementioned collections to reading travel accounts and natural historical books that discussed species from further away regions.[62]

After Willughby finally returned from his extended sojourn following the European tour in 1666, he invited Ray to take up residence at the Willughby family's estate, Middleton Hall in Warwickshire.[63] Both of them benefited from this arrangement. It offered Ray the (financial) stability required for his studies.[64] Research was, after all, like nowadays, time-consuming and expensive, and it required the purchase of books and specimens, as well as the undertaking of travel and field trips.[65] Naturally, Ray's presence on Willughby's estate meant that they could all the more easily pursue their shared, and rather ambitious, goal: to identify and describe all the species of plants, birds, fish and insects they had come across, and to put them into some sort of order. This arrangement continued until Willughby's premature death in 1672.

[59] Thomas Sprat, *The History of the Royal-Society of London for the Improving of Natural Knowledge* (London: John Martyn, 1667), 251.
[60] Nehemiah Grew, *Musaeum Regalis Societatis, or, A catalogue & description of the natural and artificial rarities belonging to the Royal Society and preserved at Gresham Colledge* (London: Hugh Newman, 1681), 1–10.
[61] Willughby, *Ornithology*, preface, sig. A4r.
[62] The works they cite are: Carolus Clusius, *Exoticorum libri decem* (Leiden: Ex Officina Plantiniana Raphelengii, 1605), Willem Piso and Georg Marcgraf, *Historia naturalis Brasiliae* (Amsterdam: Ludovicus Elzevier, 1648), Edward Terry, *A Voyage to East-India* (London: J. Wilkie, 1655) and Johan Nieuhof, *Gedenkweerdige Brasiliaense Zee- en Lant- Reize* (Amsterdam: J. van Meurs, 1682).
[63] Dorothy Johnston, "The Life and Domestic Context of Francis Willughby," in Birkhead, *Virtuoso by Nature*, 7.
[64] While the details of this arrangement are unclear, it seems he had a comfortable position at Middleton. Raven, *John Ray*, 166–167.
[65] For this dynamic, see: Alix Cooper, "Homes and Households," in Daston and Park, *Cambridge History of Science* vol. 4, 231–232.

Unfortunately, few traces remain of their daily life in Middleton and how they went about their considerable project. More is known about the significant changes that the household underwent during this period. In 1668, Willughby married Emma Barnard (1644–1725), with whom he had three children: Francis, Cassandra, and Thomas.[66] Ray continued to live with the family at Middleton Hall, where he had his own chamber and study.[67] After Willughby's death, Ray stayed on at the estate for almost four more years; Willughby had stipulated in his will that Ray was to act as resident executor and tutor for his sons, in exchange for an annuity. During this time, Ray married Margaret Oakley (*b.*1654) in 1673 and finished the manuscript for the *Ornithologia* in 1674. When Willughby's widow eventually remarried in 1675 and moved away from Middleton, Ray also left.[68] He and his wife finally settled in Black Notley, Essex, where they raised their four daughters. Ray continued his work, turning the extensive notes he and Willughby had produced into actual natural historical manuscripts that were fit for print.[69]

In 1685, more than ten years after Ray had commenced his preparation of the history of fishes, the Royal Society received word that it was almost ready. As is the case for the *Ornithology*, the *Historia piscium* displays Willughby's name on its title page as the author.[70] Ray, the man who had assembled the existing materials, supplementing them where necessary, was credited as the work's editor. The state of the work at the moment of Willughby's death and the decade it took Ray to turn their notes into publishable form has led to much debate regarding which of the two men ought truly be considered the book's author.[71] In his biography of Ray, Charles Raven more than once contends that the contributions of the younger, less experienced Willughby to their natural historical researches could only have been minor.[72] Two recent publications that focus solely on Willughby

[66] Johnston, "Life and Domestic Context of Francis Willughby," 10–11.
[67] Ibid., 12.
[68] Ibid., 29.
[69] In this, he was hindered by no longer having access to Willughby's notes at Middleton. It is unclear why he had not copied these notes: there may have simply been too many, or he might not have expected to lose access to them in the first place.
[70] Francis Willughby and John Ray, *Francisci Willughbeii Armig. De historia piscium libri quatuor* (Oxford: Sheldonian Theatre, 1686), title page. This work will henceforth be cited as *Hist. pisc*.
[71] This debate is addressed in more detail in Isabelle Charmantier, Dorothy Johnston and Paul J. Smith, "The Legacies of Francis Willughby," in Birkhead, *Virtuoso by Nature*, 382–385.
[72] Raven, *John Ray*, 51.

have done much to bring to light the latter's significant role in the duo's fruitful cooperation.[73] Their intertwined contributions can be teased out to some extent. The *Historia piscium* contains a few passages where Ray explicitly attributes a certain statement to Willughby, and the title page specifies that the first two parts of their publication came from Ray's hand. On the whole, the history of fishes is perhaps best considered as a collaborative project to which Fellows other than its prime movers, Willughby and Ray, also contributed. It is often difficult, therefore, to attribute particular statements or ideas directly to Willughby.

All in all, the publication of the work was an intricate affair. The most thorough study of the *Historia piscium*, both with regard to its intellectual underpinnings and the more practical side of publication, has been undertaken by Sachiko Kusukawa.[74] Before discussing the aim of the book in more detail later in this chapter, we will now turn to the process of its publication. As Kusukawa has stated, the Fellows' collective engagement with the work fundamentally shaped the way it was finally published.[75] The Royal Society had become involved in the production of the work after they had found that Ray wanted to supply it with illustrations, as he had done for the *Ornithologia*. It proved difficult to find a printer willing to publish such a work because of the high costs involved. Eager to see the work in print, the Society assumed financial responsibility for its publication,[76] having previous experience in licensing and sponsoring books.[77] The Society's involvement was not just of financial nature: the Fellows helped to amass relevant material for the book and evaluated which observations merited

[73] Birkhead, *Virtuoso by Nature*, and Birkhead, *The Wonderful Mr. Willughby: The First True Ornithologist* (London: Bloomsbury, 2018). Willughby is often counted among the *virtuosi*; for discussions of the category of the *virtuoso*, see the special issue *The Varied Role of the Amateur in Early Modern Europ* edited by Pamela Smith in *Nuncius* 31, no. 3 (2016): 485–609.
[74] Kusukawa, "The *Historia Piscium* (1686)," 179–197; Sachiko Kusukawa, "*Historia Piscium* (1686) and Its Sources," in Birkhead, *Virtuoso by Nature*, 305–334. An account of the publication process is also given in Anna Marie Roos, *Web of Nature: Martin Lister (1639–1712): The First Arachnologist* (Leiden: Brill, 2011), 318–332.
[75] Kusukawa, "The *Historia Piscium* (1686)," 180.
[76] Sachiko Kusukawa, "*Historia Piscium* (1686) and Its Sources," 305.
[77] Tara Nummedal and Paula Findlen, "Words of Nature: Scientific Books in the Seventeenth Century," in *Thorton and Tully's Scientific Books, Libraries and Collectors: A Study of Bibliography and the Book Trade in Relation to the History of Science*, ed. Andrew Hunter (Aldershot: Ashgate, 2000), 189–192.

inclusion. They also passed down their own observations.[78] Tancred Robinson (1658–1748) and Martin Lister (1639–1712) were especially active in delivering the *Historia piscium* to publication.[79]

When the book made it into print in 1686, it comprised four parts. It opened with general discussion of fish and their properties, continued with descriptions of cetaceans (whales and the like), followed by descriptions of fish with cartilaginous skeletons (for example, rays and sharks), and ended with descriptions of fish that had bony skeletons and spiny fins, like herrings and trouts, which made up the largest group. These four sets of descriptions had as their appendix descriptions of fish found in other books that were not considered precise enough to warrant inclusion in the body text.[80] The resulting work was a voluminous and impressive work in folio format.

In addition to its well over 300 pages of text, *Historia piscium* contained 189 sumptuous, often full-page, copperplate engravings, depicting no fewer than 388 species. The book was, in fact, originally envisioned as two separate works: one work containing texts, and the other (which was to bear the name *Icthyographia*) illustrations. While the works were eventually published together as one book, both parts retained their own title page. In most copies of the *Historia piscium* the illustrations are bound together, rather than being interleaved between the descriptions.[81] Because copper plates were expensive, Fellows and other donors subscribed to them; their names are inscribed on the plates. Kusukawa has calculated that this brought down the cost by almost £163, a sum that did not match the final production cost of £360, which included the commissions to the engravers, the cost of the paper, and the printing of index and text.[82] One could purchase a copy for a little over £1 on a lesser quality paper if one had subscribed, or

[78] These letters were written in English, and excerpts of them were translated into Latin for inclusion in the *Historia piscium*, for example the experiment for determining the centres of gravity for a pilchard and a herring by holding the specimens by the tip of their back-fin: Tancred Robinson to Ray, 8 September 1685 (OS), *The Correspondence of John Ray*, ed. Edwin Lankester (London: The Ray Society, 1848), 174; cf. *Hist. pisc.*, 224.
[79] For Lister's contributions, see: Roos, *Web of Nature*, 318–332.
[80] These included descriptions by Lister as well as from Nieuhof's *Gedenkweerdige Brasiliaense Zee- en Lant-Reize*.
[81] See also: Adrian Johns, *The Nature of the Book: Print and Knowledge in the Making* (Chicago: University of Chicago Press, 2000), 489.
[82] Kusukawa, "The *Historia Piscium* (1686)," 191.

spend £1 and 8 shilling for the best paper if one had not.[83] Sales, however, proved disappointing and the Society suffered a considerable loss. Although publishing books was often a risky affair, its many engravings made the *Historia piscium* a particularly delicate enterprise.[84] Its publication turned out to be such a costly venture that the Society did not have sufficient funds left with which to finance the publication of Isaac Newton's *Philosophiae naturalis principia mathematica*.[85]

Those today who are surprised that a book of fish almost sank Newton's *Principia*, besides having the gift of hindsight (for following its publication in 1687, the *Principia* became a landmark of natural philosophy), overlook the fact that a natural history of fish fitted snugly within the Royal Society's explicit programme. After all, as explained above, the Fellows were invested in bringing together observations on a wide range of topics; Robert Hooke (1635–1703), an influential figure within the Society, insisted that attention should be paid to common things.[86] Indeed, the minutes of the Society's meeting certainly reflect their investment in recording a wide range of phenomena in detail: from the workings of quicksilver to the colour variants of the teeth of sheep.[87] The communications that were published in the *Philosophical Transactions*, the learned periodical that Society's secretary Henry Oldenburg (1618–1677) founded in 1665 do likewise.[88] In short, in their shared, hot pursuit of useful studies, the Fellows did not regard scrutinizing plants, birds, fish and insects in all their intricacies as an endeavour intrinsically less worthwhile than studying the motions of planets. To better appreciate why this was the case, it is important to address the larger natural philosophical framework in which their approach to nature was embedded.

[83] Ibid.

[84] A broad treatment of the ways in which money was made (or lost) in the business of books in the early modern period can be found in: Shanti Graheli, ed., *Buying and Selling: The Business of Books in Early Modern Europe* (Leiden: Brill, 2016).

[85] Kusukawa, "The *Historia Piscium* (1686)," 193; after the *Historia piscium*, the Society would refrain from offering direct financial support of projects, see: Nummedal and Findlen, "Words of Nature," 191.

[86] Felicity Henderson, "Robert Hooke and the Visual World of the Early Royal Society," *Perspectives on Science* 27, no. 3 (2019): 398.

[87] Thomas Birch's *History of the Royal Society*, 4 vols (London: A. Millar, 1756–1757) offers accounts, albeit necessarily abridged and edited, of what transpired at the meetings of the Royal Society. Birch, *History of the Royal Society*, vol. 1, 20 and vol. 3, 97.

[88] On the early history of the *Philosophial Transactions*, see: Noah Moxham, "Authors, Editors and Newsmongers: Form and Genre in the Philosophical Transactions under Henry Oldenburg," in *News Networks in Early Modern Europe*, eds. Joad Raymond and Noah Moxham (Leiden: Brill, 2016), 465–492.

From *Aquatilia* to Fish

Even though Ray distanced himself from earlier authors, their works remained as sources of knowledge from which both he and Willughby had made ample use. Aristotle and Pliny the Elder are among the traditional authorities they cite, which also attest to the lasting influence of the classical canon.[89] And yet, the way in which they approached the study of nature was subtly different from the naturalists of the sixteenth century. Ancient texts that had been traditional sources of authority were gradually replaced by new philosophies regarding nature's underlying patterns. These philosophies, among which mechanistic conceptions of nature in particular gained currency, had repercussions for how plants and animals were approached. Against the backdrop of this gradually shifting framework, this section traces how 'fish' as an object of study underwent a change from a member of the *aquatilia*, in the sixteenth century, to a creature with fins and without feet by the late seventeenth.

Before we do so, the term *aquatilia* requires qualification. What did this term envelop? Pliny the Elder had used the term to denote aquatic animals, as a substantived adjective for that which was "living, growing, or found, in or near water".[90] In the sixteenth century, the category of *aquatilia* encompassed all water-dwelling animals, from whales and rays to oysters, shrimp, crabs, octopusses, turtles, walruses, and so on. These are the species one encounters on the pages of, for instance, Belon's *De aquatilibus* (Paris, 1551) and Salviani's *Aquatilium animalium historiae* (Rome, 1554–58).[91] The title of Gessner's *Historiae animalium liber IIII. qui est de piscium & aquatilium animantium natura* (Zurich, 1558) mentions fish and *aquatilia* separately, but discussed them in one and the same work.[92] The Latin

[89] Anthony Grafton, *New Worlds, Ancient Texts: The Power of Tradition and the Shock of Discovery* (Cambridge, Mass.: Harvard University Press, 1995), 248. They did so, however, on their own terms with their unique way of engaging with classical philosophical texts through an intricate textual, humanistic tradition, see: Dmitri Levitin, *Ancient Wisdom in the Age of the New Science: Histories of Philosophy in England, c. 1640–1700* (Cambridge: Cambridge University Press, 2015), 4.

[90] *A Latin Dictionary*, comp. Charlton T. Lewis and Charles Short (Oxford: Oxford University Press, 1879), s.v. aquatilia.

[91] Pierre Belon, *De aquatilibus, libri duo: cum eiconibus ad vivam ipsorum effigiem, quoad ejus fieri potuit, expressis* (Paris: Carolum Stephanum, 1553); Hippolyto Salviani, *Aquatilium animalium historiae liber primus* (Rome: Hippolyto Salviani, 1554–1558). Another early example is Nicolaus Marschalk, *Historia aquatilium latine ac grace cum figuris.* (Rostock: Nicolaus Marschalk, 1517).

[92] Conrad Gessner, *Historiae animalium liber IIII. qui est de piscium & aquatilium animantium natura* (Zurich: Christopher Froschauer, 1558); henceforth cited as *Hist. anim.* IIII. A dissertation on this volume is in preparation by Sophia Hendrikx at Leiden University.

term Gessner used, *piscium*, a declension from *piscis* (fish), was used in scholarly circles to refer to those aquatic animals with scales.[93] But this usage, too, was not universal. In his *L'Histoire entière des poissons* (Lyon, 1558), Rondelet included both 'fish that do not have blood' (for example, jellyfish, **Figure 1.1**) and 'fish with hard shells' (like scallops).[94] This use of the word *fish* corresponded to a broader tendency in early modern Europe to use the term for everything which lived either in, or on, the water.[95] This brief exploration of the term underlines the anachronism in only taking into account those species corresponding to our contemporary definition of fish in early modern natural histories of aquatic animals.

A defining feature of a fish, therefore, was that the creature dwelled in or on water. The correspondence between elements and animals was affirmed in Scripture: "And God said, let us make man in our image, after our likeness: and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth."[96] Pliny had divided species according to whether they inhabited land, air or water.[97] Aristotle had accorded the elements (earth, air, fire, water) a central place in his theories of matter.[98] This division continued to dictate daily life in the early modern period. The elements were thought to correspond to the changing seasons, the different ages of life, qualities (hot, dry, cold and moist) and humours (choler or yellow bile, blood, phlegm, and black bile). This may explain why, for sixteenth-century naturalists, *aquatilia* were considered a coherent group that merited treatment as such. Natural historical works on *aquatilia* of this period do indeed, in keeping with the Galenic tradition, discuss the cold and moist properties of species, and expatiate on how these could either be beneficial or harmful depending on one's humoural constitution.[99] The organization of nature based on elements thus was pervasive in the sixteenth century.

[93] Egmond, *Eye for Detail*, 60.
[94] Original French: "les poissons qui n'ont point de sang" and "les poissons coverts [couverts] de test dur"; Guillaume Rondelet, *L'Histoire entière des poissons* (Lyon: Macé Bonhomme, 1558), table of contents.
[95] Egmond, *Eye for Detail*, 60; Ogilvie, *Science of Describing*, 234–235.
[96] Gen. 1:26.
[97] Enenkel, "Die antike Vorgeschichte," 50.
[98] See also: Eric Lewis, "Aristotle's Physical Theory," in *The Cambridge History of Science*, eds. Alexander Jones and Liba Taub, vol. 1, *Ancient Science* (Cambridge: Cambridge University Press, 2018), 196–214.
[99] David Gentilcore, *Food and Health in Early Modern Europe: Diet, Medicine and Society, 1450–1800* (London: Bloomsbury, 2016), 19.

Another important notion was that of the *scala naturae*, the ladder of nature. Aristotle had proposed this idea in his *Historia animalium*, and it entailed a hierarchy, in continuous ascent, from lower to higher entities. It went from minerals to plants, to animals and, finally, humans. This linear arrangement was based on the (perceived) sentient abilities and attributes of beings. The hotter, more active, and complete, for example, the more perfect they were considered these fish outranked molluscs because of their swifter movements. What this hierarchical approach to nature entailed in practice was that some creatureswere to be.[100] Birds were considered more perfect than, say, cold-blooded fish, while considered less worthy of study, especially insects, which were believed to generate spontaneously from waste.[101] This Aristotelian approach towards the categorization of creatures proved persistent in later centuries.

In the late Medieval period, for example, the ladder of nature was recast as a "great chain of being", the grand cosmological hierarchy that unfolded from stones to plants, and from animals to humans, to angels and finally, God.[102] Its evenly spaced out steps displayed its divine design.[103] In contrast, the occurrence of 'monsters' and other irregularities of nature were often presages or portents for bad tidings.[104] When Ray asserted, in the quote that opened this chapter, that he eschewed the inclusion of *Morals*, *Fables*, *Presages* in his history of birds, he likely alluded to this approach towards nature. He certainly did assign the study of nature a moral value, albeit in a different sense: he believed that contemplating God's wisdom was best done by of admiring the 'intricate contrivances' of even the minutest beings.[105] This meant that the study of creatures hitherto undeserving of attention, such as the louse, was considered a laudable enterprise.[106] Ray's

[100] Ian Maclean, "White Crows, Graying Hair, and Eyelashes: Problems for Natural Historians in the Reception of Aristotelian Logic and Biology from Pomponazzi to Bacon," in Pomata and Siraisi, *Historia*, 151.
[101] Karl A.E. Enenkel, "The Species and Beyond: Classification and the Place of Hybrids in Early Modern Zoology," in Smith and Enenkel, *Zoology in Early Modern Culture*, 76.
[102] A greatly influential study of this notion has been Arthur Lovejoy's *The Great Chain of Being: A Study of the History of an Idea* (New York: Harper & Row, 1936).
[103] Ogilvie, "Natural History, Ethics, and Physico-Theology," 94.
[104] On the medieval and early modern meanings of monsters, see: Lorraine Daston and Katherine Park, *Wonders and the Order of Nature, 1150–1750* (New York: Zone Books, 1998).
[105] Ogilvie, "Natural History, Ethics, and Physico-Theology," 95.
[106] Eric Jorink, "Beyond the Lines of Apelles: Johannes Swammerdam, Dutch Scientific Culture and the Representation of Insect Anatomy," *Nederlands Kunsthistorisch Jaarboek (NKJ)/Netherlands Yearbook for History of Art* 61 (2011): 149–183.

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eſté à l'enuiron de Maguelone,é ſont grandes comme chapeaux que l'on porte en eſté contre le Soleil é les chaleurs. Elles ſe fondent comme glace,ſi on les manie long tems, piquent les mains, les font demanger. parquoi ie les ai miſes du nombre des Orties.

De la ſixiéme eſpece D'ortie.

Chap. XVII.

I'Ai veu pres d'Agde ceſte eſpece d'Ortie ſemblable aux autres de vie é de vertu. Elle n'ha que quatre pieds ou branches plus toſt, plus longues que toutes les autres. Au deſſus de l'autre partie i a des figures ouales, diſpoſées en forme d'eſtoille.

LE DIX

Figure 1.1 Woodcut of jellyfish | Guillaume Rondelet, *L'Histoire entière des poissons* (Macé Bonhome, Lyon, 1558), 384 | © Universiteitsbibliotheek Leiden

aforementioned *The Wisdom of God in the Works of Creation* (1691) is an early example of the physico-theological genre that connected the study of natural history and natural philosophy to that of revealed truth.[107]

Willughby and Ray defined 'fish' in a stricter, narrower sense than Gessner and other earlier Renaissance naturalists had done. Ray's clarification of "what we understand under the name of Fish"[108] deserves to be quoted extensively. He explained that he was:

> […] not ignorant of the fact that the name of *Fish* by some is extended as widely as possible to include all *Aquatilia*, both the ones which must be indicated as consisting of blood, and the bigger, bloodless ones, which *Aristotle* has divided in three genera, truly μαλάκια or *mollia* [soft], μαλακός[τ]ρακα or *crustacea* [with scales], όσρακοδερμα or *testacea* [covered with shells]. And indeed, our common people has all these for fish.[109]

Willughby and he, however, departed from these notions, introducing an altogether new demarcation:

> But we shall use in this work the word for *fish* in the stricter sense, only for those aquatic animals lacking feet, covered either in scales or smooth skin, swimming by means of fins, living constantly in water, never of its own volition coming out onto dry land, and scarcely able to survive out of the water.[110]

[107] Peter Harrison, "What's in a Name? 'Physico-theology' in Seventeenth-Century England," in *Physico-Theology: Religion and Science in Europe, 1650–1750*, eds. Ann Blair and Kaspar von Greyerz (Baltimore: Johns Hopkins University Press, 2020), 45–47.
[108] Original Latin: "*Quid Piscis nomine intellegimus*", *Hist. pisc.*, 1.
[109] Original Latin: "Non sum nescius *Piscis* nomen à nonnullis quam latissime extendi ad *Aquatilia* omnia significanda tam sanguinea, quam exanguia majora, quae *Aristoteles* in tria genera dividit, nimirum μαλάκια seu *mollia*, μαλακόςτρακα seu *crustacea*, & όσρακοδερμα seu *testacea*. Quin & vulgus nostrum haec omnia pro piscibus habet." Ibid.
[110] Original Latin: "Verum nos in hoc opere restrictiore acceptione voce *piscis* utemur, pro iis tantum aquatilibus, quae & sanguinae sunt, & pinnis natant, & pedibus carent, & in aquis perpetuo degunt, ibidemque pariunt, nec unquam sponte in siccum exeunt, aut extra aquas diu vivere possunt." Ibid.; extended translation of Kusukawa, "*Historia Piscium* (1686) and Its Sources," 308.

Those who were hoping, Ray added, to learn more about, for example, hippopotami, crocodiles, seals and manatees, should turn elsewhere.[111] While this definition of a fish was notably different from ours today, as it included species that we now categorize as sea mammals, such as whales and porpoises, their definition entailed a new approach to what a fish actually was (and what it was not). In a letter to Robinson in 1684, Ray furthermore explained that as "[*e*]*xanguia aquatica* I account rather insects than fishes."[112] These bloodless aquatic creatures included the shells and molluscs that, as we have seen, were counted among fish by other authors. For Willughby and Ray, what made a fish a fish was thus not that it swam in the water, but that it displayed specific physical characteristics.

Although Willughby and Ray do not make the philosophical underpinnings of this new definition explicit, with its emphasis on the properties of a subject itself rather than on those of its surroundings it is exemplary for a wider reconceptualization of the structure of nature. Some decades before the *Historia piscium* was published, the philosopher and mathematician René Descartes (1596–1650) had hypothesized that nature did not consist of four elements, but of small particles that clashed and collided with one another.[113] As Eric Jorink has put it, he wished to "explode the Aristotelian system and replace it by his own",[114] which by and large was a mechanist one. In his *Principia philosophiae* (Amsterdam, 1644), Descartes offered a new metaphysical framework for the study of, among other things, planetary and celestial motions, the inner structures of the earth, as well as the physiologies of plants and animals.[115] All creatures could be studied on a par with one another, if the hitherto well-established hierarchical division of beings was explicitly rejected, with every creature relegated to the same ontological status, *viz*. that of a machine that was structured and governed by the fixed laws of nature.[116] One could understand the working of these laws through a close examination of a flea, a flounder or a falcon – it did not matter, for they were all made of the

[111] *Hist. pisc.*, 2.
[112] Ray to Robinson, 13 March 1684 (OS), *The Further Correspondence of Ray*, ed. Robert W. Theodore Gunther (London: The Ray Society, 1928), 164.
[113] Eric Jorink, "Insects, Philosophy and the Microscope," in Curry, Jardine, Secord, and Spary, *Worlds of Natural History*, 136.
[114] Ibid.
[115] A systematic discussion of Descartes' *Principia philosophiae* is offered in Stephen Gaukroger, *Descartes' System of Natural Philosophy* (Cambridge: Cambridge University Press, 2002).
[116] Jorink, "Insects, Philosophy and the Microscope," 136.

same matter based on the same laws. By implication, the erstwhile organization of animals into elemental realms as discussed above, lost its relevance.

Descartes had risen to considerable prominence by the time that Willughby and Ray resided in Cambridge. Willughby dedicated several pages of notes to Cartesian philosophy in his commonplace book, while Ray purchased a copy of the *Principia philosophiae*.[117] While Britain's own, particular blend of mechanical philosophy had clear Cartesian notes,[118] some of the French philosopher's ideas were met with apprehension. Ray, for instance, accused Descartes of trying "to solve all the *Phoenomena* of Nature, and to give an account of the Production and Efformation of the Universe, and all corporeal Beings therein, both celestial and terrestial, as well animate as inanimate, not excluding Animals themselves, by a slight *Hypothesis* of Matter so and so divided and mov'd'."[119] He thus warned that not all natural phenomena could be explained as mere matter in motion, and it was best not to attempt this – to do so, after all, would be to bypass God. Nevertheless, Descartes's philosophy did inspire a mechanistic approach to the workings of animal and human bodies in England.[120]

In the first part of the *Historia piscium*, after having defined what a fish is, Ray offered general discussions of a broad range of aspects relating to the physiology of fishes. They expound on, among other things, what these creatures ate, how they moved, whether they could hear, how some species used swim bladders, and how they spawned.[121] This last subject, spawning, was a point of especial contention. In his discussion of the procreation of fish, Ray put forth how Aristotle had rightly observed that there were three different types of fish, which each had their own way of propagation: first, the cetaceans reproduced in the same manner as mammals did, gave birth to live young and were thus viviparous; second, the cartilaginous fish that lay and hatched eggs in their own body, and then brought forth live young; and, lastly, the spiny fish that were oviparous,

[117] Serjeantson, "The Education of Francis Willughby," 75, 94–95, 97.
[118] John Henry, "The Reception of Cartesianism," in *The Oxford Handbook of British Philosophy in the Seventeenth Century*, ed. Peter R. Anstey (Oxford: Oxford University Press, 2013), 120.
[119] Ray, *The Wisdom of God*, 44.
[120] Henry, "The Reception of Cartesianism," 127.
[121] *Hist. pisc.*, 1–22.

which meant that the females lay eggs (called roe) which were then fertilized by the milt (seminal fluid) of males.[122] Aristotle also held that some species of fish were neither oviparous nor viviparous: they generated spontaneously from mud, sand or foam.[123] To make matters even more complex, Rondelet contended that the carp was of ambiguous procreation and that it proceeded sometimes from eggs, and other times from mud and sand.[124]

The matter of spontaneous generation, Ray admitted, was "a difficult question."[125] On the one hand, many early moderns had experienced situations in which living beings emerged from lifeless matter, like worms that appeared in rotten food. On the other hand, the element of chance that this process entailed was difficult to account for, as it elided the fixed laws of nature as postulated by Descartes.[126] Naturalists sought explanations for the generation of fishes that rendered it regular and predictable. One such explanation was formulated by William Harvey (1578–1657), who held that all living beings came from eggs, and whose work Ray mentions in his discussion on procreation.[127] Ray closes the discussion with a reference to the findings of a certain 'D. Levenhoeck', who had observed *animalculorum* [literally: little animals, spermatozoa] in the seminal fluid of fish.[128] This was, of course, Antoni van Leeuwenhoek (1632–1723), the Delft cloth merchant who had augmented the possibilities for close observation with a new optical instrument: the microscope. He had been corresponding with the Fellows of the Royal Society since 1673[129] and sent them drawings of what he

[122] *Hist. pisc.*, 16–18.
[123] Aristotle, *History of Animals in Ten Books*, book VI, chapter XIV, ed. and trans. Cresswell, 157.
[124] Rondelet, *L'Histoire entière des poissons*, 108. In the loose and abbreviated German translation that Conrad Forrer (*c.*1530–1594) made of Gessner's *Hist. anim.* IIII, Rondelet's statement that carp are sometimes born from chaos and dirt, and sometimes from seed and roe is copied, see: Conrad Gessner, *Fischbuch*, trans. Conrad Forrer (Zurich: Christopher Froschauer, 1563), 164–165.
[125] *Hist. pisc.*, 18. For more on Willughby and Ray's attitudes towards spontaneous generation, see: Brian Ogilvie, "Insects in John Ray's Natural History and Natural Theology," in Enenkel and Smith, *Zoology in Early Modern Culture*, 235–262; Ogilvie, "Willughby on Insects," 350–351. John Ray's *Historia insectorum* (London: A. & J. Churchill, 1710) appeared posthumously.
[126] Jorink,"Beyond the Lines of Apelles," 153–159. Descartes himself did not entirely rule out spontaneous generation, see: Eric Jorink, "Snakes, Fungi and Insects. Otto Marseus van Schrieck, Johannes Swammerdam and the Theory of Spontaneous Generation," in Smith and Enenkel, *Zoology in Early Modern Culture*, 199–207.
[127] This was William Harvey's *Exercitationes de generatione animalium* (London: Du Gardianis, 1651).
[128] *Hist. pisc.*, 18.
[129] Lodewijk Palm, "Leeuwenhoek and Other Dutch Correspondents of the Royal Society," *Notes and Records of the Royal Society of London* 43, no. 2 (1989): 192–193.

observed through his lenses.[130] Around 1677, he discovered the spermatozoa and, slightly later, studied the semen of fish.[131] The *Historia piscium* thus incorporated both old and newer ideas regarding the procreation of fish.

When Willughby and Ray embarked on their study of nature in the seventeenth century, they did so in a context different to that of Gessner and his contemporaries in significant respects. By the later seventeenth century, ancient works had been largely superseded by contemporary ones, and classical claims were no longer at the forefront of research agendas.[132] New philosophies had challenged ancient and widely accepted views on the structure of the created world. The hierarchical view of nature gradually gave way to a more mechanist one, in which the anatomy and physiology of each and every animal was governed by the same natural laws. While it is difficult to assess the full impact of these ideas on the *Historia piscium*, the work does cite and incorporate new philosophies. A crucial difference in this work compared to the earlier books on which it drew, was that it defined a fish by its physical characteristics (namely, having fins and lacking feet), rather than by its surroundings (namely, living in the water). Fish were thus notionally separated from the element in which they dwelled. As we will see, Ray and Willughby would also tease them out from the web of literary, encyclopedic associations of which they had long formed part.

Drawing up Species Descriptions

It is now time to take a closer look at the species descriptions of the *Historia piscium*, for it is in these descriptions that Willughby and Ray ultimately reveal what they thought properly related to natural history. In the epilogue of the history of fishes, Ray explained that it was not meant as a pandect, which is as an comprehensive account of everything that had ever been written about all fish. That, he stated, had already been done by the great Conrad Gessner.[133] Instead, they would include those observations made by themselves, their friends, and

[130] Sietske Fransen, "Antoni van Leeuwenhoek, His Images and Draughtsmen," *Perspectives on Science* 27, no. 3 (2019): 485–544.
[131] Edward G. Ruestow, "Images and Ideas: Leeuwenhoek's Perception of the Spermatozoa," *Journal of the History of Biology* 16, no. 2 (1983): 188, 199.
[132] Ogilvie, "Visions of Ancient Natural History," 25.
[133] *Hist. pisc. app.*, sig. Hr/v. Kusukawa, "The *Historia Piscium* (1686)," 182.

other trustworthy witnesses. Through careful observations, they wanted to set right the multiplication of species that earlier authors of natural history had caused by describing two or three species where there had, in fact, only been one. Cleaning up this confusion required writing diligent species descriptions. We will now turn to these, and compare them with sixteenth-century species descriptions on the level of form, content and organisation.

As it is beyond the scope of this dissertation to discuss the specific styles and approaches of every Renaissance naturalist, Gessner's description format in his history fish and other aquatic animals will be taken as an exemplum. Each species description was structured according to the same format. He included an overview of the names of the species in various languages, a characterization of its physical features, an indication of its habitat, a discussion of its habits, possible medicinal and culinary uses, as well as a large section under the heading 'philology', which brought together various references to the species at hand in the arts.[134] Gessner assigned these elements of the description to subsequent letters of the alphabet (from A to H), so that the readers would know, for example, that they could expected to find discussions of animal character and behaviour under D, and anecdotes and allegories under H.[135] In this latter category, he compiled excerpts from literature, poetry, proverbs, myths, fables and emblems in which the species at hand figured – in short, its cultural context.[136] This web of associations helped to make sense of the species and its place in the world.

It is this latter category to which Ray alluded in the passage opening in this chapter: *Hieroglyphics, Emblems, Morals, Fables, Presages*. Renaissance curiosity in Egyptian hieroglyphs had been stirred up with the rediscovery of the fourth-century treatise *Hieroglyphica*, ascribed to the Greek grammarian Horapollo, which offered deciphered hieroglyphs alongside discussions of allegorical and symbolical interpretations of the animal descriptions that had come down from Aristotle

[134] The German translation of the work excluded such philological deliberations, see: Ogilvie, *Science of Describing*, 44.
[135] Sachiko Kusukawa, "Gessner's History of Nature," in Curry, Jardine, Secord, and Spary, *Worlds of Natural History*, 37.
[136] Charmantier, "Emblematics in Ornithology," 84.

and Pliny.[137] The publication of Piero Valeriano's *Hieroglyphica* (Basel, 1556) further aroused the general interest in hieroglyphs, which many scholars believed to contain hidden meanings on the natural world. They inspired, for example, Andrea Alciato (1492–1550) to produce his *Emblematum libellus* (Augsburg, 1531), known as the first emblem book.[138] Emblems, with their particular format of motto, depiction and explanation, conveyed digestible moral lessons. Joachim Camerarius the Younger (1534–1598), author of the quartet of emblem books *Symbola et emblemata* (Nuremberg, 1590–1604), made use of both text and image of Gessner's *Historia animalium* for several emblems in the part on aquatilia which figured fishes.[139] Aldrovandi cited Valeriano when describing the angel shark [*squatina*], as Gessner had done in his discussion of a particular species of shells [*purpura*] from which beautiful purple dye could be made.[140] The genre of the emblem book and that of natural history were thus interconnected.[141]

Most Renaissance authors sequenced their species descriptions according to some organizing principle. The criterions for grouping species were diverse: species descriptions were placed together based on, for example, medicinal uses, habitat – Rondelet, for example, sorted fishes according to whether they swam in the sea, in rivers, in lakes or in marshes –, or whether plants or animals were common or rare.[142] Other categorizations were based on morphological and physiological characters, and more closely resemble our contemporary ideas of taxonomy.[143] Sophia Hendrikx has shown that Gessner, for example, sorted physically similar species of fish into groups, such as 'trout-like' species which, among others features, shared an adipose fin.[144] The Swiss naturalist also explained how one might tell one species from another. In the group of 'herring-like' fish,

[137] Karl A.E. Enenkel, *The Invention of the Emblem Book and the Transmission of Knowledge, ca. 1510–1610* (Leiden: Brill, 2019), 14.
[138] Ibid., xvi.
[139] See: Sophia Hendrikx, "Ichthyology and Emblematics in Gessner's *Historia Piscium* and Camerarius' *Symbola et Emblemata*," in Enenkel and Smith, *Emblems and the Natural World*, 184–226.
[140] Aldrovandi, *De piscibus*, 475; Gessner, *Hist. anim.* IIII, 916
[141] The connections between natural historical works on birds and emblem books are examined in Charmantier, "Emblematics in Ornithology," 79–109.
[142] Ogilvie, *Science of Describing*, 216.
[143] For a discussion of different forms of taxonomy, see Ogilvie, *Science of Describing*, 219–228.
[144] Sophia Hendrikx, "Gessner's Taxonomical Skill Exhibited in his Discussion of Felchen," in *Conrad Gessner (1516–1565) Die Renaissance der Wissenschaften/The Renaissance of Learning*, eds. Urs B. Leu and Peter Opitz (Zurich: De Gruyter Oldenbourg, 2019), 610.

for example, the sardine could be distinguished from the herring because, while they might look much alike, the former was smaller.[145] The order in which he discussed all species throughout his *Historia animalium* was alphabetical:[146] the various trout- and herring-like species were not placed in proximity to one another on the pages of his work. To compare morphologically similar species the reader had to flick back and forth through the book. While morphological features were important in Renaissance natural history, they did not, to a large extent, form the primary ordering principles of publications.

By way of contrast, Willughby and Ray grouped species together on the basis of their external form alone, foregoing any categorization based on affinities other than physiological ones.[147] They established three overarching groups: cetaceans, cartilaginous fish, and spinous fish – as mentioned earlier, each of these groups were relegated to their own part of the *Historia piscium*. For the group of cartilaginous fish, a *tabula* is included that further splits it in different subgroups largely based on shape (e.g., whether a species was long, flat, thick or thin).[148] These groups were, in turn, divided into smaller groups according, for example, whether or not they had teeth.[149] In their categorization of spinous fish, shape again played a role, but also characteristics such as the number of dorsal fins and whether or not the rays in the fins were soft or thorny.[150] The species descriptions were sequenced according to this order. Although the books arranges species into groups, it are the species themselves that really form the prime concern for Willughby and Ray.[151] By observing species with scrupulous attention to detail, they aimed to uncover the 'true' (*viz.* God given) arrangement of species. They sought to establish an unambiguous differentiation between species as well as to understand how these were interlinked.[152] The great multitude of species, Ray

[145] Sophia Hendrikx, "Identification of Herring Species in Conrad Gessner's Ichthyological Works: A Case Study on Taxonomy, Nomenclature, and Animal Depiction in the Sixteenth Century," in Enenkel and Smith, *Zoology in Early Modern Culture*, 158.
[146] Kusukawa, "Gessner's History of Nature," 37.
[147] Kusukawa, "The *Historia Piscium* (1686)," 182.
[148] *Hist. pisc.*, 46.
[149] Ibid.
[150] A detailed overview of the morphological groupings of the *Hist. pisc.* can be found in Kusukawa, "*Historia Piscium* (1686) and Its Sources," 309.
[151] Ray later summarized and developed their methods for classifying fish in *Synopsis methodica avium & piscium* (London: William Derham, 1713).
[152] Birkhead, Smith, Doherty and Charmantier, "Willughby's Ornithology," 269.

argued, had been made to "manifest and display the Riches of the Power and Wisdom of God."[153]

As Ray contended in the preface to the *Ornithology*, earlier descriptions of birds had been "in many particulars confused and obscrue [obscure]",[154] but naturalists could dispel the confusion and multiplications of species by establishing 'characteristic marks' [*notae characteristicae*] on the basis of which species could be demarcated.[155] In their focus on characteristic marks, Willughby and Ray ensured that "the Reader might be sure of our meaning, and upon comparing any Bird with our description not fail discerning whether it be the described or no."[156] This held true, of course, not only for birds, but also for other animals as well as plants. For fish, the characteristic marks might be the number and position of fins, certain spots or colours, or other properties – as long as these properties could be inferred from the actual specimen itself. Take, for instance, the sharks. They were discussed in the third book (on cartilaginous fish), and within this book placed under the header of 'long and cartilaginous' fish.[157] In this group, the tope shark, for example, could be discerned from the similarly looking smooth hound shark by its larger size, its rows of sharp teeth and its eyes, of which the irises were of a brighter, silver colour.[158]

Assigning (the correct) names to species was crucial in their identification. But how many names were required? We saw in the citation opening this chapter that Ray and Willughby's book of birds would not list "*Homonymous* and *Synonymous* words, or the divers names of Birds". When writing down the name(s) of a certain species of fish, Ray and Willughby did not strive to compile a comprehensive list of all the fish's known names in various languages as Gessner had. For example, Gessner listed the names given to the eel in various languages, from *Aal* (High Dutch), *Ael*, *Palinck* (Low Dutch) and *Ele* (English), as well as in Latin, Greek and Hebrew;[159] this practice has by some been called 'lexicographically inflected',

[153] Ray, *The Wisdom of God*, 369.
[154] Willughby, *Ornithology*, preface, sig. A4v.
[155] The notion of "characteristic marks" is explained in more detail in Kusukawa, "The *Historia Piscium* (1686)," 182.
[156] Willughby, *Ornithology*, preface, sig. A4v.
[157] *Hist. pisc.*, 47–64.
[158] Cf. descriptions of 'Mustelus laevis secundus' in *Hist. pisc.*, 51 and 'Mustelus laevis primus', ibid., 60.
[159] Gessner, *Hist. anim.* IIII, 48.

as it was borne out of the wish to compile a complete overview of words in various languages.[160] Willughby and Ray, on the other hand, mentioned only its Latin name (*Anguilla*) and the name it was given in England (*Eel*).[161] That a species was known under one and the same name throughout a country was by no means a given, as we will see in Chapter 2. In short, Willughby and Ray were less comprehensive in the citing of names than Gessner, and included only commonly used names.

Their species descriptions follow, by and large, the same general format. Having given the name(s) of the species at hand, they would dive right into detailed descriptions of the outer and inner parts of the fish. Topics covered were, among other things, the size of the fish, its shape, colour, its head, its teeth, its scales, and its fins. In quite a few instances, they offered the measurements of a specimen, or wrote down the number of teeth or fin rays that they counted from it – a practice that, as we will see in the following chapter, would gain considerable currency among later naturalists.[162] In order to guide the reader through all these minute descriptions, key words were printed in the margin of the species descriptions (also known as *manchettes*) which signalled the topic under discussion in the adjacent text: for example, the manner in which a species procreated (*generatio*), or a description of its spleen (*lien*).[163]

In describing the inner parts of fish, writers could take recourse to the accounts published by sixteenth-century naturalists, who routinely dissected animals.[164] Rondelet in particular, with his background in comparative anatomy, was known for performing dissections of fish, and Willughby and Ray's *Historia piscium* often cites him on these.[165] But, in keeping with the authoritative weight

[160] For the 'lexicographical inflection' of Gessner's natural historical works, see Alexander Marr, Raphaële Garrod, José Ramon Marcaida and Richard J. Oosterhoff, eds., *Logodaedalus: Word Histories of Ingenuity in Early Modern Europe* (Pittsburgh, Pa.: University of Pittsburgh Press, 2018), 158, 287.
[161] *Hist. pisc.*, 109.
[162] Kusukawa, "*Historia Piscium* (1686) and Its Sources," 315–316.
[163] For this textual organization tool, see: Ann Blair, "Annotating and Indexing Natural History," in *Books and the Sciences in History*, eds. Nicholas Jardine and Marina Frasca-Spada (Cambridge: Cambridge University Press, 2000), 72.
[164] As discussed, for example, in Anita Guerrini, *The Courtiers' Anatomists: Animals and Humans in Louis XIV's Paris* (Chicago: Chicago University Press, 2016), 57–61.
[165] See also: Gillian Lewis, "The Debt of John Ray and Martin Lister to Guillaume Rondelet of Montpellier," *Notes and Records of the Royal Society of London* 66, no. 4 (2012): 323–339.

attached to an autopsy, Willughby and Ray would cut open specimens themselves if they had the chance. Their travels gave them ample chance to do so, possibly in the comfort of their lodgings.[166] A unique insight into this process is offered by a set of four drawings in the Middleton collection in Nottingham which show the step-by-step dissection of a male flair (a species of ray) that took place under the auspices of their travel companion Philip Skippon; the images are inscribed with Skippon's notes.[167]

Paraphrasing Martin Kemp's characterization of anatomical illustrations, this set of drawings attempts to produce a two-dimensional equivalent of witnessing the act of dissection with one's own eyes.[168] The first image shows the contours of the flair drawn with lead.[169] Emphasis is, however, on the flap of skin that has been folded open to show the fish's insides. For this part, drawing ink is used – making it clear what part of the image is background and what is foreground. As the marginalia indicate, the flair's gallbladder has been made visible by removing the liver. In what is presumably the final image in this series (**Figure 1.2**), the skin of different parts of the body has been sliced open, its thorax and various organs laid bare. The heart and lungs might have been revealed, Skippon notes, were it not for the fact that the 'workman' grew tired and wished to finish the drawing and hand it over.[170] The precise recording of this process, though subject to limitations of stamina, is illustrative of the care taken to examine and document fish. Although it is not clear whether this specimen formed the basis for the species description of the flair found in the *Historia piscium*, the description offers a striking level of detail by, for example, recording that its spleen is large and of reddish colour.[171]

Willughby and Ray had different ideas on precisely how much detail was desirable when compiling a species description. The former's painstaking

[166] Kusukawa, "*Historia Piscium* (1686) and Its Sources," 316.
[167] Drawings of the dissection of a flair, Middleton Collection (hereafter Mi LM), Special Collections Department of University of Nottingham (hereafter NUL), Mi LM 25/12–15; drawings 14 and 15 are reproduced in Birkhead, *The Wonderful Mr. Willughby*, 120.
[168] Martin Kemp, "Temples of the Body and Temples of the Cosmos: Vision and Visualisation in the Vesalian and Copernican Revolutions," in *Picturing Knowledge. Historical and Philosophical Problems Concerning the Use of Art in Science*, ed. Brian Scott Bairgrie (Toronto: Toronto University Press, 1996), 83.
[169] Since Skippon notes on drawing Mi LM 25/12 that it portrays "the second sight" it is possible that the drawing was originally preceded with another.
[170] NUL, Mi LM 25/14; this workman was named Mr. Okely, see: Kusukawa, "*Historia Piscium* (1686) and Its Sources," 316.
[171] *Hist. pisc.*, 69–70.

descriptions of the plumage colours of birds were met with some apprehension by the latter, as this oft-cited passage makes clear:

> I must confess that in describing the colours of each single feather he [Willughby] sometimes seems to me to be too scrupulous and particular, partly because Nature doth not in all Individuals, (perhaps not in any two) observe exactly the same spots or strokes, partly because it is very difficult so to word descriptions of this sort as to render them intelligible […].[172]

Here, Ray comments on the expedience of tending so much to individual varieties rather than species. He also touches upon the difficulties of putting different shades of colour into words. On this matter, Kusukawa relates a species description in the *Historia piscium* in which Ray considered a certain species of plaice to be of "an unripe olive colour", whereas to Willughby's eyes it seemed more of a brown-greyish colour tending to blue.[173] The discussion of colourisation was a salient one. First of all, because the colours of fish were, indeed, a complicated matter; they might vary according to a fish's age or the season, and usually disappeared once the fish died. It also made the question of what a species actually was, and how it could be conceptualised, concrete. For plants, for example, Ray argued that those that produced new plants which had grown from their seeds and resembled them were the same species.[174] If plants looked similar to one another except for exhibiting differently coloured flowers, these were not species but rather varieties. These colour variations, he thought, came from cutting rather than from the seed. He also held that species of animals always had to come from the same seed.

The descriptions in the *Historia piscium* do not stop short of listing species' characteristic marks, but include the occasional remark that relates to language or trade.[175] In the discussion of the herring, for instance, it is explained that the English expression 'as dead as a herring' comes from the sudden death of the animal as soon as it has been taken out of the water.[176] In discussing the species

[172] Willughby, *Ornithology*, preface, sig. A3r. See also: Birkhead, Smith, Doherty and Charmantier, "Willughby's Ornithology," 269–270.
[173] Kusukawa, "*Historia Piscium* (1686) and Its Sources," 315.
[174] John Ray, *Historia plantarum*, vol. 1 (London: Mary Clark, 1686), 40.
[175] As is the case for birds, see: Birkhead, Smith, Doherty and Charmantier, "Willughby's Ornithology," 293.
[176] *Hist. pisc.*, 219; examples of early modern usage can be found under Oxford English Dictionary, s.v. "dead" in VI. Phrases, 32b.

of the white shark, Ray reiterates Rondelet's presumption that it was probably this species that had swallowed the prophet Jonas, an idea that he deemed not altogether unreasonable.[177] Matters of practice were also included: the description of the herring treats the various ways in which they are prepared as a foodstuff.[178] The *Historia piscium* also remarks on the taste or flavour of the flesh of certain species, albeit less often: it reports that the flesh of the wrasse as neither good nor wholesome to the body, but commends that of the herring as fat, soft and delightful.[179] In this attention to the degustatory qualities of fish, they resemble earlier works like that of Rondelet, although the latter also offers recipes for how a species is best prepared.[180] Such interest in the consumption of these animals may have been partly prompted by the long-standing Catholic practice of abstaining from meat and instead eating fish on fast days.[181]

How do the descriptions in the *Historia piscium* compare to those earlier, sixteenth-century books discussing *aquatilia*? The naturalists of the sixteenth century had been committed to writing diligent descriptions that presented species in such a way that one could clearly be delineated from the other. Some of them, like Gessner, entwined these descriptions with literary traditions.[182] A proper species description, for Willughby and Ray, was one that unambiguously referred to one particular species – something which earlier authors, they thought, had not always managed to produce. The English naturalists therefore focussed their descriptions on morphology, and only seldom incorporated the cultural context of a species, strictly disavowing interpretations of species of plants and animals as signs and allegories.[183] Where Renaissance

[177] *Hist. pisc.*, 47.
[178] *Hist. pisc.*, 219–220.
[179] *Hist. pisc.*, 320 and 219.
[180] Pascale Barthe, "Guillaume Rondelet's Monkfish, or Natural History as Social Network," in *Itineraries in French Renaissance Literature: Essays for Mary B. McKinley*, eds. Jeff Persels, Kendall Tarte, and George Hoffman (Leiden: Brill, 2017), 394.
[181] Fish was not ordinarily considered meat; see: Gentilcore, *Food and Health in Early Modern Europe*, 97.
[182] Further discussed in Karl A.E. Enenkel and Paul J. Smith, "Introduction: Emblems and the Natural World (ca. 1530–1700)," in *Emblems and the Natural World*, eds. Karl A.E. Enenkel and Paul J. Smith (Leiden: Brill, 2017), esp. 22–35.
[183] William B. Ashworth has characterized this way of looking at the natural world as the emblematic worldview in his "Natural History and the Emblematic Worldview," in *Reappraisals of the Scientific Revolution*, eds. David C. Lindberg and Robert S. Westman (Cambridge: Cambridge University Press, 1990), 303–332 and "Emblematic Natural History of the Renaissance," in *Cultures of Natural History*, eds. Nicholas Jardine, James Secord and Emma C. Spary (Cambridge: Cambridge University Press, 1996), 17–37.

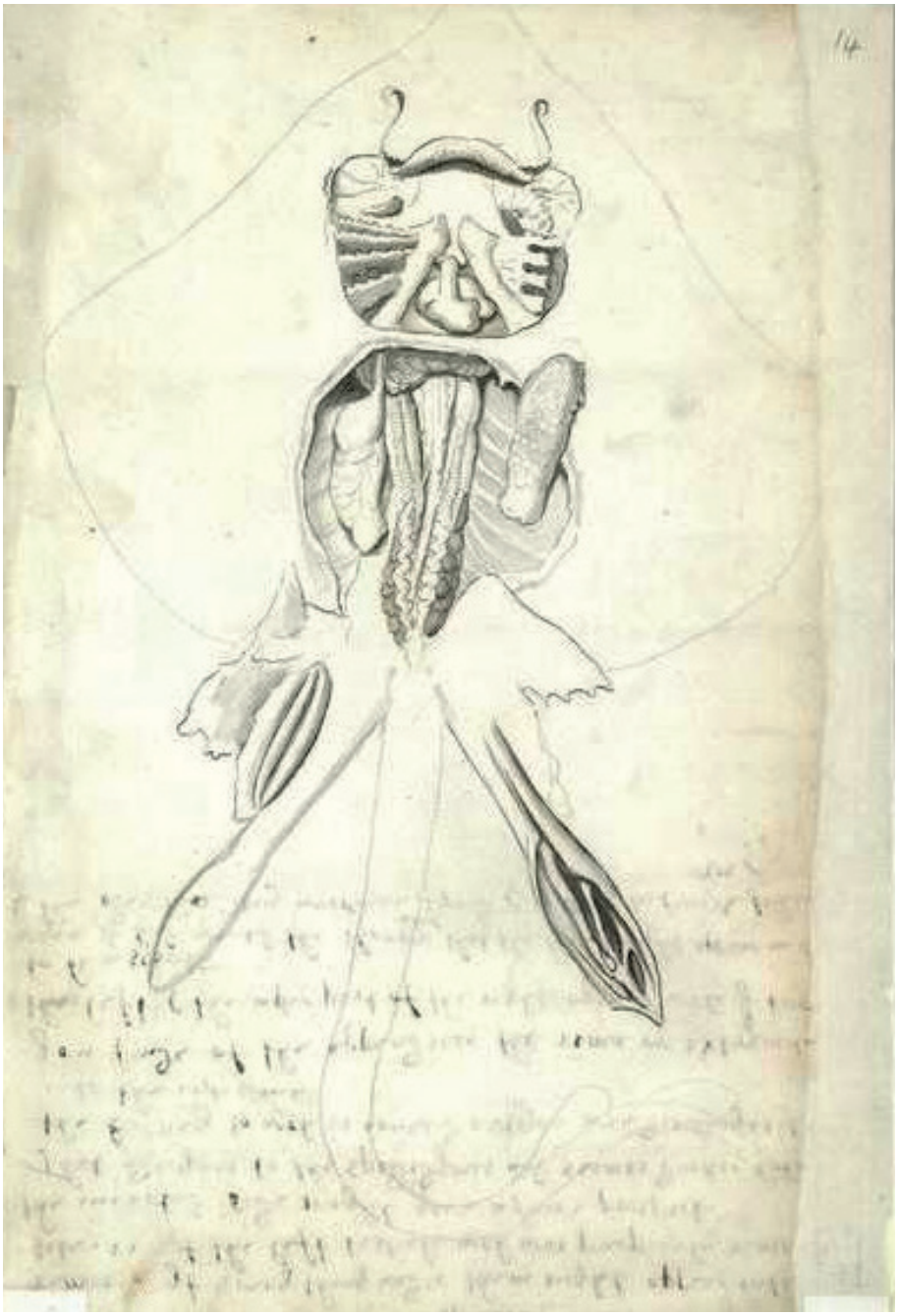


Figure 1.2 Drawing of dissected flair | NUL, Mi LM 25/14 | © University of Nottingham Manuscripts and Special Collections

authors like Gessner had taken a philological and lexicographical approach to the names of species, Willughby and Ray opted to only convey those names that were most commonly used.[184] At the same time, what Ray, Willughby and their Fellows considered to relate to natural history was thus more broadly construed than strictly morphological discussions: they included matters related to trade and commerce, rehearsed proverbs, and on occasion curious anecdotes.

The Best Figures

The illustrations in Willughby and Ray's *Historia piscium* are of considerable diversity in terms of design. This is a result of their being culled from a wide range of sources: about two thirds of them were taken from earlier printed works, while the rest were designated as 'new' and marked with a dagger.[185] The designation of 'new' many not have indicated much more than that they were newly-acquired, and this could mean they were copied from newly-purchased manuscripts, drawn from specimens in the Society's Repository, or perhaps had recently been received by a Fellow from a personal contact.[186] Though expensive, Ray probably considered these engravings to be worth every penny. When preparing his book of plants for publication, Ray had asserted his belief that for such a history to lack images would be as remiss as producing an atlas without maps.[187] That images were sources of knowledge on a par with texts has been pointed out by Kusukawa, who has noted Ray treated "textual description and visual illustration as equally referring to a possibly real fish."[188] For the authors of the *Historia piscium*, illustrations were important sources of knowledge and thus an important component of its output. Images, contrary to common parlance, did not speak for themselves, but required interpretation and assessment. We will now turn to the policy and practice of Willughby, Ray and the other Fellows involved, towards illustrations, and how this interacted with the pictorial conventions of the time.

[184] Brian Ogilvie, "Natural History, Ethics, and Physico-Theology," in Pomata and Siraisi, *Historia*, 81.
[185] Original Latin: "Figurae Novae, quae non paucae sunt, † notantur"; on how the daggers have not been consistently applied, see Kusukawa, "The *Historia Piscium* (1686)," 186.
[186] A detailed overview of the sources for the images can be found in Kusukawa, "*Historia Piscium* and Its Sources," 318–333.
[187] Alexander Wragge-Morley, *Aesthetic Science: Representing Nature in the Royal Society of London, 1650–1720* (Chicago: Chicago University Press, 2020), 106; chapter 4 esp. examines the interrelations between verbal and textual depictions and their affects, 106–134.
[188] Kusukawa, "The *Historia Piscium* (1686)," 183.

When the *Historia piscium* was being prepared for print, the selection of suitable illustrations caused some consternation. At the meeting of 18 March 1685 (OS), a letter from Ray to Robinson was read aloud which stated that "with respect to the designs for the cuts, he [Ray] said, that he had several drawn from life, and had made references to the places in authors, where the best figures were extant."[189] This report was not received well. On the very same day the meeting was held, Robert Plot (1640–1696) had penned a response to Francis Aston (1645–1715), who had written him on the matter. During the following meeting, on 25 March 1685 (OS), Plot's response was shared, which suggested that Ray's statement had "much lessened the opinion concerning that history".[190] It had been presumed by the Society that *all* the draughts would be taken "from the life, where as it was now found, that the cuts must be picked up here and there out of books".[191] Now that doubt had been cast on the quality of the illustrations, the intended printer John Fell (1625–1686), who besides being the bishop of Oxford founded the University Press, was hesitant to go ahead with publication.[192] He was not willing to commit to publishing the work "till he had seen what it was; and that therefore those draughts, which were ready, should be sent thither".[193]

An intervention was required. As the Royal Society had decided to finance the work, they set up a committee to oversee the printing process and subject it to quality control. This committee consisted of several Fellows and included Lister, Robinson and Aston, as well as Ray himself.[194] Under the adage that he who pays the piper, calls the tune, the assembling and evaluating of illustrations became a collective project of the Society.[195] When the Fellows found out, for example, that Henry Hunt (d.1713) possessed some of the illustrations of birds and fish made by bishop of Chester John Wilkins (1614–1672), he was "ordered to get the plates of the fishes rolled off against the next meeting, in order that the

[189] Birch, *History of the Royal Society*, vol. 4, 380.
[190] Ibid., 382.
[191] Ibid.
[192] Ibid. See also: Roos, *Web of Nature*, 321.
[193] Birch, *History of the Royal Society* vol. 4, 382.
[194] Ibid.
[195] Ibid., 380; Sachiko Kusukawa, "Picturing Knowledge in the Early Royal Society: The Examples of Richard Waller and Henry Hunt," *Notes and Records of the Royal Society of London* 65, no. 3 (2011): 280.

Society might judge, whether they would be useful to this book."[196] The debate on suitable drawings for the *Historia piscium* suggests there was no consensus among the Royal Society members with regard to what constituted an epistemologically sound image. Furthermore, these kinds of back and forths between the Fellows not only signal the weight attached to selecting proper illustrations, but also invite reflection on what options they had.

Illustrations played a considerable but not necessarily clear-cut role in the early Royal Society, as a recent research project on its graphic culture has shown.[197] Study of the Fellows' visual practices shows that they valued images for communicating, claiming, and proving observations, ideas and theories; and that they took care to copy and preserve illustrations in their own archives, although they did not include every single drawing or graph.[198] In certain instances, they may have held some animus against images; the aforementioned Hooke, who authored a sumptuously illustrated book on microscopic entities, approached images with a certain wariness as he felt that they could sway the passions and cloud the intellect.[199] All in all, there was not one clear, overarching epistemological programme for images on the part of the Society, and not too much coherence should be ascribed to the Fellows' approaches towards illustrations.[200]

The matter of illustrations was, of course, not unique to the Royal Society. Specifically in the field of natural history, the purpose of illustrations had long been subject to debate. The German botanist Hieronymus Bock (1498–1554), for example, contended that having access to either living specimens of plants in the garden or carefully written descriptions was enough for the experienced naturalist.[201] When illustrations were created, they were often not sufficient to settle disputes over the identification of plants because naturalists would not

[196] Birch, *History of the Royal Society* vol. 4, 380.
[197] The project, entitled *Making Visible: The Visual and Graphic Practices of the Early Royal Socie*ty at CRASSH at the University of Cambridge took place from 2015–2019 with Sachiko Kusukawa principal investigor.
[198] See: Sietske Fransen, Katherine M. Reinhart and Sachiko Kusukawa, "Copying Images in the Archives of the Early Royal Society," *Word & Image* 35, no. 3 (2019): 256–276.
[199] Henderson, "Robert Hooke and the Visual World of the Early Royal Society," 421.
[200] Sachiko Kusukawa, "The Early Royal Society and Visual Culture," *Perspectives on Science* 27, no. 3 (2019): 381.
[201] Ogilvie, *Science of Describing*, 145.

always agree on how to use and/or interpret them.[202] A recurring discussion in the sixteenth and seventeenth centuries was whether one should describe or portray one individual specimen with all its possible variations, or collate several specimens to approximate a certain universal description or depiction of a species.[203] Should a illustration be based on the witnessing of one particular specimen, or a collation of several observations, perhaps of multiple objects? What level of detail ought an image portray, and how? Florike Egmond has recently highlighted the sheer variety of depictions of the natural world in early modern Europe: animals and plants might be placed within elaborate landscapes or against an unicolour background, in a naturalistic or more stylized manner, with perspective or without.[204] Combinations of different approaches in one and the same drawing were also possible.[205]

As the Fellows had feared, a fair share of the illustrations in the *Historia piscium* were copied from the books of Aldrovandi, Belon, Gessner, Rondelet and Salviani. The copying of images from other books was itself a well-established practice. Although it can be difficult to reconstruct such filiations with absolute certainty, it is clear that early modern authors generally drew upon each other's illustrations, just as they drew upon each other's texts.[206] Take for example the image of the sea serpent in Belon's book published 1553 on aquatic animals that depicts it coiled as if it were a rope. A very similar image of the same species can be found in Salviani's work published a year later; while it is not an exact copy (especially in the design of the head), it nonetheless corresponds to it in specific details. It is similarly coiled, has the same curl in the tail, and an open mouth showing its teeth. A few years later, Gessner's 1558 book displays an image unmistakeably similar to that of Salviani, albeit with some slight variations in the teeth. The depiction of the sea serpent in the *Historia piscium*, lastly, itself shows

[202] Sachiko Kusukawa, *Picturing the Book of Nature: Image, Text, and Argument in Sixteenth-Century Human Anatomy and Medical Botany* (Chicago: Chicago University Press, 2012), 170.
[203] Kusukawa, *Picturing the Book of Nature*, 250.
[204] Florike Egmond, *Eye for Detail*, passim.
[205] Ibid., 106.
[206] Kusukawa, *Picturing the Book of Nature*, 64–69. A careful study on the reuse of botanical woodblocks can be found in Jessie Wei-Hsuan Chen, "A Woodblock's Career Transferring Visual Botanical Knowledge in the Early Modern Low Countries," *Nuncius* 35, no. 1 (2020): 20–63.

clear resemblance to Salviani and is captioned with 'Serpens marinus Salviani', which, as said, was also similar to the serpent depicted in Belon.[207] What this cursory comparison shows is that natural historical images were quite freely copied and adapted.[208] The Fellows thus had a large visual archive to draw upon.

With the exception of Salviani, the authors discussed in the above paragraph used woodcuts, the standard medium in the sixteenth century for the production of images. Salviani deployed engravings, a form of intaglio printing in which lines were incised on metal plates (often of copper).[209] While this technique had been applied since the fifteenth century, it was not always the preferred option due to its high cost and because it meant that illustrations had to be printed separately from the text.[210] The advantage of intaglio printing was resolution, however, and while some artists had the skill to work very fine detail into woodcuts, copper engravings generally lent themselves to more precise depiction. This is perhaps why the Fellows preferred them: they used almost three quarters of the engravings in Salviani.[211] As mentioned earlier, all the illustrations, either copied or designed afresh, were engraved on plates for the *Historia piscium*. In this, the printer Fell advised that only one hand should be employed so that stylistic consistency could be ensured.[212] This advice would not be heeded; it appears that no less than eighteen engravers were commissioned, although the individual plates do not specify who worked on which engraving.[213] While we know the names of a considerable number of these engravers, through Kusukawa's diligence, this is not the case for the artists who made the initial drawings.

Although Willughby and Ray were careful to put the exact colour of birds and fish in writing, the engravings in the *Ornithologia* and the *Historia piscium* appeared without colour.[214] It was, at this time, possible but not necessarily

[207] Cf. Salviani, *Aquatilium animalium historiae*, tab P1 and *Hist. pisc.*, tab G4.
[208] See also: Angela Fischel, *Natur im Bild: Zeichnung und Naturerkenntnis bei Conrad Gessner und Ulisse Aldrovandi* (Berlin: Gebr. Mann, 2009), 103–106.
[209] Kusukawa, *Picturing the Book of Nature*, 32–33.
[210] Ibid. 32–34.
[211] Kusukawa, "*Historia Piscium* (1686) and Its Sources," 307.
[212] Roos, *Web of Nature*, 323.
[213] Most of the engravers are identified by name in Kusukawa, "The *Historia Piscium* (1686)," 191.
[214] A (partially) coloured copy of the *Ornithology* is described, however, in Robert Montgomerie and Tim R. Birkhead, "Samuel Pepys's Hand-Coloured Copy of John Ray's 'The Ornithology of Francis Willughby' (1678)," *Journal of Ornithology* 150, no. 4 (2009): 884.

common to have copies of natural historical works coloured in the workshop of a printer, where colourists often worked from a master copy. This could, however, be tricky; Gessner, for example, pointed out that the colourists employed by the publisher for his *Historia animalium* had carried out their task all too carelessly.[215] The colourisation of engravings, which might be done either before or after purchase, added a considerable additional expense on the part of the buyer.

When Ray announced that some of the drawings for the book were taken from life, Plot contended that all of them should have been. The multivalent meaning of the phrase 'from the life' (and its Latin cognate *ad vivum* as well as counterparts in other languages) has been amply discussed in the last years by art historians and historians of science alike.[216] Kusukawa has noted that one should be careful to attach too much coherence to the ways in which this term was used. It did not necessarily imply that the artists had any direct experience with the object they portrayed.[217] In fact, the qualification of 'ad vivum' by no means confirmed the existence of the thing that was depicted.[218] It could mean, rather, that a certain object was painted as lifelike enough to evoke in the spectator the idea that the thing was really there.[219] It could also serve as in indication of an intention on behalf of the artist to have rendered the animal or plant as accurately as possible.[220] None of the plates in the *Historia piscium* carry an inscription stating that they were done "from the life"; we have seen, however, that Ray did distinguish between images that were done "from the life" and those that had been copied from books.

The ambiguity of the qualification 'from the life' can be further illustrated by a species of puffer fish described and depicted in *Historia piscium*. It concerns the Guamaica atinga, as it was called by the Tupi people of the coastal regions of Brazil. Neither Willughby nor Ray had ever seen the species alive. They had taken the species description from the *Historia naturalis Brasiliae* (Amsterdam, 1648), the

[215] Kusukawa, *Picturing the Book of Nature*, 76.
[216] The historiography on the theme has been summarized and analyzed by Thomas Balfe and Joanna Woodall, "Introduction: The Lives of *Ad vivum*," in *Ad vivum? Visual Materials and the Vocabulary of Life-Likeness in Europe before 1800*, eds. Thomas Balfe, Joanna Woodall and Claus Zittel (Leiden: Brill, 2019).
[217] Sachiko Kusukawa, "*Ad vivum* Images and Knowledge of Nature in Early Modern Europe," in Balfe, Woodall and Zittel, *Ad vivum?*, 112.
[218] Ibid., 90–91.
[219] bid.
[220] Egmond, *Eye for Detail*, 94.

natural historical work of Georg Marcgraf (1610–1644) and Willem Piso (1611–1678).[221] These authors had travelled through the north-eastern provinces of Brazil in the service of Johan Maurits van Nassau-Siegen (1604–1679), who had been made the governor-general of this Dutch colony in 1636.[222] Many woodcuts from their work were used in the *Historia piscium*. In the case of the Guamaica atinga, however, rather than simply copying the published woodcut that was based on an in situ drawing in Brazil, a drawing was designed afresh. This drawing **(Figure 1.3)**, which is among the Willughby legacy, was one of those made from a specimen in the Royal Society's Repository.[223] It was one among the six specimens in the Repository that were drawn and engraved for the Historia piscium.[224] The pufferfish was drawn from the life, in the sense that the artist based the drawing from direct access to the specimen at hand, rather than copying an earlier illustration. By including the shadow cast by the pufferfish onto the paper, the artist directs attention to both his own physical presence and that of the specimen. Both the drawing, and the engraving based on it, thus employ a 'rhetoric of the real.'[225] Obviously, the specimen was no longer alive at this point, whereas the illustrations in the *Historia naturalis Brasiliae* were explicitly declared ad vivum in the dedication of the work.[226] This shows that the qualification ad vivum is, indeed, problematic.

In describing species, characteristic marks were key to Willughby and Ray. How did this emphasis manifest itself in the book's illustrations? First of all, most of the depicted fish species are shown from a side elevation, to borrow an architectural term – with the obvious exception of rays and flatfishes, where often both the upper and lower surfaces are shown. This angle of depiction best conveys

[221] See also: Peter Whitehead, "George Markgraf and Brazilian Zoology," in *Johan Maurits van Nassau-Siegen: A Humanist Prince in Europe and Brazil*, ed. E. van den Boogaard (The Hague: Mauritshuis, 1979), 424–471; *A Portrait of Dutch 17th Century Brasil: Animals, Plants and People by the Artists of Johan Maurits of Nassau*, eds. Peter Whitehead and Marinus Boeseman (Amsterdam: North-Holland Publishing Company, 1989).

[222] A research project entitled *Revisiting Dutch Brazil and Johan Maurits*, which pays particular attention to Johan Maurits's role in the transatlantic slave trade, has been initiated by the Mauritshuis in The Hague. Erik Odegard is the head of this project, which runs from September 2020 to December 2021.

[223] Drawing of a pufferfish, NUL, Mi LM 25/21.

[224] The Middleton collection holds six drawings that served as models for these engravings, see: Kusukawa, "*Historia Piscium* (1686) and Its Sources," 326–327.

[225] Cf. *Hist. pisc.* tab I8. For the notion "rhetoric of the real", see Martin Kemp, "Style and Non-Style in Anatomical Illustration: From Renaissance Humanism to Henry Gray," *Journal of Anatomy* 216, no. 2 (2010): 192–208.

[226] Paul J. Smith, "Marcgraf's Fish in the *Historia Naturalis Brasiliae* and the Rhetorics of Autoptic Testimony," [forthcoming volume on Brazilian natural history edited by Mariana C. Françozo].

the morphological characters of fish pertinent for identification and categorization, such as their overall shape and their fins. Furthermore, they are depicted according to what Janice Neri has dubbed 'specimen logic', which entailed "removing objects from their contexts and placing them against the blank space of a page for the viewer's inspection."[227] The water in which the fish dwell is therefore not shown. Both showing fishes from the side and placing them against a white background are common depictive strategies in natural historical works from the sixteenth through to the nineteenth centuries. That did not mean, however, that all characteristic marks were necessarily rendered visible. In the earlier discussion of the differences between the tope shark and smooth hound shark as an example,

Figure 1.3 Drawing of a pufferfish specimen from the Royal Society Repository | NUL, Mi LM 25/21 | © University of Nottingham Manuscripts and Special Collections

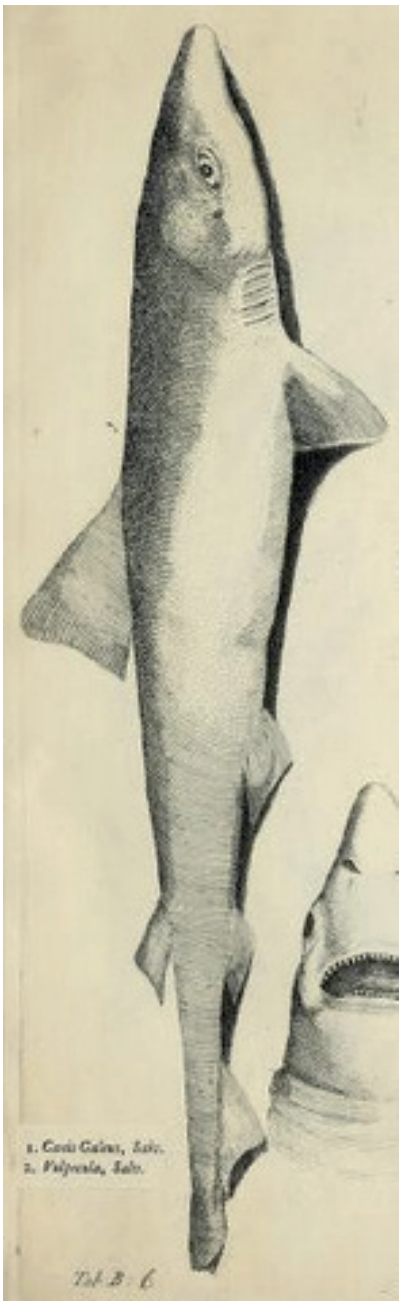
it was shown how these related to the colour of the irises, their teeth, and their size. None of these features can be inferred from the respective illustrations in the *Historia piscium*, for none of these depictions convey the colour, inner anatomies, or size of their depicted species (**Figure 1.4a/b**).[228] The illustrations therefore,

[227] Janice Neri, *The Insect and the Image: Visualizing Nature in Early Modern Europe 1500–1700* (Minneapolis: University of Minnesota Press, 2011), xii; a critique of this term is found in Egmond, *Eye for Detail*, 104.
[228] Cf. *Hist. pisc.*, tab B5 and B6.

were not in themselves always sufficient to enable species to be told apart. They were nonetheless important, according to Ray, because they conveyed knowledge about them with ease and pleasure.[229]

Ray himself was pleased with how the illustrations in the *Historia piscium* turned out, praising their veracity.[230] At the same time, representations were mediations, as the compilers of the *Historia piscium* also seemed aware. Authors did not always exercise complete control over the process of illustration.[231] It involved many people, from draftsmen to block-cutters or engravers, and printers and colourists. The drawings for the *Historia piscium* of fishes were selected on a case-by-case basis. In the selection process, we may recognize the decisions made by earlier natural historians, like Gessner, who had drawings made from life, but also used images that were sent to him, or copied figures from elsewhere. In fact, a share of of these images were copied into the *Historia piscium*. The question of what were the 'best figures', in Ray's words, thus had pragmatic answers that were a function of a plethora of factors such as the qualities of the artists, depiction strategies and conventions, and technological possibilities.

[229] Wragge-Morley, *Aesthetic Science*, 107.
[230] Kusukawa, "The *Historia Piscium* (1686)," 186.
[231] Kusukawa, "Illustrating Nature," 97.



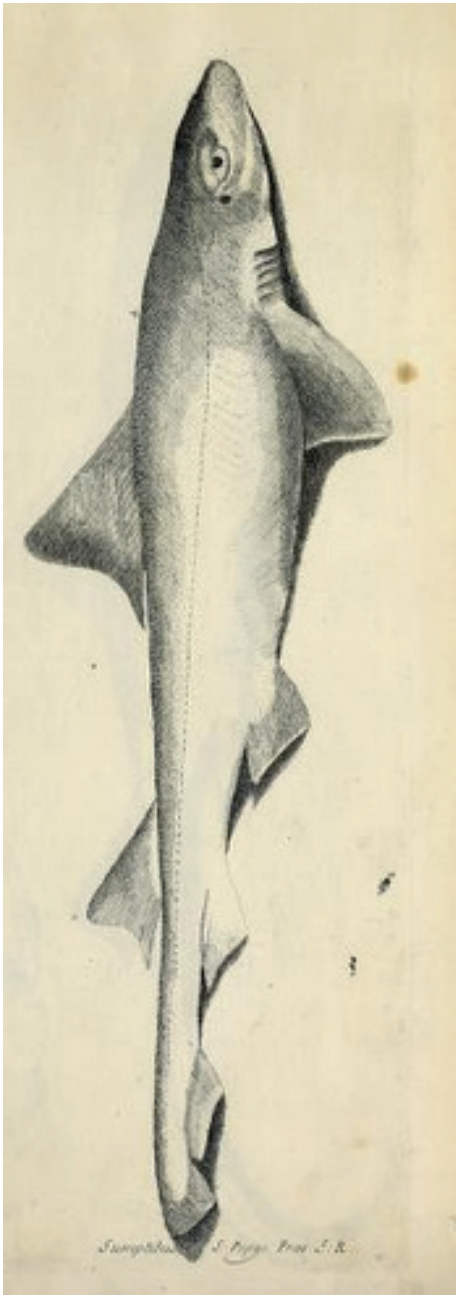


Figure 1.4a (left) Engraving of smooth hound shark | Francis Willughby and John Ray, *Historia piscium* (Oxford: Sheldonian Theatre, 1686), tab B5 | © Universiteitsbibliotheek Leiden

Figure 1.4b (right) Engraving of tope shark | Francis Willughby and John Ray, *Historia piscium* (Oxford: Sheldonian Theatre, 1686), tab B6 | © Universiteitsbibliotheek Leiden

Conclusions

The *Historia piscium* had yet to be published when an anonymous reader, given the chance to peruse it ahead of print, recommended it for purchase in the *Philosophical Transactions*:

> […] that which gives this work the greatest advantage above any other *History of Fishes* hitherto published, and recommends it to the purchase and perusall of all curious and ingenious persons, is the clear and accurate method, the many new Observations, the multitude and elegancy of the *Sculpts*; in all which respects jointly taken, it far transcends any book of this nature already extant.[232]

This endorsement reveals on what counts the *Historia piscium* was considered to be a work apart from earlier histories of fishes, and echoes the quote that opened this chapter – both stressing that these were new and improved books of fish and of birds, respectively. In the *Historia piscium*, Willughby and Ray had furthermore defined their subject matter differently than authors had done before them: both in with regard of what a fish was (i.e., an animal with fins rather than any creature that dwelled in the water), and as to how they should be studied. Where sixteenth-century naturalists had described species by placing them in a philological context, and combined this with accounts of their physiological aspects, their lengthy, encyclopedic descriptions were less appropriate for the purposes of Willughby and Ray. They wished to demarcate species based on clearly established characteristic marks. To do so, they adhered to the empirical program employed by the other Fellows of the Royal Society, and which valued observations made with one's own eyes over received accounts.

And yet, as we have seen, the *Historia piscium* was also not all that different from earlier publications. The description of species remained the core aim. The book also retained a compilatory character, in the sense that Willughby, Ray and the Fellows incorporated material from a wide range of sources, from earlier books and travel accounts, to loose drawings, and observations communicated in

[232] "Francisci Willughbeii Armig. de *Historia piscium* libri quatuor," *Philosophical Transactions*, 15, no. 178 (1685): 1308.

letters. The debates surrounding species descriptions (Willughby and Ray) and illustrations (Ray and the rest of the Fellows) have demonstrated how choices had to be pragmatic. Willughby and Ray and other Fellows very much had to rely on the observations and experiences of others. Studying nature entailed different degrees of observation, as one could see the specimen itself, either dead or alive, or peruse an illustration, read a description, or hear it reported from someone. This meant that Fellows had to continually evaluate which observations were worthwhile and trustworthy, and which were not. The following chapter will expand on this idea and foreground questions of reliability and credibility. It centres on the ideals of empirical observation as espoused by the Royal Society in general and the *Historia piscium* more specifically, and looks at how these required the subsumption of the direct experiences of fishermen and fishmongers. It takes us to the shops, the ports and the fish markets.