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Fish Books, Natural History and Questions of Demarcation in Eighteenth-Century Europe (ca. 1680-1820)

Didi van Trijp

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Didi Rosa van Trijp

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Fish Books, Natural History and Questions of Demarcation in Eighteenth-Century Europe (ca. 1680–1820)

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NOTES

On translations

Most of the translations have been made by the author. If existing translations have been adapted or expanded, this is indicated. The Latin translations have been checked and corrected by Hilke Hoogenboom at Leiden University. In most cases, the '&' has been written out as 'and' in order to improve readability.

On dates

Dates given conform to the Gregorian calendar and thus are New Style (NS), except when marked OS (Old Style) to accommodate the Julian calendar that was still in use in England until 1752. When giving dates in OS, the English traditional new year of 25 March (Lady Day) rather than 1 January is observed.

On transcriptions

In passages transcribed from letters and manuscripts, the spelling, punctuation, capitalisation and italics have been rendered faithfully. The long 's', however, has been normalized for readability. If emphasis has been altered or added, this is indicated in the footnote.

On references

In citing unpublished source material, reference is made to folio 'f', with indication of the recto 'r' or verso 'v' side of the page.

In citing primary printed works, the page numbers are given where possible. Where no page number is available, as is often the case with prefatory material, for example, references are given by signature (sig.). In the case that no pagination is offered and signature references are also lacking, this is signalled with n.p.

ABBREVIATIONS

Archives, Libraries and Collections

AFSt	Archiv der Franckeschen Stiftungen (Halle an der Saale)
BBAW	Brandenburgische Akademie der Wissenschaften (Berlin)
PAW	Preußischen Akademie der Wissenschaften
BL	British Library (London)
Add	Additional
MS	Manuscript
KB	Koninklijke Bibliotheek (The Hague)
KBS	Kungliga Biblioteket (Stockholm)
LS	Linnean Society (London)
MfN	Museum für Naturkunde (Berlin)
GNF	Gesellschaft Naturforschender Freunde
ZMB	Bestand Zoologisches Museum
NHM	Natural History Museum (London)
NUL	Nottingham University Library (Nottingham)
RS	Royal Society (London)
SA	Stadsarchief Amsterdam (Amsterdam)
SBB	Staatsbibliothek zu Berlin (Berlin)
SUB	Stockholms Universitetsbibliotek (Stockholm)

UBA	Universiteitsbibliotheek Amsterdam (Amsterdam)
UBL	Universiteitsbibliotheek Leiden (Leiden)
UL	Universitätsbibliothek Leipzig (Leipzig)
UUB	Uppsala Universitetsbibliotek (Uppsala)

Other

Allg. Nat. der Fische	Marcus Élieser Bloch, *Allgemeine Naturgeschichte der Fische* (Berlin: Hesse, Realschule and J. Morino, 1782–1795)
aph.	aphorism
Hist. anim. IIII	Conrad Gessner, *Historiae animalium liber IIII* (Zurich: Christopher Froschauer, 1558)
Hist. pisc.	Francis Willughby and John Ray, *Historia piscium* (Oxford: Sheldonian Theatre, 1686)
Icht.	Peter Artedi, *Ichthyologia, sive opera omnia de piscibus* (Leiden: Conrad Wishoff, 1738)
OFB	Oxford Francis Bacon

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INTRODUCTION

No Such Thing as a Fish

There is no such thing as a fish, and this is a dissertation about it. A recent encyclopaedia of aquatic life has raised the question of whether we can know a fish when we see one, submitting that "the concept is merely a convenient umbrella term to describe an aquatic vertebrate that is not a mammal, a turtle, or anything else."[1] The question of what, exactly, comprises a fish, and how best to approach it as a subject of research, has a long history. This study examines how people in Europe, in the course of the 'long' eighteenth century (taken here as lasting from the 1680s to the 1820s),[2] dedicated themselves to the natural history of fishes, a domain of knowledge that, in retrospect, formed the basis for what has become the disciplinary specialisation of ichthyology. It addresses the question of what early moderns qualified as 'fish', the methods they thought best suited to the study of this slippery subject, and who, precisely, could be counted on to produce solid, authoritative knowledge about it. This dissertation does not purport to answer the teleological and somewhat anachronistic question of when and how 'ichthyology' became an autonomous discipline, but rather examines the process of delimiting object, method and practitioners in the study of fish.

The long eighteenth century presents a particularly opportune period for a historical inquiry into such discussions of demarcation. The significance of the

[1] *The Encyclopedia of Underwater Life*, comp. Andrew Campbell and John Dawes (Oxford: Oxford University Press, 2005), s.v. "Fish, What is A?"

[2] Of course, what historians decide marks the beginning and the end of the 'long' eighteenth century differs from study to study. I have selected this particular time span because it encompasses the period from the publication of the *Historia piscium* (Oxford, 1686) by Francis Willughby and John Ray, which opens the first chapter of this dissertation, to Georges Cuvier's *Histoire naturelle des poissons* (Paris, 1828) that is discussed in the conclusion.

developments in this century has not always been recognized by historians of science who, as for example Roy Porter has noted, for quite some time considered this century a time of stagnation, situated between two epochs far more deserving of interest: the 'Scientific Revolution' of the seventeenth century on the one hand, and the 'Second Scientific Revolution' of the nineteenth on the other.[3] In the last few decades, however, historians have become more aware that the long eighteenth century was a compelling period of fermentation, in which both ideas about how nature should be studied and how the study of nature should be organized underwent significant changes.[4] Evidence for this new awareness can be inferred from the impressive range and volume of recent publications concerning the plethora of studies into plants and animals and new ideas about medicine that took place in this period.[5] At the same time, we are reminded by Richard Yeo that "people in the eighteenth century did not share our modern sense of the scope and boundaries of scientific subjects. They certainly did not recognize the closely differentiated array of disciplines, often marked by special journals and institutions, that began to emerge in the early nineteenth century."[6] We are thus presented with a situation in which, on the one hand, the study of living nature intensified and people came to apply themselves to specific topics within this field, but on the other hand, these investigations did not crystallize into clearly separated disciplinary categories. It is this murky process underlying the demarcation of knowledge on which this dissertation seeks to shed light.

When perusing early modern natural historical works addressing aquatic life, it soon becomes clear that this kind of investigation came with its own idiosyncrasies. Naturalists were struck by the sheer number of species of aquatic animals they came across, and the dazzling diversity of their colours, shapes and sizes. They also found it was decidedly more cumbersome to study fish in their

[3] Roy Porter, "Introduction," in *The Cambridge History of Science*, ed. Roy Porter, vol. 4, *Eighteenth-Century Science* (Cambridge: Cambridge University Press, 2003), 2.
[4] As was the premise of George Sebastian Rousseau and Roy Porter, eds., *The Ferment of Knowledge: Studies in the Historiography of Eighteenth-Century Science*, (Cambridge: Cambridge University Press, 1980).
[5] Anita Guerrini, "The Material Turn in the History of Life Science: Life Sciences," *Literature Compass* 13, no. 7 (2016): 470; the term 'life sciences' does not reflect how the study of living nature was referred to in the eighteenth century.
[6] Richard Yeo, "Classifying the Sciences," in Porter, *Cambridge History of Science*, vol. 4, 243–244.

own habitat than, say, plants, which could be grown in one's garden. Fish, after all, dwelled in places beyond the read of most early moderns: there was no easy way to peer into the depths of the water, and those fledgeling diving technologies that existed were unsuitable for the prolonged examination of the world underwater.[7] While it is known that the humanist Conrad Gessner (1516–1565) swam out into the Swiss lakes to collect water plants for closer inspection,[8] this does not seem to have been common practice. Ways to examine fish without getting one's feet wet included keeping them in tubs or garden ponds, or boarding boats to venture out onto rivers or seas – observations of fish *in situ* mostly took place from the surface of the water. Naturalists also had to contend with the fact that once fish and other aquatic animals were taken out of their element for a closer look, they soon decayed. Their books and letters contain litanies bemoaning the impossibility of preserving fishes once they had perished, especially when compared to the ease with which other animals like birds or insects, or the flowers or leaves of plants were kept. Therefore, while naturalists recognized there was a great variety of fishes, they were also painfully aware of how difficult they were to access and preserve.

The difficulties that are embedded in observing (fresh) fish render the matter of making authoritative statements about them acute. This dissertation deals with the various ways in which the authors of three different fish books that were published in the long eighteenth century sought to demarcate pertinent natural historical knowledge about fish from the non-pertinent, and presented themselves as authoritative in the study of these creatures. The reasons for selecting these particular works will be discussed in more detail later in this introduction. The books are briefly presented here.

The first work to concern us is the *Historia piscium* [History of Fishes] (Oxford, 1686) by the English parson naturalists John Ray (1627–1705) and Francis Willughby (1635–1672). It forms a suitable book to commence this

[7] For late sixteenth-century prints depicting glasses seemingly used as diving goggles, see: Marlise Rijks, "'Unusual Excrescences of Nature': Collected Coral and the Study of Petrified Luxury in Early Modern Antwerp," *Dutch Crossing: Journal of Low Countries Studies* 43, no. 2 (2019): 131; for diving engines in the late seventeenth century, see: Philippa Hellawell, "Diving Engines, Submarine Knowledge and the 'Wealth Fetch'd out of the Sea,'" *Renaissance Studies* 34, no. 1 (2019): 78–94.
[8] Florike Egmond, *Eye for Detail*: *Images of Plants and Animals in Art and Science 1500–1630* (London: Reaktion Books, 2017), 94.

study because while it was rooted in encyclopaedic, sixteenth-century traditions of natural history its authors explicitly attempted to break away from such an approach to studying nature. The second book to be discussed is the *Ichthyologia sive opera omnia de piscibus* [Ichthyology, or complete works about fish] (Leiden, 1738) by the Swedish naturalist Peter Artedi (1705–1735), who sought to lay solid, new foundations for the study of fish through his method of classification. The last book is the series *Allgemeine Naturgeschichte der Fische* [General Natural History of Fishes] (Berlin, 1782–1795) by the Jewish-German physician and collector Marcus Élieser Bloch (1723–1799), whose collection of fish was the most comprehensive of the time.

In this dissertation, I submit that while the study of fish was an integrated branch of natural history until well into the eighteenth century, it more and more became to be regarded as a distinct field with its own particular rules. I will demonstrate how the heuristic approach within this branch of study changed from an encyclopedic approach which included the analysis of ancient sources and texts, to a growing insistence on empirical observation and an emphasis on taxonomy marked by a quantitative focus. I will show that authors of fish books sought to position themselves as authoritative knowers of fish by virtue of their methods for studying these animals. I argue that historians should pay attention to the various acts of demarcation embedded in the shift that occurred during the long eighteenth century with regard to which materials and methods were considered of import to inquiries into fish, but also who was to decide this, and on the basis of what.

Histories of Natural History

Paula Findlen has characterized the emergence of natural history in the early modern period as a process of gradual reinvention, rather than as a succession of revolutions. In contrast to, say, astronomy, she contends, natural history "produced no single moment of discovery, no dramatic transformation of mind that we might associate with one individual."[9] She considers this lack of sudden

[9] Paula Findlen, "Natural History," in *The Cambridge History of Science*, eds. Katharine Park and Lorraine Daston, vol. 3, *Early Modern Science* (Cambridge: Cambridge University Press, 2006), 436.

shifts as the main reason for why historians of science had largely neglected the history of natural history up until the 1990s in their narratives of how science came into the world. Such lack of attention for natural history as Findlen has outlined is scarcely imaginable today, as these studies have, in the last few decades, become a burgeoning field. By paying greater attention to the textual, material and visual cultures of natural historical knowledge, themes which feature heavily in this dissertation, historians have generated exciting new insights into the production and dissemination of natural historical knowledge.

In her remark on the history of natural history, Findlen touches upon a wider discussion within the history of science. It concerns the question of whether the creation of scientific knowledge should best be conceived as a continuous process or rather as a series of revolutions and striking changes. A notable proponent of the latter was Thomas Kuhn, who in his work *The Structure of Scientific Revolutions* introduced the concept of paradigm shifts in which pressing new insights overthrow a broadly accepted view.[10] A few years later, Michel Foucault published his *Les Mots et les choses* in which he spoke of epistomological breaks. One of his case studies was, markedly, natural history, for which he argued that in the eighteenth century, a drastic change took place in which naturalists came to regard nature in terms of visible structures instead of embedding it in semantic contexts.[11] Such frames of breaks and shifts seem to have meanwhile lost appeal to most historians of science, regardless of the field they study.

Rather than a paradigmatic shift or epistemic break, historians recognize the succession of knowledge as a slow and subtle process. The traditional aim of natural history was, at least since Pliny the Elder, to describe nature's productions in all their particularities (which was a different aim from what we would today call 'biology').[12] When it came to studying plants and animals, early moderns wondered what species existed in the world – and what a species actually *was* – as well as what meanings might be derived from these natural creatures. Over the course of the early modern period, a process of demarcation did take place

[10] Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962).
[11] Michel Foucault's *Les Mots et les choses* (Paris: Editions Gallimard, 19616) – with the fifth chapter focussing specifically on the episteme of eighteenth-century natural history during the "Classical age," see: *The Order of Things* (New York: Routledge, 2001), 136–179, esp. 140, 147.
[12] Mary Beagon, *Roman Nature: the Thought of Pliny the Elder* (Oxford: Clarendon Press, 1992); Roger French, *Ancient Natural History: Histories of Nature* (London: Taylor and Francis, 1994).

in which natural historical knowledge perceived as pertinent was set apart from knowledge assumed not pertinent. Where, in exploring the natural historical world of fish, naturalists up until the sixteenth century drew from a wide array of sources, including ancient natural historical texts, poetry, cookery books, and medicinal treatises, in the long eighteenth century this kind of encyclopaedic approach gave way to a more or less exclusive focus on the physical, visible features of species. While the description of nature did remain the primary aim, naturalists' ideas of where proper answers might be found, and in what form these should be cast, underwent a steady yet profound change. In other words: what constituted proper natural historical knowledge of fish was subject to a gradual historical development.

The present dissertation seeks to make a novel contribution to the history of science by offering a long-term view of the development of one particular domain of natural history – fish –, and examining how people appropriate this domain and present themselves as authorities in it. In this, it departs from the histories of eighteenth-century natural history that tend to focus on a particular author, region, period, and thus seldom cover developments spanning the century. This dissertation pays particular attention to the *methods* that the naturalists under discussion use for the study of fish, and how they employ them to claim authority. 'Method' here is not necessarily taken as a detailed, watertight methodology that we might associate with the scientific method today. Rather, it is understood as any explicitly articulated approach on part of the author to the way in which one can come to the most certain, pertinent knowledge about fish. Each chapter of this dissertation takes as its place of departure the qualifications that Willughby, Ray, Artedi and Bloch themselves use: how do they envision their work and its approach? And how do they evaluate their own contributions apropos those of earlier naturalists or their peers? At the same time, it is important to not take these qualifications at face value, but to try to understand why certain claims were made, and in which context – and how they worked out in practice. Rather than looking at these authors through our contemporary lens, therefore, the historical actors will, as much as is possible, be studied in their own context and on their own terms. This requires interrogating the terminology that naturalists themselves used, but also asking why they deployed these, and to what purposes and effects.

In its attention to how naturalists presented themselves as authorities on fish, this dissertation adheres to the conception of knowledge creation as an inherently social activity. The idea that the social factors into the creation of knowledge is by now well established, and historians continue to examine the nature and extent of such intersections. There are several ways of approaching this. Pierre Bourdieu's assertion, for example, that the term 'capital' should not only be understood in its narrow economic sense but also in a social, cultural and symbolic sense has gained traction with historians.[13] The notion of cultural capital, especially, has led historians of science to reflect on how people of the past could wield educational qualifications or the possession of books or instruments, among others things, to gain and assert influence in a certain group.[14] Steven Shapin and Simon Schaffer have published canonical studies in the history of science in which they minutely analyse the social and cultural aspects of how authority, credibility, and trust are built, focussing on seventeenth-century England.[15]

In the last years, historians of science have directed specific attention to the idea of the 'scholarly self' or 'scientific persona'. Lorraine Daston and H. Otto Sibum introduced the notion of the 'scientific persona' as a social type (for example 'the scholar', 'the naturalist' or 'the experimenter') displaying distinctive traits (such as forgetful, humble or creative), that both shape and are shaped by the individuals who incarnate them.[16] Besides this rather broad approach to personae as cultural templates, one can also look at the values resonating in scholarly communities regarding what it takes to be, say, a philosopher or a naturalist, as well as how individual scholars make themselves appear credible by presenting

[13] Pierre Bourdieu developed his notion of cultural capital most extensively in his *La distinction : Critique sociale du jugement* (1979), trans. by Richard Nice as *Distinction: A Social Critique of the Judgement of Taste* (Cambridge Mass.: Harvard University Press, 1987).

[14] Kostas Tampakis, "The Science of Practice and the Practice of Science: Pierre Bourdieu and the History of Science," *Sociology Compass* 10, no. 9 (2016): 813–822.

[15] Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle and the Experimental Life* (Princeton: Princeton University Press, 1985); Steven Shapin, *A Social History of Truth: Civility and Science in Seventeenth-Century England* (Chicago: Chicago University Press, 1994); and idem, *Never Pure: Historical Studies of Science as If It Was Produced by People with Bodies, Situated in Time, Space, Culture, and Society, and Struggling for Credibility and Authority* (Baltimore: Johns Hopkins University Press, 2010).

[16] Lorraine Daston and H. Otto Sibum, "Introduction: Scientific Personae and Their Histories," *Science in Context* 16, no. 1–2 (2003): 5.

themselves a certain way.[17] It is not the intent of this dissertation to shed new light on persona as an analytical category. Rather, it draws on the abovementioned historiographical insights in examining the appeals to authority, reliability and credibility made by the authors of the three books that form its corpus.

These authorial appeals to authority, reliability and credibility can manifest themselves in several ways, but in order for them to not fall flat, they have to correspond to broader shared ideals of how natural history should be done. This means that rather than looking at abstract theories, historins should turn to concrete practices. An important impetus for the study of practices has come from sociology, notably Bourdieu who submitted that through examining practices, one can uncover the social fabric of cultures.[18] When it comes to scientific practices, a classic study is Bruno Latour's analysis of scientists in their laboratories.[19] In his study of the French chemist Louis Pasteur (1822–1895), Latour has shown how microbes became accepted as existing entities through complex exchanges and interactions between various historical actors – and that this outcome was not necessarily predictable.[20] Historians of science are indebted to such sociological ideas about the 'madeness' of knowledge. At the same time, as Lorraine Daston and Peter Dear have pointed out, science studies and the history of science have come to diverge in their aims and approaches as historians have increasingly contextualized and questioned the value of the very notion of 'science'.[21]

The main benefit of the focus on practices for historians of science is that it reframes the production of natural knowledge as a process rather than an

[17] These levels are discussed in more detail in Herman Paul, "Introduction: Scholarly Personae: What They Are and Why They Matter," in *How to Be a Historian: Scholarly Personae in Historical Studies, 1800–2000*, ed. Herman Paul (Manchester: Manchester University Press, 2019), 1–14; Gadi Algazi, "Exemplum and Wundertier. Three Concepts of the Scholarly Persona," *BMGN – Low Countries Historical Review* 131, no. 4 (2016): 9–17.
[18] See: Pierre Bourdieu, *Esquisse d'une theorie de la pratique* (Genève: Librairie Droz, 1972), trans. Richard Nice as *Outline of a Theory of Practice* (Cambridge: Cambridge University Press, 2013).
[19] Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society* (Cambridge, Mass.: Harvard University Press, 1987).
[20] These actors were both human and non-human (like the microbes themselves), see also: Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge, Mass.: Harvard University Press, 1999), 145–173, esp. 148.
[21] Lorraine Daston, "Science Studies and the History of Science," *Critical Inquiry* 35, no. 4 (2009): 798–813, esp. 808 and Peter Dear, "Science is Dead; Long Live Science," *Osiris* 27, no. 1 (2012): 37–55, esp. 44.

outcome.[22] In exploring the question of what where the kinds of activities early modern naturalists considered worthwhile for the making of natural historical knowledge, this dissertation will draw on the insights generated by historians of science who have been looking closely at historically situated practices in the production of natural knowledge. When it comes to the study of natural history of the eighteenth century, we can discern a set of four practices particularly central to it, those of collecting, classifying, describing, and illustrating species. These practices were, of course, often closely related to one another: verbal species descriptions, for instance, could be based on illustrations that were, in turn, made of preserved specimens. Each one of these four practices, therefore, recurs throughout the chapters of this dissertation. I will now briefly discuss them in turn, and explain their relevance for answering my research question.

The first is **collecting**. The centrality of collecting in the production of early modern natural knowledge has been established since the 1980s, a development in which Oliver Impey and Arthur MacGregor's *The Origins of Museums* and Paula Findlen's *Possessing Nature* are often considered important instigators.[23] Since then, historians of science have both built upon these works and departed from them, ever extending their questions into the material aspects of knowledge making.[24] They have started examining objects as carriers of knowledge with their own uses and limits.[25] A recent development is the focus on the material properties of objects. Historians have turned, for example, to the taxidermy strategies explained in early modern manuals of animal preservation, and even started re-enacting them.[26] Historians have furthermore become attuned to the arduous process of transporting plants and animals across long distances, with the ships

[22] James Secord, "Knowledge in Transit," *Isis* 95, no. 4 (2004): 658.
[23] Oliver Impey and Arthur MacGregor, eds., *The Origins of Museums: The Cabinet of Curiosities in Sixteenth- and Seventeenth-Century Europe*, (Oxford: Clarendon Press, 1985); Paula Findlen, *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy* (Berkeley: University of California Press, 1994). An influential work in the Dutch language has been Ellinoor S. Bergvelt and Renée Kistemaker, eds., *De Wereld Binnen Handbereik: Nederlandse Kunst- en Rariteitenverzamelingen, 1585–1735* (Zwolle: Waanders, 1992).
[24] An overview is given in William Burgess, "State of the Field: The History of Collecting," *History* 106, no. 369 (2020): 108–119; pages 111–112 reflect specifically on the influence of Impey and MacGregor on the history of collecting.
[25] Sven Dupré and Christoph Lüthy, "Introduction," in *Silent Messengers: The Circulation of Material Objects of Knowledge in the Early Modern Low Countries*, eds. Sven Dupré and Christoph Lüthy (Berlin: LIT, 2011), 12.
[26] Marieke M.A. Hendriksen, "Animal Bodies between Wonder and Natural History: Taxidermy in the Cabinet and Menagerie of Stadholder Willem V (1748–1806)," *Journal of Social History* 52, no. 4 (2019): 1110–1111.

carrying them endangered by storms or pirates, and the specimens themselves damaged by vermin and neglected by crews.[27] The spaces where all these objects were assembled, such as cabinets of curiosities, natural historical collections or any other name used, continue to attract interest.[28] Historians have pointed out that such collections were multivalent spaces that facilitated different ways of seeing.[29] A natural historical object might, for example, be taken as evidence to support a certain observation or theory. Taken together, rooms and drawers filled with specimens helped self-conscious collectors to display of their possession of, and command over, nature.[30] In terms of matters of authority, credibility, and reliability therefore, collecting worked in different ways, as will also be shown in this dissertation.

Classifying was an important, if not the most important, practice of eighteenth-century natural history. This was, after all, the time in which Carl Linnaeus (1707–1778) the man often characterised as being the one 'who ordered nature',[31] published his works. No matter that he was by no means the only individual preoccupied with the categorization of species, and that those collections that were now bursting at the seams with ever more specimens made classification a must. It is perhaps because classification has since come to occupy such a central place in natural history that internalistic narratives have been produced around it. These take the form of assessments of whether or not people of past times were the first to describe a certain species, and whether they had assigned it to its 'rightful' place in the larger system of classification (according to our contemporary standards).[32] Over the last decades, however,

[27] Christopher M. Parsons and Kathleen S. Murphy, "Ecosystems under Sail: Specimen Transport in the Eighteenth-Century French and British Atlantics," *Early American Studies* 10, no. 3 (2012): 538.
[28] Paula Findlen, *Possessing Nature*, 48–49.
[29] Daniela Bleichmar, "Seeing the World in a Room: Looking at Exotica in Early Modern Collections," in *Collecting Across Cultures: Material Exchanges in the Early Modern Atlantic World*, eds. Daniela Bleichmar and Peter C. Mancall (Philadelphia: University of Pennsylvania Press, 2011), 20–21.
[30] Paula Findlen and Anna Toledano, "The Materials of Natural History," in *Worlds of Natural History*, eds. Helen Anne Curry, Nicholas Jardine, James Secord and Emma C. Spary (Cambridge: Cambridge University Press, 2018), 151.
[31] Translation from the title of Gunnar Broberg's recent biography of Linnaeus: *Mannen som ordnade naturen: En biografi över Carl von Linné* (Stockholm: Natur & Kultur, 2019). This dissertation will cite from the Dutch translation: *Carl Linnaeus: De man die de natuur rangschikte*, trans. Ger Meesters (Amsterdam: Spectrum, 2020). An English translation should appear shortly.
[32] Sara T. Scharf, "Identification Keys, the 'Natural Method,' and the Development of Plant Identification Manuals," *Journal of the History of Biology* 42, no. 1 (2009): 77–78.

historians have come to consider precisely what it was that naturalists sought to accomplish by classifying nature, as well as how they went about it. This means that these historians no longer perceive classification as a neutral act, but as one that necessarily reflects certain cultural values and social values, for example, notions of gender and/or class.[33] Furthermore, as this dissertation will also show, the act of classifying nature *itself* became considered paramount for what it took to be a naturalist.

With regard to **describing**, rather than focussing only on the contents that books *present*, historians have become more and more attentive to how these ideas have been formulated. This may entail considering how the language in which a work is published, such as Latin or one of the European vernaculars, relates to a possible audience or envisioned readership.[34] In fact, the very practice of description formed communities. Brian Ogilvie, for example, has argued that the invention of natural history, which he locates in the sixteenth century, was born out of a preoccupation with description.[35] He claims that it was Renaissance naturalists' shared concern for the best way to describe species of plants that tied this newly forming community together. Yet even if natural historical description was 'routinized and systematized' in the seventeenth century, as Ogilvie contends,[36] this dissertation shows it nevertheless remained a topic of reflection and discussion. A clear example of this is to be found in changing conventions surrounding the descriptions of species, from elaborate encyclopedic narratives to succinct lists.

The last practice is that of **illustrating**. Natural historical illustrations have tended "to fall through the scholarly cracks, dismissed by most art historians and historians of science as neither great art or important science"[37], as Daniela Bleichmar has pointed out. And yet, in the last decades historians have come to acknowledge that illustrations in natural historical and natural philosophical

[33] See: Londa Schiebinger, "Why Mammals are Called Mammals: Gender Politics in Eighteenth-Century Natural History," *The American Historical Review* 98, no. 2 (1993): 382–411.
[34] Sietkse Fransen, "Introduction: Translators and Translations of Early Modern Science," in *Translating Early Modern Science*, eds. Sietske Fransen, Niall Hodson and Karl A.E. Enenkel (Leiden: Brill, 2017), 5–6.
[35] Brian Ogilvie, *The Science of Describing: Natural History in Renaissance Europe* (Chicago: University of Chicago Press, 2006).
[36] Ogilvie, *Science of Describing*, 7.
[37] Daniela Bleichmar, *Visible Empire: Botanical Expeditions & Visual Culture in the Hispanic Enlightenment* (Chicago: Chicago University Press, 2012), 5.

works were seldom mere adornments to the text. The precise role of illustrations in capturing and conveying knowledge about nature remains subject to lively discussion. In reviewing this debate, Alexander Marr has noticed how some historians tend to attribute agency mostly to the images themselves, focussing on their form, style and aesthetic properties, whereas others privilege the intention of the maker or commissioner of the image, and are thus mostly concerned with human agency.[38] This is a question of emphasis and nuance, however, rather than an absolute dichotomy. A fruitful way to think of illustrations is to consider them, as Susan Dackerman has proposed for prints, as both 'tools of research'[39] and 'tools of persuasion with argumentative as well as descriptive and demonstrative functions.'[40] As Sachiko Kusukawa has reminded us, for every illustration published in a natural historical work, one should ask what it was meant to represent, why it was included, and how it related to the printed text, while also being aware of how these decisions were shaped and driven by practical, pragmatic and financial incentives.[41] This dissertation therefore considers how the images it discusses were made, by whom, and for what reasons.

As the above discussion of personae and practices already shows, this dissertation takes into account a wide variety of factors. It considers not only how fish were collected, classified, described and illustrated in the eighteenth century, but also examines the approaches adopted by authors of fish books, and analyzes how the decisions made by the authors regarding these factors made their statements appear credible and reliable, and bolstered their authority. Taking on board such a substantial number of variables can make it difficult at times to single out one particular development and confidently attribute it to a certain cause. And yet, not one of these variables can be left out of the equation. Looking at the set of practices described above is necessary because focussing only one of these, for example on collecting or illustrating, would give an incomplete idea of natural historical study of fish in the eighteenth century. Natural historical study,

[38] As summarized in Alexander Marr, "Knowing Images," *Renaissance Quarterly* 69, no. 3 (2016): 1000–1013, esp. 1002.
[39] Susan Dackerman, "Introduction: Prints as Instruments," in *Prints and the Pursuit of Knowledge*, ed. Susan Dackerman (Cambridge, Mass.: Harvard Art Museums, 2011), 20.
[40] Ibid., 28.
[41] Sachiko Kusukawa, "Illustrating Nature," in *Books and the Sciences in History*, eds. Nicholas Jardine and Marina Frasca-Spada (Cambridge: Cambridge University Press, 2000), 109.

after all, was never just a matter of only one practice, like collecting or classifying, but rather one of intertwined, integrated activities. This dissertation thus intends to show how many factors and variables were involved in producing authoritative knowledge about nature in this period.

An important consequence of the historiographical turn towards knowledge production as a practice has been the increasing understanding of the diversity of people that were, in one way or the other, engaged in the study of nature in the early modern period. The study of nature was far from the exclusive domain of professors or physicians, but also taken up by apothecaries, women healers, herbalists, gardeners, draughtsmen and goldsmiths, and so forth. The 'concerted program of boundary expansion'[42] that Deborah E. Harkness has signalled in her book on the production of knowledge in Elizabethan London, still continues. It has required historians to let go of preconceived ideas of what does and what does not constitute natural knowledge, and has often required some industry on their part to retrieve past efforts that are no longer readily visible. Pamela Smith, for example, has demonstrated that artisanal knowledge, which was heavily reliant on bodily experience, came to be absorbed by the work of the natural philosopher, while the artisans themselves were gradually expelled from it.[43] This broad variety of natural historical practitioners also inhabits the sources that form the corpus of this dissertation, both in overt and more subtle ways.

On Definitions

In the period covered by this dissertation, building a career around the sustained study of nature was far from a straightforward matter. Katharine Park and Lorraine Daston have signalled how early modern career trajectories can seem to our eyes both "dazzlingly diverse and oddly circumscribed".[44] They stress that when it came to creating knowledge about nature, labour divisions were differently from those of today. For example, we might assume that such research

[42] Deborah E. Harkness, *The Jewel House: Elizabethan London and the Scientific Revolution* (New Haven: Yale University Press, 2007), 255.
[43] Pamela Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution* (Chicago: University of Chicago Press, 2004), 186.
[44] Katharine Park and Lorraine Daston, "Introduction," in Daston and Park, *Cambridge History of Science*, vol. 3, 5.

was primarily conducted at the universities, but these were more focussed on teaching; if professors wished to do research, they often had to do so in their spare time. As the above paragraph has already indicated, research was also conducted in those places where one might less expect it. Artisans and apothecaries examined and experimented with the properties of all kinds of materials in their workshops and kitchens. Mathematicians or naturalists, furthermore, found occasional patronage in courts or estates with observatories or lavish gardens. In sum, those early moderns that were bent on dedicating their life to the study of living nature had different routes available to them, but could seldom take one effortless, obvious path towards comfortable remuneration.

In the absence of, to us, clearly recognizable job titles, how to best refer to that motley group of early moderns busying themselves with the study of nature has been a contentious subject. Historians have long agreed that the application of the term 'scientist' to those scrutinizing nature in the early modern period is misguided.[45] Their study of nature did seek out *scientia*, with which they meant causal, certain and demonstrable knowledge,[46] but this does not necessarily map onto the later, narrower English conception of science as the natural sciences.[47] This particular concept of 'science' was only coined in the nineteenth century and even then remained a matter of contention.[48] Furthermore, using the term science suggests an unwarranted continuity with present-day research, and carries the risk of evaluating the merits of a past project solely within the context of contemporary ideas. By way of contrast, this dissertation does not seek to retrieve any obscured 'scientific value' of the naturalists under discussion, or deploy a language of 'firsts', that is, it does not name the first 'true' scientist, biologist, ecologist, or hail the founder of a discipline. Instead, it shows that the generation of new natural historical insights is often a contingent process that involves many variables.

[45] Nicholas Jardine, "Uses and Abuses of Anachronism in the History of the Sciences," *History of Science* 38, no. 3 (2000): 261.
[46] Pomata and Siraisi, *Historia*, 10.
[47] For this discussion, see: Denise Phillips, *Acolytes of Nature: Defining Natural Science in Germany, 1770–1850* (Chicago: Chicago University Press, 2012), 3–5.
[48] See, for example, Paul Lucier, "The Professional and the Scientist in Nineteenth-Century America," *Isis* 100, no. 4 (2009): 699–732.

The term 'naturalist' is generally considered a more apt term to capture an individual who busied him or herself with the study of nature in the early modern period. Even although it is not contemporary, historians of science have taken to using this designation because it is relatively close to the categories that were used by historical actors themselves.[49] The term is also sufficiently broad to still apply to those early moderns who studied the general properties of nature as well as to those investigating its particularities – even to those who did both.

Accommodating as the term 'naturalist' may indeed be for capturing the variety of people that examined nature, it can still be quite somewhat discriminatory. After all, the naturalists on whom historians write are often men of higher social standing who were possessed of sufficient private means to carry out their studies. This tendency is largely reflective of long-established boundaries in the acquisition of knowledge; women, for example, were invariably not granted access to places where knowledge about nature was taught or discussed, like universities or learned societies.[50] In their privileging of universities and learned societies as sites for knowledge production, historians of science have thus long marginalized female contributions to the production of natural knowledge. Apart from academies, the study of nature also took place in a domestic context, where various members of the household tended to the examination of nature as a sort of collaborative project.[51] In a similar vein, indigenous naturalists were not always recognized as such by their western counterparts. And yet, as we will see the various chapters of this dissertation, those who consumed and contributed to the natural historical study of fish were not just European men of social stature. Women of means might finance the publication of natural historical books or purchase them, or share specimens; Indian informants of German missionaries might collect or draw species. While historians are incorporating the contributions and perspectives of

[49] For the term 'studiosus rerum naturae' used for those who were devoted to the study of the nature of things, or of natural things, see: Park and Daston, "Introduction," 10; Ogilvie, *Science of Describing*, 54.
[50] Londa Schiebinger, "Women of Natural Knowledge," in Daston and Park, *Cambridge History of Science*, vol. 3, 195.
[51] Elaine Leong, *Recipes and Everyday Knowledge: Medicine, Science, and the Household in Early Modern England* (Chicago: Chicago University Press, 2018), esp. 46–70.

those that have fallen outside of the traditional purview of the history of science into the narrative more explicitly, there is much left to explore.[52]

The naturalists on which this dissertation focusses studied fish. Nowadays those who study fish are called ichthyologists, but from which point does it make sense to refer to them as such? During the beginning of the period with which this dissertation is concerned, the late seventeenth century, 'ichthyology' was not a word that was used by those studying aquatic animals to describe what they were doing. This is why, to illustrate my point, that even though Gessner published a lavish volume on the natural history of creatures living in and near the water, it would hardly make sense to call him an ichthyologist, or to refer to his work as an ichthyological one. The term 'ichthyology' seemed rather to have gained currency over the course of the eighteenth century. Being attentive to these kinds of shifts in terminology, as Porter has remarked in his work on the emergence of geology in eighteenth-century Britain, is important because "the coining of the term 'geology' and its derivatives" indicate "changing ways of seeing".[53] His reasoning can, of course, be extended to other designations such as ornithology, entomology, ichthyology etc. I will therefore approach the term 'ichthyology' with an eye to the way in which historical actors themselves defined it, why they wielded it and how it gained currency as a marker of a certain kind of knowledge about fish. As we will see in Chapter 3, Peter Artedi did this deliberately and even exhaustively.

Of course, terms such as geology, ichthyology and ornithology today designate disciplinary specialisations. To understand why those terms did not quite have the same coherence in the eighteenth century, some words on discipline formation are in order. The concept of 'discipline' has its etymological roots in the Latin *disciplinas*, which is derived from the term *discere* (to learn); in the early modern period, it was mostly used in the context of teaching.[54] Today, the word 'discipline'

[52] See, for example: Anna Winterbottom, *Hybrid Knowledge in the Early East India Company World* (Basingstoke: Palgrave Macmillan, 2015); Jaime Marroquin Arredondo and Ralph Bauer, eds., *Translating Nature: Cross-Cultural Histories of Early Modern Science* (Philadelphia: University of Pennsylvania Press, 2019); Anna Marie Roos, *Martin Lister and His Remarkable Daughters: The Art of Science in the Seventeenth Century* (Oxford: The Bodleian Library, 2019); Arlene Leis and Kacie L. Wills, eds., *Women and the Art and Science of Collecting in Eighteenth-Century Europe* (New York: Routledge, 2021).
[53] Roy Porter, *The Making of Geology: Earth Science in Britain, 1660–1815* (Cambridge: Cambridge University Press, 1977), 5.
[54] For more, see: Donald R. Kelley, "The Problem of Knowledge and the Concept of Discipline," in *History and the Disciplines: The Reclassification of Knowledge in Early Modern Europe*, ed. Donald R. Kelley (New York: University of Rochester Press, 1997), 44–46.

has come to denote an autonomous field of knowledge. Although the history of how modern disciplines have come into being has long held the interest of historians of science, there is no uniform understanding of what the contemporary term 'discipline' encompasses, and the concept has not been consistently applied.[55] The formation of distinct and definable disciplines is often attributed to the nineteenth century, although there exists no consensus on whether this should be earlier or later in that century. There is consensus, however, on the markers for considering a field of knowledge an actual discipline. These relate both to the content of the discipline (for example, the formulation of shared questions, methods and goals) and to its organisational structure (for example, the formation of appropriate roles, designated spaces and institutional embedding).[56] Yeo, as we saw, gives examples of the latter by mentioning special institutions and journals.

The study of discipline formation can be tricky. In her incisive study of the construction of authority in an emerging discipline, namely the rise of meteorology as the science of the weather in the nineteenth century, Azadeh Achbari has argued that one should examine the formation of disciplines "without taking their current form or their supposed coherence for granted."[57] Matters may well have developed differently. One of her conclusions is that academics came to dominate this new field by demonstrating how the weather operated according to natural laws, at the expense of naval captains who made predictions based on observing corresponding signs in winds and currents during their voyages. She argues that it was due to the continuous process of 'boundary work' on the part of university professors that legitimacy became increasingly located in a mathematical model for the acquisition of knowledge.[58] She thus shows that the making of disciplines is an active process, rather than one that unfolds as if by natural law, in which individuals have stakes.

[55] Rudolf Stichweh, "The Sociology of Scientific Disciplines: On the Genesis and Stability of the Disciplinary Structure of Modern Science," *Science in Context* 5, no. 1 (1992): 7.
[56] Ibid., 9.
[57] Azadeh Achbari, "Rulers of the Winds: How Academics Came to Dominate the Science of Weather" (PhD diss., Vrije Universiteit Amsterdam, 2017), 227.
[58] The notion of "boundary work" is defined as "an ideological style found in scientists' attempts to create a public image for science by contrasting it favorably to non-scientific intellectual or technical activities" in Thomas F. Gieryn, "Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists," *American Sociological Review* 48, no. 6 (1983): 781.

Although the present dissertation does not aim to offer a disciplinary history of ichthyology, the conclusions are still useful for those who are interested in the boundary aspect of the formation of disciplines. The mechanisms underlying the claiming of authority on a specific topic of study, after all, certainly predate the nineteenth century. Tracing their manifestations in an earlier period allows insight to be gained into the processes in which people come to claim themselves as specialists in a certain field, and the basis on which they do so. In sum, this dissertation does not consider those early modern naturalists who studied fish to be ichthyologists, but it is attentive to the extent to which they themselves demarcate the study of fish as a separate kind of study requiring a particular practitioner.

This brings us to the last term that merits qualification, and which also figures in the title of this dissertation: that of 'demarcation'. Sociologists and philosophers of science have used this term in order to denote the act in which science is differentiated from non-science.[59] The usage of the term, however, extends beyond this specific issue and scholars generally use it to indicate the act of marking off one thing from the other. In this dissertation, I use the term demarcation on different levels – for example, setting apart fish from non-fish, or admissible methods from supposedly unsuitable ones – in order to address and draw attention to the continuous process of shifting boundaries in the natural historical study of fish.

Sources and Structure

The primary entrance into answering the question of how authors came to establish themselves as authoritative knowers of fish will be the analysis of 'fish books', i.e., natural historical works that describe and discuss fish. Natural historical books were critical means by which observations and insights could be communicated from one naturalist to another, and across generations as well as geographical regions. Despite their significance in the history of natural history, the books that are examined in this dissertation have hitherto seldom been studied – or

[59] For a background to this discussion, see ibid.

else only very recently. I have selected these works because each has pretensions of comprehension. As the titles of these books announce (Ray and Willughby's *Historia piscium*, Artedi's *Ichthyologia sive opera omnia de piscibus*, and, lastly, Bloch's *Allgemeine Naturgeschichte der Fische*) they purport to examine the natural history of fishes in its entirety, rather than, for example, the fish of a particular region. The authors explicitly address why they have made certain decisions, and as such offer insight into their ideas about how natural history should be carried out. Furthermore, this selection of three voluminous books, ranging as they do from several hundreds to several thousands of pages, allows for an in-depth study of the contents of these works, including the way in which they demarcate object and method, their processes of production, and their authors.

The second reason for this particular selection of primary texts is that the authors of these books explicitly build on one another.[60] While Willughby and Ray sought to ameliorate the books of earlier Renaissance naturalists, Artedi set out to improve on the work of this English duo, and Bloch in his turn used the Swede's system as the basis for his own work. The authors thus consciously constructed something of a line of succession, taking from their predecessors only those matters that they considered worthwhile, discarding the rest. On the one hand, the books discussed in this dissertation build on one another: they contribute to a growing base of knowledge about fish, and together show a development from an encyclopaedic approach towards an increasing focus on the description of the morphologies of individual types of fish and thus their classification. On the other hand, the books display rather different approaches towards its subject matter. Each of these books, as will be discussed below, has its own focus and as such relate to different debates within natural history. Selecting multiple works from different national and chronological contexts also allows for a comparative approach. This does not entail a schematic, rigid comparison of every book with the other – which would be rather anachronistic – but insight in the diversity of ways in which people were acquiring, assessing and presenting

[60] The French naturalist Bernard Germain de Lacépède (1756–1825) also published a book of fish, under the title *Histoire naturelle des poissons*, 12 vols (Paris: Plassan, 1798–1803). Although it likewise aimed to describe and categorize all fish hitherto known, it is not included in the source selection because it does not explicitly position itself in relation to earlier fish books.

knowledge about fish in the long eighteenth century at a time at which the contours of demarcation were becoming clearly visible.

The books that this dissertation examines are the burnished outcomes of complex and sometimes messy research. Naturalists undertook field trips to examine living animals, visited cabinets of curiosities, purchased specimens and natural historical works at auctions, and consulted books in libraries. For naturalists, fishes needed to be caught, stored, preserved, circulated, described, classified and depicted – and not necessarily in that order. Besides the engagement of learned scholars, this entailed the involvement of multiple persons: from fishermen to fishmongers, cooks, artists, missionaries, pupils, publishers and printers. This dissertation does not merely consider the end result, the three monographs in their published state, but also takes into account how these books were formed from their early beginnings. My examination of these works is therefore supplemented by other sources. These include manuscripts, travel accounts, circulars, letters, natural historical sketches and drawings and natural historical specimens. The research that I have conducted for this dissertation in the British Library, the Nottingham University Library, the Royal Society Archives, the Linnean Society, the Natural History Museum, the Franckesche Stiftungen, the Berlin-Brandenburgische Akademie der Wissenschaften, the Museum für Naturkunde, as well as other archives and libraries, has also in some instances brought hitherto unstudied source materials to the surface. These materials turn out to be crucial for a fuller understanding of how the natural historical study of fish took place in practice, as well as the variety of actors that were involved in the process.

The first chapter offers an introduction into the field of natural history. It does so by taking the *Historia piscium* as its point of departure. This book, based on research undertaken by Willughby and Ray, was published under the auspices of the Royal Society in London. This chapter compares and contrasts their book to Renaissance works on *aquatilia*. Natural history of the sixteenth century was embedded in an encyclopaedic model of studying nature, bent upon knowing and describing the particular properties of species of plants and animals based on a wide range of sources, from cookery books and literary works to medicinal treatises. Willughby and Ray, in seeking to reform the study of nature, explicitly bade farewell to this humanistic research tradition. Their primary aim was to restore order to the study of fish, because earlier authors, they held, had caused a 'multiplication of species.' To do so, they propagated a strict focus on describing morphological features of fish through close observation. In practice, however, their work retained a compilatory character akin to that of its predecessors, as its species descriptions and illustrations were combed from a variety of sources, from written accounts to picture books to eye-witness reports. This last form of source materials was considered essential.

Chapter 2 takes the meanings of direct observation as its focus. In preparing the *Historia piscium*, Ray emphasized how they drew on their own observations, as well as those of friends and other reliable authorities. Despite their preference to see species with their own eyes, Willughby, Ray and their peers at the Royal Society simply could not examine each and every species for themselves. This chapter investigates how they went about evaluating their sources. It shows that while the Fellows could turn to preserved specimens and illustrations, these came to them with their own epistemological uncertainties. To come to a clear understanding of species, therefore, direct observation of (more or less) fresh fish remained much preferred. Willughby and Ray took to ports and fish markets and made glad use of the 'experiential understanding' of fishermen and fishmongers. Besides examining the *Historia piscium* itself, this chapter also considers evidence of these interactions from travel accounts, letters, and natural historical manuscripts that the authors used as sources. While fishermen and fishmongers, with their sustained access to samples of fresh specimens, were seen as authoritative knowers of nature, whose claims invited further investigation and discussion, their experience was ultimately mediated by the Fellows.

The third chapter revolves around the little-studied Artedi and his book *Ichthyologia, sive opera omnia de piscibus* (Leiden, 1738) published posthumously by his friend Linnaeus. While Artedi commended Willughby and Ray for their efforts in clearing up some of the confusion in the organization of species, he believed that an additional step was needed: a strictly defined taxonomic system that encompassed classes, order, genera, species and finally, varieties – and clear rules for establishing each. His book can be read, and indeed was intended, as a programme for an 'ichthyology': Artedi drew up definitions for both the study of fish and its practitioners, and laid down the principles on which the latter should operate. He proposed a quantitative method for examining and describing fish, rather than a qualitative one. In the process, he excluded any kind of knowledge that he considered 'amethodic', like the experience of fishermen, demarcating ichthyological knowledge from artisanal knowledge while also separating ichthyology from neighbouring fields such as comparative anatomy or other parts of zoology. By presenting himself as an ichthyologist and thus a specialized naturalist, Artedi tried to carve out a space for himself; unfortunately, he passed away before he could come to truly establish his name.

The fourth and final chapter zooms in on Marcus Élieser Bloch's *Allgemeine Naturgeschichte der Fische* (12 vols, Berlin, 1782–1795). This Berlin physician of Jewish descent began his series when he found out that even some of the most common fish in the Prussian states had been described by neither Artedi nor Linnaeus. He thus set out to complete the gaps in their classification systems, collecting fish first from Germany and then all over the world. Each of these species were described and depicted in his series of lavishly illustrated, expensively made books. This chapter reconstructs how both collection and book were created, drawing on the correspondence between Bloch and one of his collectors, amongst other primary sources. As hand-coloured engravings lay at the heart of his project, particular focus is on how specimens in Bloch's collection were made into drawings and subsequent engravings. The chapter argues that the *Allgemeine Naturgeschichte der Fische* was a way for Bloch to preserve and present his collection and to establish himself as an authority on fish.

Drawing these various case studies together, the conclusion addresses both the diversity of approaches that these naturalists took in establishing themselves as authoritative knowers of fish as well as the broader developments that can be detected in the natural history of fishes in the eighteenth century. As we shall see, we witness a tendency to move away from an enyclopedic approach to the study of fish to a more decontextualized one in which the focus is on physical properties of the animal itself, and from naturalists broadly oriented on the study of nature to those who decided to dedicate themselves to the study of fish, rather than aspiring to examine the natural world in its full breadth.

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.

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[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.Ell'e 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.

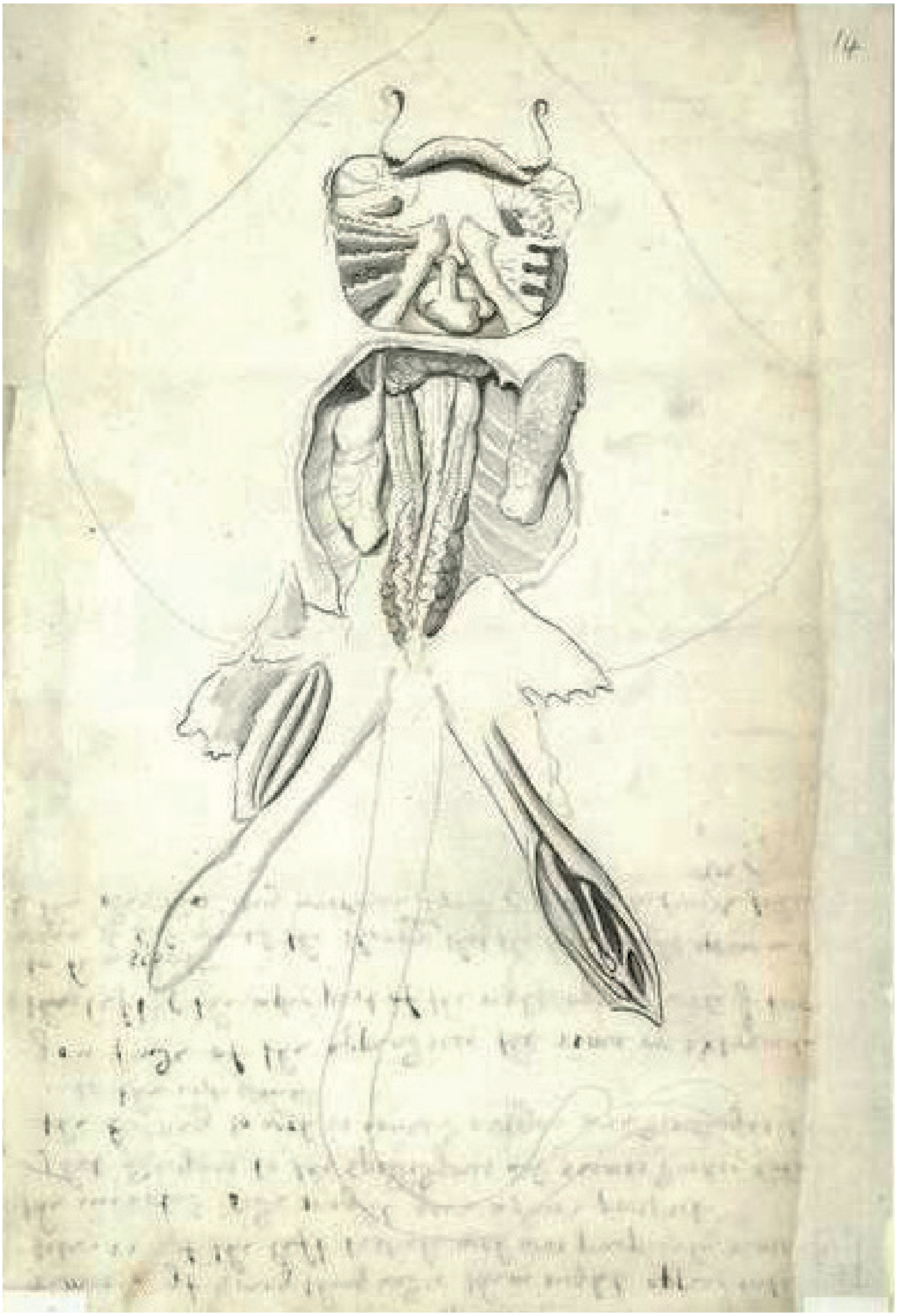


Figure 1.2 Drawing of dissected flair | NUL, Mi LM 25/14 | © University of Nottingham Manuscripts and Special Collections

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 fililations 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

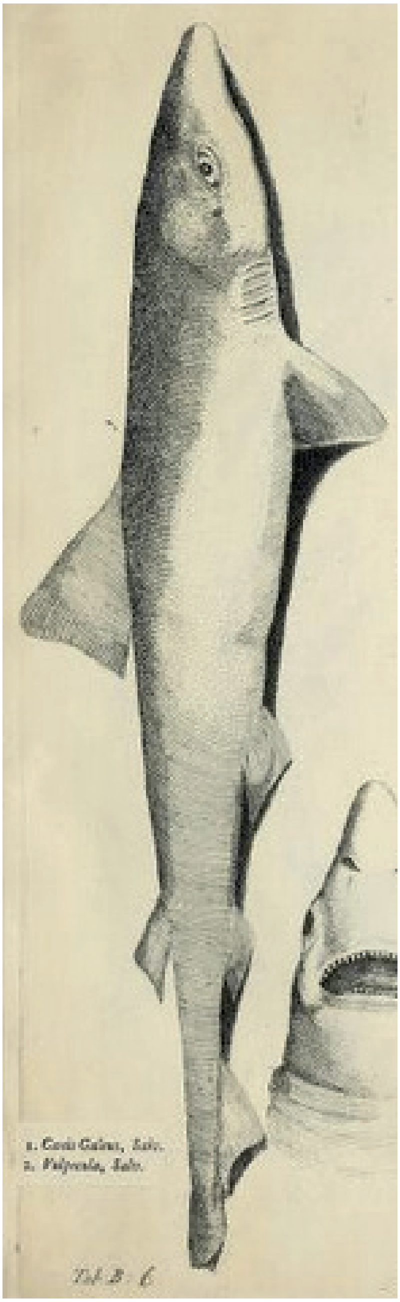
it was shown how these related to the colour of the irises, their teeth, and their size. None of these features can be inferred from the respective illustrations in the *Historia piscium*, for none of these depictions convey the colour, inner anatomies, or size of their depicted species (**Figure 1.4a/b**).[228]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



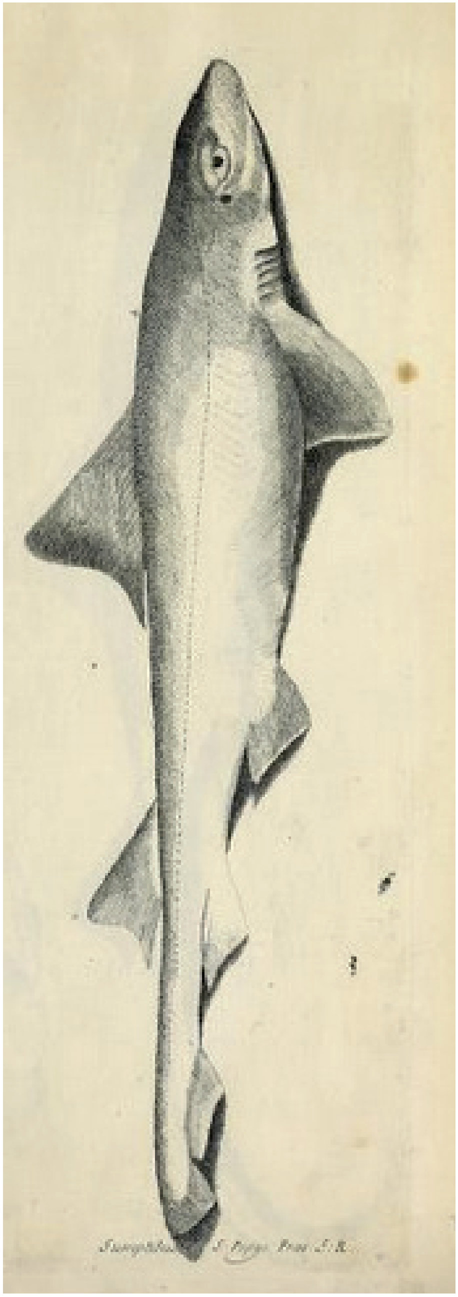


Figure 1.4a (left) Engraving of smooth hound shark | Francis Willughby and John Ray, *Historia piscium* (Oxford: Sheldonian Theatre, 1686), tab B5 | © Universiteitsbibliotheek Leiden

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.

CHAPTER 2

Fresh Fish: Observation Up Close in Francis Willughby and John Ray's *Historia piscium* (Oxford, 1686)

Fishes were part and parcel of daily life in early modern England. This becomes clear when perusing some of the species descriptions in Willughby and Ray's *Historia piscium.* An annotated copy in the archives of the Royal Society further accentuates this. It is the Society's original, very own copy, and both Tancred Robinson and, later, Cromwell Mortimer (1693–1752) took the liberty of adding their own remarks and observations in the margins of certain species descriptions.[1] As such, it offers insight into the questions that Fellows continued to explore even after the history of fishes was published. A considerable proportion of these notes is dedicated to specifying where in London one might chance upon which species of fish. They reveal, for example, that lampreys could be seen shining in the water of the Thames before fishermen hauled them up in wicker nets, whereas London shops displayed a selection of dab.[2] A dolphin – at that time still considered a fish – taken "in our Channell; very smooth like polisht marble a long snout with 2 rows of teeth on each side, very little Eyes & c. about 4 feet long" could be encountered "at the Ship Tavern at Butcher Row's end near

* An adaptation of this chapter has appeared as article: Didi van Trijp, "Fresh Fish: Observation up Close in Late Seventeenth-Century England," *Notes and Records of the Royal Society of London* (2020), published online ahead of print, https://royalsocietypublishing.org/doi/10.1098/rsnr.2019.0051.

[1] Willughby and Ray, *Historia piscium*, RCN 18574, Library and Archives of the Royal Society (hereafter RS), London. The annotations are the remarks of Tancred Robinson (TR) as inscribed by Francis Aston; later annotations are Cromwell Mortimer's (CM). The copy is also mentioned in Kusukawa, "*Historia Piscium* (1686) and Its Sources," 328.

[2] Willughby and Ray, *Historia piscium*, RS, RCN 18574RCN, 96–97, 105 (TR).

Temple Bar."[3] The swim bladder of the cod counted as a "very luxurious" dish in the city.[4] Any strange fishes caught in the Thames, furthermore, were brought to the Lord Mayor's home.[5] Despite their ubiquitous presence, however, fish were also somewhat elusive. Some of these 'slippery denizens'[6] of the water were difficult to capture, and once caught they promptly began to falter and spoil.[7] Where and how, then, could one establish solid knowledge about these unstable objects of inquiry?

The previous chapter has explained that the aim of the *Historia piscium* was to provide accurate accounts of all fish hitherto known, and to do so in an orderly manner. It has elaborated on how Willughby and Ray focussed on the physical characteristics that fish displayed, and which they had, ideally, selected after close observation of the species at hand. We saw how the materials on which they could draw were rich, and that these encompassed earlier natural historical works, travel accounts, objects in cabinets of curiosities, drawings bound together in books, loose drawings, and observations shared in letters. We also saw how the process of creating precise species descriptions and selecting suitable accompanying illustrations every now and then provoked discussions regarding what ought to be the proper selection criteria. The aim of this chapter is to address such matters of evaluation in more detail. It looks closely at how the observation of fish took place in practice, and at how observations were assessed as reliable and credible and thence incorporated into the *Historia piscium*.

In addressing these matters, the engraved title page (**Figure 2.1**) made by the Dutch painter and printmaker Paul van Somer II (1644–1698) entreats the reader to take a closer look. Set against the backdrop of an Arcadian fishing port, several people tend to the arrival of fresh fish announced by a herald blowing a large conch shell.[8] Fishermen in loincloths haul in their nets. Two men dressed

[3] Ibid., 28 (CM).
[4] Ibid., 166 (CM).
[5] Birch, *The History of the Royal Society*, vol. 4, 42.
[6] The phrase "slippery denizens" comes from Matthew C. Hunter, *Wicked Intelligence: Visual Art and the Science of Experiment in Restoration London* (Chicago: University of Chicago Press, 2013), 69.
[7] This elusiveness is explored in Elspeth Graham, "Ways of Being, Ways of Knowing: Fish, Fishing, and Forms of Identity in Seventeenth-Century English Culture," in *Animals and Early Modern Identity*, ed. Pia F. Cuneo (Farnham: Ashgate, 2014).
[8] Anna Marie Roos has suggested that the ship on the title page is a visual nod to the one featured on the engraved title page to Bacon's *Instauratio magna* (London: John Bill, 1620). See Roos, *Web of Nature*, 325.

in tunics examine the scene, one of whom gestures at the catch. Just below them, a female figure in a helmet, possibly a reference to Minerva, the Roman goddess of wisdom and the arts, draws the specimen that is set before her. A garland of fish lines the sides and top of the frontispiece; the pufferfish, turbot, and hound shark are copied from the engraved plates of the book.[9] These depictions are decidedly different from the dolphin, taken from classical iconography, which adorns the lower left corner of the engraving. The colossal fish in the foreground, containing the book's imprint and its affiliation to the Royal Society in its gaping mouth, is rendered in a similarly stylized manner.[10] To the right of this creature, a female figure reposes on a jug from which water is pouring, adding to the sense of flow and movement of the scene. All in all, the title page conjures an image of exuberance and abundance. Considering that frontispieces of early modern works of natural history and philosophy often present a visual programme of a book's contents,[11] this one brings together the various sources available for finding knowledge about fish: classical accounts, illustration, and first-hand observation.

This chapter investigates one of the sources displayed on the title page: namely, those people practically engaged with fish such as fishermen and fishmongers. The nature and extent of the contributions of these practical men can be inferred both from the *Historia piscium* itself, and from other source materials related to the book and its authors, such as natural historical manuscripts, minutes of Royal Society meetings, and letters to and from the Fellows.[12] While recent studies of the *Historia piscium* do mention their contributions, they do so only in passing

[9] For a discussion of title pages of natural historical works on fish, see: Paul J. Smith and Didi van Trijp, "Dynamiques européennes de l'humanisme érudit dans l'histoire naturelle. Le cas de l'ichtyologie, de Belon, Rondelet et Gessner à Willughby et Ray," in *L'humanisme à l'épreuve de l'Europe (XVe-XVIe siècles)*, eds. Denis Crouzet, Elisabeth Crouzet-Pavan, Philippe Desan and Clémence Revest (Ceyzérieu: Champ Vallon, 2019), 167–181.

[10] A print proof of the engraved title page, in which both title and affiliation have yet to be inserted, can be found in NUL, Mi LM 24/170.

[11] Volker R. Remmert, "'Docet parva picture, quod multae scripturae non dicunt.' Frontispieces, Their Functions, and Their Audiences in Seventeenth-Century Mathematical Sciences," in *Transmitting Knowledge: Words, Images, and Instruments in Early Modern Europe*, eds. Sachiko Kusukawa and Ian Maclean (Oxford: Oxford University Press, 2006), 240; see also idem, *Picturing the Scientific Revolution* (Philadelphia: Saint Joseph's University Press, 2011).

[12] It was indeed often men; no fishwives figure in the sources examined here. In England, fishwives were not allowed to sell inside public marketplaces, see: Alena Buis, Christi Spain-Savage and Myra E. Wright, "Attending to Fishwives: Views from Seventeenth-Century London and Amsterdam," in *Mapping Gendered Routes and Spaces in the Early Modern World*, ed. Merry E. Wiesner-Hanks (Farnham: Ashgate, 2015), 193.

Figure 2.1 Engraved title page of *Icthyographia* (1685), Paul van Somer II | © The Royal Society

and a thorough has not as yet been undertaken.[13] Examining the interactions between fishermen and Fellows is particularly relevant to this dissertation, which seeks to examine what was considered valuable knowledge about fish, and especially who could be counted on to produce said knowledge.

This chapter consists of three parts. The first part embeds the *Historia piscium* in the broader social-cultural context of knowledge production particular to the Royal Society, which valued the (direct) experiences of trustworthy observers. It discusses how we can position fishermen and fishmongers in the Society's circle of informants. The second part examines why Fellows turned to fishermen, and argues that, in natural historical studies, a supply of fresh fish was often much preferred to examining preserved specimens or illustrations. The third part addresses how these practical men contributed to the identification of, and distinction between, particular species and remarked on specific behaviour. As such, it looks into what fishermen knew about fish, and the extent to which Willughby, Ray and the other Fellows considered them as useful and reliable sources. As we will see, experience was an important factor in evaluating these men's claims and observations. The chapter shows that the emphasis that the Society placed on direct observation as necessary in the establishment of accurate accounts of species required both a wide range of observers and an assessment of these observers on the part of the Fellows.

A Wider Cast

The variety of sources displayed on the title page of the *Historia piscium* is also reflected in the text itself, such as in discussion of the peculiar way in which the salmon every so often leaps out of the water:

> The *salmon* constantly presses forward against the stream, and when it encounters in its ascent an enclosure or another obstacle of this kind, it seizes, after it has bent its body in a circle, its tail with its mouth, and, while it holds fast to this [i.e., its tail], it, releasing [its grip] again, with

[13] Other studies of the *Historia piscium* can be found in Kusukawa, "The *Historia Piscium* (1686),"; idem, "*Historia Piscium* (1686) and Its Sources," and Raven, *John* Ray, 339–370.

> great force, leaps across it. Author of *De natura rerum* with *Gesner*. We have heard multiple times of many fishermen that this happens continually. That salmon are most agile in jumping we confirm willingly, and our daily experience confirms this: but what is told about the seizing of the tail seems to us less plausible.[14]

Several layers of observation come together in this passage. It begins with a medieval account of this phenomenon, by Thomas of Cantimpré (1201–1272), as cited in Gessner.[15] While this is illustrative of the extent to which Willughby and Ray drew on the works of earlier Renaissance authors, as has been argued in the previous chapter, they also did not take such accounts at face value. Willughby and Ray verified this account, not once, but in multiple instances, and not with one, but with many fishermen – who, furthermore, confirmed that they saw this happening all the time. This, in itself, however, still did not settle the matter of the salmon's strange behaviour. While Willughby and Ray's own, daily experiences confirmed the tenor of the report, namely that salmon are nimble jumpers, they remained sceptical about its specifics, namely the manner in which the salmon gripped and released its tail, which they had not seen themselves. The *Historia piscium* contains more passages like these, which cite observations from past and/or present sources before concluding with the authors' own verdict on the matter.[16]

The previous chapter has addressed how the publication of the book was the result of a collective effort of the Fellows of the Royal Society. They were closely involved in selecting what merited inclusion in the work. As we will see, the work can also be recognized as a product of the Society in its insistence on knowledge derived from direct experience with the object of study. This certainly did not mean that the Fellows no longer consulted texts, but that these texts

[14] Original Latin: "*Salmo* adversus fluvios perpetuo nititur, cumque in ascensu sepem vel aliud hujusmodi obstaculum invenerit, in circulum flexo corpore caudam ore apprehendit, eamque mordicus tenens, iterumque dimittens magno impetu transilit. *Author de natura rerum* apud *Gesner*. Hoc à plurimis piscatoribus assidue fieri multoties audivimus. Quod Salmones ad saliendum agillimi sunt, libenter concedimus, & experientia quotidiana confirmat: verum quod de caudae apprehensione fertur minus verisimile nobis videtur." *Hist. pisc.*, 191–192.

[15] Cf. Gessner, *Hist. anim.* IIII, 974 and Thomas of Cantimpré, *De natura rerum*, ed. Helmut Boese (Berlin: De Gruyter, 1973), 270. See also: Baudouin Van den Abeele, "Conrad Gessner als Leser mittelalterlicher Enzyklopädien," in Leu and Opitz, *Conrad Gessner*, 15–28.

[16] See also, for example, *Hist. pisc.*, 105, 229 and 342.

were not considered sufficient in themselves.[17] In the epilogue to the *Historia piscium*, Ray contended that it would "bring across exactly these things which were either observed by ourselves and our friends, or which had proper witnesses and authors, worthy of our trust."[18] While earlier authors counted as credible past witnesses, their written observations would, ideally, be corroborated with those of contemporary ones. Indications of direct observation are present in the fish book in various ways. Willughby and Ray, for example, added 'I have seen' [*vidi*] or 'we have seen' [*vidimus*] to certain species descriptions – this variation of the singular and plural form being another indication of the complicated layers of authorship discussed in Chapter 1.[19] These kinds of pithy phrases, specifying whether one had acquired knowledge of a thing with one's own eyes or from hearsay, had already been proposed by Bacon in order to indicate the reliability of a statement.[20]

In other cases, Willughby and Ray punctuated statements with appeals to 'experience' [*experientia*], as in the case of the salmon. The exact meaning of this term was far from fixed in the early modern period.[21] Although Peter Dear argued that, in the early years of the Royal Society, 'experience' was used for witnessing or participating in a particular, singular event tied to a specific moment, rather than for generalized statements on universal phenomena (in the Aristotelian sense of the term),[22] it seems that the term figures in both senses within the *Historia piscium*. The usage of the term ranges from the more general 'experience agrees' [*experientia constat*], to the collective 'experience has taught us'

[17] As discussed in Fabian Krämer, *Ein Zentaur in London: Lektüre und Beobachtung in der frühneuzeitlichen Naturforschung* (Korb: Didymos, 2014).
[18] Original Latin: " […] duntaxat tradere quae vel à nobismetipsis & amicis observata essent, vel idoneos & fide dignos testes & auctores haberent." *Hist. pisc. app.*, sig. Hv.
[19] For example, *vidi* usually (but not always) refers to Ray, and *vidimus* usually to both Willughby and Ray, but sometimes only to Ray.
[20] See: Bacon, *Parasceve ad historiam naturalem*, OFB XI, 467 and Andrew Peter Langman, "'Beyond, both the Old World, and the New': Authority and Knowledge in the Works of Francis Bacon, with Special Reference to the *New Atlantis*" (PhD. diss., Queen Mary University of London, 2007), 243–244.
[21] See for example, Alberto Vanzo, ed., *Experience in Natural Philosophy and Medicine*, special issue of *Perspectives on Science* 24, no. 3 (2016): 255–379; Peter Dear, "The Meanings of Experience," in Daston and Park, *Cambridge History of Science*, vol. 3, 106–131; and Ogilvie, *Science of Describing*, 17–23.
[22] Peter Dear, *Discipline and Experience: The Mathematical Way in the Scientific Revolution* (Chicago: Chicago University Press, 1995), 13–14.

[*experientia didicimus*] to the more specific, individual 'that which my experience has confirmed' [*id quod experientia mihi confirmavit*].[23]

In the previous chapter, it has been explained that emphasis on first-hand observation (for which the terms *observatio* and *autopsia* gained currency) rose steadily from the early sixteenth century onwards.[24] It has also been remarked that Society's foregrounding of direct experience as the foundation of natural knowledge owes much to Bacon's work.[25] Experience of nature might be gained, Bacon had stated, through hunting, husbandry, gardening, shepherding, animal breeding and travelling, among other things.[26] "The materials for the intellect", he wrote, "are so widely spread out that they ought to be sought out and gathered in (as if by agents and merchants) from all sides."[27] A similar sentiment can be read from the words of Thomas Sprat (1635–1713), chronicler of the early Royal Society, when he wrote that knowledge was to be gathered "from the Shops of Mechanicks; from the Voyages of Merchants; from the Ploughs of Husbandmen; from the Sports, the *Fishponds*, the Parks, the Gardens of Gentlemen".[28]

Bacon, however, also held that one would be "forever tossed and turned on the waves of experience" when pursuing it without clear course.[29] Those who wished to interpret nature required a degree of 'literate experience' [*experientia literata*].[30] Characteristically perhaps for Bacon's at times somewhat opaque manner of formulating, historians of science have grappled with what exactly this

[23] *Hist. pisc.*, 7, 9 and 246.
[24] Gianna Pomata, "Observation Rising: Birth of an Epistemic Genre, ca. 1500–1650," in *Histories of Scientific Observation*, eds. Lorraine Daston and Elizabeth Lunbeck (Chicago: University of Chicago Press, 2011), 45–80.
[25] As it is impossible to do justice to the intricacies of Bacon's epistemology or historiography here, I mention particularly on natural history: *Francis Bacon and the Reconfiguration of Early Modern Natural History*, eds. Guido Giglioni, Dana Jalobeanu and Sorana Corneanu, special issue of *Early Science and Medicine* 17, no. 1/2 (2012): 1–271.
[26] Guido Giglioni, "Learning to Read Nature: Francis Bacon's Notion of Experiential Literacy (*Experientia Literata*)," *Early Science and Medicine* 18, no. 4/5 (2013): 409.
[27] Francis Bacon, *The Instauratio Magna Part II: Novum Organum and Associated Texts*, eds. Graham Rees and Maria Wakely (Oxford: Clarendon Press, 2004), 451. Henceforth abbreviated as OFB XI.
[28] Sprat, *History of the Royal Society*, 72; emphasis mine.
[29] Bacon, *Novum organum*, OFB XI, 16–17.
[30] A notion that Bacon developed in ibid., 158–159, according to Cesare Pastorino, "Weighing Experience: Experimental Histories and Francis Bacon's Quantitative Program," *Early Science and Medicine* 16, no. 6 (2011): 543.

kind of experience signified, and offered various interpretations of this notion.[31] Bacon himself stated that "no discovery should be sanctioned save that it be put in writing. Only when that becomes standard practise, with experience at last becoming literate, should we hope for better things."[32] Sophie Weeks has highlighted how the primary difference between literate and illiterate experience was not a matter of erudition, but rather one of mediated access to nature. This meditation entailed a disciplined examination of nature, in which it was "set down and presented in suitable order" rather than investigated in all its fecundity at random.[33] Whether this then meant that such this orderly way of probing nature was restricted to the educated or learned is another question. Deborah E. Harkness has contended that Bacon's precepts for obtaining true and certain natural knowledge harked back to the daily vernacular science that was practiced in the streets of Elizabethan London.[34]

Fishermen and fishmongers, as attentive observers of nature, were consulted broadly throughout both the classical and early modern period. In their study of nature, Aristotle and Pliny drew on the reports of those whose experience of nature stemmed from practice, such as fishermen, huntsmen, shepherds, farmers and seafarers.[35] Sixteenth-century naturalists like Guillaume Rondelet and Pierre Belon, for example, conversed with fishermen on their observations of Mediterranean marine life in addition to perusing learned books; a practice that Florike Egmond has referred to as 'fieldwork once removed.'[36] Gessner, too, stated that he benefited from the knowledge of fishermen, and attributed a higher value

[31] Cf. Dana Jalobeanu, "Disciplining Experience: Francis Bacon's Experimental Series and the Art of Experimenting," *Perspectives on Science* 24, no. 3 (2016): 324–342; Giglioni, "Learning to Read Nature," 405–434; Sophie Weeks, "The Role of Mechanics in Bacon's *Great Instauration*," in *Philosophies of Technology: Francis Bacon and his Contemporaries*, eds. Claus Zittel, Gisela Engel, Romano Nanni and Nicole C. Karafyllis (Leiden: Brill, 2008), 133–195; Lisa Jardine, "*Experientia literata* or *Novum organum*? The Dilemma of Bacon's Scientific Method," in *Francis Bacon's Legacy of Texts: 'The Art of Discovery Grows with Discovery'*, ed. William A. Sessions (New York: Ams Press, 1990), 47–67.
[32] Bacon, *Novum organum*, OFB XI, 159.
[33] Bacon, *Novum organum,* OFB XI, 215 as cited in Weeks, "Mechanics in Bacon's Great Instauration," 172.
[34] Harkness, *The Jewel House*, 213.
[35] Maclean, "White Crows, Graying Hair, and Eyelashes," 157.
[36] Florike Egmond, "On Northern Shores: Sixteenth-Century Observations of Fish and Seabirds (North Sea and North Atlantic)," in *Naturalists in the Field: Collecting, Recording and Preserving the Natural World from the Fifteenth to the Twenty-First Century*, ed. Arthur MacGregor (Leiden: Brill, 2018), 131.

to direct-hand observation than he did to natural knowledge of the textual kind.[37] Aldrovandi's correspondents wrote him about their trips to fish markets to glean information about species from fishmongers.[38] Monica Azzolini has shown how, in early seventeenth-century Rome, naturalists like Johannes Faber (1574–1629) made ample use of a plurality of oral sources including fishermen, merchants, and servants, when investigating beached whales.[39]

As we will see, these interactions take on a new meaning with the emergence of scientific societies in the seventeenth century. Learned societies of this kind emerged over the course of the seventeenth century, in Florence, Rome, Schweinfurt and Paris, amongst other places. As has been argued, most forcefully for the English context, membership of such societies, which was usually restricted to those of the upper classes, was closely linked to matters of trustworthiness.[40] This worked in two directions: if its members thought someone was credible, they selected him to figure in their midst; conversely, belonging to such a group considerably heightened one's credibility. When discussing Faber's report on the whale in the *Historia piscium*, for example, Ray noted with some insistence that the Roman was a member of the Accademia dei Lincei.[41] In the Royal Society, the existing convention of assigning reliability to those of higher social status remained in place when observing and interpreting natural phenomena.[42]

This did not mean, however, that status was the sole criterion of credibility.[43] While those from a genteel background were generally seen as trustworthy, they were also considered prone to bending their observations to fit with preconceived ideas.[44] Philippa Hellawell has argued that credibility was not the exclusive prerogative of one particular social group, but that it could be shared, albeit still attributed in various degrees, among people of various backgrounds.[45] Felicity

[37] Anthony Grafton, "Philological and Artisanal Knowledge Making in Renaissance Natural History: A Study in Cultures of Knowledge," *History of the Humanities* 3, no. 1 (2018): 43–45.
[38] Findlen, *Possessing Nature*, 176–177.
[39] Monica Azzolini, "Talking of Animals: Whales, Ambergris, and the Circulation of Knowledge in Seventeenth-Century Rome," *Renaissance Studies* 31, no 2 (2017): 318.
[40] Shapin, *A Social History of Truth*, 122–123; Shapin and Schaffer, *Leviathan and the Air-Pump*, 58.
[41] Kusukawa, "*Historia Piscium* (1686) and Its Sources," 333.
[42] Shapin and Schaffer, *Leviathan and the Air-Pump*, 58.
[43] Barbara Shapiro, *A Culture of Fact: England 1550–1720* (Ithaca: Cornell University Press, 2000), 140.
[44] Peter Dear, "*Totius in verba*: Rhetoric and Authority in the Early Royal Society," *Isis* 76, no. 2 (1985): 156.
[45] Philippa Hellawell, "'The Best and Most Practical Philosophers': Seamen and the Authority of Experience in Early Modern Science," *History of Science* 58, no. 1 (2019): 32.

Henderson has submitted that the Royal Society, as an institution, relied on "the activities and expertise of a wider penumbra of individuals" than that of the Fellows themselves.[46] Certain individuals within the Society itself blurred social boundaries, such as Hooke, who, as son of a curate, required financial support for his studies of nature.[47] Despite being employed as Curator of Experiments, regarded as a lesser position than that of Fellow because of the paid labour involved, he took part in natural philosophical debates and was elected Fellow in 1663.[48]

Experiments held a special place in the deliberations of the early Royal Society. Bacon had contended that experiments served to deliberately seek out a certain experience, as opposed to mere experience which derived from 'accident' – allotting an active role to the observer, rather than a passive one.[49] While the Fellows seem to have had their own approaches to the meaning and use of experiments, it is clear that several of them took to performing them as a way of understanding nature's intriguing properties.[50]

Regarding fish, they pondered such questions as: did they breathe? How did these creatures move in the water? How did they spawn, and how long could they go without food? The minutes of meetings found in the Journal Books of the early 1660s reveal that the Society's Operator, whose task it was to facilitate experiments and make inquiries, was ordered several times to collect and keep fish for experiments.[51] He was also instructed to ask fishermen how long they could

[46] Henderson, "Robert Hooke and the Visual World of the Royal Society," 397.
[47] Steven Pumfrey, "Ideas above His Station: A Social Study of Hooke's Curatorship of Experiments," *History of Science* 29, no. 1 (1991): 4.
[48] Steven Pumfrey, "Who did the Work? Experimental Philosophers and Public Demonstrators in Augustan England," *British Journal for the History of Science*, 28, no. 2 (1995): 153.
[49] Bacon, *Novum organum*, 131. It is important to note that he did not apply the notions *experientia*, *experimentum*, and *observatio* particulary strictly, see Lorraine Daston, "The Empire of Observation, 1600–1800," in Daston and Lunbeck, *Histories of Scientific Observation*, 83. 81–113
[50] Peter Anstey, "Philosophy of Experiment in Early Modern England: The Case of Bacon, Boyle and Hooke," *Early Science and Medicine* 19, no. 2 (2014): 103–132; Michael Hunter, "Robert Boyle and the Early Royal Society: A Reciprocal Exchange in the Making of Baconian Science," *British Journal for the History of Science* 40, no. 1 (2007): 1–23.
[51] See, for example: 25 June 1662 (OS), RS JBO/1/66; 15 April 1663 (OS), JBO/1/159; 30 December 1663 (OS); JBO/2/23. Journal Book Original, London. Richard Shortgrave (d. 1676) may have been the Operator, see: Marie Boas Hall, *Promoting Experimental Learning: Experiment and the Royal Society, 1660–1727* (Cambridge: Cambridge University Press, 1991), 27.

keep their fish alive without feeding them.[52] Furthermore, the minutes indicate that "all those [present at the Society], that had the opportun[it]y, were desired to make several Experiments in several fish, concerning their growth."[53]

Although the precise set-up of these experiments is not always disclosed in the minutes, the careful reports published in the *Philosophical Transactions* may give us an idea.[54] Around 1670, Robert Boyle (1627–1691) had a gudgeon placed into a 'Pneumatical Engin', or air pump.[55] Of course, Boyle and his company are known to have inserted various small animals into this device, including birds, mice and snakes.[56] The experiment on the gudgeon, "far from being the first" that had been done on a fish with this sort of instrument, was devised to show what happened to a fish when "it should be kept for some hours together from all supply of fresh Air."[57] Although after mostly all of the air was removed "there appeared a great store of Bubbles all about the Fish", no definitive conclusions could be drawn.[58] The specimen lived for some ten days more; Boyle's postscript that "divers Gudgeons since taken dy'd there in much fewer dayes" suggests that several trials were run. The *Historia piscium* lauds Boyle for his "most excellent experiments" on the effects of water pressure upon bodies of air.[59] It recounts an experiment to fill up a swim bladder with air and submerge it in a clear, deep vessel filled with water. The deeper the bladder was plunged, the more contracted it would become, and vice versa.[60]

[52] Entry of 18 June 1662 (OS), RS, JBO/1/66.
[53] Entry of 24 June 1663 (OS), RS, JBO/1/194.
[54] For a discussion of the early *Philosophical Transactions*, vide: Adrian Johns, "Miscellaneous Methods: Authors, Societies and Journals in Early Modern England," *British Journal for the History of Science,* 33, no. 2 (2000): 165–174.
[55] Robert Boyle, "New Pneumatical Experiments About Respiration," *Philosophical Transactions of the Royal Society of London* 5, no. 62 (1670): 2011.
[56] Anita Guerrini, *Experimenting with Humans and Animals: From Galen to Animal Rights* (Baltimore: Johns Hopkins University Press, 2003), 38.
[57] Boyle, "New Pneumatical Experiments About Respiration," 2024.
[58] Ibid., 2025–2026.
[59] *Hist. pisc.*, 8.
[60] Similar questions are asked in A.I. and Robert Boyle, "A Conjecture Concerning the Bladders of Air That are Found in Fishes, Communicated by A.I.; And Illustrated by an Experiment Suggested by the Honorable Robert Boyle," *Philosophical Transactions of the Royal Society of London* 10, no. 114 (1675): 310–311. The experiment entailed placing a specimen into a tall, long-necked vessel filled with water, and observe whether upward or downward motions of the fish caused changes in the water level.

Fellows did not only pursue their inquiries on fish within the confines of Gresham College, where their weekly meetings took place.[61] Hooke recounts coming across a porpoise displayed at Ulbars (possibly a fishmonger's shop) in November 1679.[62] He bought the specimen and transported it to Garraway's coffee house, near the Royal Exchange.[63] Here he performed a public dissection.[64] Just like demonstrations of instruments, examinations of animal species in taverns or coffee houses could facilitate discourse on natural phenomena among individuals of various stripes.[65] These might well be people possessing valuable experience regarding the subject, such as sailors. Hellawell has demonstrated, for example, how the Society considered seamen uniquely positioned to record and examine certain natural phenomena. The Fellows asked them to conduct experiments and make observations while at sea, for example recording sightings of species of birds, fish, and other animals as well as magnetic variations of the tides.[66] Her study confirms Lux and Cook's hypothesis that the Royal Society was a relatively open institution that welcomed contributions from outside of its own geographical and social reach, provided, of course, that a member vouched for the credibility of any such informant.[67]

While Hellawell proposes further, specialized case studies be conducted of the evaluation of the knowledge and skills of other occupational groups,[68] she signals that this can be difficult as such groups do not always fit "the conventional artisanal mold."[69] Like seamen, fishermen do not readily fall into those

[61] Michael Hunter, "A 'College' for the Royal Society: The Abortive Plan of 1667–1668," *Notes and Records of the Royal Society of London* 38, no. 2 (1984): 159.
[62] Robert Hooke, *The Diary of Robert Hooke, 1672–1680*, eds. Henry W. Robinson and Walter Adams (London: Taylor and Francis, 1935), 430–431. See also Hunter, *Wicked Intelligence*, 118.
[63] Rob Iliffe, "Material Doubts: Hooke, Artisan Culture and the Exchange of Information in 1670s London," *British Journal for the History of Science* 28, no. 3 (1995): 286.
[64] See: Noah Moxham, "Edward Tyson's *Phocaena*: A Case Study in the Institutional Context of Scientific Publishing," *Notes and Records of the Royal Society of London* 66, no. 3 (2012): 235–252.
[65] Adrian Johns, "Coffeehouses and Print Shops," in Park and Daston, *The Cambridge History of Science*, vol. 3, 336.
[66] Hellawell, "Best and Most Practical Philosophers," 36, 46.
[67] David S. Lux and Harold J. Cook, "Closed Circles or Open Networks? Communicating at a Distance During the Scientific Revolution," *History of Science* 36, no. 2 (1998): 201.
[68] Hellawell, "Best and Most Practical Philosophers," 33. An example of such a case study are the miners discussed in Kerrewin van Blanken, "Earthquake Observations in the Age Before Lisbon: Eyewitness Observation and Earthquake Philosophy in the Royal Society, 1665–1755," *Notes and Records of the Royal Society of London* (2020), published online ahead of print.
[69] Hellawell, "Best and Most Practical Philosophers," 33–34.

historiographical categories of workmen who have received sustained attention of historians of science over the past decades, notably invisible technicians and artisans. The work of fishermen and fishmongers was, after all, not technical in the sense that they handled (scientific) instruments – in contrast to, for example, those technicians who assisted Boyle.[70] They also do not quite resemble the self-aware artisans that we might encounter in the works of Pamela Smith and Pamela Long. These historians have reconstructed the approaches of these early modern makers towards the natural world from the texts and artefacts which have come down to us today, such as recipes, manuals, drawings, paintings, casts, or ceramics.[71] There is a lacuna of sources, however, when it comes to the attitudes of fishermen and fishmongers towards the study of nature. That makes it difficult to gauge what kinds of knowledge they possessed about fish.

There are various reasons for this scarcity. The quite obvious one is that fishermen and fishmongers have not generally left much behind in writing – with some exceptions here and there, as we will see shortly. Within these practical communities, interactions were perhaps, or likely to have been of a local and oral nature. These are precisely the kinds of connections that are difficult to reconstruct, and that tend to be overlooked as a result of the emphasis on texts when reconstructing early modern networks.[72] And yet, as Azzolini has argued, we "accord undue weight to the authority of writers" while not taking the spoken word into account.[73] While we know from the reports of scholars that they had conservations with fishermen and fishmongers, their accounts are of course edited and much condensed. They offer, therefore, only mediated access. As the passage opening this section has also highlighted, the authors and compilers of the *Historia piscium* ultimately selected what was included in the book, and what was left out.

In order to get a less one-sided view of the interactions between Fellows and fishermen, another approach is required: we must consider sources other than

[70] Steven Shapin, "The Invisible Technician," *American Scientist* 77, no. 6 (1989): 544–563; Rob Iliffe, ed., *Technicians*, special issue of *Notes and Records of the Royal Society of London* 62, no. 1 (2008): 3–148.
[71] Pamela O. Long, *Artisan/Practitioners and the Rise of the New Sciences, 1400–1600* (Corvallis: Oregon State University Press, 2011); Smith, *The Body of the Artisan.*
[72] Ruth Ahnert, "Maps versus Networks," in *News Networks in Early Modern Europe*, eds. Joad Raymond and Noah Moxham, (Leiden: Brill, 2016), 140.
[73] Azzolini, "Talking of Animals," 299–301.

the accounts of scholars. Take for example the petition (1663) of the London fishmongers held in the archives of the Royal Society. This petition, which was presented to Parliament, was read aloud during a Society meeting.[74] The fishmongers wished "that our Sea coste & rivers may swarme with the fry & brood of fish, & our Towns and Cittyes better provided for" through stricter enforcement of the law prohibiting too many young fish from being taken.[75] Although the document does not touch upon natural historical reflections explicitly, this remark shows that these fishmongers were occupied with the generation and growth of fish. It also reminds us that, while the relative inconspicuousness of fishermen and fishmongers may lead them to seem like a monolithic group, they had their own stakes and interests in the world of fish.[76] That these interests need not only be economic becomes clear from the rare manuscripts of the hands of men who caught and traded in fish while also subjecting them to closer study.[77] Willughby and Ray in fact drew on one such manuscript: that of the Strasbourg fisherman and burger Leonhard Baldner (1612–1694), entitled *Vogel-, Fisch- und Thierbuch* [Book of Birds, Fish and Animals]. It is cited throughout the *Historia piscium*. As it offers a unique entry into Baldner's own ideas about what the study of fish entailed, the last section of chapter will discuss this work in more detail.

So, while this chapter departs from the *Historia piscium*, and asks how the compilers of the work incorporated the experiences of fishermen and fishmongers, it also considers the perspective of the latter's groups where possible. This can give us a more well-rounded idea of what such exchanges may have entailed. We will, for the remainder of this chapter, reconstruct the nature, extent, diversity and significance of the contributions of practical men to the *Historia piscium*, and how these were evaluated by the Fellows.

[74] Petition, RS Cl.P.15i/8, Classified Papers. It was read on 23 September 1663 (OS) and brought in by John Graunt (1620–1674).
[75] Ibid.
[76] An overview of the various types of fishing in different European regions can be found in A.R. Michell, "The European Fisheries in Early Modern History," in *The Cambridge Economic History of Europe*, eds. E.E. Rich and C.H Wilson, (Cambridge: Cambridge University Press, 1977), 133–184.
[77] A striking example for the sixteenth century is the manuscript entitled *Visboeck* (Fish book) by Adriaen Coenen (1514–1587). For more on him, see Egmond, "On Northern Shores," 132–139.

Knowledge at the Fish Market

Fishermen take centre stage in the engraved title page, even if they are depicted as rather more genteel individuals than they probably were. Fishermen and fishmongers provided (if not always wittingly) the raw material for natural historical and philosophical investigations. Fellows considered access to fresh specimens of fish to be of great importance. This section compares the kinds of evidence that could be taken from preserved specimens, illustrations and fresh specimens. It thus picks up on themes such as field trips, illustrations, and natural historical collections that have been mentioned in Chapter 1 but thus far have not yet been elaborated on.

At his home in Middleton Hall, Willughby could examine the plants in his garden and the animals in his *vivarium*,[78] just as Ray examined the trees in his own orchard.[79] When Willughby and Ray travelled through the British Isles and across continental Europe, they frequented markets to get their hands on new species of birds and fish. As Ray put it, they "visited almost all the chief fishing ports of England, and the markets of Belgium, Germany, Italy and France; [...] bought all the species new to us and described them so that the reader can easily recognize them."[80] Their daily visits to the fish market in Rome produced rich results, as they found that there was "scarce any fish to be found anywhere on the coast of Italy but some time or other it may be met withal heer [*sic*]."[81] Travel companion Philip Skippon listed no fewer than eighty-nine species of fish that they had come across at Venice's market.[82] He described, for example, finding "a little fish with a scarlet belly, called Sanguinuole" in the market of Brescia.[83] Visiting (fish) markets to spot new specimens was in fact a widely utilised practice. When stationed in Jamaica in the service of the second Duke of Albemarle (1653–1688), for example, the physician and collector Hans Sloane (1660–1753) scoured the island's markets for new specimens to examine.[84]

[78] Poole, "The Willughby Library," 229.
[79] Dániel Márgocsy, *Commercial Visions: Science, Trade, and Visual Culture in the Dutch Golden Age* (Chicago: Chicago University Press, 2014), 53.
[80] As quoted in Raven, *John Ray*, 365.
[81] Ray, *Observations*, 362.
[82] Skippon, *Journey*, 496, and Kusukawa, "*Historia Piscium* (1686) and Its Sources," 323.
[83] Skippon, *Journey,* 571.
[84] James Delbourgo, *Collecting the World: The Life and Curiosity of Hans Sloane* (London: Allen Lane, 2017), 91.

The piscine wealth to be found at fish markets was further proof that the underwater world teemed with creatures that merited closer examination. In one of his physico-theological treatises, Ray marvelled – echoing psalm 104.25 – "The Sea, what infinite Variety of Fish doth it nourish!"[85] While fish were indeed wonderfully varied, Ray also believed that God had created a fixed number of species.[86] From the onset, Ray set his expectations for the *Historia piscium* at a high mark. As he wrote to Robinson in 1684: "For this history of fish, I can warrant it to be as full and perfect as to the number of species, and their descriptions […] as was the history of birds."[87] As the previous chapter discussed at length, Willughby and Ray's idea of a perfect fish book differed from those extensive volumes full of anecdotes, fables and proverbs, which certain earlier Renaissance authors had compiled. Rather, they wished to rectify the unnecessary duplication of species by plotting characteristic marks.

This was also a matter of precise language, as the previous chapter explained. Their study of fish, and of nature more generally, was carried out in the context of larger philosophical reflections on the connections between knowledge and language, an interest they shared with fellow Royal Society member Wilkins. Along with many of his contemporaries, Wilkins thought that God had greatly compromised man's ability to communicate in his judgement that followed the attempt to build the tower at Babel (Genesis 11.1-9).[88] Wilkins therefore set out to compose a universal language, by creating word tables that showed the true relation between words and things. Willughby and Ray both contributed to Wilkins' project, which eventually appeared as *An Essay Towards a Real Character, and a Philosophical Language* (London, 1668).[89] Ray, however, would later privately admit to be "ashamed and disgusted" to have been so publicly associated with a project that he, found, at its core, to be ludicrous.[90] This was not because

[85] Ray, *The Wisdom of God*, 78.
[86] Kusukawa, "*Historia Piscium* (1686) and Its Sources," 313.
[87] Ray, letter to Robinson, 13 March 1684 (OS), *Correspondence of John Ray*, 164.
[88] Kusukawa, "The *Historia Piscium* (1686)," 183. A standard work on the natural philosophical pursuits of constructing a universal language is Mary Slaughter's *Universal Language and Scientific Taxonomy in the Seventeenth Century* (Cambridge: Cambridge University Press, 1982).
[89] Ray worked on the plants, Willughby on the animals. John Wilkins, *An Essay Towards a Real Character, and a Philosophical Language* (London: S. Gellibrand and John Martyn, 1668).
[90] David Cram, "Francis Willughby and John Ray on Words and Things," in Birkhead, *Virtuoso by Nature*, 255.

he disagreed with the idea that a proper connection could – and should – be established between a word and a thing: he himself was very much concerned, as we will see, with reconciling the proper relations between fish species and their names. Ray shared Wilkins' quest for a language that was stripped of ambiguity, especially when it came to describing living things.[91] What he denounced, however, was the imposition of a pre-contrived system onto nature's rich variations. By way of contrast, Ray was convinced that true knowledge came from the senses.[92]

When deploying the senses to study a species of fish, having recourse to (more or less) fresh samples was much to be desired. For this, they need not always visit fish markets, as sometimes fishermen delivered specimens to the naturalist's doorsteps. In a letter to the Royal Society detailing his dissection of a porpoise, Ray relates how, during his visit to Wilkins in Chester in late April 1669, he had had "the good fortune to meet with a young porpess of a convenient size for dissection, brought tither by some fishermen, who caught him upon the sands, where the tide had left him […]."[93] These men seemed well aware that the novelty value of certain fish washed ashore could be converted into actual coin. Their hustling was rewarded; the bishop purchased the animal (for an unknown sum) and handed it to Ray for dissection.[94] As was shown in the previous chapter, examining animals' anatomies was in fact a key component of Willughby and Ray's research; the dissection of a flair was an exemplary piece of the kind of close observation that they held up as an ideal.

When no fresh specimen was at hand, they made do with preserved ones. Willughby and Ray were dependent on what their correspondents were willing and able to send them, or what they could find or buy themselves. Willughby himself amassed a collection of "Birds, Fishes, Shells, stones and other fossils,

[91] See also: Mary Slaughter's *Universal Language and Scientific Taxonomy in the Seventeenth Century* (Cambridge: Cambridge University Press, 1982), 62–64.
[92] Kusukawa, "The *Historia Piscium* (1686)," 184; the role of sensory experience in the Royal Society is discussed at length in Wragge-Morley's *Aesthetic Science*.
[93] John Ray, "An account of the dissection of a Porpess, promised numb. 74; made, and communicated in a letter of Sept. 12 1671, by the learned Mr. John Ray, having there in obser'd some things omitted by Rondeletius," *Philosophical Transactions of the Royal Society of London* 6, no. 76 (1671): 2274.
[94] *Hist. pisc.*, 32.

seeds, dried plants, coins, etc" on his estate.[95] In London, dried fish could, as we have learned in the introduction to this chapter, even be found in taverns. And as discussed in Chapter 1, the Royal Society itself possessed a repository of objects. The catalogue made from it included a section on aquatic fauna entitled "Of Fishes" encompassing the "RIB of a TRITON, or MAREMAN" alongside several kinds of whale bones, the horn of a sea-unicorn that the Icelanders called a narwhal, some seals, the claw of a lobster – all of which attests to the wide category of creatures the word 'fish' continued to encompass in this period.[96] The collection may have included a great range of species, but its value for making proper species descriptions was limited, because, as Michael Hunter has noted: "preserved exhibits were decidedly inferior to live ones".[97]

The difference in utility between that of a living specimen and a dead, prepared one was especially marked in fish because they disintegrated so easily. What is more, different species demanded different methods of preservation. Larger specimens would often be dried, and sometimes stuffed with hay so as to retain some of their shape. Smaller specimens were usually stored within glass jars filled with spirits. Each method of preservation had its merits and pitfalls; inundating specimens with spirits, for example, was rather costly and not altogether attractive for display, whereas dried specimens could become brittle so that only the sturdier parts of the fish endured.[98] Objects preserved in the latter fashion also failed to allow for any examination of internal organs. These parts of the fish would be removed along with the flesh during the process of preservation as, unlike the fish's skin, the internal organs would not desiccate easily. Regardless of the preservation strategy used, however, the fish in question would often lose much, if not all, of its original colour in the process.

[95] Poole, "The Willughby Library," 230; a part of this collection is still extant, see: Tim R. Birkhead, Paul J. Smith, Meghan Doherty and Isabelle Charmantier, "Willughby's Ornithology," in Birkhead, *Virtuoso by Nature*, 277; Charmantier, Johnston and Smith, "The Legacies of Francis Willughby," in idem, 375.
[96] Grew, *Musaeum Regalis Societatis*, 81–124.
[97] Michael Hunter, *Establishing the New Science: The Experience of the Early Royal Society* (Suffolk: The Boydell Press, 1989), 152.
[98] See also: Peter Davis, "Collecting and Preserving Fish: A Historical Perspective," in MacGregor, *Naturalists in the Field*, 149–165; Marlise Rijks, "Scales, Skins, and Carapaces in Antwerp Collections," [forthcoming in *The Matter of Mimesis: Studies on Mimesis and Materials in Nature, Art and Science*, eds. Marjolein Bol and Emma C. Spary].

That there was often a considerable discrepancy between a fresh specimen of a species on the one hand and a preserved exemplar on the other was far from lost on the Fellows of the Royal Society. Grew had written in his description of a "little SEA-UNICORNE […] sent from Brasil", not earlier described or depicted, that from the top of the fish "is prolonged a smooth (now) blackish, round, taper'd, strait Horn […]" and that the fish itself is "cover'd with a (now) blackish, thick and tough Skin, and when you draw your hand forward, also rough."[99] The insertion of "(now)" shows that Grew was cognizant of the fact that the passage of time probably had affected the look of the specimen since it had made its way over to England from the South Americas. This caveat was included into the species description of this '*Monoceros Minor Mus. Soc. Reg.* D. Grew' in the *Historia piscium*. In the description of the horn, it is noted that the blackish colour could be glimpsed "in exsiccato pisce", *viz.* in the dried fish in the Repository of the Society.[100]

Images could address this problem of deterioration – at least, to an extent, as we have also seen in the previous chapter. The importance of illustrations for the *Historia piscium* was signalled on its engraved title page by the inclusion of the helmeted artist. As Chapter 1 has discussed at length, the book included new figures that were usually based on drawings that Willughby, Ray or others in their circle had acquired. While some preliminary sketches of fish made during their trip seem exist among the Middleton Collection, these did not make it into the book.[101]

One of the sources for illustrations was a manuscript, now inscribed 'A Book of Fishes done at Hamburgh, with Mr Ray's Notes', which has hitherto received scant attention from historians.[102] As of yet, very little is known about how it came into Ray's possession, or even when or where it was produced. During their tour through continental Europe in the mid 1660s, Ray and his company

[99] Grew, *Musaeum Regalis Societatis*, 104; the interjection 'now' is found in other object descriptions too, among others on 98, 100.
[100] *Hist. pisc.*, 216.
[101] Kusukawa, "*Historia Piscium* and Its Sources," 321.
[102] Anonymous, *A Book of Fishes done at Hamburgh, with Mr Ray's Notes*, Add MS 5308c, British Library (hereafter BL), London; the manuscript stems from Sloane's collection, and I thank Sachiko Kusukawa for drawing my attention to it.

had not ventured further north in the German states than Cologne, so he must have acquired it elsewhere than in Hamburg. The manuscript contains dozens of coloured illustrations of aquatic fauna, executed in watercolour and gouache. These illustrations are accompanied by cursory descriptions in a German hand, which appears to be from the sixteenth century.[103] Certain drawings in the manuscript show an unmistakeable correspondence to a set of fish drawings within the Gessner-Platter albums recently discovered by Florike Egmond;[104] these are clues that can help throw light on the manuscript's origins.[105] Ray's annotations give insight into how he used the book. He comments, for example, on the correct identification of a species ("these are not separate species, but the front and back side of the same fish") or on the quality of certain drawings ("badly painted").[106] While, as Chapter 1 also suggested, the natural historical value of illustrations was related to the skill of the artist and the freshness of the specimen concerned, and while the former might have been reasonably simple to ascertain, the latter would remain difficult had one not personally seen a suitably lively, or at least fresh, example of the species. Fish tend to change appearance soon after being taken out of the water, and Leah Aranowsky has argued for drawings of dead fish that they reflect the interstitial time between life and death, observation and presentation.[107] The qualifying phrase "drawn from the life", with its multivalent early modern usages, thus takes on special meaning in the case of fish.

Both preserved objects and drawings, therefore, came with their own limitations for representation. This was potentially problematic, as we saw in the previous chapter, as meticulous attention to detail was highly desirable if fish were to be properly distinguished from one another. A characteristic mark might well be lost in the preservation process, or inadvertently left out of a drawing. Its is probably for these reasons that the experiences of fishermen and fishmongers were particularly handy. They saw, after all, a relatively large quantity of each species of fish, and live examples at that, as opposed to either the few dried

103 The watermarks in the paper, furthermore, date to the mid-sixteenth century.
104 Gessner-Platter Albums, UBA, hs. III C 22. See also footnote 28 in Chapter 1.
105 An article on this matter is in preparation by the author.
106 Original Latin: "Non sunt distincta species, sed ejusdem piscis pars supina & prona" BL, Add MS 5308c, f2v; "male pingitur" ibid., f5v.
107 Leah Aranowsky, "On Drawing Dead Fish," *Environmental History* 21, no. 3 (2016): 549.

exemplars in natural historical collections or possibly imprecise drawings that were available to naturalists. As the following section will show, the larger 'sample size' of specimens that these fishermen had observed proved useful for Willughby and Ray for drawing conclusions about demarcating species.

Before fish could be captured on paper, they first needed to be caught. One can easily forget this when looking at the engraved plates in the *Historia piscium*, which present the fish as if untouched by human hands, exhibiting none of the tell-tale marks left by hooks or nets.[108] One exception to this rule is the engraving of a species of flatfish which does convey obvious traces of its capture: a thin black cord has been tied from its head to the peduncle of its tail.[109] The engraving was based on one of the drawings (**Figure 2.2**) in the 'A Book of Fishes done at Hamburgh.'[110] This particular manner of tying up flatfish is depicted in various fish still lifes by seventeenth-century Netherlandish painters such as Abraham van Beijeren (1620–1690), Isaac van Duijnen (1628–*c.*1680) and Jacob Foppens van Es (1596–1666). These still lifes often show fish specimens acted upon in one way or the other: they are cut, sliced, smoked or tied. This way of binding a flatfish head to tail seems to have served a very practical purpose, namely to facilitate its transport, or delay the spoiling process.[111] The illustration serves as a reminder that fish had to be caught, carried, stored and preserved before they could be subjected to scrutiny; and thus were subject to the attentions of many individuals, fishermen, fishmongers and other handlers, before they could be subjected to the gaze of the naturalist.

Detail and Distinction

Fishermen did not only supply the goods for natural historical research, but were also sources of knowledge in themselves. For Willughby and Ray, the fishermen embodied several different types of evidence, all of which could be recorded. First

[108] Cf. the drawing of a spiky blowfish that Gessner had drawn, including a hook and tasseled string, into and its printed counterpart in *Hist. anim.* IIII, 155, where these have not been represented, although a trace is still visible through a slight bump on the body. See: Egmond, *Eye for Detail*, 160–163.
[109] *Hist. pisc.*, tab F1.
[110] BL, Add MS 5308c, f4v.
[111] Julie Berger Hochstrasser, "From the Waters: Fish Still Life," in *The Magic of Things: Still-life Painting, 1500–1800*, ed. Jochen Sander (Berlin: Hatje Cantz, 2008), 188; "Description of Isaac van Duynen's 'Stilleven met vissen op een tafel'," *Hoogsteder Journal* 3 (1997), 21.

of all, fishermen shared the techniques they used to catch the fish. Willughby's and Ray's interest in these techniques is evident from some of the species descriptions in the *Historia piscium*, which explain the intricacies of catching herring or trapping tuna.[112] The latter is even rendered in one of the few diagrams in the book, which elucidates the ingenious system they saw in Marseille.

Figure 2.2 Drawing of a species of flat fish, inscribed 'Eÿn Terbott' and 'Rhombus' in unknown hand(s) | MS 5308c f4v | © British Library Board

When in Sicily, Ray and Skippon took the opportunity to examine fishing from up close. In his travel account, Ray relates that they had hired a boat so that they could better understand how swordfish were caught.[113] While they did not witness the capture of any such fish, they did take this opportunity to study the harpoons that the fishermen had brought along for the occasion. Similarly, the *Ornithology* was furnished with several pages expatiating the art of fowling.[114] This attention to techniques for catching and trapping animals is on par with the

[112] *Hist. pisc.*, 220 and 178.
[113] Greengrass, Hildyard, Preston, Smith, "Science on the Move," 183.
[114] This had not been part of the Latin original; Birkhead, Smith, Doherty, and Charmantier, "Willughby's Ornithology," 283.

broader interest of the Fellows in various trades, for which the Royal Society set up an official program.[115]

Secondly, Willughby and Ray recorded common words in various languages and dialects during their travels through the British Isles. For example, when visiting the West Country of England in 1667, they noticed that Cornish differed only a little from Welsh and also that it was much akin to the Breton language. The similarities were such "that they [the Cornish and the Bretons] understand one another, as we found by severall Fisherman of that countrey w[hi]ch were then drying of cartilagineous Fish at Pensans & St Ives."[116] Thus, Willughby and Ray talked to fishermen to learn more about which words were used for what things in different regions. This was not tangential to their project. In fact, being attentive to the words for fish in various dialects was key to their ambition to bring order to the world of fish, as will be elucidated below.

Last not but not least, fishermen were asked about their knowledge of the occurrence of species. When Ray toured through the British Isles in 1662 with Willughby, he compiled catalogues of English birds, fish, metals and minerals.[117] He noted down several fish taken around Pensance and Saint Ives in Cornwall, presented to him by "one of the ancientest and most experienced fishermen", who remains nameless.[118] Ray here stressed his informant's decades-worth of experience; other Fellows used similar phrasing while asserting the seniority of the seamen they had consulted.[119] The first entry on Ray's fish list was a whale, which the old fisherman had spotted from the coast. Ray added that he could not tell them of what sort it was, remarking that "*vulgus enim non distinguit* – the common people, after all, do not distinguish.[120] In the *Historia piscium* it is similarly declared that fishermen do not really discern the mackerel from any

[115] Kusukawa, "*Historia Piscium* (1686) and Its Sources," 329. For this interest, see: Kathleen H. Ochs, "The Royal Society of London's History of Trades Programme: An Early Episode in Applied Science," *Notes and Records of the Royal Society of London* 39, no. 2 (1985): 129–158.
[116] John Ray, *Further Correspondence*, 262–263.
[117] John Ray, *A Collection of English words, not generally used ... in two alphabetical catalogues, ... northern ... [and] southern counties, with catalogues of English birds and fish, and an account of preparing ... metals and minerals* (London: Thomas Burrell, 1674).
[118] Ibid., 97.
[119] Hellawell, "The Best and Most Practical Philosophers," 44.
[120] Ray, *A Collection of English Words*, 97.

other fish that may look like it.[121] These men's seeming lack of interest on in the categorization or classification of fish ran very much in opposition to Willughby and Ray's asserted aim, namely to precisely distinguish between species.

Ray's remark was somewhat unjust. Not only did the diversity to be found in fish present a complex puzzle, as species often closely resembled each other and could thus only be differentiated through subtle variation, but Ray actually drew on fishermen's own distinctions in trying to solve such conundrums. Consider the following passage, in which Willughby and Ray deliberate on whether sprats formed a separate species or were nothing else than the offspring of herring:

> A certain senior fisherman from *Cornwall*, whom we have consulted about this matter and other things, has told us that two kinds of *Sprats* are caught in the sea which flows near to Cornwall, one of Herring, another of Pilchards or the offspring of Celerini, which can in turn easily be distinguished from another. Pilchards frequent the shores of Cornwall and Devon, they very rarely progress further to the east in the British sea; from whence elsewhere around England only one type of Sprat is found.[122]

Here, yet again, a fisherman – possibly that same wise and experienced individual – imparts his knowledge. His answers did not make matters simpler, as he explained that there are, in fact, different kinds of sprats, which stem from at least two different species, and that these are, furthermore, not distributed equally along the coastlines of the British Isles. A looming problem in these interactions was that a fish might be accorded one name in Cornwall, and yet another in London.. The 'Scad' in Cornwall was known as a 'horse Mackrell' in London; conversely, the species of flat fish that Londoners dubbed a 'Pearle', the Cornish called 'Lug-aleaf.'[123] In keeping with Willughby and Ray's preoccupations with language, the

[121] *Hist. pisc.*, 182.

[122] Original Latin: "Piscator quidam senior *Cornubiensis*, quem super hac re aliisque consuluimus, nobis retulit duo *Sprattorum* genera in mari Cornubiam alluente capi, alterum Harengorum, alterum Pilcardorum, seu Celerinorum sobolem, quae à se invicem facile distingui possint. Pilcardi Cornubiae & Devoniae littora frequentant, ulterius in mari Britannico orientem versus raro progrediuntur; unde alibi circa Angliam unicum tantum Sprattorum genus invenitur." *Hist. pisc.*, 221.

[123] The names 'Scad' and 'Lug-Aleaf' are those listed in the species descriptions in *Hist. pisc.*, on page 290 and 95 respectively; the 'horse Mackrell' and 'Pearle' are handwritten additions in the Royal Society's copy of Willughby and Ray, *Historia piscium*, RS, RCN 18574, on the pags mentioned (both TR).

Historia piscium and its related writings abound with attempts to establish which fish was called by which name where, and by whom.

The taxonomies of fishermen did not always overlap with those of the naturalist. This added a linguistic layer to the already intricate puzzle presented by the relationships between the various species. Ray wrote to Lister: "Of the flat cartilaginous [fish] I have seen and described four or five sorts, but I am to seek what our fishermen mean by the Skate, and what by Flair, and what by Maid – as Skate-maid, Homelyn-maid, Thornback-maid, &c. &c."[124] Distinctions between (or even within) species by people that engaged with fish in a more practical sense also appear to have been based on attributes with particular relevance to their commerce. In the species description of the herring, it is explained that the people who washed, salted and dried this fish, and who were called Towers, separated it "into six species or rather grades".[125] These encompassed the 'fat herring', which was large and fat, and the 'meat herring' which was equally large and rich in meat but less fat.[126] 'Pluck' was the name used for herring damaged or torn from being stuck in the nets, while a 'shotten herring' had emptied itself of its roe.[127] We thus find, subsumed in Willughby and Ray's natural historical taxonomy based on characteristic marks, a further taxonomy drawn up from properties stemming from commercial practice.

Ray's erstwhile fellow Cambridge student and vicar of Brignall Ralph Johnson (1629–1695) wrote to complain of how difficult it was to decide whether dissimilar-looking exemplars of salmon were truly different species, or rather one and the same species at different stages of growth.[128] He said that in "the mouth of Eden in Cumberland the fishers have four distinctions of yearly growth (after the first summer, when they call them free, or frie, as we smowts, or smelts) before they come to be lackes; and this, they say, they have curiously observed, by fixing so many pins in the fins of yearlings, or two years old, and after taking them again;

124 Ray to Martin Lister, 19 December 1674 (OS), *Correspondence of John Ray*, 113.
125 Original Latin: "[i]n sex autem species seu potius ordines […]" *Hist. pisc.*, 220. I thank Hans Aili for sharing his translation of this passage.
126 Ibid.
127 Ibid.
128 Johnson also shared observations on and specimens of birds and plants. Raven, *John Ray*, 319. A biographical note can be found in *Teesdale Record Society* 15 (1945): 9–32.

[…]."[129] This procedure, of fixing pins into individual specimens and tracing their growth over a period of time, was effectively an experiment. Like the experiments conducted by the Fellows, it was designed to allow for certain observations to be made. Fishermen's distinctions between salmon of different ages were deemed dependable enough to be included into the book:

> And what is handed down by authors about the quick *growth* of small salmon in the sea does not find faith with us: for our fishermen distinguish salmon by each year of their age, as we have said above, and they say that they are not full-grown before the sixth year of their life.[130]

Willughby and Ray here plainly stated that they placed their trust in the collective account of 'their' fishermen rather than in the written knowledge transmitted by various earlier authors (whom they do not specify here). This sentence can also be read as a rhetorical phrasing reminding the reader that relying on ancient authors is a matter of faith, whereas believing the fishermen is a matter of lived experience.[131]

How could one tell whether a specimen was exemplary for its species? Fishermen and fishmongers had a good sense of irregularities and averages. Willughby and Ray were told by a fishmonger that bigger specimens of salmon weighed around six pounds.[132] They also drew, albeit indirectly, on the observations of the Cambridge fishmonger, Mr. Mayfield, who went down to the London market every Friday to procure species not readily available in his own town.[133] The physician Peter Dent (*c.*1628–1689) wrote to Ray that "Mr. Mayfeild [*sic*] could not procure any dried *Mayds* or *Thornback* at the mart. He helped me to a fresh *Thornback*, which he said was full grown: its weight was ten pounds."[134] Dent added the fishmonger was "acquainted with the Tamworth carrier and will undertake to send you any of these [fishes] fresh into the country […]",[135]

[129] Ralph Johnson to Ray, 16 April 1677 (OS), *Correspondence of John Ray*, 127.
[130] Original Latin: "Quae de celeri Salmunculorum in mari *auctu* ab Autoribus traduntur apud nos fidem non inveniunt: nostratis enim piscatores Salmones annuatim ab aetate distinguunt, ut superius diximus, neque ante sextum aetatis annum perfici aiunt." *Hist. pisc.*, 192.
[131] I thank Pete Langman for this observation.
[132] *Hist. pisc.*, 196.
[133] Raven, *John Ray*, 393.
[134] Peter Dent to Ray, 15 February 1674 (OS), *Correspondence of John Ray*, 15–17.
[135] Dent to Ray, 15 February 1674 (OS), passage omitted in Lankester's *Correspondence of John Ray* but reproduced in Gunther, *Further Correspondence of Ray*, 113.

and thus could also do deliveries. He had furthermore told Dent that he once sold an exceptionally large specimen of flair to the cook of St John's College in Cambridge, and it ended up feeding all those attending lunch that day. Dent sought verification of the story from the cook in question, and having received it, he passed it along to Ray who then inserted it into the *Historia piscium*.[136] The reader could rest assured that the fishmonger Mayfield was of trustworthy character [*fide dignus*].[137]

Fishermen and fishmongers could furthermore tell whether a certain specimen was male or female, and how particular species procreated. The dependable Mayfield, for example, assured Dent that flairs were viviparous.[138] While Dent doubted whether this was true, he resolved to observe the alterations of the fish's eggs on a weekly basis and give Ray a full account.[139] Although Dent's ultimate findings cannot be found in Ray's correspondence, the letter underscores the fact that the statements of fishmongers, like that of fishermen, merited further research and that their claims invited both validation and repudiation.

The *Historia piscium* frequently cites from Leonhard Baldner's manuscript *Vogel-, Fisch- und Thierbuch*, mentioned earlier in this chapter as a suitable source to reconstruct the experiences of those who worked with fish on a daily basis. Baldner is the first fisherman mentioned by name in the *Historia piscium*; rarer still, his portrait has come down to us.[140] This is probably because Baldner was not a 'typical' fisherman. He was born into an established Strasbourg fishing family (whose crest consisted of three crossed fish), must have received some education as he could read and write, and combined his occupation as fisherman with a seat in the city council.[141] Baldner produced several, largely similar, manuscripts in quarto describing the quadrupeds, birds, fish and insects of his home region,

[136] Where it was now claimed that the flair had fed all College's hundred-twenty alumni. Kusukawa, "*Historia Piscium* (1686) and Its Sources," 331 and *Hist. pisc.*, 69.
[137] *Hist. pisc.*, 69.
[138] Dent to Ray, without date, *Correspondence of John Ray*, 120.
[139] Ibid.
[140] The portraits are at NUL, Mi LM25/80 and Brown University Library, RARE 3-SIZE QL41 .B3 1653 v.1; see also: Kusukawa, "*Historia Piscium* (1686) and Its Sources," 320.
[141] Hans-R. Fluck and Albert Scharbach, "Leonhard Baldner – Zu seinem Testament and Nachlassverzeichniss," *Revue d'Alsace* 142 (2016): 293–294. He also collected duties on the Rhine: Armin Geus, "Leonhard Baldner: A Strasbourg Fisherman," *Isis* 55, no. 2 (1964): 196.

most of which were skilfully illustrated and painted by the painter Johann Georg Walther (1634–1697). While some of these manuscripts have sadly been destroyed or lost, 4 copies are known to be preserved in libraries and archives.[142] Both the descriptions and the drawings in these manuscripts as of yet await detailed analysis, and a comparison between the extant editions would be most welcome to offer insight into Baldner's approaches to the study of nature as well as how, through these diligently produced works, he presented himself as a naturalist.

This chapter focusses on the copy in the British Library. Willughby seems to have bought this manuscript, the preface to which is dated 31 December 1653, from Baldner himself during the continental tour.[143] It contains very fine watercolours, and the descriptions are carefully calligraphed; certain details of both the text and the images have been accentuated with gold. Willughby and Ray used the manuscript as a source for their studies of both birds and fish: the *Ornithology* contains 37 drawings from Baldner (making up a little over a tenth of the total illustrations in their work),[144] whereas the *Historia piscium* includes 25 of Baldner's illustrations and cites from it in several species descriptions.[145] We will now discuss how these English naturalists used the manuscript, and what Baldner's own intentions for it were.

In the preface to the *Ornithology*, Ray expressed his appreciation of the high quality of the manuscript's illustrations, praising their great exactness and excellent hand.[146] It struck him that Baldner had taken and described these fish himself, and had them drawn at his own charge and cost. Such curiosity, Ray thought, was "much to be admired and commended in a Person of his Condition and Education."[147] He also acknowledged that he had received "much light and information from the Work of this poor man", which had enabled him to "clear

[142] Besides the aformentioned copies at the British Library and Brown University, Library, there is one at the University Library of Kassel, 2° Ms. phys. et hist. nat. 3; and one at the Bibliothèque Nationale Universitaire de Strasbourg, call number unknown. For a discussion of the various copies see also Birkhead, *The Wonderful Mr. Willughby*, 101–103.
[143] Leonhard Baldner, *Vogel-, Fisch- und Thierbuch* [Book of Birds, Fish and Animals], BL, Add MS 6485.
[144] Birkhead, Smith, Doherty, and Charmantier, "Willughby's Ornithology," 295.
[145] Kusukawa, "*Historia Piscium* (1686) and Its Sources," 320.
[146] Willughby, *Ornithology*, preface, sig. A6v.
[147] Ibid.

many difficulties, and rectifie some mistakes in *Gesner*."[148] Ray furthermore wrote to Robinson: "though it is not to be supposed, that a man of his education should be able to describe animals well, yet so much might be gathered from the notes he gives, as might lead an understanding and attentive man into the knowledge of them, and with the figures (which are in all very exact) give him so much light as to enable him to determine the species."[149]

On the title page of his manuscript, Baldner proclaimed that both the species descriptions and illustrations conformed to nature.[150] Looking at a drawing that Willughby purchased from Baldner alongside the manuscript, a watercolour of a carp (**Figure 2.3**), one can see why Ray was so enthused.[151] The artist has drawn the fish from a slight bottom perspective view, and diligently rendered the scales, and fins, which in particular show fine brushstrokes. By subtly applying a greyish light blue pigment to the edges of the gills and scales, a technique known as heightening, the artists conveyed the glistening of a fish that has just been taken out of the water. The drawing was used for the *Historia piscium*.[152] Baldner's intention was that the descriptions and images in his manuscript would complement one another. He stated, for example, that "[t]he species of 'Rothaug' are not dissimilar to that of the 'Rotel', but they are more beautiful in colour and of more rubescent eyes, and fins, as can be seen from the illustration […]."[153] In their description of the 'Rootaug', Willughby and Ray used the same distinctive marks.[154]

The authors looked to Baldner's manuscript for a wider range of observations, copying, for example, his statements on whether a certain species was rare or common, how its appearance could vary along with time or place, when and

148 Ibid. Ray did not read German, and used Frederick Slare's abridged translations of the species descriptions, BL, Add MS 6486, ff12r–23v. That Ray also engaged directly with Baldner's manuscript is evidenced by the Latin names he added to some of its descriptions.
149 Birch, *History of the Royal Society*, vol. 4, 390.
150 Original German: "Recht Naturliche Beschreibung Und abmahlung […]," BL, Add MS 6485, f1r; inserting the word "recht", Baldner modestly says they are "almost" natural.
151 NUL, Mi LM 25/51.
152 *Hist. pisc.*, Tab Q1. The other loose drawings are a perch (Mi LM 25/58) and a portrait (Mi LM 25/80). The former is represented in Kusukawa, "*Historia Piscium* (1686) and Its Sources," 321.
153 Original German: "Die Rothaugen sehen den Rottlen nicht ohngleich, seind aber von farben hüpscher, und Rothere Augen, und Schwümfedern, wie von dem abgemahlten zu sehen […]." Add MS 6485, f135v.
154 *Hist. pisc.*, 249. Some confusion around the identification of this species is related in Birch, *History of the Royal Society*, vol. 4, 390.

how it procreated, and when it was best to eat, in the descriptions of no fewer than twenty species.[155] To focus on only those parts of the manuscript that were included in the *Historia piscium*, however, is to miss out on Baldner's own questions and approaches in studying fish. Among the volume's fascinating observations is his account of having caught a sturgeon of "about the thickness of a man", and subsequently finding its bowels to weigh 130 pounds.[156] Like Willughby, Ray and their peers, Baldner thus dissected fish and studied their internal anatomies; he even counted the thousands of eggs in the roe of pike and burbot.[157] He noticed that the species of wood trout took on the colours of their environment: they turned completely white when placed in a white tub, and black once put in a black tub.[158]

Figure 2.3 Watercolour of a species of carp, inscribed 'Cyprinus' in Willughby's hand | © NUL Mi LM 25/51 | © University of Nottingham Manuscripts Collections

He disagreed with Gessner that carp were (sometimes) born from mud, and said that they all came from roe.[159] On the whole, Baldner's manuscript shows that he aimed to discern species from one another, to examine their anatomies, to understand how they behaved and procreated, and that he compared the reports of earlier authors with his own observations – again, much like Willughby and Ray.

[155] Baldner's manuscript is referenced on the following pages: *Hist. pisc.*, 105–107, 118, 201, 125, 227–228, 236, 238, 248, 249, 250, 252–254, 259, 260–262, 265, 266.
[156] Add MS 6485, f119r.
[157] *Hist. pisc.*, 201 and 125, cf. Add MS 6485, f121r and f134r.
[158] Add MS 6485, f125r.
[159] Add MS 6485, ff121v–122r. In his German history of fishes, a loose and much abbreviated translation from the Latin, Conrad Gessner copies Rondelet's statement that carp are sometimes born from chaos and dirt, and sometimes from seed and roe, see: Gessner, *Fischbuch*, 164–165.

The preface to Baldner's manuscript gives us a sense of how he envisioned his work. It reveals that the author thought there to be no better place to contemplate God's omnipotence than on and near the water. Since God had at the beginning created the great whales, fish had received His first blessing; and He had also called upon the fishermen to follow him. God had, furthermore, made the rivers of the Rhineland with their endless benefits to those who lived around them. It was this delight in and admiration for the Creation, Baldner submitted, that had inspired him to make this manuscript brimming with the animals that swam, flew and crept in these waters. All of the creatures described in it, he wrote, he had held in his own hands. Each of the species was drawn from life, called by its name, and after sustained study, described briefly from Baldner's own 'experience' [*Erfahrung*].[160] He admits his attempts are necessarily 'simple' [*einfältig*] and 'scant' [*gering*], casting himself as a modest fisherman and hunter, and bids those considering themselves better suited to write such a work to keep that humble background in mind.[161] At the same time, he emphasizes his three decades worth of experience with fish – although he uses the terms 'learned' [*erlernt*] and 'studied' [*studiert*] to describe this involvement.[162] Quite apart from its complicating of certain assumptions about what constitutes 'a' fisherman, Baldner's manuscript also testifies to the fluid boundaries of theoretical and practical engagements with nature.

The examples listed in this section offer an idea of the topics Willughby, Ray and their friends discussed with practical men: from distinguishing between species to noting their various names in different languages, the intricacies of procreation to deciding if a certain specimen was of a typical size for its species. The preoccupation of fishermen and fishmongers with, for example, the occurrence of certain species or the growth stages of young salmon, can likely be

[160] Original German: " […] und ich alles selbst in meiner Hand gehabt, dieselbige nach dem leben abmahlen laszen, und wird ein jdes bey Seinem Nahmen genännet, und so viel ich bey einem jeden gelernt, in Seiner Natur, Kurtzlich ausz eigener erfahrung daszelbe beschrieben." Add MS 6485, f3v.

[161] Original German: "Und so mir Einer disze meine einfältige und geringe Arbeit, besser Verstehet, der wolle mirh, wo etwas gefehlt zu guth halten, Dann es von einem geringen Fischer und Weydman herkommet." Add MS 6485, ff3v-4r.

[162] Original German: "So hab ich im Nahmen desz Herrn mein Netz und Fischerkarn ausz geworffen, und ein wenig von dem was ich erlernt, und in Dreysig Jahren dabey Studiert hab, ein wenig wollen anzeigen." Add MS 6485, f4r.

traced back to commercial considerations, but that was not necessarily the sole motivation. Baldner's manuscript presents a natural historical study in its own right. His book contains observations that are of a practical nature, like whether a certain species is edible, but also includes reflections on long-standing theoretical debates into the generation of fishes. He presents himself as a student of nature who does not strive for profit, but instead wishes to praise God through studying His Creation. This approach compares to that of other, learned, naturalists. All in all, Willughby and Ray included a wide range of the observations that they gathered from fishermen and fishmongers in their *Historia piscium*. They also qualified these observers that came from outside their own ranks: as ancient and most experienced, as trustworthy, or as possessing commendable curiosity despite lacking proper education.

Conclusions

Let us return to the *Historia piscium*'s discussions of the curious behaviours of the salmon one last time. A few lines after its peculiar matter of jumping is discussed, Ray addresses its mysterious eating habits:

> What food salmons use, because I see that authors disagree [on the matter], has to be consulted by experience.[163]

The matter of the salmon's diet had been discussed at a meeting of the Royal Society in 1678, where it was brought forth that fishmongers never found anything in the maws of salmon and that an (unnamed) lady, "very inquisitive in that kind", had observed the same.[164] The previous year, Johnson had written to Ray on the same subject. "I wonder as much that Fishers have not certainly determined whether Salmons live upon anything save Water, and what?"[165] He continued by noting that:

[163] Original Latin: "Quo cibo utantur Salmones cum Autores diffentire videam, experientia consulenda est." *Hist. pisc.*, 192.
[164] Birch, *History of the Royal Society*, vol. 3, 425. See also Felicity Henderson, "Translation in the Circle of Robert Hooke," in *Translating Early Modern Science*, eds. Sietske Fransen, Niall Hodson, and Karl A.E. Enenkel (Leiden: Brill, 2017), 17.
[165] Johnson to Ray, 16 April 1677 (OS), *Correspondence of John Ray*, 128.

> I think only the Anglers have made the Observation of finding their Stomachs always empty; but I am persuaded that, if the Net-fishers would open any considerable Number, they would find in them Food indigested, which they seldom do, but sell them whole. Perhaps I may give farther Answer to this *Quaere*, and some others about *Whitsontide*; at which Time I purpose to go to our Coasts, and gather what I can.[166]

These discourses are indicative of the sorts of questions on which the Fellows pondered, and where they expected to find answers.

The variety of places where Johnson suggests answers can be gathered fit well into recent widened conceptions on the part of historians with regard to the spaces where early moderns created (or perhaps stumbled upon) natural knowledge.[167] In London, fertile sites for assembling knowledge about fish encompassed – besides the rooms of Gresham College – coffeehouses, taverns, ports, fish markets, and the banks of the Thames.[168] Beyond the confines of the city, such locations included the coast of Cornwall and the (fish) markets of continental Europe. Each of these places allowed for the making of first-hand observations, but, even more importantly, for meeting those people whose observations of fish were informed by years of practice. These might be fishmongers, anglers, and net fishers. This chapter has tried to reconstruct the conversations between fishmongers, fishermen and Fellows so as to better apprehend what they actually consisted, and to analyze how these contributed to a deepened understanding of fish, whether individual species or as a whole. It has also emphasized how the extent and nature of these contributions might differ from person to person, relative to experience and skill. Taken together, the various examples discussed here demonstrate that exchanges with fishmongers and fishermen were not incidental, but rather were central to Willughby and Ray's project.

166 Ibid.

167 This historiography has become too vast to list exhaustively, but see, for example: Jim Bennett and Rebekah Higgitt, eds., *London 1600–1800: Communities of Natural Knowledge and Artificial Practice*, special issue of *British Journal for the History of Science* 52, no. 2 (2019): 183–343; Harkness, *The Jewel House*.

168 On the port of London as (continued) source for faraway species, see: Arthur MacGregor, "Patrons and Collectors: Contributors of Zoological Subjects to the Works of George Edwards (1694–1773)," *Journal for the History of Collections* 25, no. 1 (2013): 36.

As this chapter has shown, the interactions between practical men and Fellows could be rather complicated. Fishermen and Fellows sometimes talked at cross-purposes, reminding us of similar difficulties in communication that arose in the Society's history of trades project.[169] Another issue was that while the Fellows appropriated knowledge from practical men and women for their discussions or publications, the practitioners themselves often were hidden well out of sight.[170] This also held true for other categories of fish connoisseurs, not discussed in this chapter, whose observations of fish were drawn upon for the *Historia piscium* and which merit further consideration. Anglers, for example, also knew their way around fish. Willughby and Ray consulted Leonard Mascall's (*d*. 1589) well-known angling manual, *A Booke of Fishing with Hooke & Line, and of All Other Instruments There-unto Belonging* (London, 1590) when discussing the fact that while the carp was a relatively recent introduction to the waterways of England, it was now plentiful in rivers and ponds.[171] Anglers were also aware of whether a species was common or rare, and, as Johnson implied, knew what was in a fish's stomach. Other specific knowledge of fish pertains to their consumption. As we saw, *Historia piscium* offers glimpses of fish salters and cooks; and on occasion the taste and preparation of particular species of fish received attention in this book.[172]

For Willughby, Ray and other Fellows of the Royal Society, the value of interacting with fishermen and fishmongers lay in their repeated engagement with a large quantity and wide variety of fresh fish in an either living or recently deceased state. They did not only supply raw material, but also offered information that was crucial for the central tenet of the *Historia piscium*: to distinguish one species from the other by delineating their differences. Fishermen and fishmongers did not only know how to catch fish and how to tell them apart from another, but also commented on particular behaviours of certain species. It was on the basis of

[169] Ochs, "The Royal Society of London's History of Trades Programme," 130.
[170] Jasmine Kilburn-Toppin, "A Place of Great Trust to be Supplied by Men of Skill and Integrity': Assayers and Knowledge Cultures in Late Sixteenth- and Seventeenth-Century London," in Bennett and Higgitt, *Communities of Natural Knowledge and Artificial Practice*, 222.
[171] *Hist. pisc.*, 246 and Leonard Mascall, *A Booke of Fishing with Hooke & Line, and of All Other Instruments There-unto Belonging* (London: John Wolfe, 1590), 8.
[172] See, for example: *Hist. pisc.*, 219, 320.

this sustained experience that Fellows regarded them as authorities in the world of fish. While, ultimately, the Fellows positioned themselves as prime arbiters on what passed as a credible observation and who qualified as a credible observer, this chapter has shown that they gladly ventured beyond the realm of the learned when seeking reliable and recognized authorities on fish.

As we saw in both the previous and current chapter, the *Historia piscium* was an attempt to create a universal work on the natural history of fish based on clearly defined principles, so that the proper relations between species and their names could be re-established and order restored in the wonderfully varied world of fish. Ray and Willughby's attempts to forge a new method for the study of fish were part of their broader aspiration to reform the study of nature. This ambitious agenda demanded that naturalists should privilege empirical examination of the physical characteristics of plants and animals over the claims of ancient or even more recent authorities. In this, they had to contend with all kinds of practical constraints, such as the at times imperfect evidence that drawings or preserved specimens might present. This is why they sought out first-hand observations from a wide range of collocutors. The resulting work made it clear that the world of fish was well worthy of inquiry and yet still fundamentally difficult to fix in place. The dizzying variety of species, and the heuristic challenges that the study of them posed to the naturalist, required a further, even firmer grip on the order of fish. As we will see in the next chapter, Peter Artedi sought to accomplish precisely that. He developed an 'ichthyology' that drew up new demarcations not only between fish, but also between those who handled and studied them.

CHAPTER 3

A True Ichthyologist? Peter Artedi's *Ichthyologia* (Leiden, 1738) and Making Classifications

Some decades after the *Historia piscium* was published, the young Swedish naturalist Peter Artedi picked up a copy, and it was a revelation. He had been trying to match his own observations of fish to species descriptions published in books, they had been too vague and insufficient. That changed when he encountered the history of fishes by Willughby (regarding him as the sole author of the work), who he found "stood out above all others in his descriptions of species."[1] Artedi nevertheless believed the work lacked a firm grasp on the morphological relations between species of fish on different taxonomical levels. As he explains in the preface to his *Ichthyologia, sive opera omnia de piscibus* [Ichthyology, or complete works about fish] posthumously published by his friend Carl Linnaeus in Leiden in 1738:

> I then noticed that by not one of the Ichthyologists up to that time the distinct genera, nor their characteristics, nor their Species had been established; hereupon I began to examine all parts of Fish with great effort, so that I would see which parts of these were most similar according to Number, Figure, and Position, and which would be the most dissimilar, especially in regard to the fish which are consistent in their external

[1] Original Latin: "[…] in descriptionibus specierum omnes supererat." Peter Artedi, *Ichthyologia, sive opera omnia de piscibus* (Leiden: Coenraad Wishoff, 1738), *Praefatio authoris*, sig. *r. The *Ichthyologia* will henceforth be referred to as *Icht.*, followed by the title of the part of the book from which the citation derives.

> appearance, from which the *Characteristics of Genera* and the *Genera* themselves are born […].[2]

Despite its modest octavo format and lack of any illustrations, the *Ichthyologia* was a far from unassuming book. In it, Artedi presented an elaborate system for the classification of fishes, introducing the taxonomical ranks of class, order, and genus, and offering clear definitions of both species and varieties. As we saw in the previous chapters, naturalists had grouped species together based on their habitat, their letter of the alphabet, or according to their morphological characters. Artedi clearly and distinctly allocated species into ranks based on shared characteristics, which could consist of intricate combinations of external features and inner parts. His aim was to uncover the intricate, taxonomical arrangements of fishes through the application of uniform and consistent rules for their description, naming and classification. In so doing, he sought to impose a unity, consistency and logical order onto the natural history of fish that he found to be sorely lacking.

Artedi's system was an expression of the widely shared search for regularities and patterns in nature. Three years before the *Ichthyologia* appeared, Linnaeus had published the first edition of his *Systema naturae* (Leiden, 1735) in which he unfolded his classification system for minerals, plants, and animals. In the case of fish, he adopted Artedi's method of classification.[3] Both Linnaeus' and Artedi's works fitted well into the broader development in eighteenth-century Europe that saw the quantification of nature, of measuring and calculating, ordering and systematizing it.[4] This entailed turning observations rich with detail and tied to a specific time and place, for example medical cases or weather diaries, into synthetic, general observations on the changing character of a disease or deviations of an average climate.[5] Observations of nature were compressed into tables

[2] Original Latin: "Deinde distincta genera, eorumque characteres & Species à nullo Ichthyologorum adhucdum constituta esse animadvertabam; hinc magno nisu omes Piscium partes examinere incipiebam, ut viderem quaenam illorum partes secundum Numerum, Figuram & situm maxime convenirent, & quaenam maxime discreparent, imprimis in Piscibus facie externa convenientibus, unde *Characteres Generum* & ipsa *Genera* nata sunt […]" *Icht.*, *Praefatio authoris*, sig. *r.

[3] Broberg, *Carl Linnaeus*, 142.

[4] John Heilbron, "Introduction," in *The Quantifying Spirit in the Eighteenth Century*, eds. Tore Frängsmyr, J.L. Heilbron, and Robin E. Rider (Berkeley: University of California Press, 1990), 2.

[5] J. Andrew Mendelsohn, "The World on a Page: Making a General Observation in the Eighteenth Century," in Daston and Lunbeck, *Histories of Observation*, 69–89.

from which correlations might be deduced.[6] Analogous to this development, naturalists like Artedi and Linnaeus increasingly set their sights on arriving at uniform and consistent principles with which they could name, describe and classify minerals, plants and animals.[7] In formulating these principles, numbers and measurements played a role to such a considerable extent that historians have characterized such pursuits as mathematical, arithmetical, or geometrical.[8]

But how could one quantify a fish? Plants and animals were not that easily condensed in formulae, precisely because of the sheer variety of parts, shapes and colours they exhibited. While categorisations of nature based on morphological features had been around for quite some time, as we have seen in the previous chapters, over the course of the eighteenth century naturalists began to place strong emphasis on the enumeration of characteristics that they considered consequential, such as the pistils of flowers or, in the case of Artedi, the fin rays of fish. Artedi's ambition to design a comprehensive system to classify nature was thus not, in itself, unique. The seventeenth and eighteenth centuries in particular saw a proliferation of competing models aimed at classifying animals based on their physiologies. The one that Artedi devised for fish proved to be particularly successful however, and naturalists would apply his system in their examinations of fish for decades to come. Bloch, the subject of the next chapter, was one of them.

What makes Artedi's book a compelling source is its painstaking discussion of the principles that underpin his classification, and how he equates his method with the self-defined field of 'ichthyology.' His work offered rules for how ichthyology should be done – and by whom. As such, it almost reads like a handbook or code of practice. That there was a need for ichthyologists was, according to Artedi, demonstrated by the enigmatic case of the siren. The question of whether such a being existed, and how it fitted into the larger scheme of creation if it did, had

[6] Lorraine Daston, "Super-Vision: Weather Watching and Table Reading in the Early Modern Royal Society and Académie Royale des Sciences," *Huntington Library Quarterly* 78, no. 2 (2015): 189.
[7] John E. Lesch, "Systematics and the Geometrical Spirit," in Frängsmyr, Heilbron and Rider, *The Quantifying Spirit*, 75.
[8] See: Heilbron, "Introduction," 20–21; Lesch, "Systematics and the Geometrical Spirit," 73–111; William T. Stearn, "Carl Linnaeus and the Theory and Practice of Horticulture," *Taxon* 25, no. 1 (1976): 24.

long been a matter of contention.[9] Merman or mermaid parts were rare and coveted collectables – as we saw in Chapter 2, the Royal Society held the rib of a merman in its Repository.[10] Artedi included the siren as a genus belonging to his order of cetaceans, or whale-like fishes (which continued to be counted among the fish).[11] He subjected it to the same natural historical principles as other fishes, but the uncertainty surrounding its existence put him in a delicate position. It led him to exclaim: "if only there were a true Ichthyologist, that could examine this animal, and find whether it is a fable, or a true fish? Not having seen the matter for myself, I prefer to not form a judgment, rather than to make any bold claim."[12] A 'true ichthyologist', then, could settle the matter, after having had the opportunity to examine a specimen in the flesh.

The example of the siren highlights the questions that form the core of this chapter. How can one arrive at true, certain knowledge about fish? How can all species be fitted into one system? Who gets to decide, and on the basis of what? Who was a true ichthyologist? This chapter explores these questions through the *Ichthyologia*. It examines how Artedi offered the first explicit articulation of what 'ichthyology' was (or, at least, what he thought it ought to be) and how its practitioners were to operate. Besides seeking to understand what this term meant according to Artedi, it is also worthwhile considering how he wielded it to lend credence to his own system. This entails being attentive to the context in which the term 'ichthyology' emerged to denote a specialized knowledge on fish, a process that is seldom reflected upon by historians of natural history. The chapter will first introduce Peter Artedi, and shed light on his attempts to establish his name as a naturalist. It will then look more closely into his *Ichthyologia* and analyze its

[9] A standard work on sirens in early modern Europe is Bernd Roling, *Drachen und Sirenen: Die Aufarbeitung und Abwicklung der Mythologie an den europäischen Universitäten* (Leiden: Brill, 2010).

[10] See: Marjorie Swann, *Curiosities and Texts: The Culture of Collecting in Early Modern England* (Philadelphia: University of Pennsylvania Press, 2001), 28; Tara E. Pedersen, *Mermaids and the Production of Knowledge in Early Modern England* (Farnham: Ashgate, 2015), 51; Eric Jorink, *Reading the Book of Nature in the Dutch Golden Age, 1575–1715* (Leiden: Brill, 2010), 295, 298, 310–311.

[11] Artedi postulated that while most fishes respired through gills, some species of fish could also breathe through lungs. Linnaeus later ruled that cetaceans were mammals and not fish: see Carl Linnaeus, *Systema naturae*, ed. 10 (Stockholm: Lars Salvi, 1758), 17.

[12] Original Latin: "Utinam existeret verus Ichthyologus, hoc qui examinaret animal, fabula utrum sit, an verus piscus? De re non visa potius est non judiciare, quam audacter quid pronuntiare." *Icht.*, *Genera piscium*, 81.

structure and the rhetorical strategies it employs. Subsequently, it will examine Artedi's classification system, *viz*. his division into classes, orders, genera, and species. Lastly, it will reflect on what impact the publication of this system had on what was considered to be of import to learned inquiries into fish, and how, by privileging certain characteristics of fish over other ones, it prescribed which aspects of the piscine population should be studied, preserved, and presented.

The Short Career of Peter Artedi

Relatively little has been, so far, published on Artedi.[13] He was born in 1705 in the Swedish province of Ångermanland, in a family of modest means. His father was a minister in the Anundsjö parish. When the family moved to the coastal province of Nordmaling in 1716, Artedi was sent to grammar school in Härnösand – where he spent his free hours collecting plants and dissecting fish.[14] As he was expected to follow in his father's footsteps and become a clergyman, he enrolled at the School of Divinity at Uppsala University in 1724 with the support of an annual stipend.[15] After two years, however, he switched to the faculty of medicine so that he could fully apply himself to the study of natural history.[16] He mostly worked alone, not being surrounded by students as eager as he. This changed when the young Linnaeus arrived at Uppsala university in 1728. Linnaeus, who came from a similar humble background, had transferred from Lund to take up the study of natural history. The students struck up a friendship based on their shared enthusiasm. For the next seven years, they examined nature in tandem. Three manuscripts that Artedi produced in the late 1720s are still

[13] The most extensive biographical sketch is well over a century old, *viz*. that of Einar Lönnberg, *Peter Artedi: A Bicentenary Memoir Written on Behalf of the Swedish Royal Academy of Science*, trans. W.E. Harlock (Uppsala: Almqvist & Wiksells, 1905). More recent publications are, in chronological order, Daniel Merriman, "Peter Artedi – Systematist and Ichthyologist," *Copeia* 25, no 1 (1938): 33–39; Gunnar Broberg, "Petrus Artedi in his Swedish Context," in *Proceedings of the Fifth Congress on European Ichthyology*, eds. Sven O. Kullander and Bo Fernholm (Stockholm: Swedish Museum of Natural History, 1987): 11–15; and Alwhyne Wheeler, "Petrus Artedi, Founder of Modern Ichthyology," in Kullander and Fernholm, *Proceedings of the Fifth Congress on European Ichthyology*, 3–10.
[14] Lönnberg, *Peter Artedi*, 5; Artedi's father had "been admonished by the bishop on account of his connection with an adventuress, Maja Stina Fröling, who had acquired both the parish funds and the little money he had […]," see: Broberg, "Petrus Artedi in his Swedish Context," 11.
[15] Ibid., 15.
[16] Some of his lecture notes and a bound manuscript of book summaries remain. The letter is glued to the inside of the cover of the latter (communication via email with Thomas Artedi, descendant of the Artedi family). Kungliga Biblioteket (hereafter KBS), Stockholm, MS X1002; I used the transcription offered at http://artedi.nu/?page_id=24 (last accessed 9 April 2021). I thank Anna Svensson for translating this letter into English.

extant: an overview of the herbs and trees of Nordmaling; a classification system for hirsute animals, and a catalogue of fish of the Baltic region.[17] Each of these works, to be discussed in more detail below, reveal his preoccupation with the categorization of species. It was also around this time that he started preparing his extensive manuscript on the study of fish.[18] Linnaeus recounts how, on leaving Uppsala, they promised one another that should either of them die, the survivor would see to it that their late friend's observations and investigations would be published.[19]

A decade after enrolling at Uppsala University, Artedi left Sweden to seek out new flora, new fauna and, most pressingly, new opportunities. In September 1734, he set sail for England.[20] He visited naturalists and collections. He then set course for the Dutch Republic in the summer of 1735, where he was, by chance, reunited with Linnaeus in Leiden. Linnaeus had received his doctorate at the University of Harderwijk a month previously. He had also been commissioned by the wealthy merchant banker George Clifford (1685–1760), to curate the garden of his estate Hartekamp, near the village of Heemstede. Upon learning of Artedi's financial struggles, Linnaeus introduced him to the wealthy apothecary and collector Albertus Seba (1665–1736), who commissioned Artedi to describe the fish in his collection. The manuscript containing his notes still remains, and shows how he carefully described and classified these species.[21] Before he could complete the task, however, Artedi drowned in an Amsterdam canal after a convivial evening at Seba's house in 1735.[22] Now that his friend's life had been

[17] Peter Artedi, *Kårt Förtekning på de Träen, Buskar åg Örter, såmm wäxa sponté wid Nordmalings Prästebord äller i de närmaste byar där åmmkring Äfter Dänn Alldra-simplaste åg Klaraste Methoden i årdning satte av Petro Arctædio A:o 1729 in Februario*. Special Collections Department of Uppsala Universitetsbibliotek (hereafter UUB), D 82 a; *Catalogus Piscium Maris Balthici ut et Fluviorum ac Lacuum Sveciae*, BL, Add MS 3870; and *Idea Institutionum Trichozoologiae*, Bergius Library, Universitetsbibliotek Stockholm (hereafter SUB), Stockholm, H.VII.8.1.n.4.

[18] In the preface, dated 1735, Artedi explains that he had began his examination of fishes eight years ago. *Icht.*, *Praefatio authoris*, n.p.

[19] Lönnberg, *Peter Artedi*, 22.

[20] Merriman, "Peter Artedi," 35.

[21] Peter Artedi, *Manuscriptum ichthyologicum quod Petrus Artedi elaboravit in usum Thesauri Sebani*, Library of Congress (hereafter LC), Washington D.C., QL618.15 A78 1735; it is mentioned in Pietsch and Aili, "Peter Artedi's Catalogue," 3, and described in more detail in Peter Merriman, "A Rare Manuscript Adding to our Knowledge of the Work of Peter Artedi," *Copeia* 2, no. 1 (1941): 64–69. This is the manuscript Margócsy writes having looked for in vain in *Commercial Visions*, 243.

[22] The possibility that this unfortunate event might not have been, in fact, an accident is explored in a murder mystery by Theodore W. Pietsch, *The Curious Death of Peter Artedi: A Mystery in the History of Science* (New York: Scott & Nix, 2010).

brought to an abrupt halt, it was left to Linnaeus to prepare his nearly finished manuscript on fish in print. Although Seba initially was unwilling to release the manuscript,[23] Linnaeus managed to secure it for a little less than 100 guilders with the financial support of his patron Clifford.[24] He finally published the *Ichthyologia* in 1738.

In his recent biography of Linnaeus, Gunnar Broberg has characterized Artedi as one of the big mysteries in Swedish history of science.[25] It is, indeed, not exactly easy to examine Artedi's life. He died young and left relatively few sources behind. Most of what is known about him comes from the biography that was written by his much better-known friend and collaborator Linnaeus, and which opens the *Ichthyologia*. As a result, Artedi's name has become almost inextricably connected with that of Linnaeus. Conversely, few of the works that detail Linnaeus' life mention Artedi's name.[26] The lack of source material surrounding Artedi is especially marked when compared to those concerning Linnaeus, who was very eager to make himself known to the learned world. This contrast becomes clear at once when considering their respective correspondences that have come down to us: while only one letter by Artedi is known to remain, the Linnean Society of London alone retains several thousand letters sent by and to Linnaeus.[27] During his long life, furthermore, Linnaeus published a plethora of natural historical works and issued updates of some of these, like the *Systema naturae* (Leiden, 1735), of which he published the twelfth and last edition in 1767. As we saw, of Artedi's manuscripts, only his *Ichthyologia* appeared in print. The friendship between the two naturalists, and its unfortunate end, offers a striking parallel to that of Willughby and Ray. Linnaeus himself was aware of this connection, likening his collaboration with Artedi to that of the English naturalists.[28]

[23] Seba appeared to have taken the manuscript as collateral for unpaid bills. Broberg, *Carl Linnaeus*, 135.
[24] Ibid., 136.
[25] Ibid., 74.
[26] Lisbet Koerner [Rausing], "Linnaeus in His Time and Place," in Jardine, Secord and Spary, *Cultures of Natural History*, 150.
[27] The Uppsala Universitetsbibliotek holds hundreds more, digitized as part of the *The Linnaean Correspondence* and accessible via http://www.alvin-portal.org (last accessed 9 April 2021).
[28] Charmantier, Johnston and Smith, "The Legacies of Francis Willughby," in Birkhead, *Virtuoso by Nature*, 380.

To the extent that Artedi has been written about (which has, incidentally, seldom been done by historians of science) these writings often have had a commemorative character, sometimes veering into the hagiographic.[29] Due to his rigorous reform of the study of fish, for example, he has often been called the 'father' or 'founder' of ichthyology.[30] On a monument that was unveiled in the Zoological Garden of Amsterdam in 1905, Artedi was crowned 'Prince of Ichthyology', just as Linnaeus has often been dubbed 'Prince of Botanists.'[31] While the classification system he devised was indeed consequential for the natural history of fishes, as the last part of this chapter will discuss in more detail, it is by focussing only on this system's merits that one loses sight of the larger cultural context in which it was devised. An internalist tendency also colours the well-rehearsed discussion of whether it was Artedi who made significant contributions to the development of Linnaeus' taxonomic thinking or vice versa, and whether the two were competitors or close collaborators.[32] This chapter is less concerned with questions of primacy, and all the more with the epistemological meanings of new classification systems for natural history at large, and the emerging field of ichthyology in particular.

In the past years, Linnaeus has been the focus of historical inquiries going well beyond a celebration of his accomplishments to in-depth studies of his ideas and working practices; so much so that Linnaean studies has become a flourishing subset of the history of science.[33] Some of the insights on Linnaeus' work that have emerged from this scholarship also pertain to Artedi's life and works. Both Artedi and Linnaeus developed a classification system that entailed a hierarchical taxonomy based on clearly defined rules and proposed a reform of naming practices. Although Artedi never used the kind of binomials that

[29] Such as Lönnberg, *Peter Artedi* and the Dutch translation by C. Kerbert, *Peter Artedi 1705–1785, Rede uitgesproken bij de onthulling van zijn gedenkteeken, in den tuin van het Koninklijk Zoölogisch Genootschap "Natura Artis Magistra"* (Amsterdam: J.H. de Bussy, 1905).

[30] Daniel Merriman, "Peter Artedi – Systematist and Ichthyologist," *Copeia* 25, no 1 (1938): 33; Alwhyne Wheeler, "Petrus Artedi, Founder of Modern Ichthyology," in Kullander and Fernholm, *Proceedings of the Fifth Congress on European Ichthyology*, 6.

[31] Original Latin: "Ichthyologorum longe princeps", Kerbert, *Peter Artedi*, 15.

[32] Cf. Broberg, *Carl Linnaeus*, 74; Lönnberg, *Peter Artedi*, 37–38; Merriman, *Peter Artedi*, 36.

[33] Hanna Hodacs, Kenneth Nyberg and Stéphane Van Damme, "Introduction: De-centring and Re-centring Linnaeus," in *Linnaeus, Natural History and the Circulation of Knowledge*, eds. Hodacs, Nyberg and Van Damme (Oxford: Voltaire Foundation, 2018), 9–15.

Linnaeus introduced in his *Species plantarum* in 1753, he did, as we will see, have specific ideas about how species and genera names should be selected. This chapter can thus draw on the work done in Linnaean studies to better situate and understand Artedi and his work, and the implications of his system for the field of natural history. At the same time, it is perhaps precisely by looking at this, still rather unknown, character bent upon establishing a place for himself in the study of natural history, that light can be thrown on the efficacy of various strategies for doing so.

The similarities between Linnaeus' and Artedi's approach to natural history are not surprising. After all, they spent the larger part of their student days (from the late 1720s to early 1730s) in close contact. We can infer from Artedi's manuscripts that he spent much of his time observing his immediate, natural surroundings, examining plants, mammals, and fish. Given that his species descriptions include some subsurface anatomical detail that extends beyond those features visible on the outside of the fish, we can conclude that he must have occasionally performed dissections. Linnaeus devoted his days to similar pursuits. As he explains, he had daily meetings with Artedi during which they disclosed whatever they had discovered.[34] Together, they discussed how they might bring order to nature's varied productions. Their collaboration also entailed competition. Linnaeus remarks how after a few years and some "[…] protracted labour to attain premier position in Ichthyology, I was finally fain to admit my inferiority to my rival, and thenceforth I left that subject entirely in his hands, as also the study of Amphibia, while, on the other hand, he willingly acknowledged that I was ahead of him in knowledge of Birds and Insects."[35] Linnaeus and Artedi thus each came to focus themselves on particular types of animals.

Artedi's zeal for classification is already evident in his earliest manuscript. In February 1729, he completed a flora of his native Nordmaling under the title *Kårt Förtekning på de Träen, Buskar åg Örter, såmm wäxa sponté wid Nordmalings*

[34] Carl Linnaeus, "Vita authoris," in Artedi, *Ichthyologia*, sig. *4r.
[35] Original Latin: " […] certabat uterque nostrum de victoria obtinenda in Ichthyologicis, donec post diuturnos labores ei victas deberem dare manus, totum hinc studium hoc ipsi commisi, ut & amphibiorum notitiam; contra vero in Avium & Insectorum notitia ille libens mihi cedebat primas." Ibid., sig. *3v, adapted translation from Lönnberg, *Peter Artedi*, 11.

Prästebord äller i de närmaste byar där åmmkring [A Short List of the Trees, Bushes and Herbs that are Indigenous to the Glebe-Lands in Nordmaling and the Villages Lying in its Immediate Vicinity].[36] The title went on to indicate that it was "put in order after the most simple and clear method";[37] something that, as we will see, was a recurrent theme for Artedi. His taxonomical organisation was inspired by the system of the French naturalist Joseph Pitton de Tournefort (1656–1708).[38] In his *Institutiones rei herbariae* (1700), de Tournefort had made a clear distinction between a genus and species in the realm of plants, grouping those plants together that resembled one another in flower and fruits.[39] Genera were collections of species that corresponded to one another in certain parts (for example, the number, shape and symmetry of the petals), and differed in these respects from the members of other genera.[40] Artedi came to consider the rank of genera as an integral part to the study of natural history because of its value for grouping species. In his (undated) manuscript entitled *Idea Institutionum Trichozoologiae* [Outline of principles of the zoology of hirsute animals] he proposed a classification scheme for mammals that subdivided them into genera.[41] He did the same for fish, as will be discussed in more detail later in this chapter.

Artedi and Linnaeus came into contact with contemporary ideas in natural history through their university's library, rather than through lectures. Linnaeus complained about the lack of instruction in the field of natural history at their university, saying that: "I myself never had the opportunity of attending a single lecture on Botany, either private or public."[42] After the two students had finished their degree, and their funding had run out, they sought to leave Uppsala and try their hand elsewhere. In order to effect this, they applied for stipends with

[36] As cited in note 16.
[37] Original Swedish: "*Äfter Dänn Alldra-simplaste åg Klaraste Methoden i årdning satte* […]" UUB, D 82 a, title page.
[38] Artedi probably took hold of the Tournefort's work through Lars Roberg (1664–1742), who was professor of medicine at Uppsala University. A catalogue of his library, which can be found in UUB, D60, shows he possessed at least one of Tournefort's botanical books.
[39] Yves Cambefort, "How General are Genera? The Genus in Systematic Zoology," in *The Oxford Handbook of Generality in Mathematics and the Sciences*, eds. Karine Chemla, Renaud Chorlay, David Rabouin (Oxford: Oxford University Press, 2016), 260.
[40] This definition comes from Merriman, "Peter Artedi – Systematist and Ichthyologist," 38–39.
[41] The contents of this manuscript have been transcribed in Orvar Nybelin, "Tvenne Opublicerade Artedi-Manuskript," *Svenska Linnésällskapets Årsskrift* 18 (1935): 58–77.
[42] Lönnberg, *Peter Artedi*, 8.

the Royal Society of Letters and Sciences in Uppsala (known as the *Societas regia literaria et scientarium*). This society, modelled after the Royal Society in London, had been founded in the early eighteenth century.[43] Linnaeus subsequently received the support of the Uppsalian Society for his natural historical expedition to the province of Lapland in 1732.[44] Artedi seems to have applied for another funding stream offered by this academy, the 'Stipendium Stiglerianum' set up by the merchant Jacob Stiegler (1649–1716) in May 1734; probably without success, for he later appealed to his inlaws Peter Biur and Jonas Liungberg for funding.[45] One still needed to be prosperous to be a naturalist.

Artedi's entreaty to his inlaws was successful, and he ventured to London. As the previous chapters has shown, this was a suitable destination for someone interested in natural history. Artedi had prepared this trip well. Besides securing financial support from his inlaws, he also capitalized on his connections in another way. He found Jacob Serenius (1700–1776), chaplain to the Swedish congregation in London, willing to write him a letter of recommendation to Hans Sloane, who had by this time become the president of the Royal Society. In this letter, Serenius stated that he thought that Sloane would be "pleased to grant him [Artedi] when you find his skill in ictyology [*sic*] and other parts of natural history."[46] When Artedi visited Sloane in London, he brought along a gift: his manuscript entitled *Catalogus Piscium Maris Balthici ut et Fluviorum ac Lacuum Sveciae* [Catalogue of Fish in the Baltic Sea and the Rivers and Lakes of Sweden]. It was a result of his prolonged study of fishes in his vicinity; the last few pages gave a brief summary of the *Ichthyologia*, which he probably intended to publish in the foreseeable future.[47] Artedi presented himself, and was presented by others,

[43] Tore Frängsmyr, "Linnaeus in his Swedish Context," in *Contemporary Perspectives on Linnaeus*, ed. John Weinstock (Lanham: University Press of America, 1985), 183–186.
[44] For the background of this enterprise, see: Lisbet Koerner [Rausing], *Linnaeus: Nature and Nation* (Cambridge, Mass.: Harvard University Press, 1999), 56–81.
[45] Application, dated 22 May 1734; UUB, Waller Ms se-00136. This stipend is described in *Samling af testamenten och författningar om stipendien* (Uppsala: Johan Fr. Edman, 1795), 62–78.
[46] Jacob Serenius to Hans Sloane, 26 October 1734 (OS) as reproduced in Orvar Nybelin, "Kring Petrus Artedi's vistelse i England 1734-1735," *Svenska Linnésällskapets Årsskrift* 49 (1966): 23–25.
[47] BL, Add MS 3870. The contents of this manuscript have been reproduced in Nybelin, "Tvenne Opublicerade Artedi-Manuskript," 78–90. For an English translation, see: Theodore W. Pietsch and Hans Aili, "Peter Artedi's Catalogue of the Fishes of the Baltic Sea: An English Translation with an Introduction and Commentary," *Zoological Journal of the Linnean Society* 189, no. 3 (2020): 975–997.

as a naturalist particularly skilled in the study of fishes. As broad as his natural historical interests ranged, he made name as an ichthyologist.

The species descriptions in the *Ichthyologia* make it possible to retrace some of Artedi's itinerary in London. He made use of the opportunity to study Sloane's expansive collection by describing some of its species of boxfish.[48] Sloane was also the patron of James Salter (d.1728), who preferred to call himself Don Saltero, and owned a Chelsea coffee house in which he displayed a broad range of *artificialia* and *naturalia*.[49] In this coffee house, Artedi further saw species of boxfish.[50] He took note of the whale that found its way into the city in November 1734.[51] Artedi also visited the Swedish publican Lars Lilja (d.1744) at his establishment in Shadwell, as well as the taverns called Nag's Head, Green Dragon and White Bear.[52] These pubs were frequented by sailors returning from a journey to faraway places, and Ovar Nybelin has conjectured that they may have used dried exemplars of fish acquired during these travels to pay their drinking bills – a hypothesis that does correspond to the value that was attributed to rare natural historical objects.[53] Artedi's visits to collections in London, and later Amsterdam, led him to remark that the fish he had seen were "altogether rare and curious, so I have seen more curiosities in this part of natural history than someone who has travelled through all of Europe."[54] As centres of global commerce, after all, these cites were hubs for the study of specimens from faraway places.

After a brief, albeit expensive, stay in London Artedi travelled to the Dutch Republic in 1735, with the hope of attaining a doctorate in medicine.[55] He had, however, used up all his financial reserves and could not afford to enrol straightaway. Linnaeus' introduction to Albertus Seba must have appeared propitious. Seba was a renowned collector of *naturalia* from the East and West Indies and beyond –

[48] Original Latin: "vidi in museo Hans Sloane", "vidi apud Sir Hans Sloane", *Icht.*, *Genera piscium*, 56–57.
[49] For an idea of the contents of this collection, see: James Salter, *A Catalogue of the Rarities, to be Seen at Don Saltero's Coffee House*, vol. 10 (London: s.n., 1731).
[50] *Icht.*, *Genera piscium*, 58.
[51] Original Latin: "Ex observatione propria, Londini 1734 in Novembri", *Icht.*, *Genera piscium*, 77 and "visa a me Londini anno 1734" and *Icht.*, *Descriptiones specierum*, 107.
[52] Nybelin, "Kring Petrus Artedi's vistelse i England 1734–1735," 27.
[53] Ibid., 10–12.
[54] Original Swedish: " […] allesammans rare, och curieuse, så att jag sedt flera curieusiteter utj den delen af Hist. naturali, än den som rest genom hela Europa." KBS, MS X1002.
[55] Merriman, "Peter Artedi," 35.

tsar Peter the Great (1672–1725) had visited his collection in Amsterdam and purchased it for an enormous sum in 1716.[56] Seba had meanwhile built another impressive collection of natural curios, which he was codifying into print under the abbreviated title *Thesaurus* [Treasure].[57] In the one letter of Artedi's that has survived, written to his relatives a few days before his death in September 1735 in Amsterdam, Artedi narrates that: "[t]he first time I was in Amsterdam, there was much talk of an Apothecary, that will soon publish a great work of natural history, I visited him, and when he noticed that I was at home in Ichthyology, he convinced me to stay on a while in Amsterdam and describe his East-Indian and American fish, for he does not know any of them."[58] Artedi's intimate knowledge of the natural history of fish, which he explicitly refers to as ichthyology, made him a suitable candidate for this task.

Artedi assumed this task on the understanding that his name would be included in the work as an author.[59] It is likely that he had seen the book's first volume, which was published in 1734. The second volume had either just appeared or was close to doing so. In his letter, Artedi states to have heard that Her Majesty of Sweden, Queen consort Ulrika Eleonora (1688–1741), had bought these splendidly illustrated volumes for the library of Drottningholm Palace. Being a recognized contributor to Seba's project would help further Artedi's reputation. Possibilities like these seem to have been something of a preoccupation for him, as he continued to write: "[i]t is a hard thing when one first begins to show oneself in the world and one's name begins to be known, but can't fulfil his ambition and rise as far as he would wish."[60] He goes on to explain that he was glad to have met Seba, because the commission he received meant that he could exert himself and get something

[56] Margócsy, *Commercial Visions*, 89. For details of the sale, see: Jozien J. Driessen-van het Reve, *De* Kunstkamera *van Peter de Grote: De Hollandse Inbreng, Gereconstrueerd uit Brieven van Albert Seba en Johann Daniel Schumacher, uit de Jaren 1711–1752* (Hilversum: Verloren, 2006), esp. 107–117.

[57] Albertus Seba, *Locupletissimi rerum naturalium thesauri accurate description et iconibus artificiosissimis expressio* (Amsterdam: apud Wetstenium, & Gul. Smith, & Janssonio-Waesbergios, 1734–1765).

[58] Original Swedish: "När jag första gången kåm hit till Amsterdam taltes mycket åm en Apothecare, såm härstädes gier ut ett stort werck utj historia Naturali, jag hälsade på hånom, och effter han märchte jag war hemma utj Ichthyologien, så öwertalte han mig att bliwa en tid qwar i Amsterdam och gifa en beskrifning på hans Ost-Indiska och Amerikansca fiskar, ty han kiänner sielf icke en enda." KBS, MS X1002.

[59] Ibid.

[60] Original Swedish: "Det är en swår ting när man först begynner wisa sig i werlden och ens namn begynner bli bekant att man då intet kan hålla fort och bringa det så högt såm man vill, hwilket åffta obigerar en att han icke wåndar att bliwa det han kan." Ibid.

for his trouble. The aforementioned manuscript of the original descriptions Artedi made of these specimens has the title *Manuscriptum ichthyologicum quod Petrus Artedi elaboravit in usum Thesauri Seba* [Ichthyological manuscript compiled by Peter Artedi for the use of Seba's *Thesaurus*].[61] Just like Artedi's other manuscripts, it offers species descriptions listing the main characteristics of each species ordered according to their genus; he used some of these descriptions in the *Ichthyologia*.[62]

While Artedi's name was indeed mentioned in the preface to the third volume of the *Thesaurus*, which was entirely devoted to aquatic flora and fauna, he would never see it in print (nor, incidentally, would Seba – the book was finally published in 1759).[63] Artedi died before his efforts to establish a name for himself as a naturalist had borne fruit. Linnaeus, by way of contrast, would have ample chance to make his name, and he took full advantage. Through the patronage of various wealthy individuals and the awarding of various stipends, Linnaeus published a plethora of works which succeeded in getting both his name and his ideas out onto the stage of the natural historical world. In 1741, he was appointed professor in Medicine, with special emphasis on botany, at the University of Uppsala. He became rector in 1750, and was ennobled in 1761, all the while continuing his research.[64]

Even though Artedi's life was cut tragically short, the career trajectories both he and Linnaeus travelled illustrate some of the hardships that aspiring naturalists encountered when building a name for themselves. As with other fields of knowledge, salaried positions in the field of natural history remained few and far between, so that the ability to dedicate one's life towards investigating nature often depended on one's financial resources, or those of one's family. It is apparent from the little remaining material pertaining to Artedi just how preoccupied he

[61] LC, QL618.15 A78 1735; it is mentioned in Pietsch and Aili, "Peter Artedi's Catalogue," 3, and described in more detail in Peter Merriman, "A Rare Manuscript Adding to our Knowledge of the Work of Peter Artedi," *Copeia* 2, no. 1 (1941): 64–69. This is the manuscript Margócsy writes of having looked for in vain in *Commercial Visions*, 243.
[62] Its title page states it is "an ichthyological treatise describing more than a hundred of the principal fishes of Amboina and Surinam, which are arranged according to the natural method, with their distinct genera and new specific differences, and with the principal synonyms used by authors in previous descriptions"; translation taken from Merriman, "A Rare Manuscript," 66–67.
[63] Artedi's descriptions were edited by Arnout Vosmaer (1720–1799), who would later be appointed director of the menagerie of Stadholder William V in The Hague. See: Margócsy, *Commercial Visions*, 98, 105–106; L.B. Holthuis, "Albertus Seba's "Locupletissimi rerum naturalium thesauri …" (1734–1765) and the "Planches de Seba" (1827–1831)," *Zoologische Mededelingen* 43, no. 19 (1969): 243, 247.
[64] For the honours that Linnaeus accrued towards the end of his life, see: Broberg, *Carl Linnaeus*, 339–342.

was with establishing his name. The remainder of this chapter will discuss how Artedi confidently presented a new approach for the natural historical study of fishes, and how he allocated himself an important role in this process.

Demarcating a Field

The *Ichthyologia* was published in 5 volumes in 1738. Linnaeus had lived up to his promise by ensuring the work of his friend made it into print. He found a suitable publisher in Coenraad Wishoff (*c.* 1690–1763), the Leiden bookseller with whom he had printed a few of his own works and who appears to have specialized in scholarly publications.[65] In the newspaper the *Leydse courant*, Wishoff advertised the work alongside Linnaeus' *Classes plantarum* and a reissue of Johannes Swammerdam's 1667 *Tractatus physico-anatomico-medicus de respiratione usuque pulmonum*, revised by Albert von Haller (1708–1777) – some serious scholarly tomes.[66] It praised the *Ichthyologia* as an "opus sine pari, curante Linnaeo", an incomparable work that had been attended to by Linnaeus.[67] No price was listed, but it must have been relatively affordable.[68]

At first sight it appears a quite unassuming book, especially when compared to the luscious, illustrated natural historical folios that were published in the eighteenth century, like Seba's *Thesaurus*.[69] Not only was the *Ichthyologia* published in smaller, cheaper octavo format, but not a single image was to be found amongst its five hundred or so pages. The book opens with the biographical sketch by Linnaeus, as said, followed by Artedi's own preface that expatiates on the genesis, aim and structure of his work. The book comprises five parts, each endowed with its own title page. The first, *Bibliotheca ichthyologia*, offers a bibliographic overview; the second, the *Philosophia*, a theoretical framework laid

[65] Wishoff seems to have specialized in learned books: among his portfolio were works on medicine and natural history, as well as many academic dissertations and a mathematical dictionary. No extensive study on the Wishoff booksellers exists, but they are mentioned in André Bouwman, Ed van der Vlist, Berry Dongelmans and Paul Hoftijzer, eds., *Stad van Boeken: Handschrift en Druk in Leiden, 1260–2000* (Leiden: Primavera, 2008), 202, 223; Rietje van Vliet, *Elie Luzac (1721–1796): Boekverkoper van de Verlichting* (Nijmegen: Vantilt, 2005), 53.
[66] Advertisement for books of Conrad Wishoff, *Leydse Courant*, May 7, 1738, verso.
[67] Ibid.
[68] As has been argued for Linnaeus' similarly slender work (albeit without mention of specific prices), see for example: Broberg, *Carl Linnaeus*, 272; Koerner, *Linnaeus*, 40.
[69] Benjamin Schmidt, *Inventing Exoticism: Geography, Globalism, and Europe's Early Modern World* (Philadelphia: University of Pennsylvania Press, 2015), 18.

out in aphorisms; the third, *Genera piscium*, a discussion of genera; the fourth, *Synonyma*, an overview of synonyms; and the fifth and last, *Descriptiones specierum piscium*, species descriptions of fishes. The third part of the book is preceded by a pair of dedicatory letters from Linnaeus' hand. One is addressed to his maecenas Clifford, praising his financial support in printing this work, the other to Artedi's inlaws Liungberg and Biur, for having done the same.[70] The publication of this work gave Linnaeus the occasion to further strengthen these ties.[71]

Linnaeus had a hand in shaping the book. But how much? As the original manuscript is unfortunately lost, it is difficult to know whether, and to what extent, he altered it in the process of preparing the book for publication. A copy of the manuscript was listed among the sale of the estate of the Leiden naturalist Laurens Theodorus Gronovius (1730–1777), but its subsequent fate is unknown.[72] The *Ichthyologia*'s title page states that Linnaeus had not only saved it from oblivion, but had also examined, adapted and edited it[73] – although Broberg claims that it was the medicine student Tiburtius Kiellman (dates unknown) who actually did the editing.[74] From the inventory of Artedi's possessions that an Amsterdam notary drew up after his death we learn that though Linnaeus did adapt the titles both of the book as a whole and its constituent parts, these parts did, in fact, exist as discrete entities.[75] Some scholars have argued that as Linnaeus mentions in his biographical note that Artedi had read his entire manuscript to him, Linnaeus

[70] *Icht.*, *Genera piscium*, sig. 2r/v and sig. *3r/v.

[71] For a discussion on dedications, see: Rienk Vermij, "On the Function of Dedications in Early Modern Scientific Books," *Nuncius* 33, no. 2 (2018): 171–197.

[72] An annotated copy of the auction catalogue of Lauren Theodorus Gronovius' books lists the sum for which every item was sold, but indicates that the manuscript was '*uytgehouden*', which likely means that it was excluded from sale. *Catalogus librorum exquisitissimorum […] Laurentius Theodorus Gronovius* (Leiden: Th. Haak & socios, nec non J. Meerburg, 1778) at the Koninklijke Bibliotheek (hereafter KB), The Hague, Verzcat. 4612, items 169 and 170 on page 177. See also: Sten Lindroth, "The Two Faces of Linnaeus," in *Linnaeus, The Man and His Work*, ed. Tore Frängsmyr (Berkeley: University of California Press, 1983), 176. At least two other copies of the manuscript were made, one for Clifford and the other for Wishoff, but these have also been lost, see: Hans Aili and Theodore W. Pietsch, "Jacob Theodor Klein's Critique of Peter Artedi's *Ichthyologia* (1738)," *Svenska Linnésällskapets Årsskrift* 97 (2014): 62.

[73] Original Latin: "Vindicavit, Recognovit, Coaptavit & Edidit Carolus Linnaeus", *Icht.*, title page.

[74] Broberg, *Carl Linnaeus*, 136.

[75] Notary minutes, Stadsarchief Amsterdam (hereafter SA), Amsterdam, Archief van de Notarissen, 344 Salomon Dorper, 10695, 30 September, 1735, no. 91. The names of these parts were *Historia literaria ichtiologiae* (probably corresponding to the first part of the printed book) *Prolegomena Institutionum manuscript* (the second part), *Synonymologia manuscript* (the fourth part) and the *Historia piscium universalis manuscript* (the third and/or fifth part). See: Hendrik Engel, "Some Artedi Documents in the Amsterdam Archives," *Svenska Linnésällskapets Årsskrift* 34 (1951): 56–57.

impact on the work was actually rather minimal.[76] If Linnaeus' statement were true, the manuscript must have been as good as finished. But Linnaeus' editorial hand is unmistakably visible in the book whenever he refers to his own *Systema naturae* (Leiden, 1735) and *Fundamenta botanica* (Leiden, 1736), which had not yet appeared at the time that Artedi completed his manuscript. In certain passages Linnaeus explicates his own ideas: "In this part Mr. Linnaeus has acted on his own, since he very recently laid this very axiom in his *Botanica*, which to the greater part is valid in Ichthyology, a few things having been changed, excluded, or added."[77] All in all, Linnaeus appears to have made additions to, rather than any real changes in, the system.

This chapter is not designed to settle the matter of who, precisely, contributed what to Artedi's *Ichthyologia*, but rather to understand how it made an effort to demarcate ichthyology as a separate field of natural history by considering the work both with regard to its content and its paratexts. As said before, the book's modest looks are deceiving. The hefty claims it makes begin with the title. The aforementioned inventory indicates that Artedi had given his manuscript the general title *Institutiones ichthyologiae*.[78] This decision is telling for various reasons. First, it uses the term *ichthyologia*, which was not a common practice at the time; most natural historical works on fish used the term *historia piscium*, and on those few occasions that *ichthyologia* did find its way into a book's title, the term itself was not explicitly addressed or explained.[79] Artedi defined ichthyology [*ichthyologia*] as "the science [*scientia*] that first specifically indicates all parts of the Fish, subsequently exposes the true Genera and Species names, and finally commemorates the noteworthy Characteristics observed."[80] The term *scientia*, too, was laden with meaning, for – as we have seen – it denoted causal, certain

[76] Lönnberg, *Peter Artedi*, 36, cf. Linnaeus, "Vita authoris," *Icht.*, sig. *5v.

[77] As cited in Aili and Pietsch, "Jacob Theodor Klein's Critique," 47. Original quote *Icht.*, *Philosophia*, aphorism 189, at 64. The term "aphorism" will henceforth be abbreviated as aph., as is common in Linnaean studies.

[78] The title of the published work was thus not invented by Linnaeus. Engel, "Some Artedi Documents in the Amsterdam Archives," 56. The contents of this manuscript have been reproduced in Orvar Nybelin, "Tvenne Opublicerade Artedi-Manuskript," 58–77.

[79] See, for instance, Carolus Figulus, *Ichthyologia seu dialogus de piscibus* (Cologne: Eucharius Cervicornus, 1540) and Stephan Schoenevelde, *Ichthyologia et nomenclaturae animalium marinorum, fluviatilium, lacustrium* (Hamburg: ex Bibliopolio Heringiano, 1624).

[80] Original Latin: "Ichthyologia est scientia, quae primum omnes Piscium partes nominatim indicat, deinde nomina Generica et Specifica vera ostendit, & denique Proprietates quasdam observatu dignas interdum commemorat." *Icht.*, *Philosophia*, aph. 5, at 2. Original in emphasis.

knowledge.[81] That, decades later, the article on 'Ichthyologie' in the *Encyclopédie* of Denis Diderot (1713–1784) opened with this triad of indicating and naming parts, naming species and genera, and exposing particularities, attests to the durability of Artedi's definition.[82] A detailed breakdown of what precisely these steps entailed will be provided in the following section.

The second striking thing about the title chosen by Artedi, is that by using 'institutions' [*institutiones*], he underlined that his work was meant to serve as the foundations for this emerging field. The term *institutiones*, after all, had been used to refer to the foundations of learning of a certain branch of knowledge, such as law in Ancient Rome, and was applied to other branches of learning in the early modern period. The aforementioned Tournefort, for example, published the *Institutiones rei herbaria* (Paris, 1700), and the Dutch physician Herman Boerhaave (1668–1738) gave his medical series the title *Institutiones medicae* (Leiden, 1708). Artedi owned an edition of the latter work.[83] His choice of title thus suggests that Artedi longed to give the study of fish a similar foundational and standardised footing. Even if the original manuscript remains elusive, therefore, its title already offers valuable clues as to its author's aspirations. The remainder of this chapter will depart from the printed version of the *Ichthyologia*.

Similar to Linnaeus' *Bibliotheca botanica* (Amsterdam, 1736), the first part of Artedi's monograph is entitled *Bibliotheca ichthyologica.* It offered an *historia literaria ichthyologiae*, a bibliographic overview of ichthyological learning.[84] The genre of the *historia literaria* emerged in the context of sixteenth-century humanistic learning, and entailed a history of all human knowledge recorded in writing.[85] Artedi applied the genre of bibliographic overview to the field of ichthyology, like Linnaeus did for

[81] Pomata and Siraisi, *Historia*, 10.
[82] Original French: "L'affaire de l'Ichtyologie est premierement de distinguer toutes les parties des poissons, par leurs noms propres ; secondement, d'appliquer à chaque poisson ses noms génériques et spécifiques, c'est-à-dire ceux qui constituent son genre et ses espèces ; troisiemement d'exposer quelques-unes des qualités particulières de l'animal." Louis de Jaucourt, "Ichthyologie," in *Encyclopédie ou Dictionnaire raisonné des sciences, des arts et des métiers*, vol. 8, eds. Denis Diderot and Jean le Rond d'Alembert (Neufchâtel: Samuel Faulche, 1765), 483.
[83] SA, 344 Salomon Dorper, 10695, 30 September, 1735, no. 91.
[84] How Artedi managed to consult all these books remains unclear. The inventory drawn up after his death includes the works of Jan Jonston and Willughby and Ray, and were probably on loan from Seba.
[85] Michael C. Carhart, "Historia Literaria and Cultural History: From Mylaeus to Eichhorn," in *Momigliano and Antiquarianism: Foundations of the Cultural Sciences*, ed. Peter Miller (Toronto: University of Toronto Press, 2007), 186–187.

botany.[86] Both works offered insight not only into how these naturalists envisaged the past of these fields of natural historical knowledge, but also their present status and even future directions.[87] The overview was preceded by an index in which the various authors who had written on fishes arranged neatly by time period, from the centuries before Christ up until the moment of Artedi's own writing. In this way, Artedi put himself as the newest in an old and venerable tradition, while indicating that he ushered in a new phase in the study of fishes.

In his bibliographical overview, Artedi briefly summarised the contents of each book he listed and evaluated its merits and pitfalls, discussing its structure, the quality of the images, as well as the style. These book reviews, however concise, offer illuminating insight into his beliefs about how natural history should be done. Several things stand out. First of all, he paid particular attention to whether books displayed a certain method. Artedi distinguished between those natural histories of fishes that were based on some form of method, and those histories without. In assessing the work of others, for example, he uses 'method' for any organizing principles that they may deploy: fish could be grouped according to their external shape (Willughby and Ray), the kind of water in which they dwelled (Rondelet), according to the alphabet (Gessner), or no method may be used at all, and the fish themselves positioned at random (Salviani).[88] He noted, furthermore, if authors had, rather than drawing from their own observations, transcribed the descriptions of others (Jonston, Aldrovandi).[89] In discussing Gessner, he qualified the naturalist's style as discursive, "in the manner of the ancients."[90] Artedi contended that descriptions ought to be short and succinct because diffuse and long descriptions served no purpose. After all, he declared, the one and only goal of natural history was the discovery of the genera and species of *rerum creatarum*, created things.[91]

[86] Gessner also listed earlier authors in his natural historical works, but he did not annotate them as Artedi did; I thank Sophia Hendrikx for sharing this with me.
[87] Alix Cooper, *Inventing the Indigenous: Local Knowledge and Natural History in Early Modern Europe* (Cambridge: Cambridge University Press, 2007), 156.
[88] *Icht.*, *Bibliotheca ichthyologia*, 64–65.
[89] Ibid., 63.
[90] Original Latin: "more veterum." Ibid., 30. Incidentally, the year of publication that Artedi gives for Gessner's *Thierbuch* (1558) is incorrect.
[91] Original Latin: " […] diffusae & longae descriptions proprietatum & qualitatum in Ichthyologia & reliqua Historia Naturali inutiles sunt, quatenus vera & naturalis methodus in dignoscendis Generibus & Speciebus rerum creatarum, unicus & praecipuus finis Historiae Naturalis fit." *Icht.*, *Philosophia*, aph. 6, at 2.

On the whole, little is known about Artedi's religious ideas, but his use of the phrase *rerum creatarum* does point to the physico-theological underpinnings of his work. He believed that the task of the naturalist was to uncover God's divine blueprint by finding patterns and order in created beings: in the case of fishes, this meant looking carefully at their physical features, such as the number and position of their fins and teeth. Artedi took a quantifying approach in which number, order and structure were key concerns – very much in the spirit of early-eighteenth century science. The system that emerged from this, Artedi believed, would then reflect the actual structure that God had unfolded, and thus constitute a true and natural system. He does not explain what precisely made a system natural and true. The search for the 'natural method' in arranging plants and animals was a discussion of much longer standing and continued to be hotly debated in the eighteenth century.[92] The natural method entailed grouping plants alongside each other according to their morphological similarities, and it was widely held that by employing it one could uncover the blueprint of Creation.

As it perhaps is today, therefore, 'method' was a relatively loose concept. A late seventeenth-century dictionary, for example, dubbed as methodical that which was done "with art and with a certain order."[93] As mentioned above, in discussing the work of others, Artedi equated method with a degree of structure in presentation. When it comes to his own work, however, Artedi uses 'method' in a different way. Here, he defines his classification system as a 'natural method', which is also the 'true' method (which he opposed to an 'artificial method', which is 'false'). Linnaeus famously brought forward an 'artificial system' for classifying plants, also known as the sexual system. It entailed observing flowers' stamen and pistils to group them into genera, and was easy to understand and apply. This user-friendliness set it apart from the natural method, which was so immensely complex that Linnaeus thought it might well never be understood by anyone.[94] As he put it, "[n]atural orders are useful for getting to know the nature of plants; artificial ones for telling

[92] For the background to this discussion in the seventeenth and eighteenth centuries, see: Scharf, "Identification Keys," 86–91; Lesch, "Systematics and the Geometrical Spirit," 76–80; and James L. Larson, "Linnaeus and the Natural Method," *Isis* 58, no. 3 (1967): 304–320.

[93] Original French: "Ce qui se fait par art, & avec un certain ordre." Antoine Furetière, *Dictionnaire universel*, vol. 2 (The Hague and Rotterdam: Arnoud and Reinier Leers, 1701), s.v. methodique.

[94] Scharf, "Identification Keys," 94.

different plants apart."[95] He even likened the effort of finding a natural method to that of squaring the circle – a mathematical metaphor that underlined his search for certitude in natural history.[96] In contrast to Linnaeus, who contended that a natural division was what the naturalist should strive for but was not attainable in practice, Artedi did believe that arriving at a natural system was possible.[97]

Certain kinds of knowledge had no place in this quest. While Artedi acknowledged that there were different authors who had written about fish, doing so for various reasons and to diverse ends, he declared that he would omit writings from "Physicians, Chemists, Physicists, Mechanics, Oeconomists, and of those who wrote of Culinary matters or about Fishery."[98] He does not specify what these categories of fishy knowledge entail, but only qualifies them as being *amethodicis*, or 'without method', and therefore not meriting a place in his ichthyological work. In practice, however, the groups he specified relied, albeit to varying degrees, on their own form of method. Chapter 2 has shown, for example, how fishermen distinguished species by their physical resemblances or differences. Artedi in this case, therefore, did not equate method with *any* systematic manner, but with *his specific* method of classification that he delineated in his own work. The exclusion of knowledge with regards to culinary matters or fishery constituted a clear move away from earlier traditions of learned inquiries into fish; as we have seen in the previous chapters, natural historical volumes that discussed fish published in the sixteenth and seventeenth centuries encompassed remarks on the culinary uses of mackerel, or longer discourses on subjects such as the curing herring for trade and commerce, as found in *Historia piscium*. In examining Artedi's definition of ichthyology (and, by extension, of an ichthyologist), attention thus should not be paid only to what it includes, but also what it excludes.

Like Artedi, Linnaeus attempted to organize and classify those that inhabited his world, though of course this was the world of plants, and included gardeners

[95] Linnaeus, *Genera plantarum*, as cited in Scharf, "Identification Keys," 95.
[96] As cited in Larson, "Linnaeus and the Natural Method," 319.
[97] On Linnaeus' notion of a "natural" system for botany, see: Staffan Müller-Wille, "Collection and Collation: Theory and Practice of Linnaean Botany," *Studies in History and Philosophy of the Biological and Biomedical Sciences* 38, no. 3 (2007): 541–562.
[98] Original Latin: "Alii vero pro varia intentione & fine aliter quoque de Piscibus agunt, ut Medici, Chemici, Physici, Mechanici, Oeconomi, Coquinarie et rei Piscariae scriptores, ut jam de Amethodicis nihil dicam." *Icht.*, *Philosophia*, aph. 6, at 2.

and horticulturists.[99] For the botanist, he drew up the following job description: "he who knows to call similar vegetables with similar names and distinctly different plants with distinctive names, intelligible to everyone."[100] In his *Fundamenta botanica* (Leiden, 1736) Linnaeus had distinguished between *botanici*, who operated according to the systematic principles of botany, and *botanophili*, whose engagements with plants were not based on the fundaments of botany, such as anatomists, gardeners and physicians.[101] Here it is pertinent to note that Linnaeus himself was involved in horticulture and that this garden work informed his theoretical, taxonomical thinking, again indicating that in truth these apparently distinct areas of knowledge were not fenced off from one another.[102] Both Artedi and Linnaeus demarcated their particular kind of learned, systematized knowledge from practical or artisanal knowledge. They also set natural historical knowledge apart from the kind of knowledge they considered the prerogative of physicians and anatomists: in discussing the various parts of fish, for example, Artedi remarked that the study of their blood vessels and nerve systems did not properly relate to ichthyology, but rather to the domain of comparative anatomy, and that it, therefore, did not require discussion in his book.[103] What all of this makes abundantly clear was that, for Linnaeus and Artedi, not anyone who busied themselves with plants or fish was to be considered a botanist or an ichthyologist, respectively.

The orderly manner in which the contents of the *Ichthyologia* are structured, not least the regular use of lists, is of particular note. The authors discussed in the *Bibliotheca ichthyologia*, for instance, are divided into methodic authors and a-methodic authors.[104] Artedi's reviews of their publications take the form of consecutively numbered lists. While lists had figured in natural historical studies

99 Hodacs, Nyberg and Van Damme, "Introduction," 3.
100 Linnaeus, *Genera plantarum*, 1, as translated in Staffan Müller-Wille and Karen Reeds, "A Translation of Carl Linnaeus's Introduction to *Genera plantarum* (1737)," *Studies in History and Philosophy of Biological and Biomedical Sciences* 38, no. 3 (2007): 265.
101 Original Latin: "BOTANOPHILI (6) sunt, qui vegetabilia, licet non ex fundamentis Botanicis (151), tractant, ut: *Anatomici*, *Hortulani*, *Medici*, *Anomali*." Carl Linnaeus, *Fundamenta botanica* (Amsterdam: Salomon Schouten, 1736), aph. 43, at 4.
102 See, for example: Stearn, "Carl Linnaeus," 21–31.
103 Original Latin: "Descriptio Arteriarum, Venarum, Vasorum Lymphaticorum & Nervorum in Piscibus, non proprie ad Ichthyologiam seu Historiam Piscium naturalem, sed ad Anatomiam Comparatam pertinet […]" *Icht.*, *Philosophia*, aph. 113, at 44. Original in emphasis.
104 Linnaeus also arranged the authors discussed in his *Bibliotheca botanica*, see: John L. Heller, "Linnaeus's *Bibliotheca Botanica*," *Taxon* 19, no. 3 (1970): 363–411, esp. 365.

for centuries, the rigorous way in which they are applied in Artedi's book is remarkable, as almost every part of it takes the form of a list, table or index: not only the descriptions of genera and species of fish, but also the people writing and otherwise engaged with fish. James Delbourgo and Staffan Müller-Wille have characterized lists as tools that "simultaneously inventoried and organized the accumulated world."[105] To this it may be added that, besides offering a practical way for overwhelmed naturalists to keep track of the abundance of knowledge available to them, the making of lists also gave them an opportunity to actively shape the corpus.

Other tried and tested ways of structuring knowledge could be found in scholastic works. In explaining his principles for the study of fish, Artedi presents them in the form of a *definitio* followed by a *scholion*: a definition of a certain concept and a commentary to that definition. This is the structure of the *disputatio* that was very common to the scholastic method that still predominated university curricula.[106] In other instances, he offered his principles in short propositions which he called *theses*, and which he then elaborated upon with a *demonstratio* or *observatio*; such reasoning structures stretch back to traditional Euclidean forms of argumentation.[107] In presenting his new approach to fish, therefore, Artedi drew on traditional ways of organising and conveying knowledge, such as the *historia literaria* and the *disputatio*, to get across his method.

In short, as a document showing how one could demarcate ichthyology as a separate field of knowledge, the *Ichthyologia* is quite unique. In it, Artedi drew up the definition for ichthyology, and surveyed and commented on its history. Central in all these aspects was the notion of 'method'; which in its broad sense entailed an orderly and systematic approach, and its narrowest sense referred to the 'natural method.' Despite the ambiguities of the term prevalent in Artedi's' work, the overall idea was that any method was better than no method, and that *his* method was the best. In the process, Artedi excluded certain types of knowledge

[105] James Delbourgo and Staffan Müller-Wille, "Introduction: Listmania," *Isis* 103, no. 4 (2012): 713.
[106] For a historical overview, see: Alex J. Novikoff, "Toward a Cultural History of Scholastic Disputation," *American Historical Review* 117, no. 2 (2012): 331–364.
[107] Tore Frängsmyr, "The Mathematical Philosophy," in Frängsmyr, Heilbron and Rider, *The Quantifying Spirit*, 39.

and their practitioners, whittling away their authority in the process. This ambition was present in its content as much as in its structure: it listed what was important. So far, the main tenets of Artedi's system have only been discussed briefly. It will now be discussed more thoroughly, both because it was consequential for the natural historical study of fish, and because it demonstrates how Artedi's principles worked in practice.

Classifying Fish

What ought an ichthyologist do? According to Artedi, instilling *order* into the world of fish should be the principal aim. To do so, clear concepts and categories were required. These he offered in the second part of his book, the *Philosophia ichthyologia*. Artedi laid out an elaborate set of rules to which the ichthyologist should adhere. These rules explained, for example, how one could demarcate fish from other classes of animals, how one might first group them into orders and subsequently these orders into genera, and how one unambiguously distinguished one species from the other. Artedi also proposed a reformation of genus and species names. His focus on clear and distinct categorisation of species also entailed a process of abstraction, as we will see, in which focus was on measuring and counting and the *historical*, qualitative component of natural history came to matter less. We might recognize in this abstracted approach a distinct Cartesian influence.

The first step in classifying fish was to decide what a fish actually was. Artedi described that there were six general classes in zoology: the hairy quadrupeds, the amphibians, the birds, the fish, the insects and the zoophytes.[108] Each of these classes formed their own field of study, which were, respectively, "the natural history of hirsute animals, ornithology, amphibiology, ichthyology and entomology."[109] Artedi defined fish as "an animal without feet, always endowed with fins, breathing either through gills or lungs, dwelling mostly in water, there swimming either only with its fins, or simultaneously flexing the body, sometimes willingly venturing onto land, and in some instances flying in the air above the water with the help of

[108] *Icht.*, *Philosophia*, aph. 134, at 49.

[109] Original Latin: " […] ut in 1°. in Historiam Naturalem Animalium Quadrupedum Pilosorum. 2°. In Amphibiologiam seorsim. 3°. Ornithologiam. 4°. in Ichthyologiam & 5°. in Entomologiam." Ibid., aph. 132, at 48–49.

pectoral fins."[110] Comparing this definition to the one drawn up by Willughby and Ray, as cited in Chapter 1, some things stand out: both studies label a fish as an aquatic animal lacking feet, but where Willughby and Ray hold that a fish never comes out onto dry land, Artedi contends that certain fish sometimes venture ashore out of their own volition, and also that one may encounter them flying in the air.

After having defined what ichthyology is, and what a fish is, Artedi proceeds to describe each and every part of a fish. In doing so, he wanted to offer an "explanation of the technical terms common to ichthyology" – that is, a consistent terminology and vocabulary that could henceforth be applied in the describing of fish.[111] He discussed what, among other parts, fins, tails, scales, and gills, as well as stomachs or swim bladders, looked like in different taxonomical groups of fish, and also indicated their worth for classification. Fins, he explained, were those parts of the body of fish that protruded from the body and that had membranes that could either be soft or thorny, the latter being the fin rays.[112] Although, as we saw in Chapter 1, Willughby and Ray every now and then counted the number of rays in the fins of fish, they did not use it as one of their main taxonomical criteria, whereas Artedi saw them as key characteristics for assigning fish to both orders and genera. A proper understanding of each of part of the fish helped in the classification of species. This section dives into Artedi's classification system in more detail, discussing his taxonomical ranks in turn, from orders to genera to species, and finally, varieties. It offers us insight into the various parts from which his system was composed.

Orders

Now that the class of 'fish' had been defined, the next step was to divide it into orders. Artedi thought that the existence of this taxonomical level should be

[110] Original Latin: "Piscis est Animal apodum, Pinnis semper praeditum; vel branchiis, vel Pulmonibus respirans; plerumque in aqua habitans, ibique vel solis Pinnis, vel flexuoso corporis impulsu simul natans, interdum vero in terram sponte egrediens, & quandoque in aëre supra aquam ope pinnarum Pectoralium volans." Ibid., 1–2. Original in emphasis.
[111] *Icht.*, *Praefatio authoris*, sig. **r.
[112] *Icht.*, *Philosophia*, 3.

obvious to everyone. After all, where certain genera of fish were much alike, others differed greatly from one another. While the genus of the carp, for example, much resembled that of the herring, the genus of the herring and of the whale were different in nearly all of their parts.[113] From this one could infer that the herring and the carp belonged to one and the same order. Such a subdivision into orders was useful to natural historians, because by combining species into groups of several sizes one obtained a clearer view of how they interrelated.[114] Aiming to devise a natural system, Artedi urged:

> […] that the *Orders* should be *Natural*; for very many and diverse Orders can be formed by Number, Form, and placement of Parts without much effort, but such orders must not be tolerated, where fish of the same kind are separated badly and diverse ones are often put together in one [Order], and indeed the square things are mixed with the round and the highest with the lowest.[115]

Those jumbled orders of dissimilar-looking animals and plants emerged when one took 'accidental things' [*res accidentales*], such as place, time of bloom or procreation, nourishment, quantity, or height as the grounds for grouping them.[116]

In order to prevent such disorder, Artedi formulated a set of strict rules that should be assumed by any naturalist. The identification key that he designed unlocked the five different orders [*clavis ordinum*] (**Figure 3.1**). It can be used as a kind of flow chart, taking the reader stepwise through several physical characteristics. At every step, the reader selects the physical characteristics of the specimen at hand, from the general to the more specific, narrowing down the options so as to eventually arrive at the correct order. Linnaeus published a similar diagram in his *Philosophia botanica*, which displays Tournefort's key for the orders of plants in the same fashion. Both Matthew D. Eddy and Isabelle

[113] Ibid., aph. 125, at 47.
[114] Ibid., aph. 127, at 47.
[115] Original Latin: " […] monui ejusmodi *Ordines* debere esse *Naturales*; nam plurimi & diversi Ordines à Numero, Figura & situ Partium sine magna opera effingi possunt, sed tales ordines non tolerari debent, quatenus Pisces congeneres male separantur & diversi in unum saepe conjunguntur, adeoque quadrata rotundis & summa imis miscentur." *Icht.*, *Praefatio authoris*, sig. *v.
[116] *Icht.*, *Philosophia*, aph. 128-1, at 47.

Charmantier have drawn attention to the Ramistic roots of this particular way of organizing knowledge.[117] The French humanist Peter Ramus (1515–1572) had proposed a logical method of structuring knowledge according to dichotomous divisions, set out in tables or diagrams, and his teachings remained part of the curriculum of some European universities in the time of Artedi and Linnaeus.[118] We can encounter the organisational method in the works of both.

To decide to which order a certain fish belonged, the first thing one needed to look for was the position of its tail. Firstly, any fish with a horizontal tail belonged to the order of cetaceans (*Plagiuri*). Those fish with perpendicular tails could be divided into those with cartilaginous skeletons (*Chondodropterygii*) and those with bony skeletons. That latter group, in turn, could be further subdivided in those fish that did not have any rays in the gill flap (*Branchiostegi*) and those that did possess such rays.[119] The last dividing feature was whether a fish was 'unarmed' (*Malacopterygii*) or 'eager to fight' (*Acanthopterygii*); rather than implying something about the temper of the fish, this indicated whether the rays in its fins were soft or thorny.[120] The names that Artedi gave his five orders of fishes are, in fact, Greek descriptions naming the primary distinctive feature of each order (these were, in the same sequence as just followed: flat fins, cartilaginous fins, large gill lids, soft fins, and thorny fins).[121] One word thus sufficed to place each fish in its proper order.

[117] Isabelle Charmantier, "Carl Linnaeus and the Visual Representation of Nature," *Historical Studies in the Natural Sciences* 41, no. 4 (2011): 370–371; Matthew D. Eddy, "Tools for Reordering: Commonplacing and the Space of Words in Linnaeus's *Philosophia Botanica*," *Intellectual History Review* 20, no. 2 (2010): 227–252, esp. 243.

[118] On Ramus and his influence, see: Walter Ong, *Ramus, Method and the Decay of the Dialogue: From the Art of Discourse to the Art of Reason* (Cambridge, Mass.: Harvard University Press, 1958).

[119] The gill flap, also known as the operculum, is the part of the fish that covers the slits of the gills.

[120] Artedi subdivides these two orders on the level of the *manipules*, a category resembling what we might now call 'families' and which he does not fully define or develop. See also: *Icht.*, *Philosophia*, aph. 136 at 50 and Lönnberg, *Peter Artedi*, 29.

[121] For this observation, I thank Hans Aili.

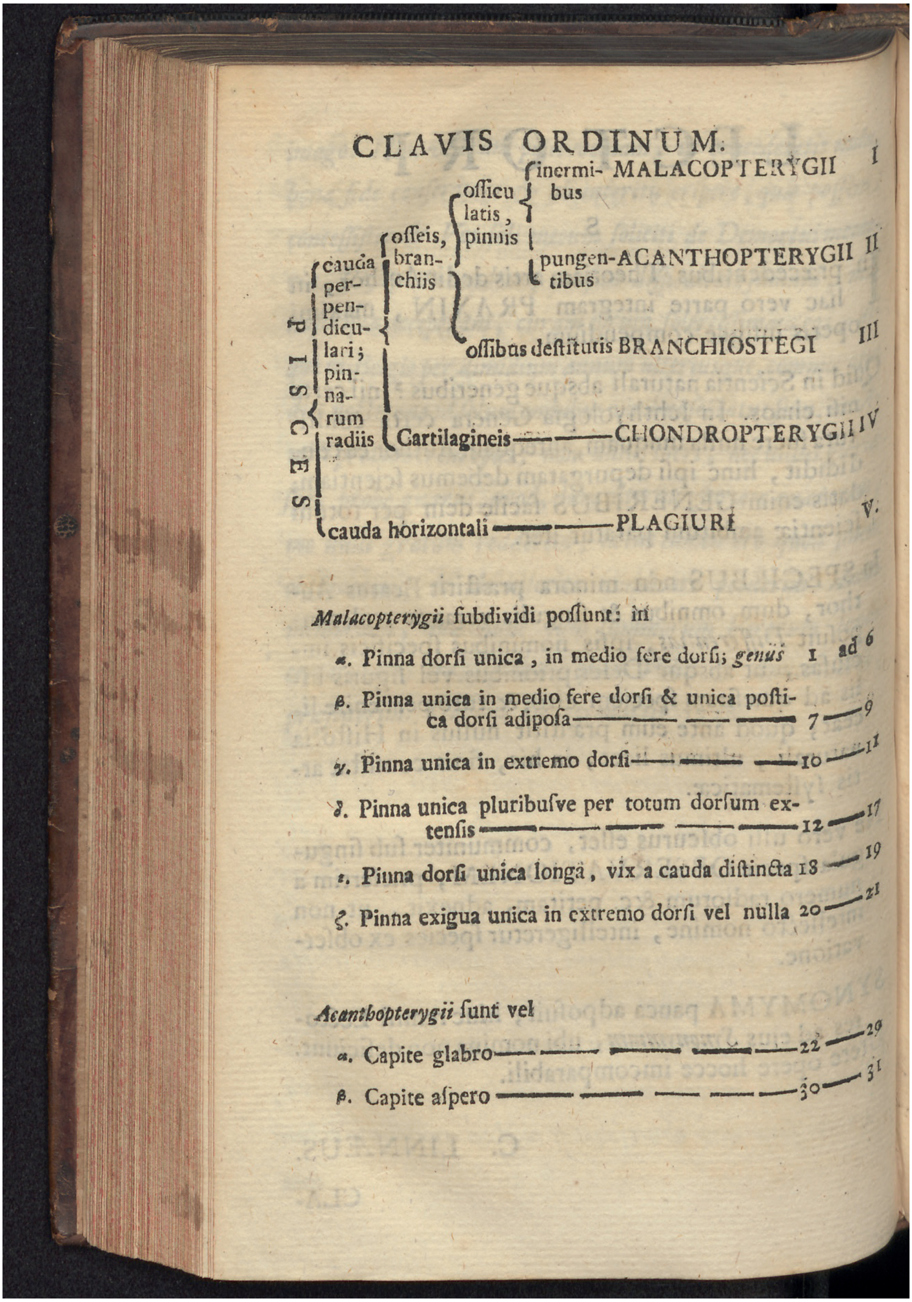


Figure 3.1 Clavis ordinum | Peter Artedi, *Ichthyologia, sive opera omnia de piscibus* (Leiden: Conrad Wishoff, 1738), n.p. | © Universiteitbibliotheek Leiden

Genera

Below the order, one entered the rank of the genus. Chapter 1 has shown that the notion of 'genus' or its plural, 'genera' had been used since Antiquity to denote groups of plants or animals that resembled one another. There was no clear agreement, however, on *what*, exactly, a genus was. As we saw in Chapter 1, for example, Willughby and Ray had applied the term rather loosely to indicate species that shared certain similar external characters. While they grouped species together based on the resemblance of their external characteristics, they did not formally establish taxonomical ranks and neither did they endow groups of species with names. Fish were sorted into broad or long fish. Subsequently, fish from the latter category were further described as elongated or shorter long fish.[122] Not of all their groupings were devised in such a way that they were necessarily mutually exclusive of one another: one species could belong to more than one group.[123] Thus, although the concept of genus was not unknown, it had never been clearly defined.[124]

Artedi, as we saw, considered the establishment of genera as the first and foremost aim of natural history, and this required a consistently defined and applied genus concept. Artedi defined a genus as a group "assembled of some certain species, or resemblance of certain fish from diverse species, that *always* convene in the placing of its external parts, *usually* in number, and *often* in figure and proportion."[125] Artedi was well aware that assigning species to their correct genera was an intricate process, and explained that general characteristics [*characteres generici*], i.e., marks that were indicators of a certain genus, had to be chosen judiciously.

He contended that even though it was important to take a good look at a species' external parts, one should at the same time not be deceived by its general outward appearance. At first glance, for example, one might be led to believe that

[122] *Hist. pisc.*, 46.
[123] Lönnberg, *Peter Artedi*, 27.
[124] Ibid., 30.
[125] Original Latin: "Genus Ichthyologiae est convenientia quaedam certarum specierum, seu similitudo quorundam Piscium ad speciem diversorum, qui in situ Partium externarum *semper*, numero *plerumque*, Figura & Proportione *saepe* conveniunt." *Icht.*, *Philosophia*, aph. 139, at 51. Original sentence in emphasis, which is not reproduced here for readibility; the emphasis of the original, however, is retained.

the tench and the lake-trout belong to one and the same genus. The overall shape of these fishes was, after all, rather similar. On closer inspection, however, Artedi argued that it was plain that the fish displayed different general characteristics.[126] The three bones in the gill flap of the tench meant it had to be assigned to the genus of the carp; the lake-trout had no fewer than ten such bones, and thus belonged to the genus of the salmon.[127] So far, so good. What complicated matters, however, was that general characteristics were not the same for every order of fish. This makes sense: there were no perfectly constant characters that could be used to determine each and every genus, simply because no one part was found in every fish. For the bony fishes, as we just saw, the best course of action was to count the number of bones in the gill flap.[128] For the cartilaginous fishes, the thing to pay attention to was the shape of their body and their gill apertures.[129] In the cetaceans, as the introduction to this chapter already mentioned, the salient generic characteristics were the number of fins and teeth. As every system seeking to refine and simplify matters had, inevitably, to contend with exceptions and anomalies, the genera had to be demarcated on a case-by-case basis.

After painstakingly examining this complex web of physical features, Artedi eventually arrived a grand total of fifty-two genera. These he discussed in the third part of the *Ichthyologia*, entitled *Genera piscium*. Like the rest of his book, this part is tightly structured. Organized by order, the *Genera piscium* describes each genus and lists the species it comprises. A discussion of the genus called 'Osmerus' – a type of smelt – can stand as example of his theory put to practice (**Figure 3.2**).[130] This description is given in the first order, the *Malacopterygii*. Of this order, the Osmerus was the eighth genus and is assigned a corresponding roman numeral (VIII). It then lists the defining physical characteristics of this genus: the bones in its gill flap number seven or eight, the dorsal and the ventral fins are positioned equally far from the tip of the snout, the teeth in this mouth

[126] Ibid., aph. 143, at 51.
[127] *Icht.*, *Philosophia*, aph. 148, at 52; see also Lönnberg, *Peter Artedi*, 31.
[128] Ibid., aph. 182, at 62.
[129] Ibid., aph. 153, at 54.
[130] *Icht.*, *Genera piscium*, 10.

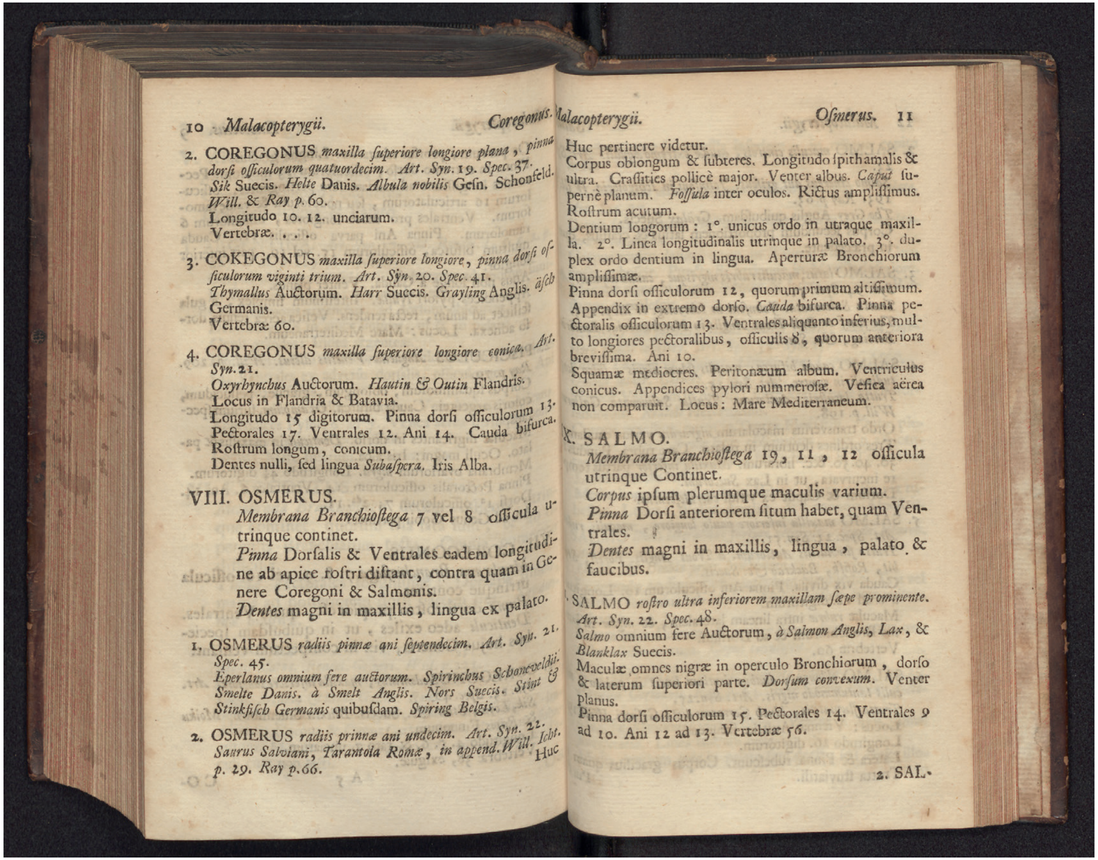
are big, and the tongue comes from the palate. Any species conforming to each and every one of these characteristics could be safely assumed to belong to the genus of the Osmerus. This description is exemplary for how carefully selected combinations of characteristics were used to discern one genus from the other.

Confusion over genera could be prevented with a rigorous naming protocol. Artedi therefore proposed a reformation [*reformatio*] of naming practices.[131] The first rule stated that each fish belonging to the same genus must be given the same generic name. While this might sound obvious to us, Artedi showed the necessity for this measure by explaining that the various species belonging the genus *Cyprinus* (carp) were referred to by no fewer than twenty-five different generic names.[132] Artedi furthermore dictated that a generic name should consist of one word only, banning composites or diminutives.[133] Instead of vernacular (or, in Artedi's words, 'barbaric' [*barbara*]) names, only those originating from Latin or Greek were to be allowed; the ancients had offered plenty such names to draw from.[134] Yet not each Greek or Latin name met his requirements. Any similitude between the names of animals living on land and those living in the water should be avoided. Fishes were not to share their species names with mammals like the wolf [*lupus*], birds like the eagle [*aquila*], insects like the scarab [*scarabaeus*], nor vegetables like parsnip [*pastinaca*].[135] Unambiguous, clearly defined and named genera were integral to Artedi's system.

Species

With Artedi's key in hand, a naturalist may have decided that the fish specimen before him belonged to the order of the *Malacopterygii* on account of it having a bony skeleton and soft fin rays. Judging from the number of bones in the gill flap, the position of its dorsal and ventral fin, and its teeth and tongue, it was part of

[131] Original Latin: "Reformatio Nominum Genericorum" *Icht.*, *Philosophia*, 64; "Reformatio Nominum Specificorum" ibid., 80.
[132] *Icht.*, *Philosophia*, aph. 191, at 64–65.
[133] Ibid., aph. 196, at 71 and aph. 202, at 78.
[134] *Icht.*, *Praefatio authoris*, sig. **v. Linnaeus contended the same for plants: Carl Linnaeus, *Critica botanica* (Leiden: Conrad Wishoff, 1737), aph. 229, at 48.
[135] *Icht.*, *Philosophia*, aph. 194-1/6, at 66–70.



10 *Malacopterygii.* *Coregonus.*

2. COREGONUS *maxilla ſuperiore longiore plana, pinnæ dorſi oſſiculorum quatuordecim. Art. Syn.* 19. *Spec.* 37.
Sik Suecis. *Helte* Danis. *Albula nobilis* Geſn. Schonfeld. *Will.* & *Ray p.* 60.
Longitudo 10. 12. unciarum.
Vertebræ. . . .

3. COKEGONUS *maxilla ſuperiore longiore, pinna dorſi oſſiculorum viginti trium. Art. Syn.* 20. *Spec.* 41.
Thymallus Auctorum. *Harr* Suecis. *Grayling* Anglis. *Äſch* Germanis.
Vertebræ 60.

4. COREGONUS *maxilla ſuperiore longiore conica. Art. Syn.* 21.
Oxyrhynchus Auctorum. *Hautin & Outin* Flandris.
Locus in Flandria & Batavia.
Longitudo 15 digitorum. Pinna dorſi oſſiculorum 13. Pectorales 17. Ventrales 12. Ani 14. Cauda bifurca.
Roſtrum longum, conicum.
Dentes nulli, ſed lingua *Subaſpera.* Iris Alba.

VIII. OSMERUS.
Membrana Branchioſtega 7 vel 8 oſſicula utrinque continet.
Pinna Dorſalis & Ventrales eadem longitudine ab apice roſtri diſtant, contra quam in Genere Coregoni & Salmonis.
Dentes magni in maxillis, lingua ex palato.

1. OSMERUS *radiis pinnæ ani ſeptendecim. Art. Syn.* 21. *Spec.* 45.
Eperlanus omnium fere auctorum. Spirinchus Schoneveldii. Smelte Danis. à Smelt Anglis. Nors Suecis. Stint & *Stinkfiſch Germanis* quibuſdam. *Spiring Belgis.*

2. OSMERUS *radiis pinnæ ani undecim. Art. Syn.* 22. *Saurus Salviani, Tarantola Romæ, in append. Will. Icht. p.* 29. *Ray p.* 66.
Huc

Malacopterygii. *Oſmerus.* 11

Huc pertinere videtur.
Corpus oblongum & ſubteres. Longitudo ſpithamalis & ultra. Craſſities pollicè major. Venter albus. *Caput* ſupernè planum. *Foſſula* inter oculos. Rictus ampliſſimus. Roſtrum acutum.
Dentium longorum: 1°. unicus ordo in utraque maxilla. 2°. Linea longitudinalis utrinque in palato. 3°. duplex ordo dentium in lingua. Aperturæ Bronchiorum ampliſſimæ.
Pinna dorſi oſſiculorum 12, quorum primum altiſſimum. Appendix in extremo dorſo. *Cauda* bifurca. Pinna pectoralis oſſiculorum 13. Ventrales aliquanto inferius, multo longiores pectoralibus, oſſiculis 8, quorum anteriora breviſſima. Ani 10.
Squamæ mediocres. Peritonæum album. Ventriculus conicus. Appendices pylori nummeroſæ. Veſica aërea non comparuit. Locus: Mare Mediterraneum.

X. SALMO.
Membrana Branchioſtega 19, 11, 12 oſſicula utrinque Continet.
Corpus ipſum plerumque maculis varium.
Pinna Dorſi anteriorem ſitum habet, quam Ventrales.
Dentes magni in maxillis, lingua, palato & faucibus.

1. SALMO *roſtro ultra inferiorem maxillam ſæpe prominente. Art. Syn.* 22. *Spec.* 48.
Salmo omnium fere Auctorum, *à Salmon Anglis, Lax,* & *Blanklax* Suecis.
Maculæ omnes nigræ in operculo Bronchiorum, dorſo & laterum ſuperiori parte. *Dorſum convexum.* Venter planus.
Pinna dorſi oſſiculorum 15. Pectorales 14. Ventrales 9 ad 10. Ani 12 ad 13. Vertebræ 56.

2. SAL.

Figure 3.2 Genus description of Osmerus | Peter Artedi, *Ichthyologia, sive opera omnia de piscibus* (Leiden: Conrad Wishoff, 1738), 10 | © Universiteitsbibliotheek Leiden the Osmerus genus. The question then arose precisely with which of the two species in this genus he was dealing. Artedi gave the following definition of a species:

> In *Ichthyology*, every Fish constitutes a species if it is different from the other species of its genus with regard to a certain external Part being absent or present, either as regards number, Proportion, or Shape, or owing to some constant difference in colour.[136]

This definition is an example of Kärin Nickelsen's contention that species are "not concrete objects the properties of which can be gathered just by looking at them", but rather "abstract concepts designating whole classes of objects whose definitions depend on the taxonomic system used at the time."[137] Species, then, are not self-evident entities, but they require a certain effort to be conceptualized as such. Artedi's definition can serve as a reminder that the way in which one species is demarcated from the other is a result of decisions made by the taxonomist. In this case, the taxonomically relevant properties that Artedi asserted as relevant were number, proportion, figure, and colour.

In his letter to the reader, Artedi asserted that he had seen each and every fish described in his book for himself (with the exception of some of the whales, including, as we have seen, the siren).[138] This attests to the weight that continued to be attached to direct observation. Like Linnaeus, Artedi had built up his system through rigorous investigation of hundreds and hundreds of specimens.[139] Unfortunately for historians wishing to reconstruct his working practices, however, his species descriptions seldom mention exactly how and where he had come across the specimen at hand. An exception are the few instances where he has added 'I have seen' [*vidi*] or 'I have discovered' [*inveni*] to his descriptions.[140]

[136] Original Latin: "Species in *Ichthyologia* appellatur unusquisque Piscis, qui a reliquis sui generis speciebus in Parte quadam externa, secundum defectum vel excessum, numerum, Proportionem, Figuram & colorem constantem variantem, diversus est." Ibid., aph. 209, at 74. Emphasis from original has been reversed.

[137] Kärin Nickelsen, *Draughtsmen, Botanists and Nature: The Construction of Eighteenth-Century Botanical Illustrations* (Dordrecht: Springer, 2006), 73.

[138] *Icht.*, *Praefatio authoris*, sig. ***r.

[139] Cf. Müller-Wille, "Collection and Collation," and Mary P. Winsor, "Linnaeus's Biology Was Not Essentialist," *Annals of the Missouri Botanical Garden* 93, no. 1 (2006): 2–7.

[140] He mostly used 'vidi' to specify that he saw a specimen, and 'inveni' for describing the internal organs of the fish. e.g., *Icht.*, *Descriptiones specierum piscium*, 19, 28, 35, 39, 59, 71, 79, 89, 110.

It is perhaps by not detailing the particular context of his observations, that he emphasized their general nature. It implied that his observations were universal: what he saw was, in effect, the platonic form of the fish rather than a particular fish. If this indeed was Artedi's intention, it presents a compelling contrast: while Willughby and Ray asserted the reliability of their observations by specifying where and when they had seen a certain specimen, Artedi made his reliable by leaving said information out.

While this often makes it difficult to establish where Artedi made his observations, a letter by Linnaeus offers a rare insight. It discusses that Artedi saw a species of smelt, known in Sweden under the name of Slom, every spring, and that he was intent on finding out whether it constituted a distinct species from the similar-looking Nors.[141] The species description of the latter can give us a sense of the practical application of Artedi's system (**Figure 3.3**).[142] Every species was discussed under the header of its corresponding genus. The number of its genus (which in the case of Osmerus was 8) was supplied for easy reference, so one could look up the characteristics of this genus in the *Genera piscium*. The species itself was also assigned a number: the Nors was the first – and only species – of the eighth genus. The description opens with the capitalized genus name ('OSMERUS'), followed by a short diagnostic sentence – this is the species name, as will be discussed in more detail.

Artedi divided the species descriptions in numbers, "so that all [parts] are distinguished more readily."[143] The description of the smelt consisted of 29 consecutively numbered items, which documented its main attributes of the fish: for example, its gills, the gill cover, as well as each of its fins and the exact number of rays in them. He also measured the sizes of the fish's various parts with almost geometric precision in inches (unc.) and twelfths of inches (lin.). These measurements, both longitudinal and latitudinal, were formatted into a table (**Figure 3.4**). It shows that the Nors measured up to 3 inches long, and that the

[141] Linnaeus to Johan Ernst Gunnerus, 4 March 1769, UUB, L4202.
[142] *Icht.*, *Descriptiones specierum piscium*, 45.
[143] Original Latin: " […] easdemque in Numeros divisi, ut omnia clariora & magis distincta essent." *Icht.*, *Praefatio authoris*, sig. **v.

distance from the tip of its snout to the middle of its eye was 5 twenty-fourths of an inch. These measurements are given for several intervals (for example, the first dorsal fin and the second one), with the base of the tail as the last measuring point. Artedi's examination of species clearly demanded some laborious effort. Linnaeus described having seen Artedi "spending in many cases several whole days over one single fish" over which time he "would count over the fins, and the individual rays in them, not once only but many times [...]."[144] In one breath, Linnaeus draws attention to both Artedi's careful and disciplined study of fish and his impulse to identify and classify them through quantification.

As we saw in the previous chapters, Willughby and Ray had been somewhat troubled by the abundance of names by which species could be known. They had tried to restore order to the nomenclature of fish, but did not propose a reformation of naming practices. Rather than simply restore order to the nomenclature under which fish laboured, Artedi proposed a reformation of naming practice. He contended that a species name should take the form of an "epithet, consisting of some few words, which is appended to the name of the genus, in order to distinguish one species from the other in the same genus."[145] This meant that a fish's name was comprised of a short, diagnostic summary of its defining characteristics. Take, for instance, the name Artedi gave to the common perch: *Perca lineis utrinque sex nigris pinnis ventralibus rubris*, a perch with six black fins on both sides and a red belly.[146] Artedi's naming system was somewhat more cumbersome than the binomial system that Linnaeus became well known for with the publication of the tenth edition of his *Systema naturae* in 1758. This system meant that one referred to a certain species by combining its genus name with it species name: for example, the above described perch became *Perca fluviatilis*.[147] It was decidedly less cumbersome than the nomenclature that Artedi

[144] *Icht.*, *Descriptiones specierum piscium*, introduction by Linnaus; translation from Lönnberg, *Peter Artedi*, 41.
[145] *Icht.*, *Philosophia*, aph. 223 at 80; translation from Lönnberg, *Peter Artedi*, 35.
[146] *Icht.*, *Descriptiones specierum piscium*, 74.
[147] Linnaeus, *Systema naturae*, ed. 10, 289.

used.[148] Nonetheless, the naming system proposed by Artedi was practical: as brief summaries of its main external features, they helped the reader distinguish between two species at a glance.[149]

However useful this new naming system was, naturalists still had to contend with the conundrum of names under which earlier authors had described species of fish. Artedi had come up with a solution for that, too. In the fourth part of his book, the *Synonymia nominum piscium*, Artedi compiled all the synonyms of fish names in various languages by means of indices. These included Latin, Swedish, Danish, German, Dutch, English, French, Italian, Spanish and Greek, as well as some 'miscellaneous' languages, such as Ambonese and Hispanic. Collecting these synonyms, Artedi stated, "created much work for me in comparison with the other parts of this work; for in reading so many authors about nearly every single species most of my time and my indefatigable mind were needed […]."[150] It allowed him to showcase his comprehensive grasp of natural historical literature and his tireless industry. This part of the book functioned as a sort of fish dictionary. He also indicated where each species had been described by earlier authors, including page numbers.[151] Any naturalist wondering, for example, how the species of smooth hound shark described in the *Historia piscium* (**Figure 1.4a**) was described by Artedi could readily find out that it was Artedi's "shark with blunt or granular teeth."[152] In this way, Artedi synchronised earlier names and descriptions of fish species with those that he himself drew up for them.

[148] Linnaeus considered the binomial name to be a 'trivial name', a useful shorthand for the actual species name, the *nomen specificum*, which, as in Artedi's naming method, consisted of the generic name followed by a short descriptive phrase giving the plant's distinctive characters which set it apart from other species, see: Nickelsen, *Draughtsmen*, 80.
[149] Lönnberg, *Peter Artedi*, 35.
[150] *Icht.*, *Praefatio authoris*, sig. **r/v.
[151] *Icht.*, *Synonymia nominum piscium*, 1–118.
[152] Ibid., 93.

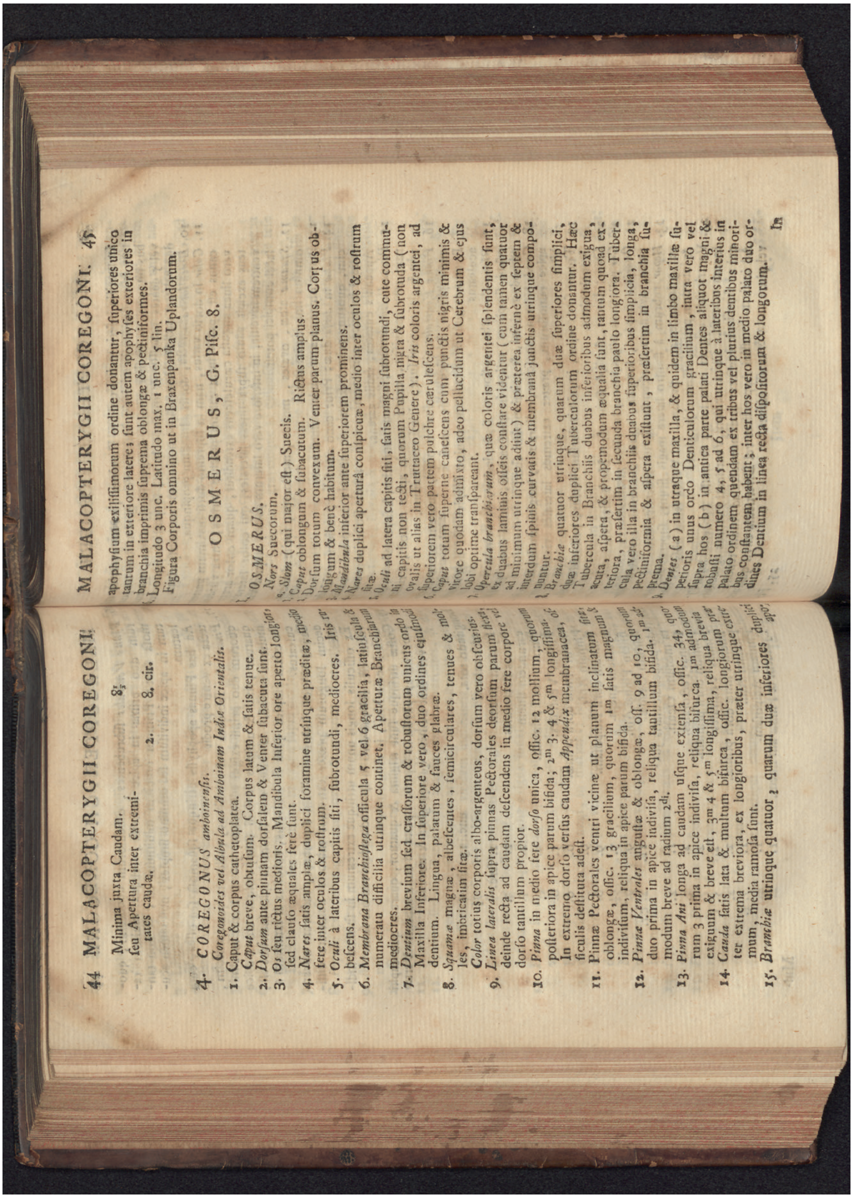


Figure 3.3 Species description of Nors | Peter Artedi, *Ichthyologia, sive opera omnia de piscibus* (Leiden: Conrad Wishoff, 1738), 45 | © Universiteitsbibliotheek Leiden

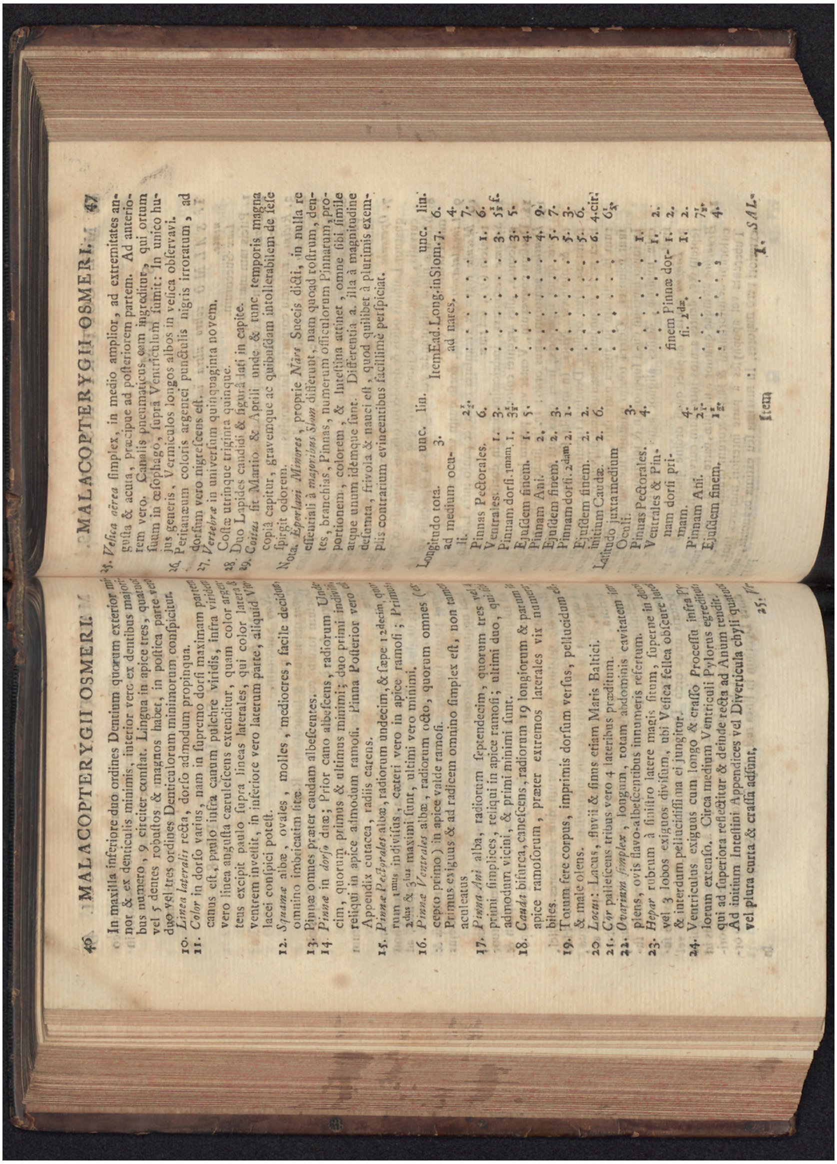


Figure 3.4 Species description of Nors | Peter Artedi, *Ichthyologia, sive opera omnia de piscibus* (Leiden: Conrad Wishoff, 1738), 47 | © Universiteitsbibliotheek Leiden

Varieties

The last and final level of the taxonomical hierarchy were the varieties. The aforementioned species description of the smelt ('Nors') ends with a note addressing whether this particular species differed from the similarly looking fish (Artedi's beloved 'Slom' that he saw each spring in Sweden):

> *The smaller Eperlani*, properly called *Närs* [sic] by the Swedes, do not differ in any essential way from *the bigger Slom*, for as far as it concerns their mouth, teeth, gills, Fins, their number of rays in the Fins, their proportion, colour, and Intestines, all are similar to each other and one and the same. The difference between them, which is selected on the basis of size, is frivolous and useless, because anyone can very easily perceive the contrary on the basis of very many evincing examples.[153]

Artedi concluded that the Nors and the Slom were the same species. For good measure, he included his calculation of the dimensions of the latter species in a table alongside that of the former (**Figure 3.4**). This example shows how ambiguities could also remain at species level. As we already saw in Chapter 1, Willughby and Ray wondered how to decide if a certain specimen constituted a separate species, or was in fact a variation within a species. This problem was also well known to Artedi, and he lectured the reader on the matter in the second part of his book, the *Philosophia*. He stated that certain things were of little consequence for demarcating one species from the other. Fishermen, Artedi contended, distinguished between species based on matters such as the colour of the fish, whether they resided in fresh or salt water, or the time of year in which they reproduced. He deemed these kind of distinctions 'false and frivolous' [*falsa et frivolae*].[154] The colour, he expounded, of one individual fish could vary depending on its age, the season, and even the type of water it inhabited.[155] It also differed from specimen to specimen. Species could and should not be assigned on

[153] Original Latin: "*Eperlani Minores*, proprie *Närs* Suecis dicti, in nulla re essentiali à *majoribus Slom* differunt, nam quod rostrum, dentes, branchias, Pinnas, numerum ossiculorum Pinnarum, proportionem, colorem, & Intestina attinet, omne sibi simile atque unum idemque sunt. Differentia a. illa à magnitudine desumta, frivola & nauci est, quod quilibet à plurimis exemplis contrarium evincentibus facillimè perspiciat." *Icht.*, *Descriptiones specierum piscium*, 47.

[154] *Icht.*, *Philosophia*, aph. 220, at 79.

[155] Ibid., aph. 213, at 75–76.

the basis of these unstable characteristics, but only on those features that he had determined to be relevant.

Because aspects such as these were too ambiguous to have meaning in any classificatory system, Artedi largely disregarded them in his species descriptions. He only occasionally mentioned the means of nutrition or procreation of a species, or the taste of its flesh, and never comments on matters relating to trade or consumption. This is what set his approach apart from earlier naturalists who had written about fish: he deliberately excluded any associations surrounding the fish, and rather focussed on the animal *in itself*, its physical presence. Zooming in on matters such as habitat or nutrition also would prove an impractical way of examining plants or animals for the naturalist who might peruse many of his or her specimens in various cabinets: these matters, after all, could not be glimpsed from looking at a specimen that had been taken out of its environment and preserved in a collection. Rather, one would have to have studied fishes for a prolonged amount of time, alive and in their own habitat. That was far from common practice for the average naturalist, however, who might combine field trips with visits to cabinets and collections. It was, in contrast, also the kind of knowledge that artisans such as fishermen, fishmongers, and cooks would be well aware of – and that, as we have seen in the previous chapter, naturalists before Artedi had made glad use of. While it is plain from the previous chapter that a fisherman's observation could be useful when it came to deciding which species was which, such individuals rarely figure in Artedi's descriptions, even though he drew on their experiences, albeit indirectly – for example, when using the descriptions of Willughby and Ray, he was benefitting from the knowledge that these practical men had given them.

The salient characteristics were, as we saw, the number, shape and position of fins, the number of rays in the fin, or the number or shape of the teeth, or the number and shape of other parts. Artedi shared this averseness to colour with Linnaeus, for whom only 'Number, Shape, Position, and Proportion' counted in describing plants, and who railed against the – in his eyes – excessive attention of his fellow botanists to the colourisation of plants.[156] Here, too, it is worthwhile

[156] Daston, "Description by Omission," 12. Linnaeus indeed complemented Artedi's aphorisms with references to equivalent rules in the *Fundamenta botanica*.

considering not only what a species description may contain, but also what has been left out. As has been discussed in the first chapter, natural historical works had long been an *encyclopedic* exercise bringing together past works and writings. Artedi's descriptions were, by and large, stripped of such historical components. While, in the *Synonymia*, he did refer to species descriptions published in earlier works, it was only with the purpose of synchronizing these descriptions and identifications with his own. In so doing, he stabilized his own species identifications, subsuming and overwriting earlier ones. His descriptions were quantitative rather than qualitative, and numerical rather than narrative.

Artedi concluded his *Philosophia* with a firm 'thus it has been demonstrated' [*quod erat demonstrandum*].[157] This phrase was commonly used to show that the proof or an argument was completed, especially in mathematical contexts.[158] It further asserted the degree of certainty with which Artedi presented his system, as well as the method that underpinned it. As we have seen, his focus on order and classification had repercussions for his species descriptions, which became, in essence, simple lists of pertinent characteristics. They are examples of what Daston has characterized as the 'description by omission' in which the description of nature changed "from long accounts bristling with particulars to concise reports made deliberately bland by summary, repetition, and omission of details."[159] She locates this development between the late seventeenth and the early eighteenth century – which is also the period that separated the *Historia piscium* and the *Ichthyologia* – and a comparison of the descriptions that these works contain substantiates this hypothesis. What Artedi introduced for fish (but also for other realms of nature, as we saw) were strictly defined taxonomical ranks. In his book, he remarks that such a system of classes, orders and genera was useful not only to ichthyology, but to natural history as a whole.[160] This system would prove highly

[157] *Icht.*, *Philosophia*, 92.
[158] It is listed in the glossary of terms in John Kirkby, *Arithmetical Institutions: Containing a Compleat System of Arithmetic* (London: B. Motte, C. Bathurst and J. Clark, 1735), table of contents.
[159] Lorraine Daston, "Description by Omission: Nature Enlightened and Obscured," in *Regimes of Description: In the Archive of the Eighteenth Century*, eds. John Bender and Michael Marrinan (Stanford: Stanford University Press, 2005), 13.
[160] Original Latin: "[…] primum et praecipuum Fundamentum, non solum Ichthyologiae, sed totius reliquae Historiae Naturalis […]" *Icht.*, *Philosophia*, aph. 143, at 51–52.

useful to later naturalists as they attempted to understand the taxonomic relations between new and already known species.

Lost in Preservation?

As mentioned in the introduction to this chapter, Linnaeus presented his own classification system consisting of orders, genera and species into the first edition of his *Systema naturae*.[161] As he explained, "[i]n Ichthyology, I have not prepared my own Method, but the greatest Ichthyologist, the famous Swede mr. Petrus Artedi […] has given me his."[162] He indeed copied the taxonomical ranks that Artedi had established with only slight alterations.[163] In the preface to the (now famous) table of orders and genera in the realm of animals of the first edition of his work, Linnaeus introduced Artedi to his readers as "the best ichthyologist of our time"[164], who had perfected the classification of fishes. While the readers could get the gist of Artedi's classification system in the present work, Linnaeus announced they could expect a more elaborate account of the underlying principles in a forthcoming publication, '*Institutiones* nempe *totius Ichthyologiae*' [*Institutions,* that is, *all of Ichthyology*] – which was, of course, eventually published as the *Ichthyologia*.[165] Where this chapter has so far analysed Artedi's *Ichthyologia* and its contents, this final section examines how Artedi's system found its way to other naturalists. It examines the consequences it had for the way in which fish were studied, and pays particular attention to discussions of whether fishes were best preserved as textual descriptions, images or objects.

We can get a better sense of how Artedi's *Ichthyologia* was received by reading the reviews that appeared in various learned journals not long after its publication. These periodicals were specifically geared towards reporting on new research and publications, and offer insight into how books were regarded by

[161] Carl Linnaeus, *Systema naturae*, ed. 1 (Leiden: Theodoor Haak, 1735).
[162] As translated by Broberg, *Carl Linnaeu*s, 142.
[163] In the order of the *Malacopterygii*, Linnaeus left out the genera of *Argentina*, *Exocoetus*, *Stromateus*, *Ophidion* and *Anableps*; in the *Acanthopterygii* order, he moved the *Blennius* genus to the *Malacopterygii* (spelling it *Blennus*), and cut the genera *Sciaena*, *Scorpoena* and *Chaetodon*. From the *Plagiuri*, he omitted the *Physeter* genus and that of the *Siren*. See: Linnaeus, *Systema naturae*, ed. 1, n.p.
[164] Original Latin: "In *Ichthyologia* nullam ipse elaboravi Methodum, verum Suam nobiscum communicavit summus nostri temporus Ichthyologus Cl. D. *Petr. Artedi* […]" Linnaeus, *Systema naturae*, ed. 1, n.p.
[165] With the addition of 'all' [*totius*], this title was perhaps even more ambitious than the one Artedi had originally envisaged. Ibid.

scholars.[166] French-speaking *savants* were served by the review that appeared in the *Bibliothèque germanique*, a periodical devoted to the learning of Germany and the countries of northern Europe,[167] while the one published in the *Nova Acta Eruditorum* catered to a Latinate audience.[168] The German polymath Johann Peter Kohl (1698–1778) wrote a glowing review of *Ichthyologia* for the *Hamburgische Berichte von den neuesten Gelehrten Sachen* in 1738, stating that the book was "arranged in a careful and provable way […] thereby, the foundations of this science are presented with a lasting power of proof […]."[169] He noted that "[f] or every fish, all the rays in the fin and all the vertebrae are counted; every single thing is noticed and investigated."[170] He concluded that "[…] the work has so cleared up this part of Natural History, otherwise the most difficult of all, to such a degree that one must be astounded."[171] Artedi would probably have been pleased with this critique; the words the reviewer uses to characterize his system, such as 'provable' and 'foundational', mirror the terms that he himself applied to it.

Other indications of how Artedi's work was received and used, and by whom, can be found in the correspondence between both well and lesser-known eighteenth-century naturalists. Paul Heinrich Gerhard Möhring (1710–1792) for example, inquired with Linnaeus from Jever when the work would be available and how much it would cost.[172] Christian Gottlieb Ludwig (1709–1773) asked him to send him a copy to Leipzig, so that he could pass it on to Jacob Theodor Klein (1685–1759).[173] Alexander Garden (1730–1791) affirmed to have used

[166] Thomas Munck, "Eighteenth-Century Review Journals and the Internationalization of the European Book Market," *The International History Review* 32, no. 3 (2010): 417.
[167] Jacob Theodoor Klein, "Peter Artedi, *Ichthyologia*," in *Bibliothèque germanique ou Histoire littéraire de l'Allemagne et des pays du Nord*, vol. 45, ed. Paul-Emile de Mauclerc (Amsterdam: Pierre Humbert et fils, 1739), 143–159. The attribution of this review to Klein, a translation of the Latin review that he proffered Sloane, has been done by Pietsch and Aili, "Jacob Theodor Klein's Critique," 53.
[168] "Petri Artedi," in *Nova acta eruditorum*, ed. Friedrich Otto Mencke (Leipzig: Johann Friedrich Gleditsch, 1741), 652–657.
[169] Johann Peter Kohl, "Opera posthuma ichtyologica," *Hamburgische Berichte von den neuesten Gelehrten Sachen* 16 (1738): 131–132. As translated in Pietsch and Aili, "Jacob Theodor Klein's Critique," 57.
[170] Pietsch and Aili, "Jacob Theodor Klein's Critique," 57.
[171] Ibid.
[172] Paul Heinrich Gerhard Möhring to Linnaeus, 4 October 1737, UUB, L0217.
[173] Christian Gottlieb Ludwig to Linnaeus, 22 October 1737, UUB, L0210. For Klein's assessment of the work, see Aili and Pietsch, "Jacob Theodor Klein's Critique," 39–84.

both Linnaeus' *Systema naturae* and Artedi's *Ichthyologia* while describing species of fish that were new to him in and around Charlestown in the province of Caroline, one of Britain's colonial territories in North America.[174] In a letter to Arnout Vosmaer (1720–1799) in October 1751, Laurens Theodorus Gronovius promised to show him his arrangement of the genera of Dutch fishes, organized according to Artedi.[175] From Montpellier, Antoine Gouan (1733–1821) wrote to Linnaeus that he found Artedi's system useful, although he proposed some small changes.[176] When Klein received the work from Ludwig, he wrote a review of it that he then sent to Sloane.[177] He noted with some surprise that the sea horse had been assigned to the order of *Malacopterygii*, even though it lacked the perpendicular tail fin this order required.[178] He did agree, however, with the premise and structure of the system itself.

For a considerable group of naturalists, Artedi's classification system became a common point of reference. The lists of genera and species that both Linnaeus and Artedi compiled were used to catalogue collections of *naturalia*, as the following chapter will discuss in more depth. Eighteenth–century naturalists, ever more inundated with specimens hitherto undescribed, found a welcome source of order in these systems. Linnaeus' binomial names, in particular, made it easier to compile data on plant and animal species, to produce clear lists of specimens. This is probably why the British naturalist and explorer Joseph Banks (1743–1820) had 'updated' his copy of the *Ichthyologia*, which formed part of the library he took on board with him on his voyage to Iceland in 1772, by adding the binomial names of Linnaeus.[179] Linnaeus did the same with his own copy of the *Ichthyologia*.[180] Just as Artedi had imposed his new standard name

[174] Alexander Garden to Linnaeus, 12 April 1762, UUB, L2902.
[175] Laurens Theodorus Gronovius to Arnout Vosmaer, 28 December 1751, Special Collections Department of Universiteitsbibliotheek Leiden (hereafter UBL), Leiden, BPL246, 51r.
[176] Antoine Gouan to Linnaeus, 8 January 1760, UUB, L2656.
[177] Jacob Theodor Klein, *Petri Artedi operum brevis recensio*, BL, Sloane MS 4020.
[178] He later published his own work on fish: Jacob Theodoor Klein, *Historiae piscium naturalis* (Gdansk: Thomas Johann Schreiber, 1740–1749).
[179] Banks's annotated copy of *Ichthyologia*, BL, 956c16.
[180] Linnaeus's annotated copy of *Ichthyologia*, Linnean Society (herafter LS), London, BL.144. For more on this practice, see: Edwin Rose, "Specimens, Slips and Systems: Daniel Solander and the Classification of Nature at the World's First Public Museum, 1753–1768," *British Journal for the History of Science* 51, no. 2 (2018): 205–237.

onto the previous ones existing for a species, therefore, Linnaeus and his adherents synchronised his carefully constructed species names with the Linnaean binomial names.

If all that was needed was to summarize nature's multifarious productions in a kind of linguistical matrix, was there any need to still bother with making illustrations? As has been mentioned, Artedi's book encompassed none. He does not explicitly address this lack of illustrative material, but it is possible to fathom some reasons, such as the practical, financial constraints on publishing illustrated natural histories that Chapter 1 has touched upon. Engraved images were costly, and thus rendered books too expensive for the average student of natural history.[181] It might well be the case that he did not consider it worth the effort. Linnaeus' *Systema naturae*, for example, appeared virtually without images because he found that his system was best expressed linguistically rather than visually.[182] While admitting that illustrations "conveyed something to the unlearned", he also said that it was his intention to "try to express by words all features just as clearly – if not more clearly – as others with their splendid drawings."[183] Artedi's readers expressed similar sentiments. In another review of the *Ichthyologia*, published in the *Neue Zeitungen von gelehrten Sachen* in 1738, the reviewer stated that "[…] in his descriptions [Artedi] has shown such clarity that one can understand everything without illustrations, such that one is capable of placing them in their proper classes, a thing that nobody has managed before him."[184] Perhaps it was alien to Artedi's approach to produce illustrations, as these were only a poor substitute for the essence of the fish itself.

This is not to say that, for Artedi, illustrations did not merit attention. In his bibliographical overview of fish books, Artedi opined on the quality of images. In his *judicium* of the illustrations in Willughby's and Ray's *Historia piscium*, for example, he criticizes the wood-cut images of Marcgraf for being particularly crude

[181] See: John L. Heller, "Linnaeus on Sumptuous Books," *Taxon* 25, no. 1 (1976): 33–52.
[182] Daniel Margócsy, "'Refer to folio and number': Encyclopedias, the Exchange of Curiosities, and Practices of Identification before Linnaeus," *Journal of the History of Ideas* 71, no. 1 (2010): 83.
[183] Linnaeus, *Genera plantarum* (Leiden: Conrad Wishoff, 1737), aph. 13, at 8; as translated in Müller-Wille and Reeds, "A Translation," 568.
[184] "Petri Artedi," *Neue Zeitungen von gelehrten Sachen* 24, no. 1 (1738): 347–351, as translated in Pietsch and Aili, "Jacob Theodor Klein's Critique," 58.

[*rudissimae*].[185] Those images taken from Rondelet and Belon had been executed slightly better, but were nonetheless underdeveloped. He was most pleased with those of Leonhard Baldner's drawings that had been copied into the book: he found them truly very handsome and, in all, most accurate [*vero nitidissimae et omnium accuratissimae*], although he did not specify what exactly made them so good.[186] Abstaining from using illustration in one's work does thus not necessarily indicate an aversion to the visual representation of nature. Charmantier has argued that the latter played a considerable role in Linnaeus' thinking; while he rarely included images in his work, he did include ample maps, diagrams and tables.[187] It was thus not that Linnaeus and Artedi were blind to the visual representation of nature, but rather that they did not consider illustrations indispensable for the identification of species, and at times even problematic.

Illustrations were also considered less advantageous than preserved specimens. To understand why, we turn to the aforementioned Laurens Theodorus Gronovius and his father, Johan Frederik (1690–1762). Civil servants of the city of Leiden, they were also avid collectors who knew Artedi's system intimately – as discussed earlier, they even seem to have been in the possession of one of the *Ichthyologia*'s original manuscripts. When Linnaeus resided in the Netherlands between 1735 and 1738, Gronovius the Elder had promptly recognized the merits of his classification scheme and helped to finance the first edition of the *Systema naturae*. Gronovius the Younger shared this appreciation, such that his father wrote of him: "he wants to describe all his pieces according to the manner of Linnaeus, [...] and has already studied more than a hundred fishes, both indigenous and exogenous ones."[188] Even though Gronovius the Elder referred to it as 'the manner of Linnaeus', when it came to fish, 'the manner of Linnaeus' was largely that of Artedi – at least in the first few editions of the *Systema naturae*. That father and son Gronovius were familiar with Artedi's system becomes clear when perusing the *Museum ichtyologicum* (Leiden, 1754–1756). This catalogue of all specimens

[185] *Icht.*, *Bibliotheca ichthyologia*, 52.
[186] Ibid.
[187] Charmantier, "Carl Linnaeus and the Visual Representation of Nature," 371.
[188] As translated by me from Dutch quotation in Bert Sliggers, *De Verzamelwoede van Martinus van Marum (1750–1837) en de Ouderdom van de Aarde: Herkomst en Functie van het Paleontologisch en Mineralogisch Kabinet van het Teylers Museum* (PhD diss., Leiden University, 2017), 156.

in their fish collection closely resembles the format of the *Ichthyologia*, following Artedi's sequence of orders, genera and species. It also makes frequent reference to Artedi's work: in describing a species of smelt, for example, the author added '*Arted. Gen.* 8' and '*Synon. p.* 21', so that the reader would know which genus this was in the *Ichthyologia*, where he might find a description of it, as well as a survey of the synonyms for this species.[189]

According to Margócsy, the need for classificatory repertories, like catalogues enumerating brief morphological descriptions of many species, was intimately linked to the increasing exchange of specimens. Plants, shells and insects were traded with particular avidity, on account of their modest size and weight, and the demand for ways with which collectors might clearly categorize them grew accordingly. For birds, fish and quadrupeds, there was less need for classificatory repertories because they were too expensive to ship in equally large numbers.[190] There is certainly truth to that pronouncement: whether, as we saw, in the case of larger fish, specimens were stuffed with hay, or, with smaller fish, submerged in spirits, specimens prepared in either way would take up considerable space in the hold of a ship or on a carriage. But, as we will now see, this was not necessarily always the case. Naturalists did have ways of preserving fish in a more compact fashion.

In the sixteenth century, Salviani had wondered whether it would be possible "to find a way to preserve dried fish in their own shape, like one does with these herbs."[191] The herbarium, in which plants were often fixed to pages with glue or thread, was a favoured method of botanical preservation at the time.[192] What Salviani thus proposed was what we might call an 'ichthyarium'; a term reminiscent of the term herbarium as a genre of preservation.[193] Despite Salviani's efforts to glue fishes to paper in the sixteenth century, it seems that his particular style of ichthyarium did not catch on widely, even if archives contain

[189] Laurens Theodorus Gronovius, *Museum ichthyologicum, sistens piscium indigenorum et quorumdam exoticorum* (Leiden: Theodoor Haak, 1754–1756), 18.
[190] Margócsy, *Commercial Visions*, 32.
[191] Findlen and Toledano, "Materials of Natural History," 158.
[192] The history of the herbarium is described in detail by Ogilvie, *Science of Describing*, 165–174.
[193] Naming it a 'fish herbarium' would be incongruous, as the term herbarium refers to herbs (from the Latin *herba*). The Greek word 'ichtus' or ἰχθύς refers to fish, and ἰχθύα can also refer to the skin of a fish. *Logeion*, s.v.ἰχθύς and ἰχθύα.

evidence of occasional use: there is, for example, an instance of a fish skin glued on paper among Sloane's papers.[194] The paper ichthyrium became a widespread practice for circulating fish specimens only after Gronovius the Elder wrote out his method for preserving fish on paper in the early 1740s.

In 1742, Gronovius the Elder communicated his method to Peter Collinson (1694–1768), who read the letter aloud during a meeting of the Royal Society and had it published in the *Philosophical Transactions*.[195] To enact the procedure successfully, one needed a pair of scissors with very fine blades and sharp points, small wooden plates (preferably of the lime tree), a very fine needle, slips of parchments as large as the fishes, and finally some very small pins. With all these materials in place, the preservation process could commence. The method, which Gronovius laid out in his letter step-by-step, entailed gently cutting a fish open with a pair of scissors, removing all of its intestines, patting it dry with a linen cloth, exposing it to the sun (in summer) or to the hearth (in winter) for further drying. The skin could then easily be separated from the flesh and was to be put between papers and pressed flat. Gronovius advised the application of a fresh sheet of parchment after two hours, "as a sort of glutinous Matter, in pressing, is always forced out from betwixt the Scales and the Skin" which might cause the fish to stick to the paper.[196] Only a few materials and a little time were needed, as Gronovius stated that "in the Space of 24 Hours, the Fish is prepared."[197] Even if the parchment were changed to absorb excess quantities of the glutinous matter that emanated from the remains of the fish, enough of the substance might have well remained to give the specimen a self-adhesive quality.[198]

In 1751, Gronovius sent a package to Pennsylvania that included "a few specimens of dryed fishes, to be kept as plants in an herbarius; the great

[194] Fish skin pasted on paper, BL, Add MS 5267 (part of Sloane's collection), f99r; it is dated 1732. I thank Felicity Roberts for bringing it to my attention.

[195] J.F. Gronovius, "A Method of preparing Specimens of Fish, by drying their Skins, as practised by John Frid. Gronovius M.D. in Leyden," *Philosophical Transactions of the Royal Society* 42, no. 463 (1742): 57–58. For the practice of reading letters aloud around this time, see: Aileen Fyfe and Noah Moxham, "Making Public Ahead of Print: Meetings and Publications at the Royal Society, 1752–1892," *Notes and Records of the Royal Society of London* 70, no. 4. (2016): 361–379.

[196] Gronovius, "A Method of preparing", 57–58.

[197] Ibid.

[198] Fish glue has historically been used for a wide range of artistic practices, see: Tatyana Petukhova, "A History of Fish Glue as an Artist's Material: Applications in Paper and Parchment Artifacts," *The Book and Paper Group Annual* 19 (2000): 111–114.

misfortune is, that the colour perish, else it shows a good way to find out the characters 1. by number of the bones in the gill flap […]; 2. by the number and position of the fins, and the bones in them. 3. by the course of the linea lateralis running in each fish from the back part of the head to the tail."[199] As Gronovius' letter indicates, the method preserved precisely those characteristics that were of most pertinence for classification according to Artedi's system. One of the things that unfortunately could not be salvaged was colour; on the goldfish, Gronovius the Younger remarked that "the colour in life is gold or silver, shining and most radiating, which in death gradually disappears and whitens."[200] The colour thus died together with the fish. Upon receiving a species of sandfish from the Cape of Good Hope, which he submitted was 'entirely new' [*plane novus*], he declared he could "barely guess the colour from this dried specimen."[201] The specimen that he referred to, and which he called the Gonorynchus, is still among the Gronovius Fish Collection at the Natural History Museum in London (**Figure 3.5**).[202]

Certain matters were definitely lost in preservation. As has already been discussed in Chapter 2, illustrations could convey liveliness in ways that dead, preserved specimens could not. The addition of colour to illustrations was significant, as this was one of the things that disappeared after death. Because colour carried no value for classification, however, Gronovius the Elder found there was no need to take the trouble. Furthermore, illustrations were mediations, and often did not relay the characteristics that the classifying naturalist desired to know – which might be because the artist was not aware of these marks, or because these could not easily be conveyed on paper. Gronovius stated, for example, that "Mr. Catesby hath indeed painted the American fishes very well. But I wish to know of all them fishes, how many bones there are in the gill flap, which is sufficient

[199] J.F. Gronovius to John Bartram, 26 June 1751, as reproduced in *The Correspondence of John Bartram 1734–1777*, eds. Edmund Berkeley Jr. and Dorothy Smith Berkeley (Gainesville: University Press of Florida, 1992), 330.
[200] Original Latin: "Color in vivus aureus vel argenteus, splendidus & fulgentissimus, qui in mortuo sensim perit & albescit." Laurens Theodorus Gronovius, *Zoophylacium Gronovianum: exhibens animalia quadrupeda, amphibia, pisces, insecta, vermes, mollusca, testacea, et zoophyta* (Leiden: Theodoor Haak, 1781), 109.
[201] Original Latin: "Colorem ex siccato specimine divinare haud potui […]". Ibid., 55.
[202] Specimen of *Gonorkynchus greyi* [*sic*], Natural History Museum (hereafter NHM), London, Gronovius Fish Collection, 53.11.12.120; the NHM keeps the ichthyarium of Gronovius, consisting of loose pages, in several dozen boxes. The fish retain some of their original odour.

to determine the genus together with the number of fins."[203] He referred to the *Natural History of Carolina, Florida and the Bahama Islands* (London, 1731) by the English naturalist Mark Catesby (1683–1749), a work that contemporaries praised for its perfectly executed watercolours.[204] Gronovius remark underscores the earlier mentioned belief that illustrations were superfluous, even if they had been done well.

Quite a few did take up the method proposed by Gronovius the Elder. Among them were the French naturalists Michel Adanson (1727–1806) and Philibert de Commerson (1727–1773), as well as Linnaeus.[205] In his autobiography, Linnaeus wrote how in his collection "were innumerable stones, in his herbarium and Garden innumerable plants, in his cabinet innumerable insects that he had assembled and pinned, in his cupboards innumerable fish glued on paper as if they were plants […]."[206] The fact that fish specimens were pressed flat enough to be inserted into an a letter wrapper facilitated their circulation between various countries and continents in large quantities and at relatively low cost, and with less chance of being damaged en route.[207]

While the spread of the ichthyarium as preservation practice was partly induced by practical circumstances, it was also welcomed because it adhered to the epistemological requirements of classification. As we saw, the essential characteristics, such as the fins and their rays and the bones in the gill flap once preserved in this manner, could be pressed into the service of the inquisitive naturalist. Using this method, naturalists could receive the actual specimens

[203] Johan Frederik Gronovius to Bartram, 6 December 1745, as reproduced in Berkeley and Berkeley, *The Correspondence of John Bartram*, 265.
[204] Amy R.W. Meyers and Margaret Beck Pritchard, "Introduction: Toward an Understanding of of Catesby," in *Empire's Nature: Mark Catesby's New World Vision*, eds. Amy R.W. Meyers and Margaret Beck Pritchard (Chapel Hill: University of North Carolina Press, 1998), 5.
[205] Amandine Péquignot, "Une peau entre deux feuilles, l'usage de l'herbier en taxidermie aux XVIIIe et XIXe siècles en France," *Revue d'histoire des sciences* 59, no. 1 (2006): 131–132. This article explains how the skins of birds as well as fishes were pressed between pages in herbarium fashion.
[206] Wilfrid Blunt, *The Compleat Naturalist: A Life of Linnaeus* (London: Collins, 1971), 151. Most of the fishes in his collection are now in the Linnean Society in London and the Gustavianum, the universitetsmuseum of Uppsala, and many are considered type specimens. See also: Alwhyne Wheeler, "The Linnaean Fish Collection in the Linnean Society of London," *Zoological Journal of the Linnean Society* 84, no. 1 (1985): 1–76; Alwhyne Wheeler, "The Linnaean Fish Collection in the Zoological Museum of the University of Uppsala," *Zoological Journal of the Linnean Society* 103, no. 2 (1991): 145–195.
[207] Whitney Barlow Robles, "Flatness," in *The Philosophy Chamber: Art and Science in Harvard's Teaching Cabinet, 1766–1820*, ed. Ethan W. Lasser (New Haven: Yale University Press, 2017), 196.

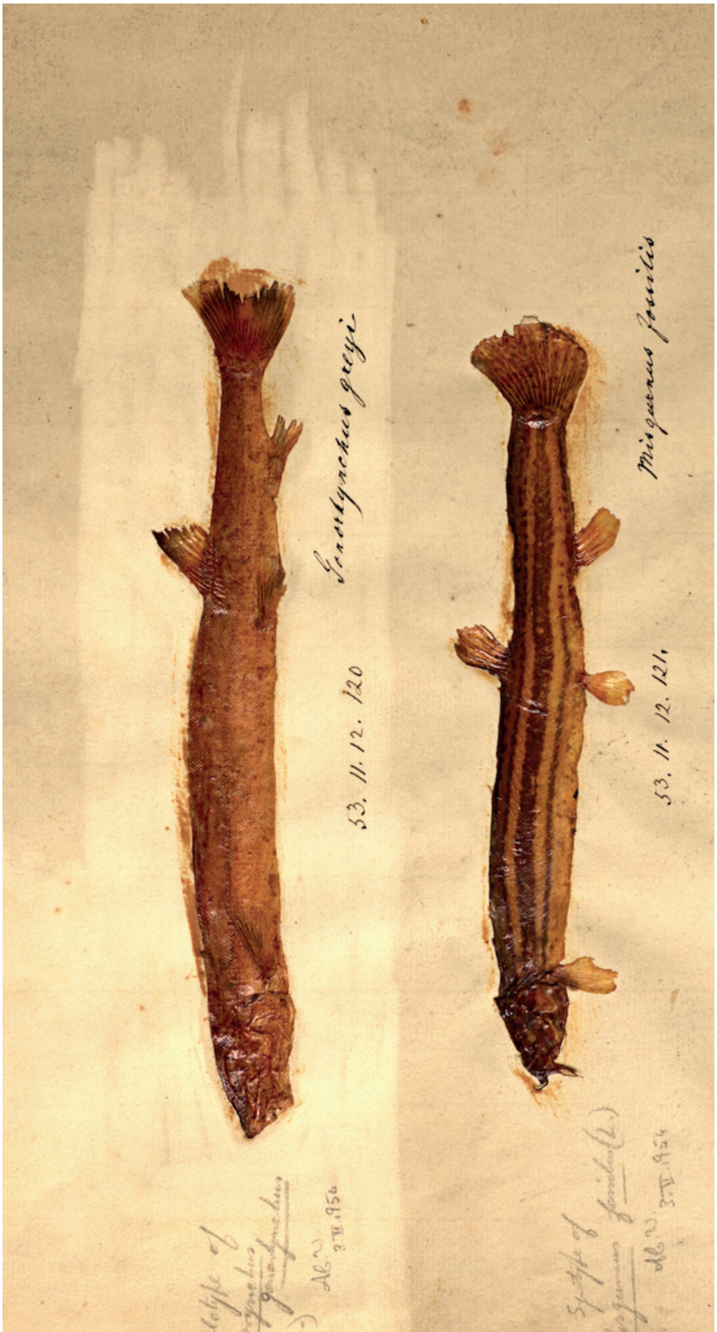


Figure 3.5 Specimen of *Gonorkynchus greyi* (above) Gronovius Fish Collection 53.11.12.120| © Trustees Natural History Museum | Photo by Lucie Goodayle

rather than mediated illustrations, and therefore did not need to rely on artists whom they had never met and whose skills they therefore had little way to assess. For adherents of Artedi's classification system, this method was thus not only a practical way to preserve fish given the constraints of money and material. As 'incarnations of themselves' (to borrow a phrase by Daniela Bleichmar)[208] fish prepared in this manner were considered by naturalists epistemologically better suited than images to base their classifications on.

What was the impact of Artedi's system? Charmantier and Staffan Müller-Wille have argued for Linnaeus' works that they were useful to naturalists in the complex process of comparing specimen to specimen, distinguishing one species from the other, and in drawing up their own species diagnoses.[209] It made it easier to count and categorize species, and to assign names and numbers to them.[210] Even though Artedi, unlike Linnaeus, did not present his readers with binomial names, his *Ichthyologia* did offer a clear overview of both genera and species, their characteristics enumerated in the form of numbered lists. It was praised by naturalists for its precise and distinct method of classification. The clear species descriptions meant that illustrations were not necessary. Because the ichthyarium method made popular by Gronovius allowed for the dispatching of fish specimens from all corners of the world in an economical fashion while retaining those characteristics that were important in classification, it was privileged as a form of preservation. It allowed naturalists to count these characteristics for themselves.

Conclusions

Artedi's book was not only an attempt to classify fish, but also to classify past and present knowledge about fish and, by extension, people who studied and worked with fish. Moreover, it was an attempt to establish ichthyology as a science; to define its object, and to unfold its epistemology. In what would be the last letter he wrote to his relatives, Artedi spoke confidently of his mastery of ichthyology, asserting that "in the Dutch Republic, there is no one who understands zoology

[208] Bleichmar, *Visible Empire*, 63.

[209] Isabelle Charmantier and Staffan Müller-Wille, "Carl Linnaeus's Botanical Paper Slips (1767–1773)," *Intellectual History Review* 24, no. 2 (2014): 227.

[210] Staffan Müller-Wille, "Names and Numbers: 'Data' in Classical Natural History, 1758–1859," Osiris 32 (2017): 120–126.

anyway, and where Ichthyology is concerned, I admit neither there nor elsewhere anyone for my master."[211] It reveals how Artedi considered himself as a specialised naturalist with an authoritative command of the natural history of fish. We will now recall the opening story of this chapter, where Artedi longed to confer with an ichthyologist – not any, but rather a 'true' [*vero*] one. Similar qualifications were made by Linnaeus, who referred to botanists as 'sound' [*sanis*].[212] So what did it take to be a sound botanist or true ichthyologist?

For Artedi, the answer to this question was his own method. In developing it, he seems to have had mind how it would distinguish him from other naturalists and serve to establish his name. We see this, for example, in his interactions with Sloane, to whom he gave a manuscript displaying his classification method for fish, and with Seba, who hired Artedi to describe his species according to it. As his life was cut short before he had fully prepared his work for publication, we cannot know to whom his dedicatory letters would have been addressed. Earlier studies of the *Icthyologia* have overlooked the social context in which the work was produced; so far, attention has always been directed to the classificatory contents of the book itself rather than its style of writing, layout, or structure. This chapter has shown the rhetorical effects of such decisions. In unfolding his new system, Artedi grafted his book onto traditional models, drawing on humanist and scholastic models of organizing knowledge, such as the genre of the *literaria* and the format of the *disputatio*, as well as by selecting Greek and Latin as the only languages acceptable for the names of genera and species. By doing so, he anchored his novel approach to long-standing scholarly traditions of organizing and presenting knowledge.

His method was novel indeed. As we saw in Chapter 1, Renaissance naturalists had grouped species together based on a wide range of characteristics, for which they consulted a diversity of sources including literary ones. Willughby and Ray had proposed a strict focus on external characteristics, and had used these to construct taxonomical groups, albeit loosely. While they eschewed

[211] Original Swedish: "Här i Holland är ingen särdeles såm förstår sig på Zoologien, och hwad Ichthyologien angår, så ärkiänner jag hwarken där eller annorstädes någor för min maitre [...]" KBS, MS X1002.
[212] Linnaeus, *Genera plantarum*, 3.

humanistic learning, their species descriptions nonetheless incorporated various anecdotes, proverbs and matters relating to fishery. For Artedi, it was not relevant whether a fish dwelled in fresh or salt water, with which letter of the alphabet its name started, or how it figured in trade. Artedi drew up strict definitions for taxonomical ranks on all levels, arranging his descriptions in list format. What earlier authors had written on a certain species only mattered in the extent to which they corresponded with his own descriptions. Artedi's method imposed abstraction by including only those characteristics that were pertinent to classification, and leaving out the rest. The innovative character of this system cannot be overstated. In the process, the study of fish became an increasingly visual and almost quantative pursuit, as closely observing species and carefully counting their physical characteristics became one of its hallmarks. Although one would expect that this would make images a vital part of natural historical study, this was not necessarily the case for Artedi and his adepts. Images were not only expensive to produce, they might also be unreliable if artists were either unaware or unable to capture these aforementioned characteristics. A preserved specimen with its fins, teeth, and other parts intact would better perform its function for classification.

The model that Artedi developed for classifying fish meant that one could take any fish, known or unknown, and through close observation navigate one's way through the correct order, via the genus, and arrive at the correct species. With this system, Artedi widened the realm of possible observers, as a fish could now be assigned its proper place in Creation simply by counting fins and checking other characteristics. He also narrowed it down, however, by deeming only particular kinds of knowledge pertinent for the field that he defined as ichthyology. As we have seen in the previous chapter, early modern natural history took place in a composite social space. In excluding artisanal and vernacular knowledge, Artedi whittled away this longstanding practical knowledge from the body of natural historical knowledge about fish, lending his own methodical principles more authority in the process. He thus narrowed the kind of knowledge that was of possible import to learned inquiries into fish.

Linnaeus, similarly, placed those who worked with nature into various categories and assigned different values to them. For him, observers of plants were interchangeable as long they had mastered a standardised set of skills, namely knowing what to look for (such as the numbers of stamen and pistils).[213] This only held, however, for the practical work of recognizing and defining species of plants; the more theoretical and abstract work of drawing up a scheme of genera, orders, and classes would have to be done by those with specialist knowledge: the botanist.[214] Harriet Ritvo has argued that after the introduction of classification systems, "taxonomy itself became a characteristic of the highest taxonomical significance."[215] In other words, an understanding of classification systems became to be seen as an indication of one's proficiency in natural history, as well as one's ability to reduce living creatures to some underlying pattern.

Staffan Müller-Wille has argued that Linnaeus' success was to no small degree due to the 'templates for communal annotation' that his taxonomic works offered.[216] These templates created a community that worked towards the collective goal to complete the system by fitting ever more species into it based on observations in the field, the museum or the library.[217] As a result, the system that Linnaeus had designed to contain and instill order into information about species contributed to the propagation of this kind of information.[218] While barely registering by comparison with the copious translations, adaptations and editions that Linnaeus' work inspired, Artedi's work was also revisited. In 1789, for instance, a revised edition of his book was issued in the German states. Johann Julius Walbaum (1724–1799) saw fit to publish the *Petri Artedi Renovati*, in which he amended Artedi's species descriptions, and added species and genera that had been described after the publication of the book.[219] Like the system of

[213] Cooper, *Inventing the Indigenous*, 171.
[214] Nickelsen, *Draughtsmen*, 74.
[215] Harriet Ritvo, "New Presbyter or Old Priest? Reconsidering Zoological Taxonomy in Britain, 1750–1840," *History of the Human Sciences* 3, no. 2 (1990): 260.
[216] Staffan Müller-Wille, "Linnaean Paper Tools," 210.
[217] Staffan Müller-Wille and Sara T. Scharf, "Indexing Nature: Carl Linnaeus (1707–1778) and His Fact-Gathering Strategies," *Svenska Linnesällskapets Årsskrift* 94 (2011): 57.
[218] Isabelle Charmantier and Staffan Müller-Wille, "Natural History and Information Overload: The Case of Linnaeus," *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* 43, no. 1 (2012): 4.
[219] Johann Julius Walbaum, *Petri Artedi Renovati* (Greifswald: Anton Ferdinand Röse, 1789).

Linnaeus, that of Artedi was flexible enough to allow for adaptations by later naturalists while keeping its basic structure intact.[220] The following chapter will look at one such naturalist, Marcus Élieser Bloch, who drew on this classification system, but took other approaches to both description and illustration.

[220] Bettina Dietz, "Linnaeus' Restless System: Translation as Textual Engineering in Eighteenth-Century Botany," *Annals of Science* 73, no. 2 (2014): 155.

CHAPTER 4

Swimming on the Page: Image and Illustration in Marcus Élieser Bloch's *Allgemeine Naturgeschichte der Fische* (Berlin, 1782–1795)

In the preface to the sixth volume of his natural history of fishes, published in 1787, Marcus Élieser Bloch announced that it would mark the conclusion of his series of such books.[1] This ambitious project, the *Allgemeine Naturgeschichte der Fische* (1782–1795), was the result of decades of investigations into the nature of fish. The first five volumes had been received with enthusiasm on account of the exacting way in which species were described and depicted.[2] That he now announced a concluding volume was not because he truly thought his project was finished. After all, he still had more than a hundred unpublished drawings of fish in his possession, executed in the most beautiful colours, and many of the specimens in his impressive collection in Berlin were yet to be depicted.[3] Lack of research material was not the issue here. It also was not the case that his books piqued no interest with an audience: the subscription list for the first volume of the series counted no less than three hundred and seventy names included in his book, and is a testimony to the wide range of people that had expressed their interest in, and thus signed up for, the next instalment of Bloch's natural

[1] Marcus Élieser Bloch, *Allgemeine Naturgeschichte der Fische*, vol. 6 (Berlin: Realschule, 1787), sig. a2r; the series is henceforth abbreviated as *Allg. Nat. der Fische*.
[2] An anonymous reviewer of the first volume characterized it as an erudite, elaborate and exacting work: "D. M. E. Bloch, *Oecnomische Naturgeschichte der Fische Teutschlands*," *Allgemeine deutsche Bibliothek* 53, no. 2 (1783): 582–583.
[3] *Allg. Nat. der Fische*, vol. 6, sig. a2r.

history of fishes.[4] The European audience for "visually sumptuous and winningly designed volumes",[5] in the words of Benjamin Schmidt, was, after all, growing in the eighteenth century; Seba's *Thesaurus* (1734–1765) and Catesby's *Natural History of Carolina* (1729–1747), mentioned in the previous chapter, are among the many books that might be cited as examples here. Among the subscribers to Bloch's fish series were royals and nobles, government officials, bankers, apothecaries, physicians, preachers, and booksellers, as well as a Luxembourgian fishing guild.[6]

The series did not fall short on attention. The problem was, rather, that many of its subscribers had not actually paid their dues. Bloch had approached first bookseller Hesse, and later the Realschule Buchhandlung in Berlin, to print his series, but paid for the full publication process himself. He conceded that of the twenty thousand Reichsthalers he had spent out of his own pocket – a staggering sum – he had earned only about half back.[7] As he explained, he saw himself forced to put his project on hold to guard his family from further impoverishment.[8] While his explicit statement of financial duress may seem somewhat unusual to us, it fitted rather well with the cultural code of the learned community of the time, which considered that one published books as a service to the society, and did not involve even the slightest hint of a pursuit of profit.[9] Presenting the public with a well-made book was also an investment in one's name. It was only upon altering his publication strategies that Bloch ultimately managed to proceed his publishing project and deliver the final six volumes, bringing the series to completion with the twelfth. All in all, Bloch's commitment to getting his series out into the world in this particularly expensive, illustrated form is remarkable. This chapter argues that Bloch's fish series, with the coloured engravings as its unique selling point, were instrumental in the creation of his image as a naturalist, and as a specialist on fish in particular. As we will see,

[4] *Allg. Nat. der Fische*, vol. 1 (Berlin: Hesse, 1782), n.p.
[5] Schmidt, *Inventing Exoticism*, 18.
[6] *Allg. Nat. der Fische*, vol. 1, n.p.
[7] *Allg. Nat. der Fische*, vol. 8 (Berlin: J. Morino, 1791), sig. *2r.
[8] At this time, Bloch had three children: a son (whose name remains unknown) from his marriage to Breinche Rintel (1747–1769) in 1765, a daughter named Rose from wedlock with Cheile Ephraim (*c.*1757–1780) whom he had married in 1774, and his daughter Rebecca after marrying Rahel Bendix (1767–1833) in 1784.
[9] Phillips, *Acolytes of Nature*, 51.

while he continued the classificatory approach that Artedi and Linnaeus had promulgated in their works, he conceived of his own work as an improvement of theirs.

When perusing the entire series, it soon becomes clear why its production was such a costly venture. Where it was common practice for authors to copy illustrations, as we have discussed for example with Willughby and Ray, almost all of the engravings in Bloch's work had been designed anew by artists. The series encompasses no fewer than 432 plates. As Bloch proudly declared, every copy of the lavishly illustrated fish series had been coloured by hand.[10] He often prided himself in "having again spared no effort or costs to give [the volumes] the highest degree of perfection."[11] The previous chapter has shown that the inclusion of illustrations in natural historical works was a much-contested topic among naturalists, and that the works of Linnaeus and Artedi appeared virtually image-free. For Bloch, however, coloured illustrations lay at the heart of his project. In the introduction to the series, he declared: "I will restrict myself to those fishes, from which I am able to offer drawings done after nature."[12] In contrast to the fish books discussed earlier in this dissertation, therefore, the availability of illustrations drawn from the life was the decisive factor in designating which species were to be included in the *Allgemeine Naturgeschichte der Fische*. Bloch stands out in his rather innovative approach towards illustrations. For the printed images, the artists used a wide array of both established and new techniques: these included the mechanical printing of colour, the hand-colouring of engravings, the heightening of illustrations with paint made from silver and gold, as well as the use of cross-sectional views of specimens. No time or effort was spared because illustrations captured fish in their best possible shape – or so Bloch believed.

The case of Bloch's fish series offers an extraordinarily rich documentation that is only seldom available for other natural historical publications. Most of the drawings that Bloch possessed were based on the preserved specimens in

[10] *Allg. Nat. der Fische*, vol. 4 (Berlin: Realschule, 1785), sig. a2v.
[11] Original German: "[…] da ich weder Mühe noch Kosten gesparet, um demselben den möglichsten Grad der Vollkommenheit zu geben." *Allg. Nat. der Fische*, vol. 3 (Berlin: Realschule, 1784), n.p.
[12] Original German: "Ich werde mich indessen nur auf solche Fische einschränken, von welchen ich nach der Natur gemalte Zeichnungen zu lieferen im Stande bin […]." *Allg. Nat. der Fische*, vol. 1, sig. Ar.

his extensive collection, which numbered well over a thousand, and counts as the most expansive private collection of fish of the eighteenth century. Its specimens took the form of dried skins and preserved fish in jars, and they had come to Bloch from all corners of the world thanks to his wide-ranging network of correspondents. A considerable part of his collection is still extant in the Museum für Naturkunde in Berlin.[13] Besides the specimens, a significant share of the drawings made from them remain in the Historische Arbeitstelle of that same museum.[14] This means that the original specimens can be coupled with the species descriptions, drawings and engravings that were made from them. While it is impossible to give a definitive answer of how *exactly* the book and collection would have related to one another for Bloch and his contemporaries, this chapter investigates the interactions and intersections that occur between Bloch's fish volumes and his collection.

Both the assembly of the collection and the production of the twelve volume series were costly and time-consuming ventures for all those involved. What led Bloch to put so much time and money towards the creation of no fewer than four hundred and thirty-two images of fish, and what was involved in these extraordinary efforts? Who assisted him in the process, and for what reasons? To the extent that his fish oeuvre, both the bibliographical and the curatorial, have been engaged with by historians, this has mostly been to describe the formation processes of book and collection as a monumental actualization of eighteenth-century German natural history.[15] This interest has not, however, led to deeper

[13] An inventory has been compiled by Hans-Joachim Paepke, *Bloch's Fish Collection in the Museum Für Naturkunde Der Humboldt-Universität Zu Berlin: An Illustrated Catalog and Historical Account* (Ruggell: A.R. Gantner, 1999). The Zentralmagazin Naturwissenschaftlicher Sammlungen of the Martin-Luther-Universität Halle Wittenberg in Halle (Saale) is currently taking stock of which specimens in their collection derive from that of Bloch.

[14] Bound manuscripts of Historische Arbeitstelle of the Museum für Naturkunde (hereafter MfN), ZMB, VIII/423 and VIII/424.

[15] Richard Lesser, "Dr. Marcus Elieser Bloch: Ein Jude begründet die moderne Ichthyologie," in *Haskala: Die jüdische Aufklärung in Deutschland 1769–1812*, ed. Christoph Schulte (Wolfenbüttel: Wallstein, 1999), 238–246; Ellen B. Wells, "M.E. Bloch's Allgemeine Naturgeschichte der Fische: A Study," *Archives of Natural History* 10, no. 1 (1981): 7–13; Christine Karrer, "Marcus Elieser Bloch (1723–1799), Sein Leben und die Geschichte seiner Fischsammlung," *Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin* 18 (1978): 129–149; Hannelore Landsberg, "Eine Fischsammlung aus Tranquebar, die Berliner Gesellschaft Naturfoschender Freunde und deren Mitglied Marcus Elieser Bloch," in *Mission und Forschung. Translokale Wissensproduktion zwischen Indien und Europa im 18. und 19. Jahrhundert*, ed. Heike Liebau (Halle: Frankesche Stiftungen, 2010), 167–179.

inquiries into their underlying epistemologies. And while the illustrations have often been, and still are, praised for their beauty, they are seldom subjected to closer study.[16]

This chapter considers the connections between collection and series, paying special attention to the illustrations. In order to bring those connections to the surface, the chapter first introduces Bloch, his collection and his book of fish and embed him in the wider community of late eighteenth-century *Naturforscher*. It then takes a step back and considers how these specimens had reached the shelves of Bloch's cabinet in the first place, with a focus on the most active contributor of specimens outside of Europe, the German missionary Christopher Samuel John (1747–1813), who enlisted local assistants to collect fish in Coromandel and had his own reasons for participating in Bloch's project.[17] The last part of the chapter analyzes the way in which Bloch's fish collection was preserved on paper, with particular emphasis on the way in which the illustrations were designed and executed and for what reasons. Ultimately, the manner in which Bloch preserved his collection on paper served to make him an authority on the fishes of the world without requiring him to travel outside of his Berlin.

Bloch and His Collection

The most detailed biographical sketch of Bloch has been written by Christine Karrer, who has pieced it together from a variety of sources, including the letters and accounts of some of Bloch's contemporaries.[18] He was born in 1723 in Ansbach in Bavaria, and grew up in a rather impoverished, orthodox Jewish household.[19] Bloch's upbringing was traditional; while he was taught Hebrew, for example, he did not learn German, as in orthodox circles this was not encouraged.[20] Around 1743, he travelled to Hamburg, where he had obtained a position as teacher to the son of a Jewish surgeon. This is where he learned German and Latin, and

[16] An exception is Claudia Kreklau, "Travel, Technology, and Theory: The Aesthetics of Ichthyology during the Second Scientific Revolution," *German Historical Review* 41, no. 3 (2018): 589–610.
[17] John's correspondence with his superiors is held by the Frankesche Stiftungen in Halle an der Saale as part of their Missionsarchiv mit der Indien- und der Amerikaabteilung, AFSt/M.
[18] Karrer, "Marcus Elieser Bloch," 130–131.
[19] Ibid., 132.
[20] Steven M. Lowenstein, *The Berlin Jewish Community: Enlightenment, Family, and Crisis, 1770–1830* (Oxford: Oxford University Press, 1994), 189.

acquired his first basic medical knowledge. Although the specific year is unclear, he subsequently travelled to relatives in Berlin to study anatomy. When Bloch wished to pursue a doctorate in Medicine in 1760, he ventured to in Frankfurt am Oder; this city's university was the only one in Prussia that admitted Jews.[21] Having received his degree in 1762, Bloch settled in Berlin where he set up practice as a physician, married, and involved himself in the city's intellectual life.

Besides attending to his patients, Bloch also studied natural history. It is not known when exactly he began gathering specimens, but sources first mention his collection in the early 1770s.[22] Following the death of his first wife in 1769, he wedded the affluent Cheile Ephraim (1757–1780) in 1774, with whom he would have a daughter.[23] His first publication, a book of medical observations, appeared in that same year.[24] In the decades after, he established himself as prolific author of natural history.[25] He spent most of his time, however, on the study of fish: a subject which he believed had received too little attention from other naturalists, as will be discussed in more detail below. He collected species of fish, scoured the natural historical literature to see if they had already been described, and classified them according to Linnaean principles if that had not yet been done. The first volume of his fish series was published in 1782. By that time, his name had become established enough that various academies and societies accepted him as a member; the book's title page mentions those of Leipzig, Göttingen, Utrecht and Frankfurt, amongst others.[26] This first volume made quite a splash, and the Holy Roman Emperor Joseph II (1765–1790) responded to the receipt of a copy by awarding Bloch with a gold medal in recognition of what he perceived to be the book's great benefits.[27]

[21] Karrer, "Marcus Elieser Bloch," 132.

[22] It is mentioned in the *Tagebuch* entry of 17 August 1773 of the Gesellschaft Naturforschender Freunde. MfN, ZMB, GNF, S. Bloch, TB 1.

[23] Karrer, "Marcus Elieser Bloch," 134.

[24] Marcus Élieser Bloch, *Medicinische Bemerkungen, Nebst einer Abhandlung vom Pyrmonter Augenbrunnen* (Berlin: Christian Friedrich Himburg, 1774).

[25] Besides publishing his fish series, Bloch wrote, among other things, on opal, tortoises and bladder worms in the *Beschäftigungen* of the *Gesellschaft Naturforschender Freunde*. His full publication list, which is too extensive to cite here can be found on https://personenlexika.digitale-sammlungen.de/Lexika/Bloch,_Markus_Elieser_(GND_118663968) (last accessed 9 April 2021).

[26] *Allg. Nat. der Fische*, vol. 1, title page.

[27] Notice in *Magazin des Buch- und Kunsthandels, welches zum Besten der Wissenschaften und Künste von den dahin gehörigen Neuigkeiten Nachtricht giebt* (Leipzig: Johann Gottlob Immanuel Breitkopf, 1782) no. 7, 558.

It must have been a welcome endorsement, and in the subsequent decades Bloch expanded both his collection and his series of fish. The Jewish physician grew into a person of note. In 1789, he posed for the Swiss painter Anton Graff (1736–1813), well known for immortalizing princes and scholars in his portraits.[28] When the last volume of his series appeared in 1795, Bloch's memberships of learned societies had doubled, and included the Royal Society in London and the Musée d'Histoire naturelle in Paris.[29] In 1796, well into his seventies, he travelled to Amsterdam and Paris where he attended auctions, visited collections and even met the renowned naturalists Georges Cuvier (1769–1832), certainly one of the most celebrated *savants* of his time.[30] Bloch was in the process of producing a general classification system for all fish hitherto described when he died from a stroke in 1799. The work was published posthumously in 1801 as the *Systema ichthyologiae* by Johann Gottlob Schneider (1750–1822).[31] Where Bloch had, for his series, drawn on Linnaean principles for classifying fish which, as we saw in Chapter 3, entailed taking into account a careful combination of characteristics, he now proposed to look *solely* at the fins – Cuvier later described this work, somewhat snidely, as a 'curious production' that proposed a quite bizarre classification.[32] His classification system does not seem to have caught on.

Although Bloch's life has been relatively well documented, certain gaps remain.[33] It is not clear, for example, precisely *when* he began his collection, though it was certainly under way by 1772. It is, furthermore, not known exactly when he conceived of his plan to publish. That his collection preceded his book series is nonetheless obvious; the first volume, after all, appeared in 1782, at least a decade after he began collecting. From this moment on, his collection and his series nourished, influenced and reinforced one another. In the prefaces to the

[28] Karrer, "Marcus Elieser Bloch," 136–137.
[29] *Allg. Nat. der Fische*, vol. 12 (Berlin: J. Morino, 1795), title page.
[30] Karrer, "Marcus Elieser Bloch," 137.
[31] Marcus Élieser Bloch and Johann Gottlob Schneider, *Systema ichthyologiae iconibus CX illustratum* (Berlin: Bibliopolio Sanderiano, 1801). See also: Christine Karrer, Peter Whitehead and Hans-Joachim Paepke, "Bloch & Schneider's *Systema ichthyologiae*, 1801: History and Autorship of Fish Names," *Mitteilungen aus dem Museum für Naturkunde in Berlin* 70, no. 1 (1994): 99–111.
[32] Georges Cuvier, *Historical Portrait of the Progress of Ichthyology: From its Origins to our Own Time*, trans. Theodore W. Pietsch (Baltimore: Johns Hopkins University Press, 1995), 140; pages 147–148 offer an overview of Bloch's system.
[33] Karrer, "Marcus Elieser Bloch," 132.

volumes he published, Bloch solicited ever more fish specimens and drawings from his readers. They plainly obliged, as over the years in which his series was published, he continued to receive a good supply of specimens, which he in turn converted into descriptions and depictions in his series. Even though the development of the collection and that of the series were closely connected, we will first turn to the formation of the former, and only subsequently discuss the latter.

Bloch assembled an impressive collection in his home on the Spandauerstraße, where the more prosperous Jewish inhabitants of the city lived.[34] A characterization by the printer Christoph Friedrich Nicolai (1733–1811), in his 1779 guide to notable places in the area of Berlin and Potsdam, gives an idea of what this collection encompassed.[35] It was kept in "eight glass cabinets and five drawered chests",[36] and consisted of a broad range of *naturalia*; from birds and their nests to shells, from four-footed animals to polished stones, and from amphibians to insects. In building this natural historical collection, Bloch was representative of a wider trend in eighteenth century Europe, in which increasing numbers of merchants, physicians, professors and others assembled objects in their households.[37] Nicolai describes 27 other collections in Berlin.[38] Over the years, Bloch's collection grew steadily in both size and fame. By 1795, Wilhelm von Humboldt wrote to Johann Wolfgang von Goethe about the 'Bloch'sche Cabinet', saying that he had not visited it but that he heard it held all kinds of rarities.[39] As James Delbourgo has shown for Hans Sloane, building a collection of note was a good way to establish one's name and forge connections.[40] Emma Spary has argued that collections were considered to represent the collector's

[34] Lowenstein, *The Berlin Jewish Community*, 16.
[35] Christoph Friedrich Nicolai, *Beschreibung der Königlichen Residenzstädte Berlin und Potsdam* vol. 2 (Berlin: Friedrich Nicolai, 1779), 599–601. An abbreviated, paraphrased translation can be found in Antoine-Joseph Dézallier d'Argenville, *La conchyliologie, ou, Histoire naturelle des coquilles de mer, d'eau douce, terrestres et fossiles* (Paris: Guillaume de Bure fils aîné, 1780), 828.
[36] Nicolai, *Beschreibung*, 599.
[37] For a recent overview of types of collections in eighteenth-century Europe, see: Eva Dolezel, Rainer Godel, Andreas Peča and Holger Zaunstöck, eds., *Ordnen – Vernetzen – Vermitteln. Kunst- und Naturalienkammern der Frühen Neuzeit als Lehr- und Lernorte* (Stuttgart: Wissenschaftliche Verlagsgeselschaft, 2018).
[38] Nicolai, *Beschreibung*, 598–609.
[39] Wilhelm von Humboldt to Johann Wolfgang von Goethe, 22 August 1795, *Goethes Briefwechsel mit den Gebrüdern Humboldt (1767–1832)*, ed. F. Th. Bratranek (Leipzig: F.A. Brockhaus, 1876), 7.
[40] Delbourgo, *Collecting the World*, xxviii.

personal character, and that orderly and aesthetically pleasing cabinets were especially appreciated.[41] Bloch must have been well aware of the connection between his collection and his prestige and reputation.

What made Bloch's collection stand out in particular was, naturally, its fish. On his death, the collection had grown to encompass almost 1,400 species.[42] About three quarters of the fish were specimens preserved in spirits. The rest of the specimens were dried; some were stuffed with hay, while others were loose skins, or skins mounted on wooden models. As explained above, Bloch may have started collecting the fish that dwelled in the Prussian states in the 1770s. Just as Willughby and Ray had done a century before him, Bloch obtained specimens at marketplaces and harbours.[43] He also acquired specimens through excursions to a nearby fishing village during his summer vacations, where he collected many useful observations from the fishermen. While Bloch initially intended to chart all of German fishes, he also received *fremde Fische*, with which he seems to have meant those fish not native to the German states.[44] Bloch boasted that people were sending him natural objects from all parts of the world: his vast network of correspondence consisted of government officials, physicians and missionaries abroad. His collection thus grew to encompass specimens originating from Scandinavia, Greenland, the North Atlantic, the Mediterranean, Africa's west coast, the Caribbean, Surinam and Brazil, North America as well as Southeast Asia.[45]

What, precisely, had led Bloch to collect fish? He answers this question on the very first page of the preface to the inaugural volume of his series.[46] He relates how he had been spending much of his leisure time perusing natural history. Then one day – he does not specify when – a friend sent him a species of salmon from the lake of Miedwie, in the Province of Pomerania bordering on the east

[41] Emma Spary, "The Naturalist Collecting Community in Paris, 1760–1789: A Preliminary Survey," in Dolezel, Godel, Peča and Zaunstöck, *Ordnen – Vernetzen – Vermitteln*, 310.
[42] Eva Dolezel, "Lehrreiche Unterhalting oder Wissenschaftliche Hülfsmittel? Die Berliner Kunstkammer um 1800. Eine Sammlung am Schnittpunkt Zweier Musealer Konzepte," *Jahrbuch der Berliner Museen* 46 (2004): 151–152.
[43] Wells, "M.E. Bloch's Allgemeine Naturgeschichte der Fische: A Study," 8.
[44] *Allg. Nat. der Fische*, vol. 3, n.p.
[45] Paepke, *Bloch's Fish Collection*, 27.
[46] *Allg. Nat. der Fische*, vol. 1, sig. *2r.

of Brandenburg.[47] After consulting his copy of Linnaeus' *Systema naturae* (he does not mention which edition), he found that it did not mention this species. This astonished him so much that he decided to look up some of the other fish common in the German states. He resolved to chart the piscine population of the German states, to draw up detailed descriptions and deliver truthful images on the basis of which species could be classified. Rather than developing a new system, however, – and this is important to stress – Bloch took part in the broader effort of perfecting the existing classification system for fish. During those hours in which he did not attend to his patients, he directed his attention to that part of natural history which he thought was rather poorly attended to, the history of fishes.

That Bloch was a significant figure in the learned landscape is underscored by the portrait engraving that the German physician and naturalist Johann Georg Krünitz (1728–1796) commissioned of him for the thirteenth part of his *Oeconomische Encyclopädie* (**Figure 4.1**), published in 1784.[48] As its title indicates, this series offered an encyclopaedic overview of all matters relating to 'oekonomie' – a term that encompassed all kinds of practical endeavours that contributed to socio-economic improvement in one way or the other.[49] Bloch deserved a place in this survey: as the text on the engraving declares, he was much loved as a physician, nationally renowned for his study of nature and an esteemed philanthropist.[50] While the various portraits of eminent figures commissioned by Krünitz for his encyclopaedia are similar in style, they each convey something that is specific to the person depicted. In the case of Bloch, the scenic backdrop against which his portrait is placed signifies his interest in the study of nature. A

[47] Ibid.

[48] The engraving was done by the artist Johann Conrad Krüger (1733–1791), who also made engravings of other notable figures including Moses Mendelssohn and Krünitz himself. See: Johann Georg Krünitz, *Oeconomische Encyclopädie* (Berlin: Joachim Pauli, 1773–1796).

[49] Phillips, *Acolytes of Nature*, 35.

[50] Original German: "Als Arzt, beliebt; als Forscher der Natur, berühmt bey seiner Nation nicht nur / als Menschenfreund, wie Mendelssohn geschäzt, ist Bloch, dem Wahrheit dieses Denkmal setzt: durch ihren Freund, Krünitz."; it is not clear whether the term 'Nation' refers to the Jewish community, in its usage in the Hebrew Bible, or an envisioned German state. Bloch himself uses this term in the preface to his first volume to refer to the various German states.

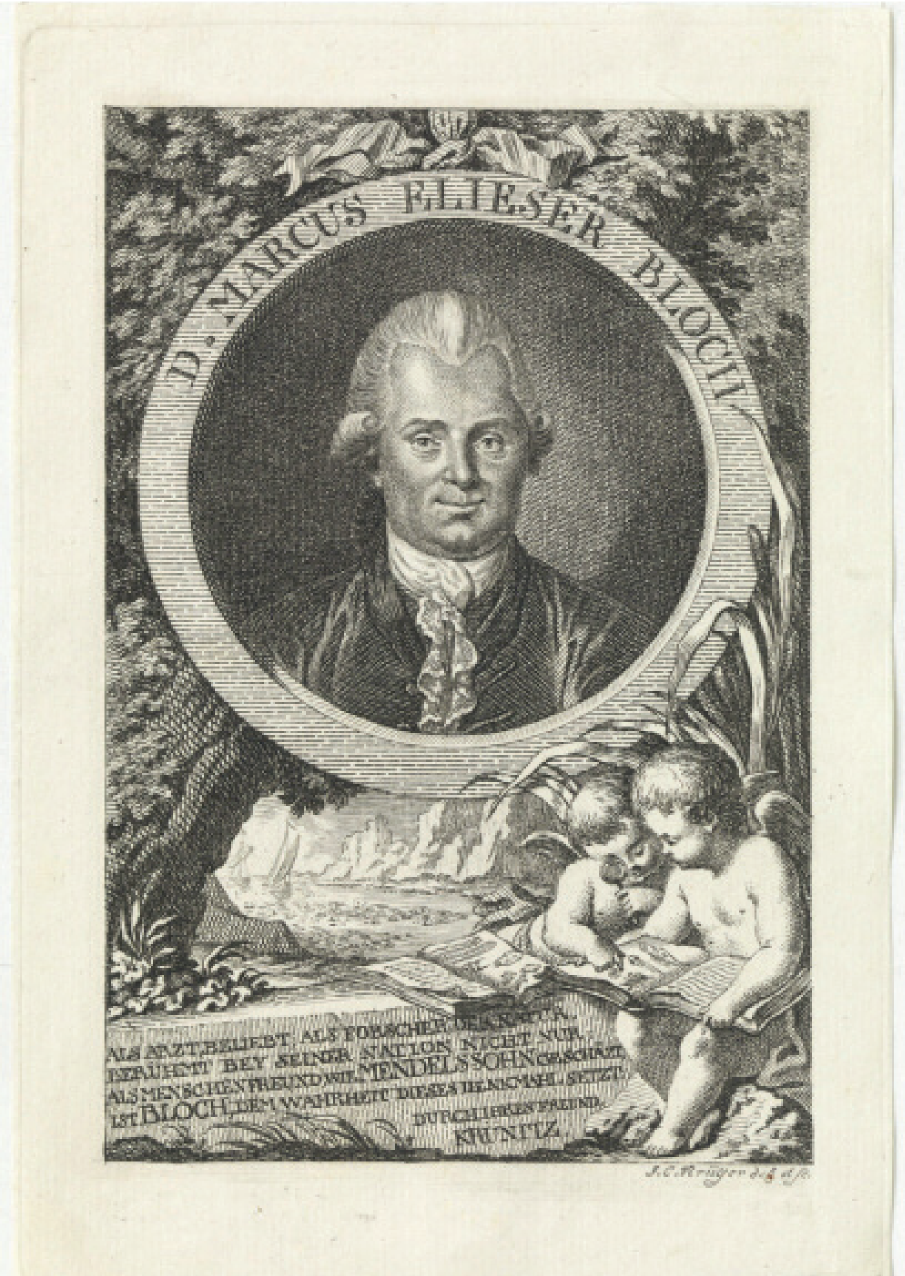


Figure 4.1 Portrait engraving of Marcus Élieser Bloch, Johann Conrad Krüger | Johann Georg Krünitz, *Oeconomische Encyclopädie* vol. 31 (Berlin: Joachim Pauli, 1778) | © Universitätsbibliothek Leipzig

pair of putti peruse natural historical volumes, one of them with a magnifying glass in hand; one can still make out the drawings of fish on the pages. They are a visual nod to the fish books that Bloch became widely known for.

The inclusion of Bloch's portrait among those of other reputable scholars is a confirmation of his place in the learned society of the German states in the late eighteenth century. He belonged to the wider community of *Naturforscher* or 'researchers of nature', the general label applied to those who investigated nature, be it physics, chemistry or one of the branches of natural history.[51] In her book *Acolytes of Nature*, Denise Phillips brings together this decentralized group of people consisting of, among others, physicians, apothecaries, merchants, and government officials – attesting to the fact that official, remunerated, positions dedicated to the study of nature remained relatively few and far between. These men nonetheless considered themselves as a community of *Naturforscher* with a joint cause, bound together by certain shared principles that pertained not only to the proper ways to study the natural world, but also how to present it to others. Bloch seemed well aware of these principles, and the treatment of his work in this chapter exemplifies some of them.

Besides this community of naturalists, Bloch belonged to a circle of Jewish thinkers. Soon after arriving in the city, he became involved in the Haskalah, also known as the Jewish Enlightenment, spurred by a group of intellectuals that had moved to Berlin due to its growing reputation as a centre of scholarship.[52] As home to the centre of Prussian government, the royal court, a military garrison as well as an emerging commercial hub, the city had been growing rapidly in the first half of the eighteenth century.[53] Among its varied population were migrants from different religious backgrounds.[54] Although the city was relatively open to newcomers, the Jews in the city, as elsewhere in Prussia, did not have full legal equality. The government curbed their rights to marry, buy property, found businesses, or attend university.[55]

[51] Phillips, *Acolytes of Nature*, 4–5.
[52] Lowenstein, *The Berlin Jewish Community*, 34, 49. On the Haskalah, see also Shmuel Feiner, *The Jewish Eighteenth Century: A European Biography, 1700–1750* (Bloomington: Indiana University Press, 2020).
[53] Lowenstein, *The Berlin Jewish Community*, 4.
[54] For example, French Huguenots and Austrian Protestants; ibid., 19.
[55] Ibid., 13.

One of the figureheads of the Haskalah, the philosopher Moses Mendelssohn (1729–1786), was a patient of Bloch's as well as a close friend.[56] Bloch was also well acquainted with the banker David Friedländer (1750–1834), who thought about and worked towards reforms to advance the legal status of the Jewish community in the city.[57] Bloch himself was one of the founders of Berlin's Jewish hospital.[58] He also dedicated one of the volumes of his series to the heir presumptive Frederick VI of Denmark (1768–1839) to thank him for bolstering the rights of his 'suppressed brethren.'[59] It is the only instance in which Bloch explicitly alludes to his Jewish background in his book series. A somewhat more implicit connection between his involvement in the Haskalah and his investigations into fish is the fact that the names of Mendelssohn and Friedländer figure in the list of subscribers to the series, along with those of a few other notable proponents of the Jewish cause, such as Jeremias Bendix (1735–1790) and Isaac Daniel Itzig (1750–1806).[60]

Bloch's Jewish background had other consequences for his position in the social, cultural and intellectual echelons of Berlin. It seems that the *Königlich-Preußische Akademie der Wissenschaften* (Royal Prussian Academy of Sciences) in Berlin admitted neither Bloch nor Mendelssohn as a member for that reason.[61] This may not have been an insurmountable blow, however, because Bloch had created his own club. He was one of the founding members of the *Gesellschaft Naturforschender Freunde* (Society of Friends of Nature Research) in 1773.[62] As its name reveals, this society consisted of people that were united by their interest in studying nature. This club was, on the one hand, open and egalitarian. It welcomed members from various backgrounds and religious denominations who

[56] Shmuel Feiner, *The Jewish Enlightenment* (Philadelphia: University of Pennsylvania Press, 2002), 117.
[57] Ibid., 315.
[58] Karrer, "Marcus Elieser Bloch," 135.
[59] Frederick VI of Denmark had decreed that Jewish pupils were to be granted access to apprenticeships with craftsmen, see: Marcus Élieser Bloch, *Allgemeine Naturgeschichte der Fische*, vol. 10 (Berlin: J. Morino, 1793), vi. See also Martin Schwartz Lauzen, *Jews and Christians in Denmark: From the Middle Ages to Recent Times* (Leiden: Brill, 2015), 89–124.
[60] *Allg. Nat. der Fische*, vol. 1, n.p.
[61] Lesser, "Dr. Marcus Elieser Bloch," 242.
[62] On the history of the Gesellschaft Naturforschender Freunde, see: Katrin Böhme, "Die Gesellschaft Naturforschender Freunde zu Berlin: Bestand und Wandel einer gelehrten Gesellschaft Ein Überblick," *Berichte zur Wissenschaftsgeschichte* 24, no. 4 (2001): 273.

wished to contemplate God's creation through the study of nature. Its statutes stressed that its members were considered equal without regard for birth, rank or standing.[63] On the other hand, the Gesellschaft Naturforschender Freunde did have a member policy. The founders were hesitant to admit people who were too affluent, as they feared that they would be too full of pride in their wealth and reputation to engage in debates in the spirit of equality and friendliness.[64] The membership of the Gesellschaft thus consisted largely of middle-class men, among them apothecaries, physicians, and government officials.[65] In order to join, these members had had to demonstrate that they were serious *Naturkenner*.

A good way to do so was to collect natural historical objects. The ownership of a collection of natural curiosities [*natürlichen Seltenheiten*] was in fact a primary requirement for admission, as founding member Friedrich Wilhelm Heinrich Martini (1729–1778) declared in the statutes.[66] In the spirit of collaboration and cooperation, the collections, libraries, or other resources for the study of nature of members were to be made accessible to the other members.[67] Just as Spary has argued for the Parisian collecting community, the Gesellschaft Naturforschender Freunde likewise preferred that collections were suitably ordered. Nicolai's guidebook indeed wrote approvingly of Bloch's *wohlgeordenete Naturaliensammlung*, which by and large adhered to Linnaean systematics.[68] By ordering his cabinet in a systematic manner, Bloch literally showcased his knowledge of the Linnaean system, whereas an unscholarly arrangement would have reflected a lack of understanding of the current methods of classification.[69] Bloch and collectors like him thus displayed their expertise as they displayed their material possessions.[70]

[63] Anke te Heesen, "Vom naturgeschichtlichen Investor zum Staatsdiener: Sammler und Sammlungen der Gesellschaft Naturforschender Freunde zu Berlin um 1800," in *Sammeln als Wissen. Das Sammeln und seine wissenschaftsgeschichtliche Bedeutung*, eds. Anke te Heesen and Emma Spary (Göttingen: Wallstein, 2001), 64.
[64] Ludwik Lesser, *Chronik der Gesellschaft der Freunde in Berlin* (Berlin: Petsch, 1842), 46.
[65] Katrin Böhme, *Gemeinschaftsunternehmen Naturforschung: Modifikation und Tradition in der Gesellschaft Naturforschender Freunde zu Berlin 1773–1906* (Stuttgart: Franz Steiner, 2005), 29.
[66] Friedrich Wilhelm Heinrich Martini, "Gesetze der Hiesigen Gesellschaft," *Beschäftigungen der Berlinischer Gesellschaft Naturforschender Freunde* 1, no. 1 (1775): xxviii.
[67] Nickelsen, *Draughtsmen, Botanists and Nature*, 109.
[68] Nicolai, *Beschreibun*g, 601.
[69] Phillips, *Acolytes of Nature*, 84.
[70] Ibid., 44.

As a Jew in Prussia, and having come from a modest background, it may have taken more effort for Bloch to find his place in the community of naturalists and scholars than for those members who found themselves in better legal and financial positions from the outset. It does not seem to have hindered him too much. He was well attuned to the ways in which one could display learned distinction, and conform to both subtle and more overt cultural codes of what it meant to be a *Naturforscher*. Both his collection of and his bibliographical series on fish were instrumental in Bloch's positioning of himself in the intellectual landscape. By converting his collected specimens into printed descriptions and finely executed illustrations, Bloch circulated his collection, and the knowledge contained within it, to a wide audience. We will now discuss the series in more detail.

Bloch's Series of Fish

Bloch's series of fish followed the expansion of his collection in close step. The first volume appeared in 1782 under the title *Oeconomische Naturgeschichte der Fische Deutschlands*. As we saw, Bloch paid for its publication out of his own pocket (or that of his wife, who was considerably more affluent than he) and it was printed by the bookseller Hesse in Berlin. It contained thirty-seven species descriptions and an equal number of engraved, hand-coloured plates. The plates, each of which corresponded to a specific species descriptions, were published in separate, bound volumes. Bloch had selected a large folio format so that all of the fishes' parts could be made clearly visible.[71] This inaugural volume was followed by two more volumes on German fish with the same title in 1783 and 1784 respectively; these were printed by Realschule Buchhandlung. Bloch's initial plan, as we have seen, had been to collect and describe all the fish of the German states. When he had done so, he still had a lot of fish in his possession that were not native to Germany. He thus continued his series by describing those foreign fishes of which he had drawings done 'after nature.' These descriptions of foreign fish were published in nine parts as *Naturgeschichte der ausländischen*

[71] *Allg. Nat. der Fische*, vol. 1, sig. *3r.

Fische. The first three of these appeared with the Realschule (1785–1787), the rest with the publishing house Johann Morino & Comp (1790–1795). On average, one volume appeared each year, with the exception of 1788 and 1789, which were those years following Bloch's announcement that he would pause the series. The combined series became known as the *Allgemeine Naturgeschichte der Fische*. When the twelfth and last volume was published in 1795, the series had classified, described and depicted well over four hundred species.

From Bloch's financial quandary that opened this chapter, we may deduce that his series was expensive to produce. Its exact margin of profit (or loss), however, is not known. To calculate it, we would have to know both the cost price and selling price per volume. An indication of the latter can be found in the price listings of late eighteenth-century sales catalogues. In 1792, publisher Morino put out an advertisement for the ninth volume of the series, which he announced would cost the same as the preceding volumes: 10 Reichsthaler for the folio, or 12 Reichsthaler for a slightly larger format.[72] That same year, a bookseller in Jena offered the set of 9 volumes that had been published so far for sale at a good discount for 70 Reichsthalers rather than the 120 he claimed it usually went for.[73] Leipzig bookseller Johann Gottlob Beygangs (1755–1823) advertised the series in 1797 and asked between 12 and 18 Reichsthalers per volume, depending on both the size and quality of the paper it was printed on.[74] These examples give a sense of the price range of the series – buyers should expect to pay at least 10 Reichsthaler per volume unless a seller made a sensational offer. For comparison: the aforementioned Beygangs priced an exegetical handbook of the Old Testament at about two thirds of a Reichsthaler.[75] The capital investment represented by Bloch's books of fish demanded no little precaution on the part of the bookseller. "Nota bene", bookseller Beygangs concluded his advertisement for the series, "this important work can, because of its too considerable expense, henceforth no longer be bought on credit, but purchased with exact money in

[72] Advertisement by Johann Morino, *Intelligenzblatt der Allgemeinen Literatur-Zeitung vom Jahre 1792* (Leipzig: Johann Gottfried Müllerischen Büchhandler, 1792), 338–339.
[73] Advertisement by Hn. Adv. Fiedler, *Intelligenzblatt der Allgemeinen Literatur-Zeitung vom Jahre 1792*, 767.
[74] Advertisement by Johann Gottlob Beygangs, *Intelligenzblatt der Allgemeinen Literatur-Zeitung vom Jahre 1797* (Leipzig: Johann Gottfried Müllerischen Büchhandler, 1797), 246.
[75] Ibid., 245.

cash."[76] As Bloch had also learned, an audience may be eager but that did not necessarily mean that it paid its bills.

Whereas it is relatively easy to get an idea of the selling price, determining precisely how much one volume cost to produce is more complicated. As we saw in Chapter 1, this depended on a variety of factors, which besides the quality of the materials used, from paper to binding, might include the wages of a plethora of craftsmen, artists and artisans. As none of Bloch's account books seem to be extant, it is difficult to assess if he (or his wife) bore the sole financial responsibility for the publication of the series, or whether he shared it with his publishers. There only remain general indications. Bloch himself asserted, as we saw, that he had spent 20000 Reichsthaler towards the publication of the first six volumes, which amounts to well over 3000 Reichsthaler per instalment. This means that, with the abovementioned price of 10 Reichstaler apiece, 330 copies of each volume would have to be sold just to recoup costs. In order to infer the cost price per actual book, we would have to know the print run of the work, which unfortunately is unknown; and even so, it is not clear if Bloch referred specifically to the expenditures of the printing process or that of his project in general, that is, the assembly and upkeep of his collection of fish.

And yet, even without precise numbers, it is beyond a doubt that the series was so expensive because of the hand-coloured engravings that accompanied each species description. The previous chapters have already addressed the financial implications of illustrations. As we saw, Willughby and Ray's *Historia piscium* was a tricky enterprise for the Royal Society on account of its many engravings, whereas Linnaeus opted to include none in his own works to keep them affordable. Hand-coloured engravings really drove the price up, as well. Bloch, who did not draw himself, employed several draughtsmen. Over the more than a decade that it took to publish his series, he hired no fewer than nineteen draughtsmen and engravers.[77] The signature of the painter Johann Friedrich August Krüger (*b.*1754)

[76] Original German: "NB. Dieses wichtige Werk kann wegen des zu grossen Kostenaufwand, fernerhin nicht mehr in Rechnung, sondern gegen gleich baare Bezahlung erlassen werden." Advertisement by Johann Gottlob Beygangs, *Intelligenzblatt der Allgemeinen Literatur-Zeitung vom Jahre 1792*, 348.

[77] Far from all of the names of these artists are known; Wells, "M.E. Bloch's *Allgemeine Naturgeschichte der Fische*," 9.

appears on many on the plates; he was also commissioned by Martini for a series on shells.[78] The drawings made by draughtsmen were turned into engravings by, among others, Johann Friedrich Hennig (*b.*1778), Johann Godlieb Schmidt (1750–1822), and Georg Bodenehr (dates unknown). It remains unclear who subsequently coloured in these engravings. At the time, it was common to hire women, or sometimes children, for this part of the process, because they were paid less.[79] In general, it is not known how much the artists involved in Bloch's project were paid nor whether these artists included women and children. It is nonetheless clear that Bloch expected much from them, as will be discussed in detail later in this chapter.

Bloch presented the three first volumes of his series as an oeconomic natural history. In the preface to his book, Bloch noted, not without astonishment, that while entire societies dedicated themselves to mastering the intricacies of bee-keeping, fish had received only scant attention.[80] "Do fishes not equally deserve", Bloch wondered, "our attention; do they not form an important part of our diet; have they not always been an important trade stuff?"[81] The German fish were certainly deserving of a series of their own. Bloch wanted his work to be useful not only to scholars [*Gelehrte*], but also to agriculturists [*Landwirthe*], and he therefore included a discussion of different types of fishing nets and how to use them.[82] Bloch also indicated which net to use for each fish, explained at what time of the year it was best to catch it and how it should be prepared.[83] Although he does not name his sources, it is probable that fishermen, cooks and housewives were among them. His interest in economic improvement through the advancement of agriculture was also evident from his membership to oeconomic and agricultural societies of Leipzig and Bavaria, among others, which were displayed on the title pages of each volume. These societies, devoted to agriculture or manufacturing,

[78] Claus Nissen, *Die Zoologische Buch-Illustration*, vol. 2 (Stuttgart: Anton Hiersemann, 1978), 153 and Wells, "M.E. Bloch's *Allgemeine Naturgeschichte der Fische*," 9–10.
[79] Nickelsen, *Draughtsmen, Botanists and Nature*, 62.
[80] *Allg. Nat. der Fische*, vol. 1, sig. *2v/*3r.
[81] Original German: "[…] verdienen aber die Fische nicht eben so wohl unsre Aufmerksamkeit; machen sie nicht einen grossen Theil unsrer Nahrung aus; waren sie nicht zu allen Zeiten ein wichtiger Handlungszweig?" Ibid.
[82] Ibid., 1.
[83] Ibid., 13.

had sprung up in the eighteenth century.[84] Rather than catering to a strictly Latinate audience, as Willughby, Ray and Artedi had done in their works of fish, Bloch decided to publish his series first and foremost in the vernacular, thus making it accessible to a wider, German-speaking public. This was, again, very much in line with the broader ideal shared by communities of *Naturforscher*, namely that one produced a work as an act of service to the community.[85]

At the same time, Bloch did not have a strictly German audience in mind. Not long after the first volume on German fish appeared, he arranged to have the series translated into French by Jean Charles Thibault de Laveaux (1749–1827), professor of French in Basel.[86] These volumes appeared between 1785 and 1797 as *Ichtyologie, ou, Histoire naturelle, générale et particulière des poissons*, with François de la Garde in Berlin.[87] The French edition follows the original German very closely: it retains its focus on German fish and does not contain a separate preface introducing the translation.[88] French was, of course, a language more widely read in international learned circles, and thus made his work accessible to a larger scholarly public. In 1787, Bloch's son undertook a journey to France and England to seek subscribers for this French translation.[89] Some years later, Bloch complained to a learned friend that he had lost money on the French translation; something for which he suspected the French Revolution was to blame (though he does not specify why).[90] It did not temper his ambition. A letter that Banks wrote to Bloch in June 1791 reveals that Bloch considered issuing an English translation, and had asked Banks whether that was a good idea. In his reply, Banks explained that while he was charmed by the idea "par amour de la science Ichtiologique" [*sic*], the British "Gens de lettres" for the most part understood

[84] See also: Verena Lehmbrock, *Der denkende Landwirt: Agrarwissen und Aufklärung in Deutschland 1750–1820* (Cologne: Böhlau, 2020).
[85] Phillips, *Acolytes of Nature*, 37.
[86] Ellen B. Wells, "M.E. Bloch's Allgemeine Naturgeschichte der Fische: A Study," *Archives of Natural History* 10, no. 1 (1981): 7–8.
[87] Marcus Élieser Bloch, *Ichtyologie, ou, Histoire naturelle, générale et particulière des poissons*, trans. Jean Charles Thibault de Laveaux (Berlin: François de la Garde, 1785–1797).
[88] The main difference appears to be that, in the German edition, descriptions and engravings were bound separately, while in the French edition, the engravings interleave the descriptions.
[89] Karrer, "Marcus Elieser Bloch," 136.
[90] Bloch to Johann Hermann, 2 February 1792, Universitätsbibliothek Leipzig (hereafter UL), Leipzig, ASL 213, f1.

either French or German or both so that it was doubtful whether he could find the number of subscribers needed for such a translation.[91] After Bloch's death, a Dutch translation was begun but never completed.[92]

From the onset, Bloch's series enjoyed a diverse audience. This can be deduced from the subscription list comprising three hundred and seventy names that was printed on the first few pages of the inaugural volume, as was customary at the time.[93] Listed among the subscribers was princess Anna Amalie von Preußen (1723–1787), who had an extensive library.[94] Martinus van Marum (1750–1837) purchased the whole set for the library of the Teylers Museum in Haarlem.[95] Working with subscription lists was a tried and tested publication strategy not only for multi-part natural historical works, but more generally for long-lasting editorial enterprises (of which Diderot's *Encyclopédie*, of which the first volume was published in 1751, was among the most famous ones). As such, it had several advantages. It could first of all soften the blow of a financially risky publication, especially if subscribers paid up front.[96] If the list contained eminent subscribers, which authors often aimed for, it also functioned a way of advertising one's connections, which lent the work authority and prestige which would help to draw new subscribers in.

What, precisely, had these subscribers signed up for? We will now to take a closer look at the structure and the contents of the work, and consider the method that Bloch applied to the study of fish. In the first volume of the series, Bloch gave his own definition of the subject: "I take the word *fish* in its common parlance, and understand by it all those water dwellers that move through their element with fins. To it [fish] therefore belong also the whales and swimming amphibians,

[91] Joseph Banks to Bloch, dated 24 June 1791, Abteiling Historische Drucke of Staatsbibliothek zu Berlin (hereafter SBB), Berlin, Sammlung Darmstaedter Weltreisen 1768: Banks, Sir Joseph, f1r.
[92] The first part was printed by Cornelis Nozeman and Johann Christiaan Sepp under the title *Afbeeldingen en beschrijvingen van in- en uitlandsche visschen M.E. Bloch; gevolgd naar het Hoogduitsch* in Zaltbommel in 1804. I thank Esther van Gelder for drawing my attention to it.
[93] A rudimentary overview of these subscribers can be found in Wells, "M.E. Bloch's Allgemeine Naturgeschichte der Fische," 10–11.
[94] A part of this library still exists; see: Marc Serge Rivière and Annett Volmer, *The Library of an Enlightened Prussian Princess: Catalogue of the Non-Music Sections of the Amalien-Bibliothek* (Berlin: Spitz, 2002).
[95] Wells, "M.E. Bloch's Allgemeine Naturgeschichte der Fische: A Study," 12.
[96] David R. Brigham, "Mark Catesby and The Patronage of Natural History in the First Half of the Eighteenth Century," in *Empire's Nature: Mark Catesby's New World Vision*, eds. Amy Meyers and Margaret Beck Pritchard (Chapel Hill: University of North Carolina Press, 1998), 109.

which Linnaeus saw fit to separate from the fish in the twelfth edition of his natural system."[97] He continued that he would not actually discuss the whales in his series, however, because he expected that Johann Christian von Schreber (1739–1810) would already do so in his natural historical series on mammals, and – as was of utmost importance to Bloch – deliver images of them.[98] Bloch then proceeded by giving brief, general discussions of the inner and outer parts of fish (from gills to swim bladder), just as Willughby, Ray and Artedi had done in their works. As said, he then discussed the procreation and growth of fish, and the nets that could be used to catch them. Each of the later volumes includes a preface in which Bloch explains what had come to pass since his last publication, and thanked those individuals who had been especially helpful to the creation of the latest volume. This preface is then followed by a brief index of the species described, before Bloch moves on to the species descriptions.

Bloch's descriptions vary in length. For instance, the species description of a carp that he had received from Malabar barely takes up one page, whereas that of the common carp, a fish well-known across the German states, stretches out over fifteen pages.[99] The descriptions adhere to the same general format. They open with the vernacular name of the fish, its Linnaean binomial, a reference to its corresponding plate, and one sentence describing its main characteristics (which will be discussed below). The first paragraph gives a more elaborate description of the main characteristics – a focus on differentiating marks that we also saw in the works Willughby and Ray, Artedi and Linnaeus. On describing a species, Bloch first ascertained whether earlier naturalists had already described it. If a species had indeed been described before, he would only correct the existing accounts where necessary. He then listed all the authors who had described the species, thus showing his extensive knowledge of the natural historical literature. His references go back as far as Aristotle and Pliny, as well as Gessner and other

[97] Original German: "Ich nehme das Wort *Fisch* nach dem gewöhnlichen Sprachgebrauche und verstehe darunter alle diejenigen Wasserbewohner, welche sich mittelst der Flossen in ihren Elemente bewegen. Es gehören daher auch die Wallfische und schwimmende Amphibien mit in meinen Plan, welche Linné in der zwölften Ausgabe seines Natursystems davon zu trennen für gut fand." *Allg. Nat. der Fische*, vol. 1, 2. Contrary to Bloch's claim, however, this separation had been suggested already in the 10th edition of the *Systema naturae*.

[98] Johann Christian von Schreber, *Die Säugthiere in Abbildungen nach der Natur mit Beschreibungen* (Erlangen: Wolfgang Walther, 1774–1804).

[99] *Allg. Nat. der Fische*, vol. 12, 50 and *Allg. Nat. der Fische*, vol. 1, 92–107.

sixteenth-century naturalists, but more often cite the work of Willughby and Ray, and Artedi.

He refers to Artedi's work well over hundred times over the course of the series. Mostly this is to refer to where in the *Ichthyologia* the Swedish naturalist had described the species at hand. In some cases, however, Bloch explains how his characterization of a particular species differs from Artedi's. For example, he stated how the tail fin of the carp consisted of 11 rays rather than the 9 rays that Artedi had reported.[100] Bloch speculated that Artedi must have copied this number from Willughby, who neglected to include the smaller rays at the end of the tail in his count.[101] Each of Bloch's species description includes discussions of the external parts of the fish; sometimes, these are supplemented by reports on their inner parts. As said, the descriptions also contain discourses of how fish can best be caught, when they are best eaten, and recipes; in the case of the common carp, it contains an elaborate account of how they are bred in ponds. All species descriptions conclude with a summary of the names given to the species in other languages.

Just as the fishes in Bloch's material collection were ordered according to Linnaean principles, so were the fishes described in his series. Bloch conceived his work as a continuation of the taxonomical system that Linnaeus had presented, stating in the introduction to his series that he would follow the Linnaean format as closely as possible, making additions where necessary. Linnaeus had by that time published the twelfth edition of his *Systema naturae*.[102] The classification system for fish in this edition diverged from that of the first edition, which had effectively presented the system of Artedi, in a few respects. Most changes had occurred on the level of orders, all of which Linnaeus replaced with his own.[103] He also added new genera.[104] The underlying aims and principles, however, where not altogether different from those of the *Ichthyologia* – it was just that

[100] *Allg. Nat. der Fische*, vol. 1, 44.
[101] Ibid.
[102] Carl Linnaeus, *Systema naturae*, ed. 12 (Stockholm: Lars Salvi, 1766–1767).
[103] Linnaeus had relegated the order of the *Plagiuri* to the class of mammals, and that of the *Chondropterygii* to the amphibians. He did away with the *Malacopterygii* and *Acanthopterygii* (a division based on soft or thorny rays). His newly established orders *Apodes*, *Jugulares*, *Thoracici*, and *Abdominales* were all based on the presence and position of pelvic fins. Linnaeus, *Systema naturae*, ed. 12, 422.
[104] See: ibid., 423–424.

other characteristics were selected as the basis for certain taxonomical ranks. The number of fins and their relative position to one another, as well as the number of rays in a fin, remained especially salient features for deciding genera and species. This is why Bloch's species descriptions open by enumerating the number of rays in each and every fin. He does so in an abbreviated and almost formulaic manner: in the case of a species of oarfish from Goa, for example, he noted 'Br. 8, B. 2, S. 13, R. 17', referring to the pectoral fin [*Brustflosse*], ventral fin [*Bauchflosse*], tail fin [*Schwanzflosse*], and back fin [*Rückenflosse*] respectively.[105] In some cases, the number of rays has been represented as a fraction: in these instances, the number above the dividing line indicated the number of rays that were bony as opposed to cartilaginous. While Bloch had likely taken this style of notation from Linnaeus, who used it in his *Systema naturae*, it is a clear example of the quantitative focus that had governed Artedi's work, and had also been visible in that of Willughby and Ray.

But there was a catch. Even though Bloch agreed with the crucial importance of classifying fish on the basis of physical marks, he did not think that Artedi and Linnaeus' decontextualized manner of description was necessarily sufficient for the purpose of demarcating species. For as he explained in the inaugural volume of his series, he had noticed that many of the fish that he came across, "could not be determined from the works of Linnaeus nor Artedi, nor of the older ichthyologists, because the descriptions in the first two are in respect to certain fish too short, and the latter are often unreliable because of their bad and unfaithful images."[106] From this critical assessment of earlier authors, we can extrapolate what Bloch envisioned as the best approach for the study of fish. His aim was to both offer descriptions of fish with elaborate morphological detail and to produce good and reliable illustrations. The largest contrast between Linnaeus and Artedi on the one hand, and Bloch on the other, was the importance attributed to illustrations. Contrary to these naturalists, indeed, Bloch did not consider description, even if

[105] *Allg. Nat. der Fische*, vol. 12, 95.

[106] Original German: " […] dass sich viele Fische, […] weder nach dem Linné und Artedi, noch nach den ältern Ichthyologen bestimmen liessen, da die Beschreibungen der erstern in Ansehung mancher Fische zu kurz, und leztre wegen der Verwechselungen der Namen und der schlechten und ungetreuen Zeichnungen, öfters unzuverlässig sind." *Allg. Nat. der Fische*, vol. 1, sig *2r.

detailed, sufficient in and of itself. The anecdote opening this chapter confirms how the illustrations were an indispensable part of his series - so much so, that Bloch would not include any fish for which he did not have a drawing made from the life. He thus deemed an illustration essential in representing a fish.

These differences come clearly into view when we look at the matter of colour. In seeking to refine the existing classification system as much and as well as he could, he did not follow Linnaeus and Artedi to the letter. He accorded weight to characteristics that these Swedish naturalists had not cared for. They, for example, had only occasionally commented on the colouration of fish in their species descriptions, as they deemed colour too unstable a quality for use in classification. Artists and naturalists alike grappled with the subjective qualities of colour, and attempts to codify it either visually or textually it proved complicated at best.[107] Bloch nonetheless did consider colour to be a valuable characteristic for recognizing species and paid it a lot of attention in both word and image. In some instances, he took colouration as the defining mark of the fish, for example in the case of a new species he described and which he named the red mackerel (*Scomber ruber*).[108] "The red colour", Bloch wrote, "sets this fish apart from the others of this department [that is, the genus]."[109] He continued "[o]n the back and on the sides until the lateral line, the red colour predominates, through which the silver colour shines through, but from thereon however, the proportion is the other way around. The fins are yellow, and play into purple."[110] As will be discussed in the last part of this chapter, he exerted himself and his artists to bring out colours the best way possible in the illustrations.

From the eighth volume (1791) onwards, plates are inscribed with the names of those who financed the engraving. Bloch opted for this publication strategy when the production of his book had become too costly. He cites

[107] On these efforts, see, for example, Richard Mulholland, "The Mechanism and Materials of Painting Colour ad vivum in the Eighteenth Century," in Balfe, Woodall and Zittel, *Ad vivum?*, 328–3355; and Joachim Rees, *Die Verzeichnete Fremde. Formen und Funktionen des Zeichnens im Kontext europäischer Forschungsreisen 1770–1830* (Paderborn: Wilhelm Fink, 2015), esp. chapter 4 entitled "Kodiertes Kolorit," 153–230.
[108] *Allg. Nat. der Fische*, vol. 10, 75–76.
[109] Original German: "Die rothe Farbe unterscheidet diesen Fisch von den übrigen dieser Abtheilung." Ibid.
[110] Original German: "Am Rücken und an den Seiten bis an die Seitenlinie hat die rothe Farbe die Oberhand, durch welche die Silberfarbe durchschimmert, von da weiter aber, verhält es sich umgekehrt. Die Flossen sind gelb, und spielen in's Violette." Ibid.

Willughby and Ray's *Historia piscium* as one of his examples.[111] The archive of the Berlin-Brandenburgische Akademie der Wissenschaften holds a circular soliciting plate subscriptions for Bloch's series.[112] Although undated, it is probable that the leaflet was published as a response to Bloch's 1787 announcement that he would cease publication. The document, likely drafted by scholars and publishers close to Bloch, is addressed to friends and patrons of learning. It encouraged "that every favourer of this enterprise subscribes to pay the costs for as many plates, for 2 Louis d'Or each [worth roughly 10 Reichsthalers][113], as his love for the completion of his work inspires him to."[114] The circular, which does not seem to have yet been cited by historians, offers a fascinating insight into the reasons that made the series one considered worthwhile. It strikes a tone of national pride. It explains that Bloch's series, "a work, that because of its accuracy has received the best reviews in Germany, France, England and every foreign country, and has universally in natural history been declared a classic work", might otherwise be left uncompleted.[115] This, the authors argued, would be a shame, for it could take centuries before another scholar might emerge who was able to combine such a unique possession of materials with the right approach, as was the case for Bloch, who was already so well established in the field.[116] Subscriptions were solicited "for only 200 plates, […] with which this work will be completed for Germany's honour."[117] Judging from the number of plates on which names are engraved, the appeal was successful. The Königliche Akademie der Wissenschaften, for example, although unwilling to admit Bloch as a member, was prepared to

[111] *Allg. Nat. der Fische*, vol. 8, sig. *3r.
[112] Circular in Berlin-Brandenburgische Akademie der Wissenschaften (hereafter BBAW), Berlin, PAW 1700-1811–I-XII-11.
[113] This equivalent is given in the newspaper *Der Anzeiger: Ein Tagblatt zum Behuf der Justiz, der Polizey und aller bürgerlicher Gewerbe, wie auch zur freyen gegenseitigen Unterhaltung der Leser über gemeinnützige Gegenstände aller Art* 19, no. 19–20 (1792): 154.
[114] Orginal German: " […] dass jeder Beförderer dieses Unternehmens die Kosten für so viele Platten, eine jede zu 2 Louisd'or zu bezahlen unterchreibt, als ihm seine Liebe zu der Vollendung dies Werks eingiebt." BBAW, PAW 1700-1811–I-XII-11, f1v.
[115] Original German: " […] ein Werk, das sowohl, wegen seiner Richtigkeit, in Deutschland als auch in Frankreich, England und jedem Auslande die besten Recensionen erhalten hat, und durchgängig in der Naturgeschichte für ein klassisches erklärt wird […]" ibid., f1r.
[116] Original German: " […] und Jahrhunderte verstchreichen, ehe wieder ein Gelehrter aufstände, wo sich Besitz der Materialien und der nehmliche richtige Standpunkt auch so vereinigten, wie bey dem in diesem Fache schon so rühmlich bekannten Herrn Doktor Bloch?" Ibid.
[117] Original German: "Für 200 Platten wird nur Subscription angenommen, als womit dieses Werk zu Deutschlands Ehre vollendet seyn wird." BBAW, PAW 1700-1811–I-XII-11, f1v.

financially support his work.[118] Other names, titles and institutions inscribed on the plates include those of the Duchess of Württemberg (1748–1811), Prussian diplomat Ewald Friedrich graf von Hertzberg (1725–1795) and the Hamburg city library.[119]

Together with the book's subscriptions lists, these engraved names are testimony to how Bloch's fish project resonated with a large audience. As we saw, what had started as a project to chart all fish from the German states branched out into a project that aimed to collect, describe and depict as many fish as possible, regardless of their geographical origins. This expansion was only possible because of Bloch's network correspondents who sent him specimens from various corners of the world, and this network depended on a global infrastructure that had been forged largely from imperial impulses. Because Bloch almost always remembered to mention in his species descriptions the names of those who generously gave him the specimen at hand – according to the principle of *do ut des* – we can, to a degree, reconstruct this network. We will now trace the trajectory that a significant share of his foreign specimens followed, *viz*. from Coromandel to Berlin. It offers insight into the effort that Bloch's correspondents took in collecting, preserving and circulating specimens, and why they busied themselves with this in the first place.

The Coast of Coromandel

Bloch's announcement of 1787, that he would halt the publication of his fish books, was read wearily by one of his correspondents in South India. The German Pietist missionary Christoph Samuel John (1747–1813) had prepared a parcel of fish drawings and prepared specimens, which would now have to remain with him in Malabar. He had reached out to Bloch after having acquired one of his fish books from the *Nachlass* of his late fellow missionary Johann Gerhard König (1728–1785), and offered to help him collect specimens.[120] König had been

[118] Plates CCCXXVIII–CCCXXX, CCCXXXII–CCCXXXIII, CCCXXXV, CCCXXXVIII–IX, Hans-Joachim Paepke, "Ein jüdischer Untertan des Preußenkönings Friedrich II. studiert die Fischfauna der Welt," in *Klasse, Ordnung, Art: 200 Jahre Museum für Naturkunde*, eds. Ferdinand Damaschun, Sabine Hackethal, Hannelore Landsberg, and Reinhold Leinfelder (Rangsdorf: Basiliskenpresse, 2010), 87.
[119] These are, respectively, plates CCC, CCCXXVII, and CCCXL–CCCXLII.
[120] Christoph Samuel John to Johann Ludwig Schulze, 18 October 1787, AFSt/M 1 C 28 : 87.

a former student of Linnaeus and had spent his time in the mission studying nature.[121] In their engagement with natural history, these two clergymen were not untypical: missionaries from various religious denominations had taken to studying the natural surroundings of their new locales in the early modern period.[122] It reminds us how, besides commercial aims, religious aspirations were no negligible factor in a growing global knowledge infrastructure. As Bloch's series drew to a close, John had become his top supplier of foreign fishes. More than fifty species descriptions mention him as donor, more than a tenth of the total of species discussed in the series.[123] The descriptions were based on specimens that John sent from Malabar, sometimes accompanied by (unfortunately no longer extant) descriptions and drawings. These included species and even an entire genus that had not been described according to the Linnaean system before; a feat that Bloch honoured by naming said genus *Johnfische*.[124]

In order to understand John's motivations for participating in Bloch's project, and how he went about it, we can turn to his aforementioned correspondence in the archives of the Franckesche Stiftungen (Francke Foundations), as well as to published reports from his hand.[125] His incentive was primary located in the religious realm, serving his missionary purpose. After studying Theology at the University of Halle, John had worked at the Foundations erected by the Lutheran pastor August Hermann Francke (1663–1727) in 1698 and served to educate and elevate orphans through Pietist faith.[126] Francke strove to unite the subjective love for God with pious, scholarly labour.[127] The orphanage was furnished with a cabinet of curiosities through which its pupils could contemplate the wisdom

[121] Anne-Charlott Trepp, "Matters of Belief and Belief that Matters: German Physico-Theology, Protestantism, and the Materialized Word of God in Nature," in Blair and Von Greyerz, *Physico-Theology*, 135.
[122] See, for example, Andrés I. Prieto, *Missionary Scientists: Jesuit Science in Spanish South America, 1570–1810* (Nashville: Vanderbilt University Press, 2011); Florence C. Hsia, *Sojourners in a Strange Land: Jesuits and Their Scientific Missions in Late Imperial China* (Chicago: University of Chicago Press, 2009).
[123] Arthur MacGregor, "European Enlightenment in India: An Episode of Anglo-German Collaboration in the Natural Sciences on the Coromandel Coast, Late 1700s– Early 1800s," in MacGregor, *Naturalists in the Field*, 378.
[124] Or, in Latin, *Johnius*. *Allg. Nat. der Fische*, vol. 10, 132.
[125] Such reports frequently appeared in the *Neue Hallesche Berichten*, the printed periodical of the mission. A general discussion of source material regarding the mission can be found in Erika Pabst and Thomas Müller-Bahlke, *Quellenbestände der Indienmission 1700–1918 in Archiven des deutschsprachigen Raums*.
[126] For a history of the Francke Foundations, see: Holger Zaunstöck, ed., *Gebaute Utopien, Franckes Schulstadt in der Geschichte europaischer Stadtentwürfe* (Halle: Frankesche Stiftungen, 2010).
[127] Jonathan Sheehan, *The Enlightenment Bible: Translation, Scholarship, Culture* (New Jersey: Princeton University Press, 2005), 60.

of God.[128] Francke's religious and societal ideals stretched out far beyond the city's borders. Together with the Danish King Frederick IV (1671–1730), he had established the Danish-Halle-Mission at the coast of Coromandel, in South-India. In 1771, John boarded ship to India to become part of this mission and settled in a Danish colony named Tranquebar. This was in fact the fishing village Tarangambâdi, 'village of the singing waves' in the Tamil language.[129] Upon arrival, John was tasked with the conversion of local inhabitants and with teaching at the mission schools, which were attended by both European and Indian pupils. It was in this context that John took up the study of nature. He began, for example, to teach the school children botany.[130] Gradually, he seems to have come to consider the study of nature as an effective tool of conversion, perhaps even more so than reciting or discussing Scripture.[131]

John amassed a collection of natural specimens containing aquatic animals, reptiles, amphibians and insects as well as stuffed birds and mammals.[132] He also possessed a considerable number of shells, some of which had been procured for him by Tamil divers.[133] The collecting of *naturalia* was a widespread practice among the various European mission posts in India such as the United Brethren of the Moravian church.[134] Besides Köning and John, the missionary Johann Peter Rottler (1749–1836), for example, was active in trading specimens. These and other nature-minded missionaries met each other in the Tranquebarian Society, founded in 1788, together with government officials and private merchants.[135]

[128] See: Stefan Laube, "Privilegierte Dinge für Unterprivilegierte? Die Kunstkammer im Waisenhaus," in Dolezel, Godel, Peča and Zaunstöck, *Ordnen – Vernetzen – Vermitteln*, 49–72.
[129] Daniel Jeyaray, "Mission Reports from South India and Their Impact on the Western Mind: The Tranquebar Mission of the Eighteenth Century," in *Converting Colonialism: Visions and Realities in Mission History, 1706–1914*, ed. Dana L. Robert (Cambridge: William B. Eerdmans, 2008), 23.
[130] Heike Liebau, *Cultural Encounters in India: The Local Co-Workers of Tranquebar Mission, 18th to 19th Centuries* (London: Routledge, 2017), 399.
[131] Karsten Hommel, "Physico-Theology as Mission Strategy: Missionary Christoph Samuel John's (1746–1813) Understanding of Nature," in *Halle and the Beginning of Protestant Christianity in India*, vol. 3, eds. Andreas Gross, Y. Vincent Kumaradoss, and Heike Liebau (Halle: Franckesche Stiftungen, 2006), 1115.
[132] Ibid., 1112.
[133] MacGregor, "European Enlightenment in India," 377.
[134] John was inspired by the collection of the Herrnhut missionaries, which also functioned as a deposit of objects for John's own collection. Thomas Ruhland, *Pietistische Konkurrenz und Naturgeschichte: Die Südasienmission der Herrnhuter Brüdergemine und die Dänisch-English-Hallesche Mission (1755–1802)* (Herrnhut: Herrnhuter Verlag, 2018), 256.
[135] Niklas Thode Jensen, "The Tranquebarian Society: Science, Enlightenment and Useful Knowledge in the Danish-Norwegian East Indies, 1768–1813," *Scandinavian Journal of History* 40, no. 4 (2015): 535.

The exclusive access to the natural riches of Tranquebar and surrounding islands these missionaries enjoyed made them invaluable for European naturalists. There was an intricate infrastructure in place through which several collectors on different continents could exchange objects. John not only collected for Bloch, but also sent items to other collectors, including the Danish preacher and naturalist Johann Hieronymus Chemnitz (1730–1800), who also seems to have acted as John's agent in transporting specimens throughout Europe.[136] By 1800, more than eight European learned societies had welcomed missionaries as corresponding members.[137] Both John and Rottler, for example, were elected to the Academy of Sciences Leopoldina, at that time based in Erlangen, as well as to the Gesellschaft Naturforschender Freunde in Berlin.[138]

John's decision to collect fishes, rather than other *naturalia*, seemed mostly a matter of practicality. A letter to his superior in Halle, the director of the Orphanage Johann Ludwig Schulze (1734–1799) reveals his reasons for doing so. First of all, John had agreed with Rottler that the latter would concern himself with the field of botany, and that he would focus on the study of animals.[139] Among the animals, John opted for those specimens which would not take too much time to collect.[140] Fishes fulfilled that requirement, as they, along with other aquatic animals, were among the easiest type of natural specimen to come by, or so John submitted.[141] Secondly, he had noticed that hitherto fish had not been deemed not a subject considered particularly deserving of attention, which made it relatively easy to stumble on as yet undescribed species.[142] For catching these fish, John drew on local fishing communities. In a letter to Bloch in February 1792, published in the enlightened, monthly magazine *Berlinische Monatschrift*, he describes organizing a fish-collecting session for which he ordered fishermen to

[136] On Chemnitz, see: Trepp, "Matters of Belief and Belief that Matters," 132.
[137] Hanco Jürgens, "Van God's Akker tot Spiegel der Natuur: Veranderende Percepties van de Indiase Natuur in Berichten van Duitse Zendelingen," *De Achttiende Eeuw* 36, no. 2 (2004): 82.
[138] Ibid., 81.
[139] John to Schulze, 20 January 1790, AFSt/M 1 C 31a : 21.
[140] Ibid.
[141] Ibid.
[142] Ibid.

take specimens from the mission garden ponds, the rivers, and the sea.[143] In other instances, the European and Malabarian pupils in his mission school collected fishes.[144] John also sent a 'black Natural Philosopher', a young boy, to the Nicobar Islands to collect fishes, among other things.[145]

While fishes might be relatively easy to catch, their preservation was far from straightforward.[146] The previous chapters have already discussed the difficulties that the preservation of fishes presented. In the tropics, however, the preservation of specimens was an even more trying undertaking. In one of his letters to Bloch, John describes in detail how his freshly collected fish soon became foul, and how the humid climate had accelerated the rotting process.[147] Bloch included an excerpt of this letter in the preface to the first book on foreign fishes to convey some of the hardships that naturalists working in the tropics had to endure – hardships that those naturalists working in Germany (such as Bloch himself, perhaps) could hardly imagine.[148] John complained about how, in Tranquebar, they had nearly nothing and could scarcely get anything required for preserving specimens. He was in want of appropriate knives and other such instruments necessary for stuffing animals, needles to pin up insects, glass jars and the cork to close these with, and cases to pack specimens in, as well as paper of adequate quality to preserve plants with. John had to import these materials from Halle at his own expense. Glass jars needed to be filled with expensive arak or other spirits; dried specimens needed to be varnished with expensive cajeput oil.[149] While John explained that he was eager to learn the *holländische Kunst* of stacking skins of fish amid wooden plates, he lacked the thin plates required for this method.[150] It is quite likely that here he meant the ichthyarium method of Gronovius, which utilized such wooden plates.

143 Christoph Samuel John, "Einige Nachrichten von Trankenbar auf der Küste Koromandel. Aus einem Briefe von dem Missionarius Hrn John an Hrn Doktor Bloch in Berlin," *Berlinische Monatschrift* 20 (1792): 587.
144 John to Schulze, 20 January 1790, AFSt/M 1 C 31a : 21.
145 Ruhland, *Pietistische Konkurrenz*, 296.
146 MacGregor, "European Enlightenment in India," 375.
147 Christoph Samuel John, "Einige Nachrichten von der Küste Koromandel. Auszug eines Schreibens des Hrn Missionarius C.S. John an Hrn D. Bloch in Berlin," *Berlinische Monatschrift* 24 (1794): 357.
148 *Allg. Nat. der Fische*, vol. 10, n.p.
149 Ruhland, *Pietistische Konkurrenz*, 263.
150 Christoph Samuel John, "Einige Nachrichten von der Küste Koromandel. Auszug eines Schreibens des Hrn Missionarius C.S. John an Hrn D. Bloch in Berlin," *Berlinische Monatschrift* 24 (1794): 357.

A little over twenty of the fishes collected by John are still extant.[151] They include both wet and dry specimens. An example among the latter category is a species of lizardfish, which Bloch named Tumbil (*Salmo tumbil*) (**Figure 4.2**).[152] It is a stuffed exemplar, furnished with a layer of varnish, that displays an impressive row of teeth; its fins and their rays appear somewhat withered. Another one of John's dried specimens is a species of carp that he and his helpers had lifted from the mission pond. The Tamil called it the *Sölköndei* (**Figure 4.3**) and Bloch named it *Fransenmund*, because of its fringed mouth.[153] It has been preserved in a very peculiar way.

Figure 4.2 Specimen of *Salmo tumbil* in Bloch's collection, ZMB 32625 | © Museum für Naturkunde, Berlin

[151] Paepke, *Bloch's Fish Collection in the Museum Für Naturkunde*.
[152] Specimen of *Salmo tumbil*, MfN, ZMB 32625. Described in *Allg. Nat. der Fische*, vol. 12, 112–113.
[153] Specimen of *Cyprinus fimbriatus*, MfN, ZMB 8794. Described in ibid., 50.

Figure 4.3 Specimen of *Cyprinus fimbriatus* in Bloch's collection, ZMB 8794 | © Museum für Naturkunde, Berlin

The specimen consists of the skin of the carp, which rather than being pressed flat on a page, has been curved a little so as to retain the original shape of the fish. In order to achieve this curve, it may well have been mounted onto a piece of wood especially made for the purpose; if so, this cast is no longer extant. A label – sadly no longer legible – has been pasted into the inner part of the skin. While this was a rather labour-intensive technique, it was also relatively cheap because less material was needed to make the specimen and it was easier to transport than glass. At the same time, the preservation method also rendered the specimen somewhat fragile: fins might tear or break, which would hinder identification and classification. Turning the frail bodies of fish into stable specimens was a challenge even under ideal conditions; doing so in the tropics near impossible.

As we have seen in previous chapters, another way to preserve a specimen was to draw it. John occasionally had drawings made of fish which he sent along with the specimens. Naturalists and the artists whom they employed were well aware that time was of the essence in illustrating fish. They started drawing the specimen as soon as possible after it was caught, and developed several tricks to aid naturalistic rendition. In the preface to his natural history of Carolina, Catesby, whose pictures Gronovius deemed to be painted very well, explained that: "fish, which do not retain their colours when out of their element, I painted at different times, having a succession of them procur'd while the former lost their colours."[154] Ferdinand Lukas Bauer (*c*.1760–1826), one of the artists accompanying the naturalist John Sibthorp (1758–1796) on his expedition to the Mediterreanan, deployed a sort of painting-by-numbers technique which allowed him to indicate the shades of colour of specimens without having to actually paint them on the spot.[155] So, although Artedi and Linnaeus had considered colour as of secondary importance, other naturalists and their artists continued to put considerable time and effort into the capturing of colour.

Unfortunately, the drawings that John himself sent to Bloch appear to have been lost.[156] We thus do not know what visual strategies he used. He does mention enlisting an Indian *Zeichenmeister* as well as instructing his European pupils to draw the *naturalia* that he had collected.[157] The latter often did not know how to draw 'after nature', and as soon as they had mastered this skill to some degree they would leave again, much to John's dismay.[158] The strains that were put on his research are a recurrent theme in his letters to his superiors. On multiple occasions, John entreated his superiors to supply him with research funding.[159] One of the items on his list of desiderata was a colour-box. In a letter to Gottlieb Friedrich Stoppelberg (d. 1797), who oversaw the accounts of the Franckesche Stiftungen, John explained that he had thus far been unable to secure any good paints from Germany, and that he required an English paint cabinet costing around 30 Reichsthalers, which he thought both his pupils at the mission schools and his draftsmen could put to good use.[160]

154 Mark Catesby*, Natural History of Carolina, Florida and the Bahama Islands* (London: W. Innys and R. Manby, 1729–1747), xi.

155 Rees, *Die Verzeichnete Fremde*, 199.

156 Karrer, "Marcus Elieser Bloch," 146.

157 Christoph Samuel John, "Fragen des Herrn Professor Forster in Halle an die Missionarien in Trankenbar, und Herrn Johns Antworten darauf," *Neuere Geschichte der evangelischen Missionsanstalten zu Bekehrung der Heiden in Ost-Indien* 4, no. 43 (1793): 655.

158 John, "Einige Nachrichten von der Küste Koromandel," 352.

159 Liebau, *Cultural Encounters in India*, 264; in a response, Schultze explained that the natural historical works were too expensive to be sent, see: Schultze to John, 19 August 1790, AFSt/M 1 C 31b : 30.

160 John to Stoppelberg, 15 September 1791, AFSt/M 1 C 33a 87; to give some context, John's annual salary in the 1780s would have been 400 Reichsthalers; Liebau, *Cultural Encounters in India*, 193.

In John's view, the study of nature was closely intertwined with and a logical component of his assignment at the mission. His superiors did not necessarily agree with him, however, and despite continued requests supplied few of the materials he asked for. John was therefore dependent on exchange with European naturalists like Bloch and Chemnitz to procure such items as he needed for his studies. The accumulation of a small library in Tranquebar facilitated the process of collecting: natural historical books served as a list from which could be inferred those species still to be obtained, and those which were already identified.[161] It was also practical to have copies of Bloch's books because questions that John received from his correspondents would often refer to the series.[162] Through his natural historical efforts, John gained access to several communities of *Naturkenner*, both in Tranquebar itself as well as in Germany. Just as was the case for Bloch, then, John had his own motives for collecting specimens, which for him entailed ensuring access to natural historical communities so that he could continue studying and teaching Scripture through nature.

In considering these movements of objects, Bruno Latour's notion of a 'centre of calculation' might come to mind. This idea of a centre where maps, specimens, diagrams etc. are accumulated and turned into universal knowledge so as to act at a distance[163] has long since been complicated by historians, who have demonstrated that the control of those residing in the centre of calculation was far from absolute.[164] Kapil Raj has stressed that new knowledge was created in contact zones where Europeans and South-Asians interacted rather than in the more unidirectional movement Latour envisages.[165] The collaborative and at times messy process of collecting and 'stabilizing' fishes substantiates these conclusions. In attempting to reconstruct the far-flung connections that made Bloch's collection possible, however, the limits of such a reconstruction also

[161] Anne Mariss, *A World of New Things: Praktiken der Naturgeschichte bei Johann Reinhold Forster* (Frankfurt am Main: Campus, 2015), 350.
[162] Ruhland, *Pietistische Konkurrenz*, 337.
[163] This concept is developed in Latour, *Science in Action*, 215–257.
[164] Lissa Roberts, "Introduction: Centres and Cycles of Accumulation," in *Centres and Cycles of Accumulation in and Around the Netherlands During the Early Modern Period*, ed. Lissa Roberts (Berlin: LIT, 2011), 6.
[165] Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Scientific Knowledge in South Asia and Europe* (Basingstoke: Palgrave Macmillan, 2007).

have to be acknowledged. While John's mission activities are relatively well documented, we often lack proper insight in what was at stake for the individuals who assisted them. Historians, in general, still know very little about the men, women (and, as we saw with the young boy sent to the Nicobar Islands, children) local to the regions where European naturalists settled, and who are mentioned in the letters and publications of their letters as contributing to their projects in some shape or form (though hardly, if ever, by name).[166] These contributors, vital as they may have been to the natural histories that were being produced, would not have new species or genera named after them. It is not always clear what they would stood to gain by this, or whether their involvement in these activities were a matter of choice, coercion, or something in between.[167]

John summarized the activities that he and his assistants carried out as collecting, preserving, drawing, describing and packing.[168] The vignette on the title page of the tenth part of Bloch's series (**Figure 4.4**), set in a hilly landscape with a lake, is a stylized depiction of the latter.[169] It depicts various putti engaged in the process of either packing or unpacking a wooden crate, the lid of which reads 'Tranquebar' – referring to the origin of many of the species described in the volume – and which contained fish submerged in glass jars. One of the putti examines one of the specimens while two others study a drawing of a fish. In this engraving, the cupids stand in for those who actually did the collecting – those people who were John's local and largely unnamed collaborators. Steven Shapin has argued this for seventeenth-century prints of the air pump of Otto von Guericke (1602–1686), where the instrument is operated by putti representing the invisible technicians.[170] When John and his assistants had a collection of fishes ready, the crates would be loaded onto the first available ship sailing for Denmark and delivered to Chemnitz in Copenhagen, who would forward the packed fish

[166] Winterbottom, *Hybrid Knowledge in the Early East India Company World*, 136.
[167] On the matter of coerced diving, see James Delbourgo, "Divers Things," esp. 159–176.
[168] Ibid.
[169] Every volume of images carries its own vignette. Some of these are modelled after prints of Theodoor de Bry, published in his reprint of Thomas Hariot, *A Briefe and True Report of the New Found Land of Virginia* (Frankfurt: Johann Wechel, 1590). I thank Kim Sloan for pointing out this connection.
[170] Shapin, "The Invisible Technician," 556; elsewhere, he and Schaffer have argued that the depiction of such cherubs is a standard convention in baroque illustrations, to imply that the depicted process of knowledge production was divine, see: Shapin and Schaffer, *Leviathan and the Air-Pump*, 334–335.

to Bloch in Berlin to be incorporated into his collection. Having passed through the hands of Indian fishermen and German missionaries, the specimens assumed a new role in Berlin.

To Capture Fishes on Paper

After the fringed carp that John's helpers had taken from the mission pond was converted into a specimen for Bloch's collection, it was described and depicted in the last volume of the series.[171] It can be assumed that most of his specimens were subjected to a similar process. We will now take a closer look at the process of illustrating specimens and turn to the depiction strategies used by Bloch and his artists. Despite the centrality of illustrations to Bloch's project, these strategies have never been examined in detail before. An analysis of them is thus long overdue. The illustration process is richly documented compared to that other of many natural historical publications.

Figure 4.4 Vignette, Johann Carl Wilhelm Rosenberg (artist) and Daniel Berger (engraver) | Marcus Élieser Bloch *Allgemeine Naturgeschichte der Fische*, vol. 10 (Berlin: J. Morino, 1793) | © Universiteitsbibliotheek Leiden

[171] *Allg. Nat. der Fische*, vol. 12, 50.

This is, first of all, because the original drawings for a considerable proportion of the specimens in Bloch's collection are still extant, as are, of course the engravings subsequently published in the series – object, drawing and engraving can thus be compared. The second reason is that Bloch was quite explicit in formulating his ideas about what made a good illustration.

Bloch outlined his illustration policy in the preface to the first volume of the series. The three pages that he devotes to it show he had given a lot of thought to how one could produce the best visual representation of a species. A good drawing, in fact, began before lead or brush had touched the paper, by selecting the most suitable specimens. These were, according to Bloch, fresh as well as fully grown exemplars, because these best showed the species' distinguishing marks.[172] Bloch argued that such a meticulous approach to illustration was necessary because fishes tended to look alike, making it hard to distinguish one from the other.[173] He thus required his artists to be attentive to even the slightest deviations in a specimen. All details needed to be recorded on paper as they were relevant to get a proper understanding of the depicted species.

Bloch highlighted six further areas to which contributing artists were to pay particular attention First of all, he stated, they needed to convey the proportions of the specimen properly. Secondly, they had to represent the position and the shape of the fins correctly, particularly that of the tailfin; these were, after all, important marks for classification. Thirdly, the precise number of bones in the gill flap as well as the number of rays in the fin were to be clearly represented. Bloch explained the reason that both were to be delineated in the same terms as Artedi, noting that the former was necessary for deciding genera, and the latter for deciding species.[174] The fourth rule was to give a truthful representation direction of the lateral line (the thin line on the side of the fish stretching from its head to its tail).[175] The fifth rule was that the artist had to consider several different elements to ensure they showed the fish's scales accurately: their size, placement,

[172] *Allg. Nat. der Fische*, vol. 1, sig. *3r.
[173] Ibid., sig. *3v.
[174] Ibid.
[175] Ibid., sig. *4r.

and shape as well as any pattern of stripes or dots they might display.[176] The sixth and last item on the list of instructions was that artists should always include the ‘natural colour’ of the fish.[177]

These were the pictorial ideals that needed to be put into practice. The process began with the creation of a drawing of a specimen in preparation for the engraving. Fortuitously, some two hundred of these of *Originalzeichnungen* still exist in the Historische Arbeitstelle of the Museum für Naturkunde.[178] These drawings are assembled together in two volumes, with many of them being carefully pasted onto the bound pages.[179] Each drawing has been executed in colour – sometimes in watercolour, other times in what appears to be a thicker, gouache-like paint. Let us take a look at one particular drawing: the one that Johan Friedrich Hennig made for the lizardfish that John had sent to Bloch (**Figure 4.5**).

The drawn fish corresponds to the preserved specimen in its shape (although the depicted specimen is somewhat more plump) and its open mouth displaying rows of teeth. While the position of the fins in the drawing correspond to their placement on the specimen, their aspect does not: while the fins on the specimen have dried out, the drawings show them fanned out, as they would have seemed when the fish had still been under water. The most striking difference between specimen and drawing, however, is to be found in the palette of colours used by the colourist. As no traces of colour remained in the specimen, and John’s rendition of its colours seemed similarly bereft, Hennig was put in a delicate position when deciding the appropriate colours. He opted for a brownish, grey colour with maroon overtones.

The drawings were subject to revision. Given Bloch’s very clear opinions on the subject, it seems unlikely that a drawing would be sent to the engraver without his stamp of approval. It was common for naturalists to closely supervise

[176] Ibid.
[177] Ibid.
[178] Bound volumes with drawings of fish for plates CCI to CCCCDDDI (with some gaps), ZMB, VIII/423 and VIII/424. It seems that there were originally two more of these volumes, according to Karrer, “Marcus Elieser Bloch,” 145.
[179] A practice also used in the drawings of *aquatilia* in the Gessner-Platter albums mentioned in Chapter 1 and 2.

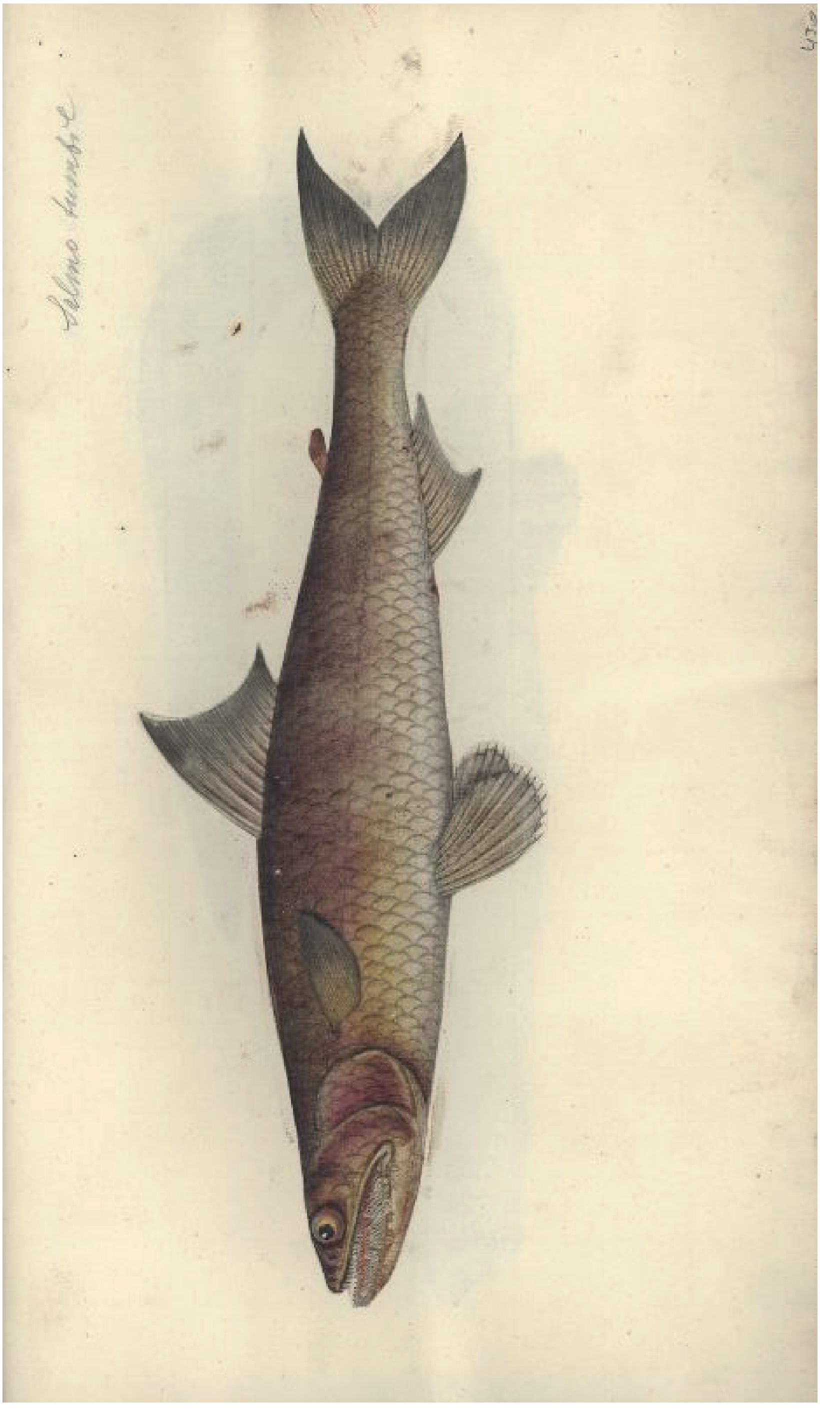


Figure 4.5 Original drawing of *Salmo tumbil*, Johann Friedrich Hennig | ZMB VIII/424 96 | © Museum für Naturkunde, Berlin

their draughtsmen, making sure that they drew the relevant, correct features.[180] A symbiotic collaboration between artist and naturalist with regard to drawing would result in, as Lorraine Daston and Peter Galison have put it, 'four-eyed sight'; the head of the naturalist fusing with the hand of the artist.[181] That there must have been at least some discussion between Bloch and his artists is evidenced by the drawings themselves. A few of them contain corrections in graphite or sometimes ink.[182] In some instances, Bloch or one of his draughtsmen might alter a fish's shape. In one image, a graphical edit was suggested, indicating that the fish's eye might be placed more accurately (**Figure 4.6**).[183] Clear evidence of the assertion of Bloch's third rule, which focussed on the correct representation of the number of rays in the fins, can be found in the annotations included in some drawings besides each of the fins of the fish that indicate how many rays it has, and how many of these rays are spikey.[184]

Bloch wanted his illustrations to be precise enough for naturalists to be able to identify and classify any fish based on its image alone where possible. His intention was thus very much the opposite of that Artedi, whose descriptions rendered drawings superfluous. Bloch's wish to cater to a broader audience than a literate or Latinate one may have been one of the reasons why he found images so expedient.

After drawings had been approved, the next step was to engrave them. Although the engravings do, as one can reasonably expect, differ somewhat in colouration between physical copies of Bloch's works, overall they are chiefly consistent especially with regard to the considerable intensity of the paint.[185] Overall, the engravings follow the model drawings closely, in everything except colour.[186] The colours of the original drawings seem more subdued that those of their engraved counterparts. This might be a result of the specific pigments or

[180] See, for example: Fransen, "Antoni van Leeuwenhoek, His Images and Draughtsmen," 493.
[181] Lorraine Daston and Peter Galison, *Objectivity* (New York: Zone Books, 2007), 88.
[182] Karrer, "Marcus Elieser Bloch," 146.
[183] Drawing of *Chaetodon nigricans*, ZMB, VIII / 423, 3.
[184] Drawing of *Bodianus maculatus*, ZMB B VIII /424, 21.
[185] I base this statement on having perused physical copies at the Universiteitsbibliotheek Leiden, Artisbibliotheek and Teylers Museum alongside digitized copies at Biodiversity Heritage Library (which can be found at https://www.biodiversitylibrary.org, last accessed 9 April 2021). Although the engravings included in this chapter stem from French edition in possession of the UBL, the captions offer the German titles to avoid confusion around publication dates.
[186] Karrer, "Marcus Elieser Bloch," 146.

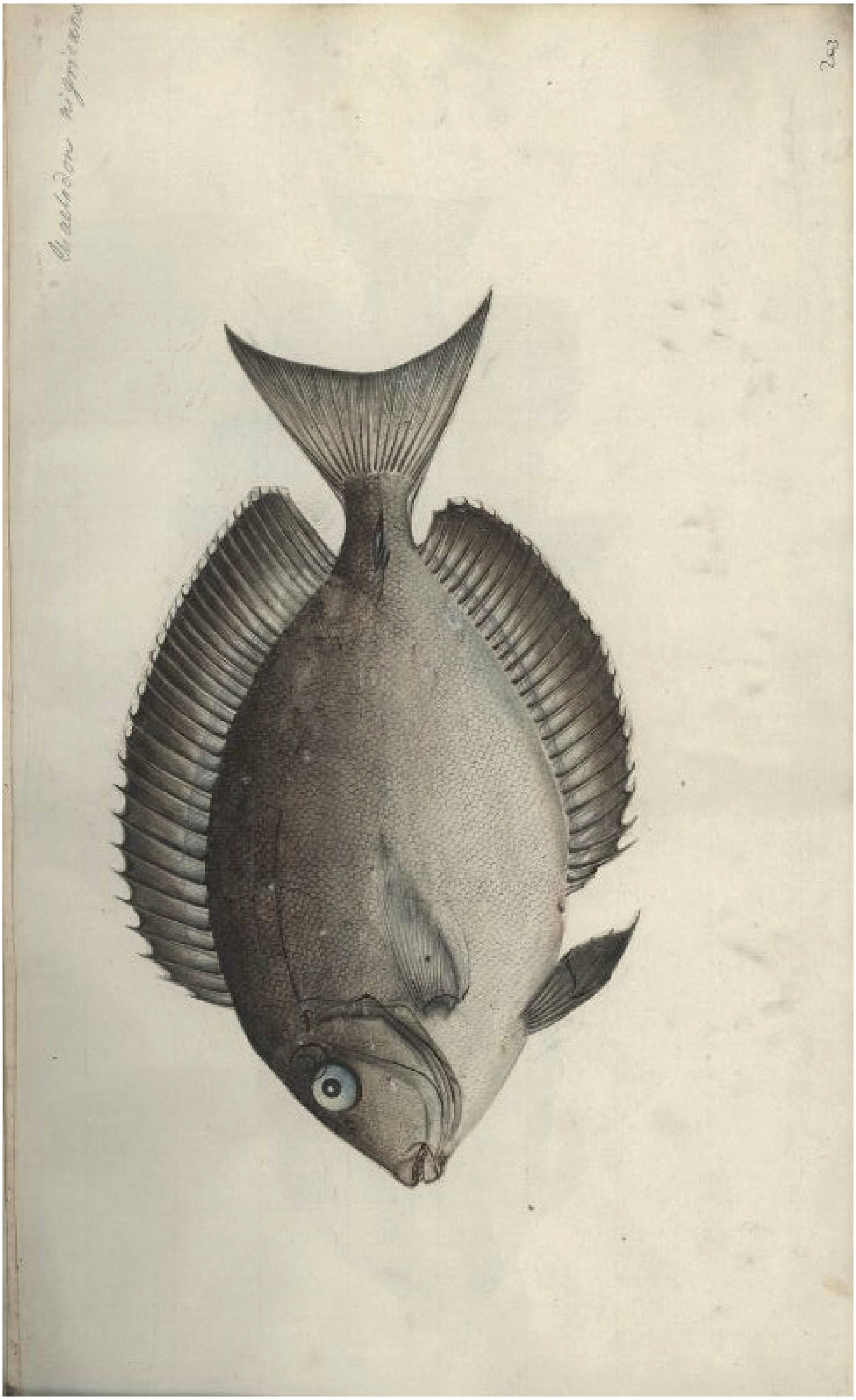


Figure 4.6 Original drawing of *Chaetodon nigrans*, Friedrich August Krüger | ZMB VIII/424 3 | © Museum für Naturkunde, Berlin

paints used, but may also have to do with whether or not a layer varnish was applied, as well as the mode of storage used; lengthy or recurrent exposition to sunlight would cause the colours to fade. Although it is of course impossible to ascertain the extent to which the colours of these engravings and drawings have altered over the past centuries, however subtly, these differences between drawings and engravings seem significant considering the very specific demands placed by Bloch on replicating the natural colour of the specimen.

Although the sixth rule, which specified that artists should portray the natural colour of the fish was quite straightforward in principle, obeying it in practice was not quite so simple. First of all, it could be a tricky exercise to exactly replicate the natural colour of a fish. In his description of the golden tench, a gift from the palace pond of Elisabeth Christine, Queen of Prussia (1715–1797), Bloch lamented the fact that the artists, despite their substantial skill and best efforts, had not managed to truly capture the beauty of the specimens' natural colour.[187] Of course, such a response would have been entirely appropriate considering the effectively royal status of the fish as gift, but it also exposes a certain tension underlying the work of colouring fishes. Bloch could of course only have assessed whether colours had been mixed correctly when he had a living specimen at hand for comparison. That was not the case for any fish that was sent to him by a correspondent. In the case of the aforementioned fringed carp, its species description reveals that the specimen had been accompanied by a drawing from the life on which Bloch's draughtsmen could base their engraving of the fish. Unfortunately, not one of the illustrations sent over by John has survived.[188] Even in those cases where John's drawings are mentioned in a species description, no indication is made of whether or not they included colour; recall John's difficulties in securing proper paint. In the cases such as the lizardfish, where no accompanying drawing is mentioned, Bloch's draughtsmen must have had to make do with the preserved objects themselves and the verbal descriptions that possibly accompanied them. Exactly how draughtsmen and colourists went

[187] Original German: "Ich muss bekennen, dass, ohnerachtet die Künstler bei dem Ausmalen desselben allen Fleiss angewendet, sie doch noch weit zurück geblieben sind, die Schönheit der natürlichen Farben zu erreichen." *Allg. Nat. der Fische*, vol. 1, 90.
[188] Karrer, "Marcus Elieser Bloch," 146.

about the business of replicating the exact colourings of any individual fish when all they had to go one was an essentially monochrome preserved specimen (and perhaps some verbal description), is a question that cannot be fully answered.

Colour was applied both during the printing process and after. As discussed in Chapter 1, early modern printed works occasionally included colour: this could be due to the use of coloured printing ink, but in most cases, colour was applied by hand.[189] In Bloch's series, however, we find a unique combination of both types of colour administration. Mechanical colour printing had by this time become a more established technique.[190] Although most of the plates are printed in black or grey ink, some 10% of the plates were printed in brown, orange, red, and green.[191] Colour printing was still relatively crude, however, and not suitable for displaying sophisticated gradations and variegations. This is why all Bloch's prints were also coloured by hand. The function and effect of colour printing can be seen on the engraving of the red mackerel (**Figure 4.7**). For this fish, a striking red has been used – as discussed earlier, Bloch had stipulated that its red colour set this species apart from other mackerel.[192] The ink used for the printing of the plate is red.[193] This gave the engraved illustration the correct undertone, on which the colourists could layer their own colouration.[194] The effect is an intense red colour, which is especially striking when compared to the subtle tints of the original drawing made for this species (**Figure 4.8**).[195] A similar contrast can be see in the case of the lizardfish, where the original drawing (**Figure 4.5**) offers distinctly subdued colouration when compared with the published engraving (**Figure 4.9**).

At the same time, one has to be careful in assuming what was and what was not known about the actual colourings of specimens. Although Claudia Kreklau

[189] See also: Kusukawa, *Picturing the Book of Nature*, 69–81.
[190] For the historical development of colour printing, see Elizabeth Savage and Ad Stijnman, "'Material Colour': The Heritage of Colour Knowledge in Seventeenth- and Eighteenth-Century Printshops," in *Colour Histories: Science, Art, and Technology in the 17th and 18th Centuries*, eds. Magdalena Bushart and Friedrich Steinle (Berlin: De Gruyter, 2015), 95–113 and Margócsy, *Commercial Visions*, chapter 4 "Knowledge as Commodity: The Invention of Color Printing," 167–199.
[191] 43 of the total of 432 plates use coloured ink rather than black. I have counted the illustrations of the copy at UBL, 137 A 1/ 6, but have not been able to verify these exact numbers for other copies.
[192] *Allg. Nat. der Fische*, vol. 10, 75.
[193] Engraving of *Scomber ruber*, *Allg. Nat. der Fische*, plate CCCXLII.
[194] I am indebted to Sabine Hackethal for this insight.
[195] Drawing of *Scomber ruber*, ZMB B VIII / 424, 342.

has argued, for example, that the dried exemplars of foreign fishes, with their brown hues, "fit comfortably in the naturalists' worldview of a dark and dreary underwater world",[196] it appears that Bloch, at least, was not prejudiced by such a dismal outlook. Bloch repeatedly marvelled at the splendid colours displayed by the fishes of faraway regions. In the preface to the ninth volume, for example, he exclaimed that its plates dedicated to foreign fishes distinguished themselves from those made after German fishes by their beautiful colours.[197] He confidently stated this without ever having seen a living fish from, say, the East Indies in the flesh. Bloch's statement is reminiscent of a broader exoticist discourse, which lauded the spectacular colours of plants and animals in the warmer climes.[198]

As Kreklau seems to overlook, however, that while stay-at-home naturalists like Bloch could not glimpse the original, dazzling colours from preserved specimens, they may well have had access to coloured drawings of either these or similar species, as well as colourful descriptions of them in letters or other textual works. These second or even third-hand colourisations of foreign fishes would become part of the visual repertoire of both naturalists and their artists, and would literally colour any subsequent encounters with specimens from a similar 'exotic' origin.

Bloch purposefully sought out other illustrations of fishes. At a public auction in Berlin, for example, he obtained a collection of drawings of Caribbean (although he calls them American) fishes by the French missionary Charles Plumier (1646–1704).[199] He also visited the city's Royal Library to peruse manuscript volumes containing drawings of fish from the West-Indies, made under the auspices of Johan Maurits van Nassau-Siegen – an expedition discussed in Chapter 1.[200] While Bloch prided himself on offering original illustrations in his works, created under his direction in his own studio after fresh or preserved samples of fish, he did have his artists copy drawings from the abovementioned manuscripts. As he explained in the preface of one of his volumes, "both [authors]

[196] Kreklau, "Travel, Technology, and Theory," 596.
[197] *Allg. Nat. der Fische*, vol. 9 (Berlin: J. Morino, 1792), sig *2r.
[198] Schmidt, *Inventing Exoticism*, 11–12.
[199] Theodore W. Pietsch, *Charles Plumier (1646–1704) and His Drawings of French and Caribbean Fishes* (Paris: Publications Scientifiques du Muséum, 2017), 83.
[200] This material is discussed in more detail in Whitehead and Boeseman, *A Portrait of Dutch 17th Century Brazil*, 40–43.

Figure 4.7 Engraving of *Scomber ruber*, Johann Friedrich Hennig | Marcus Élieser Bloch, *Allgemeine Naturgeschichte der Fische*, vol. 10 (Berlin: J. Morino, 1793), plate CCCXLII | © Universiteitsbibliotheek Leiden

Figure 4.8 Original drawing of *Scomber ruber*, Johann Friedrich Hennig | ZMB VIII/424 030 | © Museum für Naturkunde, Berlin

Figure 4.9 Engraving of *Salmo tumbil*, Johann Friedrich Hennig | Marcus Élieser Bloch, *Allgemeine Naturgeschichte der Fische*, vol. 12 (Berlin: J. Morino, 1795), plate CCCCXXX | © Universiteitsbibliotheek Leiden

had faithfully depicted the fish on the spot and painted them in lively colours."[201] That the drawings had been made *ad vivum* made them reliable enough to merit inclusion in Bloch's own work. Chapter 1 has shown that it was, in fact, quite common to use one illustration as a reference drawing for the other. Nickelsen has argued for such 'copying links' that they are not merely derivative drawings, but the outcome of a conscious process of including and excluding certain elements of the initial illustrations.[202]

One of the most striking aspects of Bloch's illustrations is that a considerable proportion of them have been heightened in silver and gold. This means that silver and gold paint is applied to certain parts of the fish, for example its scales and certain parts of its head; just as Baldner's artists had done with white in Chapter 2. Substituting white with gold and silver was not a completely new practice, but was still altogether rare.[203] The paints were, in all likelihood, made by mixing powdered silver or gold leaf with a binding medium such as gum arabic.[204] This was an expensive procedure, and one that an eighteenth-century painting manual therefore advised should only be used for special occasions.[205] Bloch seemed to believe that these costs were warranted. One reason for this might have been the luxuriousness that it added to his series. Another reason may have been the particular effect that it produced. This has to do with the luminescent qualities of silver and gold: the metals in the paint capture and reflect light. In applying the paint judiciously to the parts of a fish that would naturally catch the light, such as the edges of its scales and its gill cover, the artist endowed the illustration with some of the vivacity, as the silver or gold pigments imitated the glistening sunlight on the wet scales of the fish as it is plucked from the water. Others sought to replicate this technique. When requesting the purchase of a

[201] Original German: " […] beide haben die Fische an Ort und Stelle getreu abgebildet, und nach lebendigen Farben ausgemalt." *Allg. Nat. der Fische*, vol. 6, sig. a2r.
[202] Nickelsen, *Draughtsmen, Botanists and Nature*, 203–214.
[203] An early example of applying gold to natural historical drawings of fish is John White (1539–1593). See: Kim Sloan, *A New World: England's First View of America* (Chapel Hill: University of North Carolina Press, 2007).
[204] This technique was also known as 'shell gold', because the ingredients were often mixed in shells. See also: Michèle Seehafer, "Shimmering Virtue: Joris Hoefnagel and the Uses of Shell Gold in the Early Modern Period," in *Materialized Identities: Objects, Affects, and Effects in Early Modern Culture, 1450–1750*, eds. Susanna Burghartz, Lucas Burkart, Christine Göttler and Ulinka Rublack [forthcoming].
[205] Willem Goeree, *Verligterie-kunde, of regt gebruik der water-verwen* (Amsterdam: Andries van Damme, 1705), 22.

colour-box for his draughtsmen, John added that he also lacked sufficient silver and gold colour for them to draw the fishes.[206]

Another remarkable aspect of Bloch's fish illustrations is the degree to which they consider the fact that the specimens which they reproduce exist in three dimensions. The majority of plates contain a representation of the fish in cross section. While Hooke had already included this visual technique in depicting ammonites in the seventeenth century,[207] Bloch seems to be the first to have included such sections for fish.[208] An example can be seen on the engraving of the red mackerel (**Figure 4.7**). It is a schematic depiction of what you would see if you were to cut the fish in half at its thickest point. In his illustration policy, Bloch explains, in one sentence, the purpose of these contours: to offer an idea of whether a species was thick or thin.[209] That cannot have been the sole intent, however. For even though Bloch does not mention it, besides outlining the circumference of the fish's body, the sections also indicate the shape and location of its spine and abdominal cavity.[210] The dissection of a fish, which as we saw in Chapter 1 could be a rather complex process, revealed those parts not usually visible. The technique of the cross section offered a neat, abstracted representation, and was more widely used to portray the properties of both human and animal tissue.[211] To create such a cross section for fish required the cutting of at least one specimen in half – the specimen would then, of course, no longer be intact. This might explain why almost all of the plates of German fish, but only around half of the foreign ones, of which Bloch could not easily attain a wide sample of each

[206] Original German: "An einen guten Quantität Silberfarbe und etwas Goldfarben fische zu zeichnen fehlt es mir auch sehr eigentlich an feine Pinseln." John to Stoppelberg, 15 September 1791, AFSt/M 1 C 33a : 87.
[207] Sachiko Kusukawa, "Drawings of Fossils by Robert Hooke and Richard Waller," *Notes and Records of the Royal Society of London* 67, no. 2 (2013): 124.
[208] These cross sections also appear in later works of the 1780s, for example Pierre Joseph Bonnaterre's *Tableau encyclopédique et méthodique des trois règnes de la nature: Ichthyologie* (Paris: Mme Veuve Agasse, 1788). Bonnaterre also prepared the fish illustrations in Diderot's *Encyclopédie* depicting similar sections.
[209] Original German: "Damit man aber auch wissen möge, ob der Fisch dick oder dünn ist; so habe ich einen Umriss van stärksten Theile deselben beygefügt." *Allg. Nat. der Fische*, vol. 1, sig. *4r.
[210] The cross section also offered an indication on both the muscle mass and the amount of meat of the fish – possibly useful knowledge for consumption. I thank Martien van Oijen for this insight.
[211] For examples, see: Domenico Bertolini Meli, *Visualizing Disease: The Art and History of Pathological Illustrations* (Chicago: Chicago University Press, 2017), 79 and Matthias Bruhn, "Beyond the Icons of Knowledge: Artistic Styles and the Art History of Scientific Imagery," in *The Technical Image: A History of Styles in Scientific Imagery*, eds. Horst Bredekamp, Vera Dünkel and Birgit Schneider (Chicago: Chicago University Press, 2015), 41.

species, include this cross section. It also required a complete specimen: making such a cross section was not possible from dried exemplars, from which all flesh and intestines had already been removed.

Besides showing the thickness of species on the engraved plates, Bloch also indicated their magnitude. Many of the plates indicate whether the engraved image reflected the species' true size [*natürliche Grösse*], or whether it offered a reduced [*verkleinerte*] view.[212] This attention to the actual shape and size of a specimen was of course far from new in natural historical depictions. The representation of the 'true size' of observed entities had been a pressing problem especially for early microscopists of the seventeenth century, who often included illustrations of the naked eye view alongside the magnified drawing one to indicate the scale.[213] Bloch's specimens were not microscopic entities, however, and his size indications are less exact in nature: his aim was only to indicate that a specimen was either larger or smaller than the illustration made from it. Taken together, the decisions to include cross sections of and size indications for the specimen helped the onlooker to envision the general size and shape of the actual, three-dimensional object on which the engraving was based from its two-dimensional representation on the page.

In sum, the coloured engravings were the result of carefully measured decisions on part of Bloch and his artists. The artists set to work capturing the properties of the specimens on paper in detail – filling in the gaps where necessary. As we saw with the lizardfish from Tranquebar, a specimen and a drawing of an individual species might differ markedly, especially with regard to shape and colour, while the metamorphosis from drawing to engraving was most likely to affect a fish's colouration. Certain features could be altered in this in this three-stage act of preservation, while others might be lost irrevocably. Even though some naturalists considered illustrations to be suitable substitutes for objects, they were mediated by necessity. It is not now possible to recover the full extent of this mediation: historians cannot hope to determine just how much

[212] *Allg. Nat. der Fische*, vol. 1, sig. *4r.
[213] Fransen, "Antoni van Leeuwenhoek, His Images and Draughtsmen," 506–509.

the physical state of these materials has changed over the past two centuries, to what degree the specimens, drawings and engravings look the same as they did in the eighteenth century.

Bloch was aware that even the most truthful (*allergetreuesten*) illustrations could not always express all those marks that were of pertinence for classification, as for some species of fish these were located inside the body.[214] While the illustrations thus might help in classification, that was not their only function.

To understand why Bloch considered the time and costs incurred in these efforts worthwhile, the notion of a 'paper museum' can be useful. Historians have used this term to describe various paper formalizations of collections from the seventeenth up to the nineteenth century.[215] Debora Meijers has succinctly defined it as "a group of drawings whose coherency stems from a deliberate effort of conservation."[216] Bloch's series did not only preserve the fishes in his collection in their splendid, living state (albeit in mediated form), it also preserved the collection as a whole. Just like specimens themselves, after all, natural historical collections conceived as a whole were also in danger of disintegration. The fate of Seba's collection is a case in point. While his first collection had been purchased by Peter the Great, the apothecary's death led to his second collection being auctioned off piecemeal, its specimens dispersed into the collections of a wide variety of naturalists.[217] Many other collections suffered a similar (or worse) fate. The quarto volumes bearing Seba's name, however, with its coloured illustrations of the objects accompanied by brief descriptions, outlived his physical collection and, in a very real sense, preserved it much as he had preserved its individual specimens in the first place. Creating a visual record of the objects in one's

[214] *Allg. Nat. der Fische*, vol. 10, sig. 2r.
[215] Francis Haskell and Henrietta McBurney, "The Paper Museum of Cassiano dal Pozzo," *Visual Resources* 14, no. 1 (1998): 1–17; Debora J. Meijers, "The Paper Museum as a Genre: The Corpus of Drawings in St Petersburg within a European Perspective," in *The Paper Museum of the Academy of Sciences in St Petersburg c. 1725–1760*, eds. Renée Kistemaker, Natalya Kopaneva, Debora J. Meijers and Georgy Vilinbakhof (Amsterdam: Royal Netherlands Academy of Arts and Sciences, 2005), 19–54; Martin Rudwick, "Georges Cuvier's Paper Museum of Fossil Bones," *Archives of Natural History* 27, no. 1 (2010): 51–68.
[216] She distinguishes between "real" paper museums, which are representations of objects existing in an actual collection, and "wish-list" paper museums in which drawings act as substitutes for objects not in the possession of the collector. Meijers, "The Paper Museum as a Genre," 25.
[217] The fate of the objects of Seba's second collection has been traced in Boeseman, "The Vicissitudes and Dispersal of Albertus Seba's Zoological Specimens," *Zoologische Mededelingen* 44, no. 13 (1970): 177–210.

collection brought particular advantages. A paper museum that displayed the plants in a botanical garden, for example, as Meijers explains, "showed them in their unchanging beauty, alive and intact, and blooming all at the same time."[218]

As the discussion of the difficulties of making drawings from specimens has highlighted, it is important not to assume the (perceived) vicarious quality of drawings. While Martin Rudwick has contended that drawings of fossils could act as a stand-in for actual specimens, he attaches the caveat that "an effective proxy experience was necessarily mediated by the social and artistic conventions that underlay any pictorial representations in a given historical and cultural context."[219] This process of mediation, as has been discussed earlier in this chapter, obscured some parts of the depicted object, highlighted others, and might even add something new (whether wittingly or unwittingly). It is not difficult to imagine that the creation of a paper museum held an appeal to Bloch, as it both preserved the collection itself and made its general circulation possible. The fish specimens on the shelves in Berlin were thus only one manifestation of his collection – the book series was another.

Bloch's project was in some ways iterative in nature. As soon as a volume had found its way into bookshops and from there into the libraries of barons, countesses, physicians, merchants and naturalists, it invited its readers to send ever more specimens Bloch's way. At least some of the volumes travelled to John in Malabar. This becomes clear from his correspondence to his superior, whom he asked to send him the newest volume of the series because he only had an older, incomplete copy, as well as from a published letter in which he thanks Bloch for sending him the latest volume.[220] The missionary, it seems, used the books as reverse catalogues, reference works from which he could infer which species remained undescribed: "I was most eager to see how far the East Indian fish were known, and to support his work through bringing to light

[218] Meijers, "The Paper Museum as a Genre," 33.
[219] Martin Rudwick, *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution* (Chicago: Chicago University Press, 2005), 76.
[220] John to Stoppelberg, 15 September 1791, AFSt/M 1 C 33a 87 and John, "Einige Nachrichten von der Küste Koromandel," 351; unfortunately, he does not mention which particular copy he has received.

more [of them]."[221] In this, the series' illustrations played an essential role – the coloured engravings allowed, as John explained, for "every dumb fisherman and journeyman" to collect the desired specimens.[222] Due to their size and worth, the volumes probably would not have been taken into the field, but John used the illustrations to communicate to his collectors who were not able to read the species descriptions nevertheless. It is illustrative for how, up until the moment of the publication of the very last volume of the series, the series and the collection reinforced one another. Considering what purposes these illustrations served, even beyond Bloch's own intentions for them, allows for a better appreciation of the ways in which the publication of his series of fish books was a dynamic process rather than a static, linear one.

Conclusions

In writing to Bloch in 1794, John described the admiration that Bloch's series elicited in all those who saw it. His letter, published in the *Berlinische Monatschrift* for all of the periodical's enlightened audience to read, stated that the fishermen who had assisted him in collecting "were astounded by how lively their fishes swam about on the page."[223] Whether this exchange actually took place, this was an exaggerated account of it, or John just wanted to present Bloch a flattering fiction, the terms that he used are significant. After all, Bloch had selected each and every illustration in the series because it had, at some point at least, been done after nature. The engravings had been carefully coloured in by hand in order to capture how the species must have looked before death and subsequent decay, effectively reanimating the fishes on the paper – even if, as we saw, to do so was not a straightforward matter in practice.

With the *Allgemeine Naturgeschichte der Fische*, Bloch had expanded the list

[221] Original German: "Ich war just am begierigsten darauf um zu sehen wie weit die Ostindische Fische bekannt wären und sein Werk durch die Bekantmachung mehrere zu unterstutzen." John to Schulze, 12 October 1789, AFSt/M 1 C 30a : 2.

[222] Original German: "Hat man Werke mit gemahlten Zeichnungen, so kann jede dumme Fischer und Tagelöhner samlen halfen wie ich bey Chemnitz Conchylien Werk und Blochs Naturgeschichte der Fische ofte erfahre." John to Schulze, 20 January 1789, AFSt/M 1 C 30c : 24.

[223] Original German: " […] und meine schwarzen Fischer können nicht genug erstaunen, wie ihre Fische itzt [jetzt] auf dem Papier so lebendig herumschwimmen." John, "Einige Nachrichten von der Küste Koromandel," 351.

of known fish by no fewer than 250 species, and he created several new genera.[224] He may not have been an outstanding systematist, but he was a serious annotator to the system that Artedi first developed and Linnaeus later adjusted. As we saw, Bloch did not imitate their approach to the study of fish uncritically. He wanted his own work to offer more elaborate descriptions as well as precise illustrations that contributed to a facile identification of species. His intention was, and this is an important difference, to cater to a broader, vernacular audience. On the whole, both Bloch and his series withstand forthright categorization. The series was a genuine contribution to the natural historical study of fish, advanced oeconomic improvement, and it also did not look out of place on a display in one's library. The book and the illustrations in it thus fulfilled several functions simultaneously, depending on who was regarding them.

A striking variety of people engaged with the series in one way or the other. This variety can partially be reconstructed either from the names mentioned in the book, that is, its subscription lists and engraved plates, or in correspondence. Joseph II and other monarchs expressed their interest in and support of the project, as did government officials, naturalists, and those who worked with nature in a more practical way, like a fishing guild. It is conceivable that a part of the audience was primarily attracted to the luxuriously executed plates. For naturalists, the carefully executed illustrations were a useful work of reference because of the care that had been taken to depict those characteristics that were salient for classification, for example correctly portraying the number of rays in the fins. As we saw, John used the illustrations as a way to communicate to his assistant collectors which species still needed to be gathered, and so the plates had mnemonic value. Collectors, missionaries and others helped to amass material for the series, and artists represented it; as did other, unnamed, characters such as fishermen, draughtsmen and colourists.

Bloch was well positioned in this vast network, and it was by virtue of it that he could establish himself as an authority on fish. For him, the series may have acted as a paper museum to his collection, the illustrated fish far surpassing

[224] According to an estimation cited in Wells, "M.E. Bloch's Allgemeine Naturgeschichte der Fische: A Study," 9.

the beauty of that of the specimens stowed away on the shelves of his cabinet. He asserted himself as an expert on the natural history of fishes not only by virtue of his grasp of the natural historical literature and his proficiency in Linnaean classification, but also of his possession of all the fishes described in the book. Furthermore, because he only used drawings that had been done after nature, he could claim first-hand knowledge of the depicted species, even if only via images. The fact that these illustrations were so lively in terms of their colours helped to emphasize his near-vicinity to first-hand experience. As this chapter has submitted, by portraying fish Bloch also represented himself. His collection and his series were closely connected to his reputation as a *Naturkenner* in Berlin, the German states and in the wider enlightened circles of Europe. One of Bloch's eulogists called his fish oeuvre "the crowning glory that placed him among the ranks of our illustrious naturalists."[225] Bloch became a recognized authority on all the world's known fish without having to leave Berlin.

By the time he passed away in 1799, Bloch had become a celebrated figure in a country that did not allocate him full legal equality. Friedländer was involved in handling his legacy, which entailed finding a fitting home for the collection.[226] He, together with a dozen or so members at the Gesellschaft Naturforschender Freunde appealed to King Friedrich Wilhelm III (1770–1840) to purchase Bloch's cabinet.[227] Friedrich Wilhelm was in the process of turning his *Kunstkammer* into Berlin's first public museum.[228] In their letter to the king's representatives, the Gesellschaft members argued that Bloch's cabinet, and specifically his collection of fishes and amphibians, was the only one of its kind and that it formed an

[225] Original French: "Mais son immortel ouvrage sur l'ichthyologie acheva de mettre le comble à sa gloire, en le plaçant au rang de nos illustres naturalistes." Antoine-Jean Coquebert de Montbret, "Éloge de Monsieur Bloch," *Rapport général des travaux de la Société philomatique de Paris* 4 (1800): 145.

[226] The transfer is documented in "Acta betr. die Übergabe des Blochschen Kabinetts an Prof. Walter. 1804", BBAW, PAW 1700-1811-I-XV-30; f49r-54v contains a floor plan for the room in which Bloch's collection was to be displayed, that shows a designated spot for the chests of drawers in which dried fish could be held. The file also contains a design for these cabinets.

[227] Martin Heinrich Klaproth and David Friedländer to the King's Secretary, undated, BBAW, PAW 1700-1811–I-XV-29, f10r.

[228] See also: Eva Dolezel, *Der Traum vom Museum: die Kunstkammer im Berliner Schloss um 1800: eine museumsgeschichtliche Verortung* (Berlin: Gebr. Mann, 2019).

'exquisite ornament' to the city of Berlin.[229] They entreated the king to make haste; if he did not procure the collection before it was put to auction, they argued, it might be dismantled at the hands of eager buyers, or worse, remain intact but carried off abroad by one those foreign collectors that had been anticipating the collection being put up for offer.[230] Their attempts to save it from such a glum fate were eventually successful: Friedrich Wilhelm bought it (although he managed it to secure it for the sum of 4500 Reichsthalers, half the asking price) and Bloch's collection became, officially, a national asset.

[229] *Tagebuch*, MfN, ZMB, GNF S. Bloch 1, TB 6, 67 B 3102 a-g, 108r/v; I have made use of the transcription by Doreen Bombitzki, dated 16 June 1999 in ZMB, S. Bloch 1, bd. 4, 23–24.
[230] Ibid.

CONCLUSION

Depending on who you asked, in the early modern period, the answer to the question 'what is a fish?' may have included a jellyfish, a perch, a flair, a mermaid, or a whale. Sixteenth-century conceptions of fish were to a large extent synonymous with *aquatilia*, i.e., animals that dwelled in the water. Ray, however, defined a fish as a creature without feet and with fins that never willingly came onto land. Artedi slightly altered that definition, but added that fishes might occasionally take to the land. Linnaeus, in the tenth edition of the *Systema naturae* (1756), declared whales to be separate from the fishes and included them with the newly created category of the mammals. Bloch declared that he would not follow this definition, and that he took whales and swimming amphibians as fishes. Lacépède would, in 1804, devote a separate series to the whales rather than discussing them in his books of fish.[1] In 1818, the question of whether whales were fishes was put to trial in New York. The defendant in the court case had purchased caskets of whale oil that had not been inspected before sale, as was required by law for fish oil. Among those testifying was the esteemed physician and naturalist Samuel Mitchill (1764–1831), who argued "that a whale is no more a fish than a man."[2] When pressed, however, he admitted that disputes in classification did exist. The jury eventually ruled that whales were fishes indeed.

Even the seemingly straightforward question of what constituted a fish thus yielded a variety of replies. It is the first level of demarcation we can discern in this dissertation, *viz*. that of the subject of study. As this dissertation has demonstrated,

[1] Bernard Germain de Lacépède, *Histoire naturelle des poissons*, and his *Histoire naturelle des cétacées* (Paris: Plassan, 1804).

[2] Graham D. Burnett, *Trying Leviathan: The Nineteenth-Century New York Court Case That Put the Whale on Trial and Challenged the Order of Nature* (New Jersey: Princeton University Press, 2007), 61.

the demarcation of the natural historical study of fishes was similarly a process of shifting boundaries. Ideas about how fishes should be studied, which knowledge about them should be captured and how this knowledge should be presented, and especially who was to decide and on the basis of what, were subject to continuous revision. At the same time, by the end of the eighteenth century, the study of fishes had become more defined as a field with its own particular rules, which required the attention of a specialized naturalist. In which ways did this demarcation take place? And what does that tell us about how knowledge of nature is created?

Before diving into these questions, however, it is worthwhile to stress that naturalists who studied fishes in the long eighteenth century seldom did so without taking the examination of other aspects of living nature into account. Each of the authors that passed in review were taken by the study of natural history as a whole, and were interested in natural philosophy. Natural philosophical ideas, for example mechanist philosophies, came to bear on the study and description of living creatures. Willughby and Ray examined plants, insects, fishes, birds and quadrupeds; Artedi was inspired by Tournefort's classification of plants and trees, and used it as a model in devising classification schemes not only for fishes but also for mammals; and Bloch's collection, despite its focus on fishes, in fact covered the whole range of nature, from polished stones, shells and insects to bird nests. Conversely, observations and experiments on fishes (like inserting specimens into an air pump, or examining spawn) could be used to prove or disprove theories on the nature of air or procreation. In the long eighteenth century, therefore, the study of nature remained an intertwined endeavour that accommodated a broad curiosity about the world and its creations.

To sustain this interest in and research of nature, as we have seen, appropriate funding was needed. Even though, from the sixteenth century onwards, natural history became more and more recognized as a matter worth studying for its own sake, a life dedicated to it did not come with an obvious career trajectory. A few professorships in natural history had been established here and there, but these were generally focussed on teaching rather than research. Those wishing to undertake research thus had to find other ways to finance their work – with the exception, of course, of wealthy individuals like Willughby. Each of the other authors discussed in this dissertation grappled with how they could be recognized and remunerated for their studies. Making money from books, as we saw, was an uncertain path: publications could cost rather more in financial terms than they afforded the naturalist in terms of reputation. Naturalists pursued a range of other options, including securing patronage, as was the case with Ray, Artedi and Linnaeus, falling back on affluent in-laws or a wealthy wife, as with Artedi and Bloch, or holding on to one's day job, like Bloch who also continued his lucrative medical practice. The chapters have demonstrated how monetary considerations shaped how these different naturalists could conduct their studies.

It is against this background of financial instabilities and uncertainties that these naturalists came to apply themselves to a specific field of study. As Rudwick has noted for the eighteenth century, *savants* came to apply themselves to (and establish their reputation in) one or two specific fields even if their interests might range rather more widely.[3] Artedi certainly presented himself as a naturalist who was specialized in fishes, and Bloch concentrated his collection around them. An individual's turn towards fishes might, as we have seen, been the result of several different reasons: naturalists may simply be fascinated by them, seeing them as useful creatures meriting more attention than they had so far received, or they may have seen in the study of fishes a vacant space that they could come to occupy. When authors had come to dedicate themselves to a particular subject, and subsequently to draw up a definition of it, they also had to decide what kind of knowledge should be observed and recorded regarding it.

This is the second level of demarcation: the process in which that which properly relates to natural history is distinguished from knowledge not deemed pertinent to natural history. For naturalists, this demanded devising a *method* with which to approach their subject matter. This does not mean, however, that such methods were necessarily unique to naturalists. As we saw in Chapter 2, the boundaries between 'theoretical' and 'practical' engagements with fishes could,

[3] Rudwick, *Bursting the Limits of Time*, 48.

in practice, be blurred. Willughby, Ray and their fellow Royal Society members focussed on the physical characteristics of species so as to demarcate one from the other, examined their properties through empiric observation and the performing of experiments. Fishermen and fishmongers sometimes did similar things; in the case of Baldner, he held the claims that had been made in written books up to scrutiny. It shows how natural history, as it was demarcated by learned naturalists through their methods, was not an activity inherently separate from other activities.

For each of the authors discussed in this dissertation, direct observation was central to their approach. In the sixteenth century, Gessner and his contemporaries took to cross-referencing authorative writings with the world they encountered around them. Noticing that the claims therein far from always matched their own findings, they subjected ever more texts to similar checks. Willughby and Ray also combined textual study with empirical experience. More so than their predecessors, however, they made direct observation the core of their study of fishes; explicitly inserting, for example, the act of witnessing into their species descriptions through *vidi* and *vidimus*. While Artedi announced that he had studied almost all of the fish described in his book in the flesh, he is, when compared to Willughby and Ray, less visible as observer in the species descriptions themselves – perhaps he considered this a way of conferring a certain universality onto his own observations. Lastly, Bloch explained that his series only included those species of which he was able to deliver an illustration that had been done after nature. In doing so, he emphasized that the knowledge presented in his work was derived from a close proximity to the object under study. Although they signalled their direct experience in different ways, for each of the authors discussed here, empirical observation lent legitimacy to their findings – even though, as we have seen, this ideal could be difficult to hold up in practice.

But what to observe? Changing ideas about what did and did not belong to natural history can be clearly seen from how authors drew up species descriptions. In the sixteenth century, renowned naturalists like Gessner and Aldrovandi held that a species of fish was best understood by taking into account all that had been written about it in a wide variety of sources. Their species descriptions were encyclopaedic in nature, combining reports of morphological features with extensive philological discussions. As we saw in Chapter 1, Ray stated that he eschewed such 'humane learning', even if Willughby and he did include the occasional discussion of expressions, anecdotes, and fishing techniques. They focussed on characteristic marks, and carefully counted and measured the physical properties of species whenever possible. For Artedi, the practice of observing and counting pertinent physical characteristics became the basis of his system of classification. His species descriptions consisted of numerical lists of such characteristics, almost taking on the form of formulae – as he sought to make natural history somewhat less *historia* and more *scientia.* Over the course of the eighteenth century, the natural history of fishes thus moved from an encyclopaedic approach that incorporated historical and mythical associations to one that was quantative and mathematical. This corresponds to a wider development in the long eighteenth century signalled by historians of science, namely a growing conception of the world in which certitude was found in empirical observation, experimentation and counting. Daston, as we saw, characterized this period as one of description by omission.[4] Wolf Lepenies has analyzed how over the course of this century, natural history was stripped of its historical component, that is, the cultural meaning of species.[5] Historians have furthermore drawn attention to the increasingly quantitative bent and concern with method and order that, besides natural history, is also visible in other fields such as the study of medicine and of the weather. It was an epistemological shift that emphasized regularity over variety.

In order to render variety regular, *classification* was key. While the sixteenth century saw a vivid tradition of sorting species of *aquatilia* into various groups, based on a wide range of principles, Willughby and Ray proposed that they

[4] It should be noted that this trend of sparse descriptions was by no means absolute; the *Histoire naturelle* series of Georges-Louis Leclerc de Buffon (1707–1788) took a more diametrical approach to describing nature. His complex relationship with description is analyzed in Joanna Stalnaker, *The Unfinished Enlightenment: Description in the Age of the Encyclopedia* (Ithaca: Cornell University Press, 2010), 31–67.

[5] Wolf Lepenies, *Das Ende der Naturgeschichte: Wandel kultureller Selbstverständlichkeiten in den Wissenschaften des 18. und 19. Jahrhunderts* (München: Hanser Verlag, 1976), 29–30.

need look only at morphological features in assembling species into groups and delineating one from the other. Ray also drew up a definition of what a species was, a concept that had seldom been defined, despite having been in use for centuries. Artedi established and defined the taxonomical ranks of classes, order, genera, species and varieties for fishes, just as his friend Linnaeus did for other animals, as well as plants and minerals. According to Artedi, the one and only goal of natural history was to divide species into genera – which meant that he equated the natural historical study of fishes, which he called ichthyology, with his own method. His system was adopted and subsequently refined by other naturalists; Bloch was one of them. As we saw, classification was pursued with different goals in mind. For Willughby and Ray, their wish to instil order into the world of species was driven by a wish to return to a prelapsarian state of knowledge, a concern they shared with their contemporaries. Bloch's initial plan to classify and chart all the fish living in the German states was clearly spurred by oeconomic motivations.

Classification is a form of demarcation: not only of one species from the other, but also of pertinent from non-pertinent knowledge. This is particularly apparent in Artedi's classification system, which strongly emphasized the counting of certain parts of the fish, like teeth or fins, rather than paying attention to other features, such as their colour or habitat. Selecting those particular features was practical, because matters like colour and habitat could no longer be gleaned from a fish once it had been taken out of its environment and preserved as a specimen in a collection. Artedi's classification method also suggested a certain reliability, perhaps even a replicability: everyone so inclined could try to find an exemplar of the species under discussion, count the rays in the fin, and ascertain the validity of the reported observation for oneself. It reflects his quantitative rather than qualitative approach to studying species: what counted were the number and relative position of differentiating characteristics such as its fins. In the process, Artedi left out all kinds of knowledge that had been part of natural historical studies of fishes for centuries. This included artisanal knowledge of fishes, as we have seen, which, as we saw in Chapter 3, he deemed 'amethodic'. Furthermore, what earlier authors had written about fish was only relevant to the extent in which their species descriptions were commensurable with his own.

We can also discern a development from encyclopaedic collections to more specialised collections. A wide variety of kinds of collections has come into view in the chapters of this dissertation: Felix Platter's cabinet of curiosities, the Repository of the Royal Society, the rarities that James Salter displayed in his coffee house, the neatly ordered collection of father and son Gronovius, and of course Bloch's expansive collection of *naturalia*. This last individual was not unique in concentrating his collection on one subject; towards the end of the eighteenth century, naturalists seem to have placed their focus on collecting specimens from one particular class of species rather than from all of them, perhaps because the number of species that were known had grown to such an extent that it was no longer considered possible to strive for a complete collection of all classes of plants and animals.[6] Findlen has argued that the fact that naturalists 'stopped seeing', as she calls it, made collections exclusive rather than inclusive as it meant that they passed up on breadth.[7] The specificities and nuances in this development have received more attention by historians over the last few years,[8] and it merits further research.

To summarize, the authors discussed in this dissertation agreed that what it took to be an authority on fishes in the eighteenth century was to observe species closely, examine their morphological features, and describe their physical parts in exacting detail (but preferably not too much of it) so that it could be assigned into its rightful place in an ordered system. This is what Artedi offered as a definition for an 'ichthyologist.' This process, of course, promotes a certain circularity: namely, that one proclaims oneself an ichthyologist – which does not (yet) constitute a clear category or job title – on the basis of a certain authority, for example deploying a particular method, and in turn use this (self)designation

[6] Dominik Hünniger, "'Extolled by Foreigners': William Hunter's Collection and the Development of Science and Medicine in Eighteenth-Century Europe," in *William Hunter and the Anatomy of the Modern Museum*, eds. Mungo Campbell, Nathan Flis and María Dolores Sánchez-Jáuregui (New Haven: Yale University Press, 2018), 135.
[7] Findlen, *Possessing Nature*, 405.
[8] See, for example, the essays in Ellinoor S. Bergvelt and Debora J. Meijers, eds., *Teyler's Foundation in Haarlem and Its 'Book and Art Room' of 1779*, (Leiden: Brill, 2020).

as an ichthyologist as a claim to further authority. It would be interesting to compare this process with further, specialized case studies in other fields.

For all the wider developments outlined above, such as the importance attached to observation, to classification and to quantification, it has become clear that authors also very much had their own ideas how to best capture fish on paper. The above discussions have already shown how the authors far from agreed on all counts. This serves as the third level of demarcation: that in which authors distance themselves from earlier authors. All of the authors discussed in the chapters of the dissertation were explicit about how they envisioned their own approach to fishes, and how this differed from those of earlier authors that had written about the topic – and why their particular way of going about it was the best.

A recurring tension has been the epistemological uses of illustrations and objects. The way in which fishes were preserved over the course of the early modern period did not change drastically,[9] and it continued to be exceptionally difficult if not near impossible to conserve them in lifelike fashion. It was perhaps for this reason that illustrations were much sought after, even if Artedi did not seem to particularly care for them. Throughout the early modern period, fishes continued to be depicted according to a rather stable pictorial convention: portrayed from the side against a white background. We also saw that it was preferred that a fish was depicted while alive (or at least still relatively fresh) and illustrations drawn from the life continued to carry special weight from Belon to Bloch. There were nonetheless different visual strategies designed to convey that a drawing had been done from life. In Chapter 1, we saw how an illustration was endowed with a 'rhetoric of the real' by having the depicted object cast a shadow on the page. Chapter 4 has argued that Bloch's inclusion of colour may have been a way to suggest that they had been done after living specimens (even if this was not always the case). The visual techniques used in Bloch's series, such as the expensive hand-coloured engravings occasionally heightened with silver or gold,

[9] These same techniques of drying fish and preserving their skins continued to be used in the nineteenth century: Maria Eulàlia Gassó Miracle, "Temminck's Order: Debates on Zoological Classification (1800–1850)" (PhD diss., Leiden University, 2019), 108.

the rendition of cross sections, and the indications of actual size, were attempts to convey the material dimensions of the specimens in his collection. Illustrations thus supported claims made by naturalists through visual rhetorical strategies that suggested a proximity to the object at hand.

The above discussions on collecting, classifying, describing and depicting fish have made clear that different ways of obtaining and presenting knowledge about fish were evaluated variously depending on the author. They are thus not as uniform in their approach as one may suspect when considering that each explicitly builds upon the another. This can be explained by the fact that communal codes of what it took to be a good naturalist were context-specific. The concern of authors to abide by such shared codes can be seen on their title pages, and in their prefaces and epilogues. Take, for instance, Ray's express statements that only empirical observations of reliable witnesses had been included, Artedi's presentation of his method as one that can be demonstrably proven, and Bloch's emphasis on the usefulness of his study for the wider community, to name a few examples that have been discussed in this dissertation.

The fourth and final level of demarcation to be discussed here is that on the part of the historian, who decides how we should study the formation of knowledge in the eighteenth century, and on which (and on whose) terms. This dissertation has tried to take a broad approach, focussing not only on the authors and their books, but also considering the broader social context which made it possible to produce such works. Besides the authors of fish books, this dissertation has been populated by fishermen, fishmongers, artists and missionaries. They engaged in the study of fishes in distinct ways, even if not all their contributions can be traced back to specific individuals. Contributions of unnamed individuals consisted of catching and collecting fishes, turning species into specimens and illustrating them, as well as delineating between species, and explaining how certain species were best caught as well as how they could be cured for trade and consumption. These are matters that resurface when perusing the pages of eighteenth-century fish books, but which can be drawn out further by combining a study of these books with that of surrounding sources. Chapter 4, for example, has looked at Bloch's larger network of correspondents, considering John and his mission assistants, and their underlying motivations and dynamics. Such an approach brings to light the indispensable role played by people across the social spectrum, and who have traditionally fallen outside the purview of studies of natural history.

A discussion of the limitations of this study is in order. The first lies in its corpus: although the selection of fish books that were analyzed in this dissertation has been justified in the introduction, these works are not necessarily representative for each and every natural historical study of fishes published during the long eighteenth century. If other works had been included in this study, other facets may well have emerged. Due to their universal and synthetic pretensions, however, the examined works do nonetheless encompass the key developments in the study of fishes over this period. Another limitation that requires discussion is the extent to which we can extrapolate the insights gained in this study to other fields of natural history, or beyond. Which of the conclusions drawn in this dissertation are particular to the study of fishes, and which apply to birds, insects, the earth or the weather? Both the particularly perishable nature of fishes, and the impossibility of peering into the depths of the water, as we saw, had no little impact on the ways in which they could be studied, whereas other fields of study came with their own (dis)advantages. It is in its attention for the different levels of demarcation, as laid out in this conclusion, that this dissertation hopes to present a way to study similar developments in other fields of knowledge. To be attuned to the human efforts involved in demarcation, after all, is to understand that the process of the separation and specialisation of knowledge that we can discern both in and after the eighteenth century is a profoundly historical one.[10]

We will close by briefly looking ahead. By the end of the eighteenth century, discussions on what precisely a fish was, and how it should be studied, had by no means subsided. In his *Tableau historique des progrès de l'ichtyologie depuis son origine jusqu'à nos jours*, published in Paris in 1828, Cuvier offered a history

[10] For the value of appreciating the historical nature of such processes, see: Wijnand Mijnhardt, "'The World We Have Lost': In Praise of a Comprehensive Concept of Science and Scholarship," in Bergvelt and Meijers, *Teyler's Foundation in Haarlem and Its 'Book and Art Room' of 1779*, esp. 84–86.

of the development of, as he explicitly called it, ichthyology.[11] Cuvier had been appointed professor of comparative anatomy at the Muséum National d'Histoire Naturelle in 1802. Besides writing on comparative anatomy, he scrutinized fossils, theorized about the age of the earth and studied fishes. His 'historic tableau of the progress of ichthyology' marked the opening of his own natural history of fishes, the *Histoire naturelle des poissons* that would sprawl out over no less than twenty-two volumes, and which he regarded as the very culmination of all those fish studies that had been carried out before him.[12] Writing such an overview offered Cuvier the opportunity to construct the natural history of fishes from his own vantage point, selecting those people and ideas he thought to be worthwhile, and leaving out or dismissing those that were not. In this, Cuvier fits well into a process we saw with earlier authors of fish books.

The context in which Cuvier wrote his fish series, however, was rather different. He did so from a salaried position at a national institute, the Muséum National d'Histoire Naturelle. Much like the British Museum in London, this institute was a collection of collections: private collections that, through auctions and bequests, had found their new home in public collections – though it should be noted that the contrast between 'private' and 'public' is at times rather overblown.[13] The pertinent movement here is not so much that of private to public, but rather that of the individual to the institution. Indeed, whereas collections of *artificialia* and *naturalia* had hitherto mostly been in the hands of individuals, be it nobles, naturalists or merchants, by the early nineteenth century institutions had started to take over that role. Said institutions became the locus not only for collections, but also for the natural historical study that the specimens in their display rooms and storages invited. Of course, natural historical investigations continued to take place well beyond the scope of museums;[14] but such institutions

[11] Georges Cuvier, *Tableau historique des progrès de l'ichtyologie depuis son origine jusqu'à nos jours* (Paris & Strasbourg: F. G. Levrault, 1828).
[12] He worked on the series together with Achille Valenciennes (1794–1865), who carried on the project after Cuvier died in 1832.
[13] On the permeable boundaries between public and private collections, see: Samuel Alberti, "Owning and Collecting Natural Objects in Nineteenth-Century Britain," in *From Private to Public: Natural Collections and Museums*, ed. Marco Beretta (Sagamore Beach, Mass.: Science History Publications 2005), 141–154.
[14] See, e.g., Anne Secord, "Coming to Attention: A Commonwealth of Observers during the Napoleonic Wars," in Daston and Lunbeck, *Histories of Scientific Observation*, 421–444.

did become more present and powerful. In The Netherlands, for example, heady naturalists sought to affiliate themselves to the Rijksmuseum van Natuurlijke Historie that was established in Leiden in 1820 and in which previously existing collections were merged.[15]

We can further trace this development through the fate of Bloch's collection. As we saw, the contents of his cabinet were relocated from his home at the Spandauerstraße to King Friedrich Wilhelm III's *Kunstkammer* in the Berlin Palace in 1802. Eight years later, the natural historical specimens of Bloch's collection were parcelled up. They were transported to the newly opened Universität zu Berlin, established by the King at the instigation of Wilhelm von Humboldt, to form part of its zoological museum. This museum had the dual purpose of educating students on the natural world and facilitating research.[16] After a few decades in the research and teaching collection at the university of Berlin, Bloch's natural historical specimens moved house once again. This time, they were stored in the Museum für Naturkunde in Berlin where they remain today. Since then, all of the objects in his collection have been divided according to the class to which they belong: Bloch's fishes are part of the fish collection, his reptiles reside among the collection of reptiles and amphibians, and so on. His capacious collection has thus been separated into distinct categories, broken down into specialized departments. This development is in no way unique to the Museum für Naturkunde, but is rather illustrative for the contemporary emphasis on disciplinary categories visible in other heritage institutions, too.[17]

The naturalists discussed in this dissertation marvelled at the sheer abundance and richness of species that dwelled in the vast wildernesses of water, and tried to capture them in their books. Their natural historical ventures were often of a

[15] A dissertation on this topic focussing on the fish collection is in preparation by Robbert J. Striekwold at Leiden University.

[16] Peter Giere, Peter Bartsch, and Christiane Quaisser, "From Humboldt to HVac – The Zoological Collections of the Museum für Naturkunde Leibniz Institute for Evolution and Biodiversity Science in Berlin," in *Zoological Collections of Germany: The Animal Kingdom in its Amazing Plenty in Museums and Universities*, ed. Lothar A. Beck (Dordrecht: Springer, 2018), 95.

[17] The project *A Window on Nature and Art: A Historical Study of the Brandenburg-Prussian Kunstkammer*, supervised by Anita Hermannstädter at the Museum für Naturkunde, seeks to reassemble the *Kunstkammer* collection (including Bloch's specimens) that was distributed across multiple specialized institutions. It runs from 2018 to 2021.

collaborative nature, and accommodated a variety of perspectives and approaches. These books matter to us today. They matter because they can serve as a reminder of how learned naturalists can, nevertheless, themselves learn from communities of practice; some biodiversity scientists today indeed do so in protecting marine species of risk.[18] They are also important because ecologists can profit from natural historical works like these in their inquiries into biodiversity, as they offer insight into the presence of certain species in previous centuries, and indicate whether these, for example, were still common stock in regions from which they have since disappeared. Historical evidence has proven useful for showing the long-term developments of species populations.[19] What is more, however, the study of these books matters because it shows how even something as deceptively simple as what a fish is, is a historical question.

[18] See, for example: Andrea Saénz–Arroyo, Callum M. Roberts, Jorge Torre and Micheline Carinõ-Olvera, "Using Fishers' Anecdotes, Naturalists' Observations and Grey Literature to Reassess Marine Species at Risk: The Case of the Gulf Grouper in the Gulf of California, Mexico," *Fish and Fisheries* 6, no. 2 (2005): 121–133.
[19] Floris P. Bennema and Adriaan D. Rijnsdorp, "Fish Abundance, Fisheries, Fish Trade and Consumption in Sixteenth-Century Netherlands as Described by Adriaen Coenen," *Fisheries Research* 161 (2015): 384–399.

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NEDERLANDSE SAMENVATTING

Er is niet zoiets als een vis, en dit is een dissertatie daarover. In dit proefschrift analyseer ik hoe de studie naar vissen zich heeft ontwikkeld in Europa in de periode van de 'lange achttiende eeuw', van omstreeks 1680 tot 1820. De formele, hedendaagse term voor de studie naar vissen is ichtyologie. Ik pleit er in deze dissertatie echter voor om de deze disciplinaire categorie, die net als die van veel andere disciplines in de loop van de negentiende eeuw ontstond, niet toe te passen op het verleden. Historici karakteriseren de vroegmoderne kenniscultuur als een open terrein. Als het op de studie van de natuur aankwam bestonden er geen vast omlijnde kaders, maar hielden mensen zich hiermee bezig vanuit verschillende achtergronden en interesses, zoals het humanisme, de geneeskunde, de ambachten en de schilderkunst. Degenen die zich op de studie van planten en dieren (ofwel natuurhistorie) toelegden worden door historici aangeduid als naturalisten. Een deel van deze naturalisten begon zich in de loop van de achttiende eeuw langzaam maar zeker op te werpen als autoriteit op een door henzelf afgebakend gebied binnen de natuurhistorie. Hoewel dit een wezenlijk proces was, is het nog niet uitgebreid onderzocht noch geproblematiseerd. Deze dissertatie bekijkt hoe dergelijke afbakening plaatsvond in de studie van vissen, op het vlak van onderzoeksobject (wat een vis is), methode (de manier waarop je een vis het beste kan bestuderen), en beoefenaar (wie geacht werd betrouwbare en relevante kennis over vissen te produceren). In dit boek staat dit proces van afbakening centraal. Door dit proces te analyseren over een periode van meerdere decennia, beoogt deze dissertatie inzicht te creëert in de sociaal-culturele context waarin kennisvelden gevormd worden en bij te dragen aan historiografische discussies hieromtrent.

In deze dissertatie bestudeer ik hoe natuuronderzoekers vissen op papier probeerden te vangen. Daarin vormt een drietal "visboeken", dat wil zeggen natuurhistorische boeken waarin vissen worden beschreven, geordend en afgebeeld, het uitgangspunt. Elk van deze boeken behandelt de natuurlijke historie van vissen in haar geheel en de auteurs reflecteren expliciet op de door hen gekozen aanpak, wat het geschikte bronnen maakt om kwesties rondom autoriteit en afbakening te onderzoeken. Aan de hand van steeds een ander visboek analyseren de verschillende hoofdstukken het diachrone proces van afbakening dat zich in deze periode voltrekt. Deze dissertatie kijkt uitdrukkelijk naar de manier waarop deze boeken tot stand zijn gekomen: niet alleen de directe aanloop naar de publicatie ervan, maar ook de bredere context waarin ze werden gepubliceerd. Daartoe neemt het naast de geselecteerde visboeken ook andere gedrukte boeken in acht, waaronder reisverslagen, correspondentie, manuscripten, natuurhistorische schetsen en tekeningen evenals geprepareerde vissen. In plaats van te zoeken naar doorbraken in het denken over vissen, volg ik een viertal historisch gesitueerde praktijken die centraal stonden in de publicatie van deze boeken: het verzamelen, het beschrijven, het classificeren en het afbeelden van soorten. Ik onderzoek zowel de methodes die natuuronderzoekers voorstaan in het vergaren en produceren van betrouwbare kennis over vissen, als de weerbarstige praktijk van de uitvoering hiervan. Vissen waren complexe wezens om te bestuderen. Het was soms lastig om ze te vangen, maar nog moeilijker was het bewaren van de vissen zonder dat ze bedorven en kenmerken onherroepelijk verloren zouden gaan.

Hoofdstuk 1 geeft een vergelijkend overzicht van natuurhistorie in de zestiende en zeventiende eeuw. Dat doet het aan de hand van het boek *Historia piscium* (Oxford, 1686) [*De geschiedenis van vissen*] door John Ray (1627–1705) en Francis Willughby (1635–1672). Willughby en Ray kenden elkaar van de universiteit in Cambridge en waren beiden Fellows van de Royal Society in Londen. Ze stelden zichzelf als doel om de levende natuur te beschrijven. Daarin gingen ze, naar eigen zeggen, anders te werk dan zestiende-eeuwse auteurs zoals Conrad Gessner (1516–1565) en Ulysse Aldrovandi (1522–1605). Natuurhistorie had zich in de zestiende eeuw gevormd tot een onderwerp dat omwille van zichzelf werd bestudeerd. Naturalisten verzamelden planten en dieren om te beschrijven, af te beelden en te duiden. Dat laatste deden ze doorgaans in een encyclopedisch model, met een nadruk op hoe soorten figureerden in literaire tradities en filologische exercities. In deze periode werd de term 'vis' toegepast op allerhande wezens die in het element water te vinden waren. Willughby en Ray daarentegen kwamen in de *Historia piscium* met een engere definitie van deze term op basis van fysieke kenmerken, waaronder de aanwezigheid van vinnen. In dit werk legden ze, op basis van directe observatie, zowel de externe als de interne delen van vissoorten zo precies mogelijk vast in hun beschrijvingen en lieten ze het door zestiende-eeuwse auteurs gesponnen culturele web van associaties terzijde. Tegelijkertijd, zo laat dit hoofdstuk zien, was het werk van Willughby en Ray stevig ingebed in de traditie van deze eerdere auteurs: ze maakten gebruik van diens beschrijvingen, deelden vergelijkbare onderzoekspraktijken en namen passages over spreekwoorden en visserij op.

Hoofdstuk 2 gaat dieper in op de *Historia piscium*. Het beargumenteert dat vanwege het belang dat Willughby en Ray hechtten aan directe observatie, mensen wiens ervaring met vissen voortkwam uit dagelijkse praktijk werden gezien als betrouwbare bronnen en gezaghebbende kennis over de natuur dan ook niet exclusief was voorbehouden aan geleerden ondanks de opkomst van geleerde genootschappen zoals de Royal Society. Willughby en Ray zochten naar wat ze 'karakteristieke kenmerken' noemden – specifieke fysiologische kenmerken – om het bekende aantal vissoorten terug te brengen naar het precieze aantal dat God gecreëerd had. Omdat Willughby en Ray niet elke vis met hun eigen ogen konden bestuderen moesten ze bogen op de observaties van mensen die ze geloofwaardig en betrouwbaar achtten. Juist vissers en visverkopers, die in de loop van hun leven veel verse exemplaren van verschillende vissoorten van dichtbij zagen, bezaten een schat aan kennis over vissen. Uit zowel de *Historia piscium* als bronnen daaromheen blijkt dat Willughby en Ray deze mensen met regelmaat opzochten om uitsluitsel te krijgen over, onder andere, waarin vissoorten van elkaar verschilden, of een bepaald exemplaar representatief was voor een soort of niet evenals onder welke namen een bepaalde vis bekend was. Dit hoofdstuk toont dat Willughby en Ray in hun streven naar het vaststellen van vissoorten veelvuldig gebruik maakten van de kennis van praktische lieden, maar zij uiteindelijk degenen waren die observaties evalueerden en bepaalden of deze geloofwaardig waren of niet.

In hoofdstuk 3 staat het boek van Peter Artedi (1705–1735) getiteld *Ichthyologia sive opera omnium de piscibus* (Leiden, 1738) [*Ichtyologie ofwel alle werken over vissen*] centraal. Artedi was een Zweedse naturalist van bescheiden afkomst die samen met de, uiteindelijk veel bekender geworden, Carl Linnaeus (1707–1778) studeerde en de wens om de natuur te ordenen met hem deelde. Dit hoofdstuk stelt dat de nadruk die Artedi in zijn werk legde op strak omlijnde definities niet los kan worden gezien van zijn wens om zijn naam als naturalist te vestigen. Volgens Artedi was een 'ichtyoloog' iemand die zich op methodische wijze met vis bezighield, in tegenstelling tot vissers en koks. Zijn boek bevat de eerste definitie van 'ichtyologie' als een apart kennisveld. Artedi sloot daarin expliciet alle 'niet-methodische' kennis over vissen uit en stelde dat een ichtyoloog zich moest bezighouden met het zoeken naar de orde die God had geschapen in de vissenwereld. Zelf voldeed hij aan deze eis door middel van de door hemzelf bedachte classificatiemethode. Evenals Willughby en Ray legde hij daarin de nadruk op fysieke kenmerken van soorten, maar anders dan hen ontwierp hij een systeem bestaande uit vier taxonomische niveaus (variëteit, soort, geslacht, orde) waaraan vissen konden worden toegewezen door het tellen van zekere kenmerken, zoals bijvoorbeeld vinnen en tanden. Ondanks zijn vroegtijdige dood vond het classificatiesysteem van Artedi brede navolging, mede doordat Linnaeus het opnam in zijn eigen werk. Artedi's aanpak, zo betoogt dit hoofdstuk, had gevolgen voor welke aspecten van vissen werden bestudeerd, bewaard en vastgelegd. Hij stelde epistemologische discussies op scherp. Beschrijvingen werden gezien als volstaand en afbeeldingen als overbodig, en geprepareerde exemplaren van vissen werden geschikter gevonden dan afbeeldingen om classificaties op te baseren

Hoofdstuk 4 richt zich op de twaalfdelige vissenserie van Marcus Élieser Bloch (1723–1799), *Allgemeine Naturgeschichte der Fische* (Berlijn, 1782–1795) [*Algemene natuurhistorie van de vissen*]. Deze Joodse arts volgde de classificatieprincipes van Linnaeus en Artedi bij het beschrijven van nog niet eerder bekende soorten, maar in tegenstelling tot hen voorzag hij elke beschrijving van een met de hand ingekleurde illustratie. Zo kon hij de essentie van de vis het beste overbrengen. Hoewel deze boeken voor hem een aanzienlijke investering was, vond hij het dit gerechtvaardigd omdat hij ze van groot nut voor de Duitse staten achtte. Zijn serie was grotendeels gebaseerd op zijn omvangrijke visverzameling in zijn huis in Berlijn. Hoewel Bloch zich zelden buiten Pruissen begaf, bevatte deze verzameling vissen vanover de hele wereld dankzij zijn omvangrijke en alsmaar uitdijende netwerk van naturalisten. Een van zijn voornaamste leveranciers was de Duitse, piëtistische missionaris Christopher Samuel John (1747–1813) gestationeerd in Tranquebar in Zuid-India. Hij liet vissen vangen door Indiase vissers, prepareerde ze en verstuurde de exemplaren vervolgens naar Berlijn. Daar beschreef en classificeerde Bloch deze vispreparaten. Ook gaf hij zijn kunstenaars opdracht om deze objecten te tekenen en graveren, en de gedrukte gravures vervolgens in te kleuren. Dit alles werd gedaan volgens strikte voorschriften die ervoor moesten zorgen dat de vis zo natuurgetrouw mogelijk werd afgebeeld, zelfs als het oorspronkelijke uiterlijk niet altijd te herleiden was aan de hand van de geprepareerde vis. Dat de afgebeelde vissen er toch levendig uitzagen was van het grootste belang omdat Blochs serie als "papieren museum" als tegenhanger fungeerde van zijn vissencollectie in Berlijn. Dit hoofdstuk stelt dat Bloch met zijn serie niet alleen zijn visverzameling presenteerde, maar ook zichzelf neerzette als een wellevende burger van een staat waar hij vanwege zijn Joodse achtergrond geen volle rechten genoot en ver buiten de landsgrenzen een reputatie verwierf als gezaghebbend naturalist.

Samen tonen deze vier hoofdstukken hoe de bestudeerde visboeken tot stand kwamen dankzij rijke uitwisselingen tussen personen met allerlei achtergronden en vanuit verschillende continenten. De bijdragen van een brede groep mensen, van notabelen, geleerde genootschapslieden, apothekers en missionarissen tot koks, hengelaars, vissers en vishandelaren, waren een voorwaarde voor het verschijnen van deze boeken, ook al zijn hun namen niet meer altijd te achterhalen. De conclusie betoogt dat de studie naar vissen in de lange achttiende eeuw gekenmerkt werd door verschillende niveaus van afbakening. In de eerste plaats was het idee van wat een vis nu eigenlijk precies was voortdurend aan herziening onderhevig – zodat zelfs de op het eerste gezicht zo simpele vraag wat een vis is uiteindelijk een historische vraag blijkt. In de tweede plaats verschoof het idee van wat betrouwbare en relevante kennis over vissen was, waarbij de nadruk kwam te liggen op kwantitatieve aspecten (het tellen van onderdelen) in plaats van kwalitatieve aspecten, zoals de culturele of ambachtelijke context van een soort. Ten derde werden methodes afgebakend: de auteurs van visboeken baseerden zich op hun voorgangers, maar zetten zich ook juist tegen hen af door een nieuwe aanpak te ontwikkelen. Zoals dit proefschrift laat zien werden deze keuzes mede gevormd door de wil om met de publicatie van hun boeken een gezaghebbende positie voor zichzelf te creëren in een tijd waarin er geen gebaand pad was dat leidde naar een carrière als natuuronderzoeker. Tot slot wijst de conclusie op een vierde, hedendaags niveau van afbakening, namelijk dat van de historicus zelf die besluit wat wel en wat niet relevant is in het reconstrueren van het historische proces van afbakening. Met deze aandacht voor verschillende niveaus van afbakening hoopt deze dissertatie een voorbeeld te geven van hoe het ontstaan van andere natuurhistorische kennisvelden kan worden bestudeerd.

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CURRICULUM VITAE

Didi van Trijp was born in Roosendaal in 1991. After graduating from Gymnasium Juvenaat in Bergen op Zoom, she ventured to Utrecht in 2009. Here, she studied History. She took part in the university-wide honours course Descartes College and spent the final part of her bachelor's studies at University of California, Berkeley. Upon completing these studies in 2013, she enrolled in the research master History and Philosophy of Science at Utrecht University from which she graduated *cum laude*. As part of her training, she went to the Max-Planck Institute for the History of Science in Berlin.

In 2015, she applied to write a PhD thesis in the history of fishes at Leiden University. This research was part of the project 'A New History of Fishes. A Long-Term Approach to Fishes in Science and Culture, 1550–1880' financed by NWO. Complementary funding to conduct research in various archives, libraries and museums abroad has come from the Lisa Jardine Award of the Royal Society of London and the Dr. Liselotte Kirchner Fellowship of the Francke Foundations in Halle an der Saale. She has published in *Renaissance Studies*, *Notes and Records of the Royal Society*, and *Isis*. Besides this, she developed and taught a course for bachelor students of Leiden University on the topic of natural historical texts and illustrations.

Since June 2021, she works as curator of the Nature and Technology collections at the Museon in The Hague, where she aims to use her background in the history of science to preserve and tell stories about the cultural and social aspects of science and technology. In 2022, she will take up a two-month research fellowship at the Science History Institute in Philadelphia. Her exhibition on early modern fish books in the Boekenkabinet of Teylers Museum, based on her doctoral research, is scheduled to open in spring of that same year.