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

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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.