

6	Foreword
11	Preface Alexandra Libby, Brooks Rich, and Stacey Sell
17	Natural History in the European Renaissance Brian W. Ogilvie
33	“Through Such Variety, Nature Is Beautiful”: Joris Hoefnagel, <i>The Four Elements</i> , and Natural History Stacey Sell
93	Survival of the Finest: Animals in Early Modern Intaglio Print Series Brooks Rich
145	“Monstrous Creatures and Diverse Strange Things”: The Art of Jan van Kessel Alexandra Libby
198	Notes
208	List of Illustrations
216	Acknowledgments
218	Index

Natural History in the European Renaissance

Brian W. Ogilvie



The first natural history book I have written for the publisher is Moffett's *Insectorum sive minimorum animalium theatrum* (*Theater of Insects, or Lesser Living Creatures*). Largely complete by 1590, but not published until 1634, this landmark of Renaissance natural history combines personal observations and folklore with copious paraphrases of ancient and medieval texts (p. 18). The chapter on bees begins:

Of all Insects, Bees are the principal and are chiefly to be admired, being the only creature of that kinde, framed for the nourishment of Man; but the rest are procreated either to be useful in physick [i.e., medicine], or for delight of the eyes, the pleasure of the ears, or the compleating and ornament of the body.¹

The next forty-one folios describe the names, forms, behaviors, organization, propagation, and material outputs (honey, wax, etc.) of bees. The *Theater* illustrates a common contemporary attitude: that nature was created to serve human beings by providing labor and useful substances like food and medicine, but also beauty and delight. At the same time, nature was believed to reveal the power and majesty of its Creator.

At the center of natural history are plants, animals, and minerals—things that early modern writers like Moffett often called, collectively, *naturalia*.² That name set them apart from *artificialia*, products of human art. But early scholarly endeavors took place within wider cultural movements that prized both natural and man-made curiosities and wonders. As European powers expanded their reach across the globe through colonialism and trade, port cities like Antwerp were flooded with new plants, animals, minerals, and other natural materials to be cataloged, collected, and treasured. Artists like Joris and Jacob Hoefnagel, Wenceslaus Hollar, Jan van Kessel, and others considered in this volume worked at the nexus of these endeavors. Their drawings, prints, and paintings not only documented and disseminated knowledge, but also became collectible wonders themselves. The work of these artists and the scholars of their time provides a window onto the culture and practice of natural history in Europe during the late sixteenth and seventeenth centuries.³

The Origins of Natural History

As a literary genre, natural history goes back to the investigations of Aristotle and Theophrastus in the fourth century BCE and to the first-century CE encyclopedic *Naturalis historia* of Pliny the Elder. As a distinct discipline practiced by a growing community of naturalists who were devoted to investigating, cataloging, describing, and classifying animals, plants, and minerals, natural history took shape primarily between the late fifteenth and late sixteenth centuries. It emerged out of three distinct but related impulses: the reform of *materia medica* (substances used to produce

compound medicines), and a growing interest in curiosities and wonders in what has been called “the age of the marvelous.”⁴

The first and second of these impulses involved university-educated physicians and humanist scholars. In medieval and early modern Europe, medicines were made by apothecaries. By the late fifteenth century, Italian physicians studying ancient texts came to realize that the names used by ancient writers to describe plants and other *materia medica* were no longer the names used in their own day. To better understand those names—in part with the goal of imposing their own oversight on pharmacy—they began to systematically compare the descriptions of plants in ancient texts with the plants that grew around them, noting the differences between ancient and modern names and correcting what they called the “errors” of medieval apothecaries.⁵ As medical botany became part of medical school curricula in the sixteenth century, students learned that close empirical observation of natural objects should be part of their education.

Many ancient texts addressed various aspects of the natural world. The best known were Aristotle’s books on animals, Theophrastus’s on plants, and Pliny’s encyclopedia, but there were many more. Their descriptions of nature were often brief and vague, and sometimes contradictory. To better understand those texts, humanist scholars like Conrad Gessner compiled encyclopedias, gathering all the information they could and supplementing ancient texts with medieval works and contemporary observations (see pp. 37 and 41). Their work took a broad ambit, including not only what we would consider natural history proper, but also agriculture, medicine, and cultural history.⁶

These scholarly endeavors by physicians and humanists took place within a wider movement that has been called “green culture”: a growing interest in nature, particularly curiosities and wonders that revealed God’s creative power, and nature’s relationship with art.⁷ Simultaneously, the growing colonial and commercial networks linking Europe to Asia, Africa, and the Americas brought countless “curiosities” to Amsterdam, Seville, and other cities. It became fashionable to collect unusual, odd, wondrous, and beautiful objects—objects often violently wrenched from their cultural and ecological contexts.⁸ Renaissance European naturalists took elements from all these movements, and elsewhere, to build a discipline that is still recognizable today.

The Material Culture and Practices of Natural History

Naturalia and artificialia were often combined in the contents of *Wunderkammern* (cabinets of curiosity) or *kunstkasten* (art cabinets)—collections assembled by sixteenth- and seventeenth-century monarchs, aristocrats,

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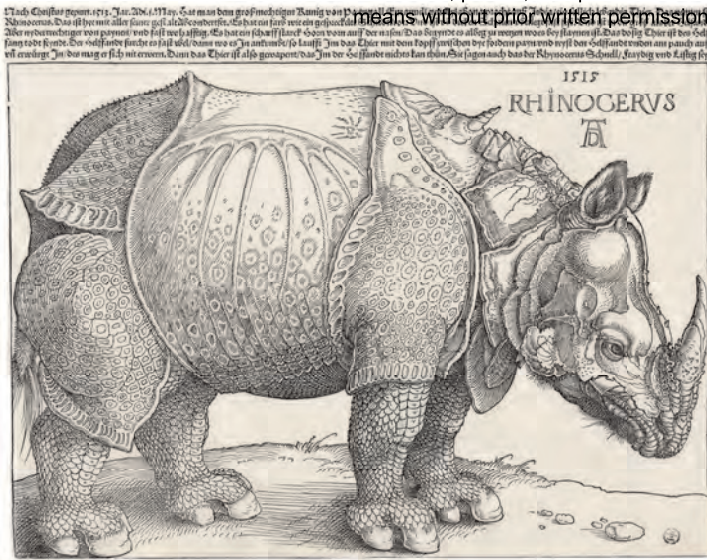
merchants, universities, and scholars. These included the grand princely collections that occupied multiple rooms to small personal collections located in a scholar's study, collections of rare ingredients in an apothecary's shop, and, by the end of the sixteenth century, university collections of naturalia used in teaching.⁹

These collections were more than natural history museums in the making. Their juxtaposition of art and nature usually included objects that combined both—a cup made of a nautilus shell or an ostrich egg set in an elaborate gold and silver stand. The creators of these collections saw them as a way to contemplate the works of God, to marvel at the extremes of nature (by placing a wren's egg next to an ostrich's, for example), and to fashion themselves as discerning collectors. They would often admit visitors of the proper social status to see and admire their collections. Many of these visitors were not scholars or naturalists, but members of the elite hoping to simultaneously develop and express their discerning taste.

Similarly, menageries and aviaries became places for the study and contemplation of nature. Keeping animals from around the world was a way for rulers to celebrate and advertise the extent of their dominion. Renaissance kings and princes kept lions, monkeys, bears, deer, reindeer, camels, and a variety of birds.¹⁰ In Lisbon, King Manuel I received the first rhinoceros and elephant seen in Europe since the fall of the western Roman Empire. The rhinoceros, which died on a voyage to Rome in 1515, was the basis for Albrecht Dürer's famous woodcut (p. 22). Manuel sent the elephant to the coronation of Pope Leo X, who kept it as a pet.¹¹ With European colonial and commercial expansion, "exotic" animals increasingly made their way to Antwerp, Amsterdam, and other port cities.¹² By the late seventeenth century, the Amsterdam inns Blauw Jan and Witte Olifant kept menageries for paying customers to visit.¹³



Gardens were yet another space for naturalists to observe plants and small creatures without going into the field.¹⁴ The first university botanical gardens were founded in the 1540s in Italy. Individual naturalists often kept their own gardens, too, even planting seeds or bulbs sent to them by colleagues. They started to assemble *herbaria*: collections of dried plants sewn or glued to sheets of paper on which they recorded the plants' names, the places where they were found, and notes about their characteristics (p. 22).¹⁵ These "winter gardens" or "dry gardens" systematized an earlier practice of pressing flowers as souvenirs. Herbaria allowed naturalists to easily compare and study plants, regardless of their natural cycle for budding, flowering, and setting seed. They had their limitations—colors faded over time and complicated flowers could easily be damaged—but they were soon an indispensable tool for naturalists. Herbaria often included common, nondescript plants alongside rare or showy ones, underscoring the primary goal of early modern natural history: providing a comprehensive catalog of nature.



Alongside their words, early modern naturalists amassed reams of paper, parchment, and vellum. They wrote down their observations, kept records of garden plantings, compiled inventories of their curiosities, and sent each other letters and packages. Postal services were new in the sixteenth century. Although the mail was slow, expensive, and unreliable by modern standards, it allowed naturalists to exchange information and small, lightweight objects like seeds and insects on a regular basis.¹⁶ Naturalists constituted their own province of the European “republic of letters,” the transnational network of exchanges in which early modern scholarship took shape.¹⁷

They also made, had made, or acquired thousands of pictures of naturalia—“paper museums” to match their physical cabinets of curiosities.¹⁸ Some naturalists were themselves artists, such as Conrad Gessner and Johannes Swammerdam. Others commissioned images or hired artists on long-term contracts. Though their quality varies, most of these images were competently executed by trained artists in a style Florike Egmond has characterized as “high-definition naturalism in the service of the study of nature”: individual objects seen from the side against a blank background, with emphasis on the parts and details that would allow a viewer to identify the species depicted (p. 24).¹⁹ Some were intended as preparatory drawings for woodcut or intaglio printing, but these often had afterlives in other collections. For example, the colored drawings made by Hans Weiditz in preparation for the woodcuts in a 1530 herbal later entered the collection of the Basel naturalist Felix Platter.²⁰ Other drawings not initially intended as models were later used as the basis for prints.²¹ Many artists—such as Hans Hoffmann and Joris Hoefnagel in the sixteenth century and Clara Peeters (p. 25), Jan van Kessel, Johannes Goedaert, and Maria Sibylla Merian in the seventeenth—themselves developed deep interests in studying and portraying naturalia.

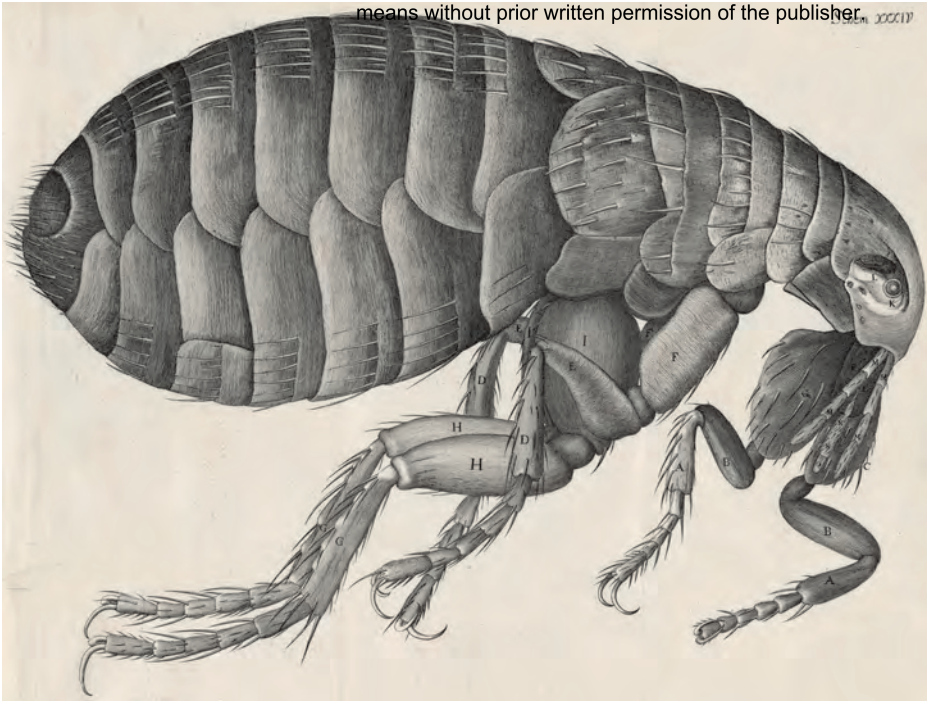
These texts and images formed the basis for the books that began to fill the libraries of naturalists and collectors. Pliny’s *Naturalis historia* and other ancient works on nature were among the first to be printed in the incunabular era. They were swiftly joined in the sixteenth century by new works on plants, animals, and minerals, including printed catalogs of collections and series of art prints focused on naturalia.²² These publications didn’t just disseminate knowledge, they also solicited new descriptions and images. Scholars like Gessner used print to appeal for more information from readers, which would then make its way into later publications.²³

By the time Hoefnagel began work on *The Four Elements*, the material culture of natural history had taken a form that, in many ways, would be familiar to a twentieth-century naturalist. Practitioners drew on this material culture to describe and catalog nature’s seemingly infinite variety. Cabinets, menageries, gardens, herbaria, images, notes, and printed books





Clara Peeters *Still Life with Flowers Surrounded
by Insects and a Snail*, c. 1610



served this process, without war, with the exception of the hybrid, often devotional: naturalists aimed to compile a catalog of God's creation, in part to contemplate the Creator through his works. Having started with *materia medica*, naturalists then turned to mammals, birds, and fishes. Gessner published four volumes during his lifetime on terrestrial mammals, reptiles, birds, and marine creatures. But his notes on insects remained unpublished until Moffett's compilation came out in 1634. It was not until the later sixteenth century that naturalists turned their attention to these little beasts.

Enter the Insect

The word *insect* does not appear in English and other vernaculars until the sixteenth century. It was originally a technical word in Latin. *Insectum*, meaning *incised*, is a translation of the Greek word *entomon*, used by Aristotle. When Raphael Holinshed sought to render the word in English in his 1577 description of the British Isles, he called them "cut waisted"—a literal translation that is particularly apt for the bees, wasps, and hornets that he had in mind.²⁴ By the 1580s, English authors had started to use the word *insect*, but usually with a gloss indicating what it meant.²⁵ We can see such a gloss in Moffett's title, *Theater of Insects, or Lesser Living Creatures*. Philemon Holland may have been the first English writer to use *insect* as if readers would know its meaning in his 1601 translation of Pliny's *Naturalis historia*. Similar developments took place in French, Italian, German, Dutch, and other vernaculars.

Before this, bees, ants, wasps, beetles, crayfish, and the like were categorized as "little beasts," "little worms," and even "little birds."²⁶ The most salient thing about them was their small size.²⁷ Unlike the minute lifeforms revealed by the microscopes of Robert Hooke (p. 26), Antonie van Leeuwenhoek, and others in the late seventeenth century, insects could be perceived with the naked eye—though in some cases, such as cheese mites, it took a fairly sharp eye. Before the late sixteenth century, insects, situated at the margins of human perception, tended to be lumped together in broad groups.

This new category was more capacious than our modern taxonomic understanding of insects. It included not only beetles, butterflies, and other hexapods, but also spiders, mites, centipedes, millipedes, and even sometimes lizards, salamanders, and the like. John Tradescant the Younger grouped "insects and serpents" in the 1656 catalog of his father's collection.²⁸ By the eighteenth century, the term was largely restricted to invertebrates with hard exteriors, but it was only in the nineteenth century that arachnids, myriapods, isopods, and other arthropods were taxonomically separated from the insects.



It is worth noting, then, that the early modern period was a time when Van Kessel, and other early modern artists and naturalists paid to insects. They looked closely at them, often with magnifying lenses, and paid attention to their anatomy and characteristics (p. 26). They marveled at their beauty and intricacy. Ulisse Aldrovandi, who amassed the largest collection of naturalia in Europe, took a keen interest in insects and published the first book devoted entirely to them, a weighty folio of over eight hundred pages (p. 28).²⁹ A common remark of early modern students of insects was taken from book 11 of Pliny's *Naturalis historia*:

We make a wonder at the monstrous and mightie shoulders of Elephants Wee marveile at the strong and stiffe necks of Bulls We keepe a woondring at the ravenings of tygres, and the shag manes of Lions: and yet in comparison of these Insects, there is nothing wherein Nature and her whole power is more seen, neither sheweth she her might more than in the least creatures of all.³⁰

Early modern thinkers gave this sentiment a Christian gloss. In works of natural theology and “physico-theology,” they argued that the intricate structures and instincts of insects revealed God’s majesty and that their variety showed his creative power.³¹

In practice naturalists studied insects in much the same way they did other creatures. In his 1602 *De animalibus insectis* (On insect animals), Aldrovandi described his approach. In summer and autumn, he would visit the countryside and ask locals, sometimes for a fee, to bring him the insects they knew, name them, and describe their habitats and behaviors. He brought an artist and one or more secretaries to depict the creatures and record information about them. Thus his collection included insects themselves, hundreds of drawings and paintings of them, and copious first- and second-hand information.³² In the book, Aldrovandi complemented those observations, where possible, with lore compiled from ancient, medieval, and contemporary writers.

Because insects were small and often easy to preserve after death, it was relatively straightforward to build a collection of them. They could be pressed and glued to the pages of a book, pinned to the bottom of a box, or, if they were relatively flat, like butterflies and moths, encased between thin sheets of mica. All three techniques were used in the oldest surviving insect collections: the Plukenet and Petiver collections from the end of the seventeenth and beginning of the eighteenth centuries.³³ Like seeds and dried plants, preserved insects were also relatively easy to ship, allowing collectors to exchange or lend them for study.

By the first third of the seventeenth century, some artists and naturalists were raising insects from eggs or larvae. In the 1630s, the Netherlandish

artist Johannes Goedaert began with collecting caterpillars and the hellgrammids, raising them in jars in his house and observing and painting their metamorphoses into pupae and adults.³⁴ Soon Merian was doing the same in Frankfurt, and then in Nuremberg. Swammerdam used his observations of metamorphosis to classify insects in his *Historia generalis insectorum* (General history of insects, 1669). These studies marked the beginning of our modern understanding of insect metamorphosis, which gradually put an end to the earlier belief that insects were “imperfect” creatures that resulted from spontaneous generation, not sexual reproduction.³⁵ Knowledge of insect reproduction and metamorphosis was also aided by the invention of the microscope, which revealed the intricate anatomy of the tiniest fleas and mites.³⁶

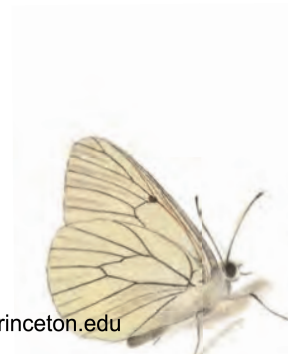
Most of our evidence about the techniques and material culture of early insect collections comes from the late seventeenth century, when insect collecting was popular enough that naturalists began to provide instructions on how to catch, kill, and preserve them.³⁷ Stephan Blankaart’s 1688 publication included tips on making a net, raising butterflies and moths from caterpillars, killing insects with a hot pin, and preserving them in round or oval boxes (p. 28).³⁸ He specified that the boxes should be pretreated with turpentine, which should be reapplied three or four times a year to keep mites away. Later writers would expand on this guidance. It seems likely that Blankaart’s published advice was the product of a century of insect collectors’ lore passed on informally in meetings and correspondence.³⁹

The study of insects in the early modern period laid the groundwork for our current understanding of biodiversity. Natural histories of beasts, birds, and fishes showed the variety of creatures in the world, but still on a human scale. Insects were different. In 1691 John Ray estimated that there were at least ten thousand species of insects in the world. The following year he doubled the number.⁴⁰ We now think that Ray was off by two orders of magnitude, but, compared to the several hundred animals named and described by ancient, medieval, and early modern authors, the number of insect species known and estimated by Van Kessel’s time was astounding.

Cabinets and rooms of curiosities, menageries, gardens, herbaria, books, and collections of drawings and prints gave naturalists a rich set of tools for contemplating and investigating naturalia. Though they were fascinated by nature’s wonders, they also cataloged and described more familiar animals, plants, and minerals. They believed that all creatures revealed God’s creative power. According to the Bible, Solomon had described the great cedar of Lebanon and the lowly hyssop, and pillars of classical knowledge

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like Aristotle and Pliny, and in the sixteenth century the Renaissance naturalists followed their examples to build the scientific discipline we now know as natural history.⁴¹

Artists were crucial contributors to this process. Many collaborated with naturalists, creating precise images that could be used to identify individual species. Others, like Hoefnagel and Merian, were themselves naturalists and were even accepted as “lay experts” by university-educated scholars.⁴² Elegant, detailed representations of nature were highly valued by naturalists and connoisseurs alike, often joining their subjects in important collections. Looking closely at the works of Hoefnagel, Hollar, Peeters, Van Kessel, and other artists of little beasts reveals the depth of the relationship between natural history and art.





“Through Such Variety,
Nature Is Beautiful”:
Joris Hoefnagel,
The Four Elements,
and Natural History

Stacey Sell



Joris Hoefnagel *Southern Hawker Dragonfly*
(*Ignis*, plate 53), c. 1575/1590s

Of the approximately three hundred watercolor miniatures Joris Hoefnagel made for his extraordinary series *The Four Elements*, the depiction of a southern hawker dragonfly is one of the most elaborate (p. 34). The level of detail in this life-size insect is dazzling. Dozens of brushstrokes convey the shape, color, and translucence of each eye. Each of the spots on the dragonfly's abdomen contains a slightly different mixture of green and yellow pigments. Every cell in the wings is delineated with brushstrokes of varying weight and color to communicate the passage of light. Contemporary collections of watercolor nature studies frequently included dragonflies, but these generally denoted wing patterns with only a bit of crosshatching (see p. 48, for example). Hoefnagel's image testifies not only to the artist's manual skill but also to a lengthy and meditational study of the insect. This uniquely thoughtful approach shaped the entire series of watercolors.

As others have demonstrated, *The Four Elements* is far more than a collection of nature studies. The complex and often deeply personal emblematic content of the series is central to its function and has served as the focus of major scholarship on the artist.¹ An examination of the miniatures in the context of sixteenth-century natural history, however, reveals that Hoefnagel approached this aspect of its content with equal sophistication. Demonstrably familiar with the conventions of watercolor image collections and treatises illustrated with woodcuts, Hoefnagel manipulated them to suit his own interests and to document his prolonged contemplation of the world around him. His choice of sources, alterations and arrangements of motifs, and even his techniques all point to his active participation in the emerging field of natural history, through both an impressive knowledge of current scholarship and his own direct observations.

Hoefnagel and *The Four Elements*

A career as a miniaturist was an improbable path for Hoefnagel. Born into a family of luxury merchants, he was expected to follow in their footsteps.² Art historian Karel van Mander, Hoefnagel's earliest biographer, recorded the family's resistance to his early inclination toward art, noting that although the young man was allowed to develop his artistic skills as a pastime, he worked as a merchant well into middle age.³ In some respects, however, Hoefnagel's early life shaped his work on *The Four Elements*. Apart from his university years in France and extended business travel to Spain and London, he spent most of his first thirty-five years in Antwerp. There, he was surrounded by the products of international trade and colonial expansion, including many of the plants and animals that he later depicted in his miniatures. The city was a center of botanical research and publishing and, during Hoefnagel's last years there, home to an active circle of animal painters clustered around his close friend, the cartographer Abraham Ortelius.⁴ Hoefnagel was also extraordinarily erudite and equipped



Aquila genus, cuius picturam ab Argentinensi quodam pictore sum nactus, qui se eandem ab alijs oculis uera accepisse aiebat. Nos hoc in ea præcipue miramur, quod crura coloribus diuersis insigniantur, sinistrum coruleo, utrostrum quoque dextrum fulco albicante, &c. Ergo si quæ huiusmodi aquila est, heteropus cognominari poterit.

GER. Ein adler geschlecht/ an ein süß oder schenckel blau/ am ander lichte grau.



Aristotelis avis Sythica magnitudine Otidis. Circa Scythiam regionem Septentrionalem remotis sinum aquila grandis detracta leporis pelle oua sua inuoluit, cuius scythico calore pulli educuntur, ut scribit Olaus Magnus, ex cuius Regionis Septentrios narium tabula hanc figuram mutauit sumus. Omne genus aquilarum (inquit Albertus) partes uulpinæ pellis colligere solet, ut oua in eis reponat, uel in alijs mollibus & calidis pilis. Quod autem Plinius prodit aquilam aquilonarem oua in pelle uulpis inuoluta à ramis arborum suspendere, donec Solis calore periciantur, expertus sum esse falsissimum, &c. Vide in Historia Aquile G.

GER. M. Ein ander groß adler geschlecht in Nymphischen lande hinter Gottes land/ welcher einem hasen in balg absücht und wickelt sineyer drey/ das sy von der werm des balgs vffschleiffen/ als etlich schreyben.



Figura hæc siue aquila, siue maioris cuiusdam auis, quæ propter magnitudinem non in unius sed duarum aut plurium arborum uicinarum ramis nidificat, ex Tabula Regionum Septentrionalium Olai Magni desumpta est. Sed ipse in Tabula & picturæ explicatione, nullam huius auis mentionem facit. Nos in Capite de Aquilis diuersis apud rescentiores, talem auem ex Gc. Fabricj ad nos epistola descripsimus.



Aristotelis Hypæctus, id est Subaquila, ut Gaza uertit: uel potius Cypæctus, id est Aquila uulturna, uidetur enim & corporis specie, & animo seu moribus, ex uulture & aquila mixtum hoc genus. Vocatur & Orpælargus, id est Ciconia montana, quod albicante & nigro coloribus ferè ut Ciconia distinguatur. & percnopterus, à nigro pennarum (in alio) colore. Hæc cuius iconem exhibemus auis, (quæ si Cypæctus non est, planè ei cognata & fortè magnitudine tantum diuersa fuerit.) semel tantum nostra memoria Basilicæ capta est, omnibus ignota. Hebræis & Arabibus Racham & Alrachme dicitur.

GALLICE percnopterum Bellonius interpretatur Boudrée,

GERMAN. Ein stömbo Adler geschlecht/ mag genennet werden Ein Weyradler.



with a humanist education and with no previous knowledge of the published and brought him within the circles of prominent naturalists. It was with this background that he began *The Four Elements*.

Most of the miniatures in the series are bound into four volumes, now in the collection of the National Gallery of Art. Each volume is named for an element and contains depictions of the creatures believed to inhabit that realm. *Aier* contains images of birds, *Aqua* includes water animals, and *Terra* features creatures that walk the earth, from elephants to caterpillars. The artist's reasons for devoting almost the entire volume of *Ignis*, or fire, to insects remain under speculation.⁵ Most of the animals and many of the plants are numbered, suggesting that a key once existed.⁶ In all four volumes, most images and their facing pages bear Latin inscriptions. Although many are taken from classical literature and the works of Erasmus, the majority are biblical. Many of the quotations, including the one used for the title of this essay, remark upon the wonder and variety of nature and God's creation, providing a constant reminder of the importance of nature study as spiritual practice during this period.⁷

Based on comments by Van Mander, scholars long assumed the series was commissioned by Holy Roman Emperor Rudolf II, who apparently owned it by the early seventeenth century.⁸ However, dates scattered throughout the series range from 1575 to 1582, indicating that Hoefnagel began work long before he entered Rudolf's service. These dates span not only the artist's final years in Antwerp and his departure after the Spanish sack of the city, but also his subsequent travels with Ortelius in Germany and Italy and his first years as court artist to the dukes of Bavaria in Munich. Work may have continued on the project until his death in 1600. Shifts in style and composition support the idea that *The Four Elements* was a long-term endeavor and a personal project rather than a commission for a patron.⁹

The unconventionality of the series supports this interpretation. This multifaceted project served a variety of purposes for Hoefnagel, blending the roles of emblem book, commonplace book, model book, and zoological watercolor collection. It was also a place for technical experimentation and—most of all—personal contemplation facilitated by natural history.¹⁰ Hoefnagel's friendships with Ortelius and Joachim Camerarius the Younger brought him within the orbits of some of the century's foremost naturalists, while his travels and commitments as a court artist exposed him to some of Europe's most important collections.¹¹ As Brooks Rich discusses in the following essay, Hoefnagel's insect designs later spread throughout Europe in the form of engravings. Hoefnagel, however, was not a naturalist compiling a collection to publish in the form of a treatise. Instead, *The Four Elements* shares many characteristics with the private natural history collections of the era, and it functioned partly in this capacity.¹²



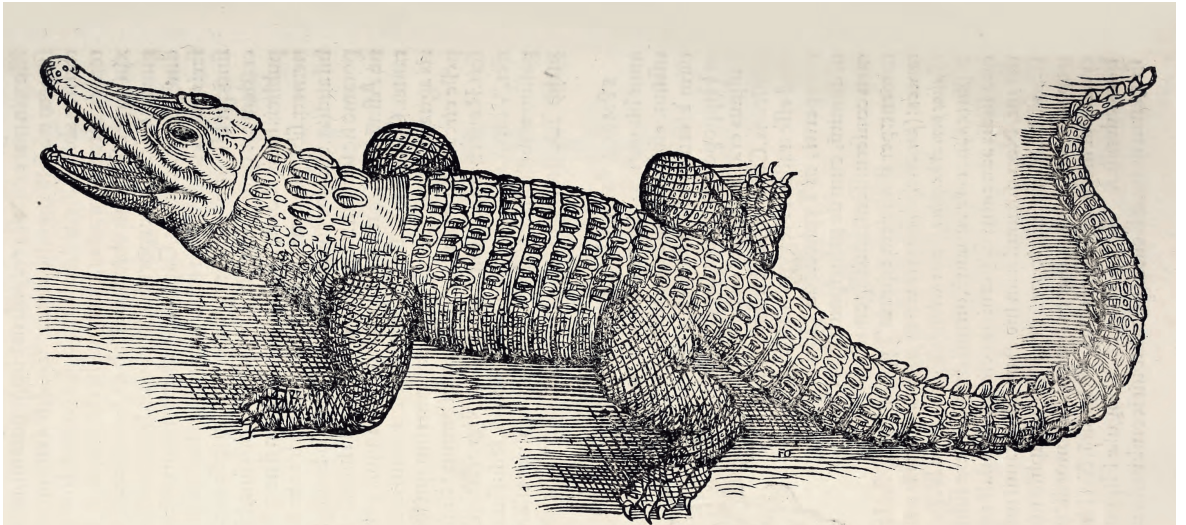
Working before the publication of the first treatises on insects, Hoefnagel studied live or preserved insects for most of the creatures in *Ignis*. Conversely, he copied most of the animals in *Terra*, *Aier*, and *Aqua* from other sources.¹³ His lively interest in natural history is evident in his selection and manipulation of these borrowings. Copying played an important role in the creation of natural history image collections, and Hoefnagel was not alone in his reliance on the woodcut illustrations in the treatises of naturalist Conrad Gessner, whose publications were standard references.¹⁴ In some ways, Hoefnagel's borrowings are specific and direct. For instance, he retained the unnatural stances of some of Gessner's birds—likely based on taxidermy—and accounted for their stretched necks by posing them to look up at vegetation or at each other (pp. 36 and 37). He often followed Gessner's color descriptions with care in these copies, down to the brown and blue legs of the *Aquila heteropode* or the minute red dots on a brethmechin's tail (*Aqua*, plate 8).¹⁵ These details are sometimes invisible to the naked eye, underlining the degree of Hoefnagel's personal satisfaction in their accuracy.

As literal as these copies appear at first glance, Hoefnagel's use of Gessner was surprisingly complex. He added details missing from the woodcuts, revealing that he supplemented the treatise's information with observations from live animals or skins. He attended carefully to patterns of fur or feather growth and texture, which were often simplified or ignored by Gessner. While maintaining the pose and patterning of Gessner's crocodile, he layered multiple shades of watercolor and gouache to evoke the dull bronze of its skin and emphasized a row of scales protruding from the back of its hind leg, a characteristic of Nile crocodiles omitted from the woodcut (pp. 40–43).¹⁶ Hoefnagel's most notable enhancements to Gessner appear in *Aier*, where the subtle coloring of birds routinely surpasses the written descriptions. For example, although Gessner described the Eurasian coot as black, Hoefnagel added mauve and blue to convey the bird's slight iridescence and emphasized the blueish appearance of the feet, recorded only as "earth-colored" in the treatise (*Aier*, plate 27).¹⁷ Similarly, in *Ignis* he apparently attempted to fill in missing information when presented with an incomplete beetle. His rendition of a jewel beetle, one of the few insects in the volume not native to Europe, features an accurate body combined with incorrectly depicted legs and antennae—an unusual error in this volume (p. 58).¹⁸ Early preservation and transportation methods often resulted in damage, and Hoefnagel may have surmised that an incomplete example originally had the lamellate antennae of more familiar European beetles (p. 59, no. 2).

Hoefnagel supplemented Gessner's images with research gleaned from other published sources, again demonstrating his grasp of contemporary natural history. He paired a bat taken from Gessner (p. 60, upper) with one



Joris Hoefnagel A Crocodile, a Hippopotamus, a Land Crocodile or Tegu Lizard(?), and a Crocodile or Spiny-Tailed Lizard with a Papyrus Plant (*Terra*, plate 50), c. 1575/1590s



Detail of page 356 from Conrad Gessner, *Icones animalium quadrupedum uiuiparorum et ouiparorum*, 1560







Joris Hoefnagel *Two Common or Mediterranean Chameleons*
above San Sebastián, Spain (Terra, plate 53), c. 1575/1590s

from a treatise by Pierre Belon (written in the 1530s) on the voracity of veins in the wings of Gessner's bat, he added this missing detail to the bat based on Belon's image.¹⁹ He often rejected Gessner's examples altogether, possibly basing these decisions on personal experience. For example, instead of copying Gessner's chameleon he depicted two examples with more detailed markings and accurate eyes (p. 44). Emphasizing his personal experience, Hoefnagel added an inscription identifying the landscape as San Sebastián, Spain, which he had visited during the 1560s. Although he included an inscription referring to Pliny the Elder's assertion that chameleons subsisted on air, he demonstrated his knowledge of more recent information by depicting one of them snapping up an insect.²⁰ In a surprising number of cases, including some of the finest pages in *Terra, Aqua*, and especially *Aier*, Hoefnagel's sources remain unknown, leaving open the possibility that he sometimes worked from life in these volumes as well as in *Ignis*.

In addition to published scientific treatises, Hoefnagel consulted collections of zoological watercolors. His involvement with a circle of animal artists in Antwerp exposed him to the work of Hans Verhagen der Stomme and Hans Bol.²¹ Hoefnagel's reliance on Bol has been overstated in the literature—possibly because Van Mander claimed that Bol was his teacher—and Hoefnagel likely played a more active role in this circle than many have assumed. Although a number of the images in *The Four Elements* also appear in Bol's three-volume collection of miniatures, Hoefnagel's versions frequently offer more or different details, suggesting that the influence worked in the opposite direction or that both artists worked from another common model. Both Hoefnagel and Bol certainly consulted Verhagen, but so little survives of this elusive master's work that the extent of his influence is unclear.²² The salient point is that during his first years of work on *The Four Elements*, Hoefnagel participated in a network of artists whose images spread throughout Europe via watercolor copies. For instance, versions of many of the animals depicted by Bol, Verhagen, and Hoefnagel, such as a pair of turkeys (p. 61), appear in the research collections of the Giardino dei Semplici in Pisa, while others were included in Ulisse Aldrovandi's collection.²³ Hoefnagel, then, selected and copied specific images that were also valued by contemporary scholars, underlining the serious nature of his endeavor.

In one plate, Hoefnagel appears to comment on the pitfalls of relying on the images of other artists for information (p. 46). Two very different lizards are marked with the same number, a device used throughout the series to indicate multiple views of the same creature. The lower lizard is highly stylized, with geometric patterning and unarticulated texture. A version of this creature also appears in Bol's watercolors (p. 47). The upper lizard, an accurate depiction of a sand lizard observed in minute detail, has no known source and was likely painted from life.²⁴



Index

Note: Page numbers in boldface refer to illustrations.

A

Accademia dei Lincei, 121
 Albert VII, Archduke of Austria, 155
 Aldrovandi, Ulisse, 13, 45, 51, 95, 199n1; *De animalibus insectis*, 29; folio 86 from *Tavole acquellerate*, vol. 7, **28**; *Tavole acquellerate*, 29
 Antwerp: art market in, 147, 159; Brueghel family of painters in, 146–147; commerce and trade in, 12–13, 19, 21, 35, 146, 155; culture of collecting in, 124, 155–156, 164; print industry in, 106, 159; zoological and botanical art and study in, 19, 35, 45, 94, 99, 106, 112
 apothecaries, 20
Aquila heteropode, **36**, 39
 Aristotle, 19, 20, 27, 31
 art cabinets. See *Wunderkammern* (cabinets of curiosity)/*Kunstkasten* (art cabinets)
artificialia, 19, 20, 54
 Arundel, Thomas Howard, Earl of, 124
 aviaries, 21

B

bats, 39, 45, 51, **60**, 121, **138**
 bees, **8–9**, 19, **141**, **144**, 146, 156, **157**
 beetles, 39, 49, **50**, 55, **57**, **58**, **59**, **66**, 94, **96**, **97**, 106–107, 112, 121, **141**, 160, 164, 167. See also elephant beetles; jewel beetles; stag beetles
 Belon, Pierre, 45
 Bible, 30, 94, 107
 Bie, Cornelis de, 146
 birds, 21, 27, 30, 38, 39, 51, 106, 147, 160, **194**, **195**
 Blankaart, Stephan, 30
 Blauw Jan (inn), 21
 Bol, Hans, 14, 45, 94, 99, 106, 202n14; *The Baptism of Christ* (print by Adriaen Collaert after Bol), 99, **104**; *Hoopoe*, 106, **109**; *Leopard*, 99, **105**; *Lizard*, 45, **47**; *The Sending Out of the Apostles* (print by Adriaen Collaert after Bol), **126**
 Boodt, Anselmus Boëtius de, *Natural History Ensemble* (No. 18) (attributed to De Boodt and Elias Verhulst, after Jacob Hoefnagel), **116**, **118–119** (detail), 121, 203n28
 Brandt's cormorant, **85**
 Braun, Georg, *Civitates orbis terrarum* (with Franz Hogenberg), 159
 Bruegel, Pieter, the Elder, 146
 Brueghel, Ambrosius, 146
 Brueghel, Jan, the Younger, 146
 Brueghel, Jan “Velvet,” the Elder, 146–147, 155; *The Entry of the Animals into Noah's Ark*, 147, **150**, **152–153** (detail), 155–156; *Flowers in a Glass*, 147, **148**
 Brueghel, Paschasia, 146
 Bruyn, Abraham de, 14, 99; *Quadrupeds*, 99, **102**, **215** (detail)
 Bry, Johann Theodor de, 117; *Letter X*, 117, **129**; *Nova alphati effictio*, 117
 butterflies, **4**, **8–9**, 27, 29, 30, 54, **72**, **88**, **141**, **142**, 156, **157**, 159, 160, 167, **170**. See also fritillaries



cabinets of curiosity. See *Wunderkammern* (cabinets of curiosity)/*Kunstkasten* (art cabinets)
 camels, **138**
 Camerarius, Joachim, the Younger, 38
 caterpillars, **2**, 30, 38, **63**, **64–65**, **77**, **89**, 94, 107, 167. See also emperor moth caterpillar
 chameleons, **44**, 45. See also lizards
 Circle of Jan van Kessel the Elder, *Study of Birds and Monkey*, **194**, **196–197** (detail); *Study of Birds and Monkeys*, **195**
 Coignet, Michiel (attributed), art cabinet with paintings on copper, **163**
 Collaert, Adriaen, 14, 99, 106, **128**, 203n15; *Avium vivae icones*, 201n28, 203n15; *The Baptism of Christ* (after Hans Bol), 99, **104**; *A Giraffe, a Chameleon, a Civet, and an Antelope*, 106, **131**, **134–135** (detail); *Hoopoe and Owl*, 106, **108**, **110–111** (detail); *The Sending Out of the Apostles* (after Hans Bol), **126**; *Weasels and Squirrels*, **130**, **132–133** (detail)
 colonialism, 12–13, 19, 20, 21, 35, 94, 124, 146, 155, 164, 167
 cormorants, **85**
 crabs, **81**, **82–83**
 crocodiles, 39, **40–43**, 49
 crowned night heron, **85**. See also herons



D

darters, **68**, **70–71**. See also dragonflies
 Dodoens, Rembert, 49
 dragonflies, **24**, **32**, **34**, 35, **52**, 54, **68**, **70–71**. See also darters
 Dürer, Albrecht, 51, 124; *The Rhinoceros*, 21, **22**

E

Egmond, Florike, 23
 Egyptian vulture, **36**
 Eighty Years' War (1568–1648), 155
 elephant beetles, 94, **96**, **97**, 106–107, 121. See also beetles
 elephants, 21
 emperor moth caterpillar, **2**, **89**. See also caterpillars
 engraving. See intaglio printmaking
 Erasmus, Desiderius, 38, 49, 107
 etching. See intaglio printmaking

F

Faber, Johann, 121
 fish, 27, 30, 51, 55, **80**, 155
 fleas, **26**
 Flemish artist, *Cognoscenti in a Room Hung with Pictures*, **154** (detail), 160, **161**, **162** (detail)
 flies, **53**, 55, **62**, **76**, 124, 167
 Forchondt, Guillaume, 164
 fritillaries, 55, **73**, **74–75**. See also butterflies
 frogs, **77**, 99, 121, **136**

G

Gama, Vasco da, 155
gardens, 21
Gessner, Conrad, 13, 20, 23, 27, 39, 45, 95, 199n1; detail of page 356 from *Icones animalium quadrupedum uiuiparorum et ouiparorum*, 39, **41**; *Historia animalium*, 159; pages 4–5 from *Icones auium omnium quae in historia auium . . .*, **37**, 39
Gheeraerts, Marcus, the Elder, 99, 106; *Giraffe, Armadillo, Ram, and Unicorn*, 99, **103**
Giardino dei Semplici, Pisa, Italy, 45
Goedaert, Johannes, 23, 30
gold, 54, 55, 159
groundhogs, **91**
Guicciardini, Lodovico, 155
guinea pigs, 51, **67**

H

Habsburg monarchy, 155, 156, 160
Hainhofer, Philipp, 164
hedgehogs, 51, **67**
herbaria, 21
herons, **85**, **120**, 121. *See also* crowned night heron
hippopotamuses, **40**, **42–43**, 49
Hoefnagel, Jacob, 14, 19, 54, 56, 112, 146, 147, 155, 159, 203n20; after Joris Hoefnagel, part 1, plate 1, from *Archetypa studiaeque patris Georgii Hoefnagelii*, 94, **98**, **100–101** (detail), 112; after Joris Hoefnagel, part 1, plate 5, from *Archetypa studiaeque patris Georgii Hoefnagelii*, **92** (detail), 107, **114**; after Joris Hoefnagel, part 3, plate 5, from *Archetypa studiaeque patris Georgii Hoefnagelii*, **15** (detail), 107, **127**; after Joris Hoefnagel, part 3, plate 12, from *Archetypa studiaeque patris Georgii Hoefnagelii*, **128**; after Joris Hoefnagel, part 4, title page, from *Archetypa studiaeque patris Georgii Hoefnagelii*, 117, **128**; *Natural History Ensemble* (No. 18) (print attributed to Elias Verhulst and Anselmus Boëtius de Boodt, after Hoefnagel), **116**, **118–119** (detail), 121, 203n28
Hoefnagel, Joris, 12, 13–14, 19, 23, 29, 31, 106–107, 112, 117, 146, 147, 155, 159, 160, 201n7, 201n28, 202n14, 203n20; *Archetypa studiaeque patris Georgii Hoefnagelii*, 54–55, 106–107, 112, 117, 121, 124, 203n16; *Bats, Quail, and Oystercatcher(?) by the Water* (Aier, plate 46), 39, 45, 51, **60**; *Blue Underwing Moth and Spurge Hawk Moth* (Ignis, plate 25), **52** (detail), 54, **69**, **205** (detail); *A Brandt's Cormorant with a Juvenile Crowned Night Heron* (Aier, plate 23), **85**; *A Crocodile, a Hippopotamus, a Land Crocodile or Tegü Lizard(?), and a Crocodile or Spiny-Tailed Lizard with a Papyrus Plant* (Terra, plate 50), 39, **40**, **42–43** (detail); *A Diving Beetle and Two Views of a Backswimmer*, 49, **66**; *An Egyptian Vulture, a Northern Goshawk(?), and an "Aquila Heteropode"* (Aier, plate 4), **36**, 39; *Elephant Beetle*, 94, **96**; *Emperor Moth Caterpillar with a Second Caterpillar on a Branch* (Terra, plate 69), **89**; *Flies and Other Insects* (Ignis, plate 60), **53** (detail), 55, **76**; *The Four Elements*, 13–14, 23, 35, 38–39, 45, 49, 51, 54–56, 106; *Guinea Pig and Hedgehogs with Melon and Cobnuts* (Terra, plate 48), 51, **67**; *Hairy Dragonfly and Two Darters* (Ignis, plate 54), **52** (detail), 54, **68**, **70–71** (detail); *Jewel Beetle with a Rosary Pea*

and a Flower (Oleander?) (Ignis, plate 42), 39, 55, **57** (detail), **58**; *Lackey Moth Caterpillar, Figure of Eight Caterpillar, Grey Dagger Caterpillar, and Other Caterpillars* (Terra, plate 66), 49, **63**, **64–65** (detail); *Musk Beetle, Oil Beetle, Tansy Beetle(?)*, *Cockroach, Leaf-Footed Bug, and Other Insects* (Ignis, plate 43), 39, 55, **59**; *Old World Porcupine (Hystrix) and Wild Pig* (Terra, plate 17), **84**, **86–87** (detail); *Orange Tip, Painted Lady, Southern Small White, and Small Tortoiseshell Butterflies* (Ignis, plate 8), 54, **72**; *A Partial Mantis Shrimp with Tower Snail Shells* (Aqua, plate 50), 107, **115**; *Southern Hawker Dragonfly* (Ignis, plate 53), **32** (detail), **34**, 35; *Squid, Gurnard, Pike, and Other Fish* (Aqua, plate 39), **80**; *Stag Beetle* (Ignis, plate 5), 49, **50**; *Still Life with Flowers and Insects*, 107, **113**; *Swallowtail Butterfly* (Ignis, plate 7), **88**; *Ten Insects, Including a Blue Fly* (Ignis, plate 78), 49, **62**; *Turkey and Turkey Hen with a Finch between a Pumpkin and a Bush of Red Berries* (Aier, former plate 13), 45, **61**; *Two Common or Mediterranean Chameleons above San Sebastián, Spain* (Terra, plate 53), **44**, 45; *Two Crabs with Seashells* (Aqua, plate 46), **81**, **82–83** (detail); *Two Sand Lizards* (Terra, plate 52), 45, **46**; *Two Sand Lizards, a Common Parsley Frog(?), and a Caterpillar* (Terra, plate 51), 55, **77**, **78–79** (detail); *Two Views of a Silver-Bordered Fritillary and a Mole Cricket* (Ignis, plate 12), 55, **73**, **74–75** (detail)

Hoeswinckel, Eduard van, 99
Hoffmann, Hans, 12, 23; *Red Squirrel*, **90**
Hogenberg, Franz, *Civitates orbis terrarum* (with Georg Braun), 159
Holinshed, Raphael, 27
Holland, Philemon, 27
Hollar, Wenceslaus, 14, 19, 29, 31, 94, 124; *Five Butterflies, a Moth, a Beetle, and a Spider*, **141**; *Muscarum scarabeorum, vermiumque varie figure & formae*, 124; *Shell (Murex brandaris)*, **122**, 124; *Shell (Vasum ceramicum)*, **123**, 124; *Six Insects*, **26**; *Three Moths, Two Butterflies, and a Bumble Bee*, **141**; *Two Butterflies, a Wasp, and a Moth*, **4** (detail), **142**; *Two Moths and Six Insects*, **143**
Hooke, Robert, 27; *A Flea*, **26**, 159; *Micrographia*, 159
hoopoes, 106, **108**, **110–111**
humanism, 20, 38, 94, 107, 117



I

Imperato, Ferrante, *Dell'istoria naturale di Ferrante Imperato napolitano libri XXVIII*, 160, **163**
insects: collection and display of, 13, 29–30, 156, 159; cultivation of, 29–30, 156; etymology and meanings of the term, 27; as manifestation of God's creative power, 29, 94; medicinal uses of, 19; metamorphosis of, 30; study of, 29–30; uses and value of, 19. *See also* bees; beetles; butterflies; caterpillars; dragonflies; fleas; flies; mole crickets; moths; water bugs
intaglio printmaking, 12, 14, 94–95, 99, 106, 121, 124–125
Isabella Clara Eugenia, Infanta of Spain, 155

J

Janssen, Hans, 159
Janssen, Zacharias, 159
jewel beetles, 39, 55, **57**, **58**. *See also* beetles

K

- Kessel, Hieronymus van, the Younger, 146
 Kessel, Jan van, the Elder, 12, 13, 14, 19, 23, 29, 30, 31, 49, 56, 117, 146–147, 155; *Artist's Name in Insects and Reptiles*, 167, **169**; *Dragonfly, Butterfly, and Other Insects, with Auricula, Morning Glory, and Shells*, 167, **168**; *Flowers in a Glass Jar*, 147, **149**; *Insects*, 156, **171, 172, 173, 174–175** (detail), **176, 177, 178, 179, 180–181** (detail), **182, 183, 184, 185, 186, 187, 188–189** (detail), **190, 192–193** (detail), **206–207** (detail); *Insects and a Sprig of Rosemary*, **8–9** (detail), **144** (detail), 146, 156, **157**, 160, 167; *Noah's Family Assembling Animals before the Ark*, 147, **151**, 156; *Reptiles*, **191**; *Study of Butterfly and Insects*, **10** (detail), **170**; *Study of Insects and Reptiles*, **158**, 159, 160, **161** (detail), 167. *See also* Circle of Jan van Kessel the Elder
Kunstkasten. *See Wunderkammern* (cabinets of curiosity)
Kunstkasten (art cabinets)

L

- land- and seascape settings, 49, 51, 99, 106
 Leeuwenhoek, Antonie van, 27, 159
 Leonardo da Vinci, 124
 Leo X, Pope, 21
 lepidochromy, 54–55
 Liagno, Teodoro Filippo di, 14, 94, 121, 124; *Seated Figure of Death with an Hourglass*, 121, **136**; *Skeleton of a Bat*, 121, **138**; *Skeleton of a Camel*, **138**; *Skeleton of a Frog*, 121, **136**; *Skeleton of a Heron*, **120**, 121; *Skeleton of a Quadraped*, **137**; *Skeleton of a Rabbit*, **139**; *Skeleton of a Starling*, **139**
 Liberale, Giorgio, 51
 Ligozzi, Jacopo, 51; *A Groundhog or Marmot with a Branch of Plums*, **91**
 little beasts, origin and use of the term, 12, 27
 lizards, **40, 42–43**, 45, **46, 47, 77, 78–79**. *See also* chameleons; reptiles
 L'Obel, Matthias de, 49
 Lombard, Lambert, *Dragonflies and Flying Insects*, **24**
 Luyken, Jan, *Geleerden bestuderen insecten*, **28**

M

- Mander, Karel van, 35, 38, 45
 mantis shrimp, 107, **115**
 Manuel I, King of Portugal, 21, 155
 Marcgraf, Georg, *Historia naturalis Brasiliae* (with Willem Piso), 159
 marmots, **91**
materia medica, 19–20
 Mauriès, Patrick, 164
 memento mori, 112, 117, 121
 menageries, 21, 155
 Merian, Maria Sibylla, 23, 30, 31, 51
 metallic paint, 55, 160
 metamorphosis, 30
 microscopes, 27, 30, 159
 Moffett, Thomas, *Insectorum sive minimorum animalium*

- the publisher, 27, 199n1; folio 96 from, **18**
 mole crickets, **73, 74–75**
 moths, 29, 30, **52, 54, 69**, 107, 117, **141, 142, 143**, 160, **205**
 Mozart, Anton, *The Handing Over of the Pomeranian Cabinet*, 164, **165**
 Musson, Matthijs, 164

N

- natural history: aims of, 19, 21, 23, 27; culture and practices of, 12–14, 20–27; origins of, 12, 13, 19–20; role of copying in, 39, 45, 121, 124–125. *See also* herbaria; insects; microscopes
naturalia, 12, 19, 20, 21, 23, 29, 54, 95
 nature: as manifestation of God's creative power, 12, 19, 20, 27, 30, 38, 124; as useful for humans, 19
 northern goshawk, **36**

O

- Ortelius, Abraham, 35, 38

P

- parchment, 51, 55
 Peeters, Clara, 23, 31; *Still Life with Flowers Surrounded by Insects and a Snail*, **25**
 Penny, Thomas, 13, 199n1
 Petiver collection, 29
 Philip II, Duke of Pomerania, 164
 phoenix, 94
 pigs, **84, 86–87**
 Piso, Willem, *Historia naturalis Brasiliae* (with Georg Marcgraf), 159
 Plato, 31
 Platter, Felix, 23
 Pliny the Elder, 45, 51; *Naturalis historia*, 19, 20, 23, 27, 29
 Pomeranian Art Cabinet, 164
 porcupines, **84, 86–87**
 printmaking. *See* intaglio printmaking; woodcut
 Psalms, book of, 94, 107
 Plukenet collection, 29

Q

- Quiccheberg, Samuel, 160, 164, 202n9

R

- rabbits, **139**
 Radermacher, Johannes, 107
 Ray, John, 30
 Remps, Andrea Domenico, *Cabinet of Curiosities*, 164, **166**
 reptiles, 27, **158**, 159, **161**, 167, **169, 191**
 rhinoceroses, 21, **22**
 Rubens, Peter Paul, 159; *Head of Medusa* (with Frans Snyder), 159
 Rudolf II, Holy Roman Emperor, 38, 106, 121



S

Sadeler, Justus, 117
 seascape settings. *See* land- and seascape settings
 silver paint, 55
 Sir Hans Sloane Herbarium, folio 31, **16** (detail), **22**
 Snyders, Frans, 159; *Head of Medusa* (with Peter Paul Rubens), 159
 squirrels, **90**
 stag beetles, 49, **50**, 107. *See also* beetles
 starlings, **139**
 swallowtail butterflies, **88**. *See also* butterflies
 Swammerdam, Johannes, 23; *Historia generalis insectorum*, 30

T

Teniers, David, the Younger, 146
 Theophrastus, 19, 20
 Tradescant, John, the Younger, 27
 turkeys, 45, **61**

U

unknown artist, *Twenty Figures of Adult Insects*, from *Libri Picturati*, **48**, 49

V

Verhagen der Stomme, Hans, 45
 Verhulst, Elias, *Natural History Ensemble* (No. 18) (attributed to Verhulst and Anselmus Boëtius de Boodt, after Jacob Hoefnagel), **116**, **118–119** (detail), 121, 203n28
 Visscher, Claes Jansz: after Jacob Hoefnagel, plate 10 from *Diversae insectorum volatilium icones ad vivum accuratissime depictae*, 117, **140**
 Volkertsz, Jan, 124

W

water bugs, 49, **66**
 watercolor, 12, 35, 38, 39, 45, 49, 51, 54, 94, 99, 106, 107, 124
 Weiditz, Hans, 23
 wings, use in illustrations of actual, 54
 Witte Olifant (inn), 21
 woodcut, 12, 21, **22**, 23, 35, 39, 95, 99, 121
 Wotton, Edward, 199n1
Wunderkammern (cabinets of curiosity)/*Kunstkasten* (art cabinets), 13, 20–27, 99, **154**, 160, **161**, **162**, **163**, 164

Z

zoological art, 13, 38, 45, 49, 51, 56, 94, 99

