The Order of Nature: Early Modern Views on Classification and Generation, and Their Theological, Ideological and Empirical Background

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CHAPTER 2

The Species and Beyond: Classification and the Place of Hybrids in Early Modern Zoology

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Introduction

In the history of science it is always a bit seductive to follow a teleological approach—to assess the achievements of the past with respect to the present status quo of scientific knowledge.[1] If one does so, lines of linear and progressive development inevitably appear. This has also happened with the history of early modern zoology. In the 16th and 17th centuries zoology brought forth monumental works, including those by Conrad Gessner (1551–1560),[2] Edward Wotton (1552),[3] Ulisse Aldrovandi (1599 ff.),[4] Wolfgang Franzius (Frantze;

1 Cf. my first draft on the topic in Dutch, for a popular audience, "Mengwezens. Hybridisatie in vroegmoderne zoölogische werken", in Rikken M. (ed.), *Veranderlijke dieren van Conrad Gesner,* in *De boekenwereld* 29.1 (2012) 44–51. In the present contribution, however, only small parts go back to this first draft.

2 *Historiae animalium* [...] 4 vols. (Zurich, Christoffel Froschauer: 1551–1558); *Icones animalium* [...] *editio secunda* (ibidem, idem: 1560).

3 *De differentiis animalium* (Paris, Michel de Vascosan: 1552).

4 *Ornithologiae, hoc est de avibus historia libri XII* (Bologna, Franciscus de Franciscis: 1599; Bologna, Antonio Bernia: 1637); *Ornithologiae tomus alter cum indice copiosissimo* (Bologna, Giovanni Battista Bellagamba: 1600; Bologna, Antonio Bernia: 1637); *Ornithologiae tomus tertius, ac postremus* (Bologna, Antonio Bernia: 1603; 1637); *De animalibus insectis libri septem, cum singulorum iconibus ad vivum expressis* (Bologna, Giovanni Battista Bellagamba: 1602; Bologna, Clemente Ferronio: 1638); *Quadrupedum omnium bisulcorum historia* [...] *Ioannes Utervius Belga colligere incaepit* [...] *Thomas Dempsterus Baro a Muresk Scotus* [...] *absolvit. Hieronymus Tamburinus in lucem edidit* [...] (Bologna, Sebastianus Bonhommius: 1621; Frankfurt a.M., Caspar Röteli: 1647); *De quadrupedibus digitatis viviparis libri tres, de quadrupedibus digitatis oviparis libri duo Bartholomaeus Ambrosinus* [...] *collegit* [...] (Bologna, Antonio Bernia – Nicolao Tebaldeo: 1645); *De reliquis animalibus exanguibus libri quatuor post mortem eius editi, nempe de mollibus, crustaceis, testaceis et zoophytis* (Bologna, Giovanni Battista Bellagamba: 1606); *De piscibus libri V et De cetis liber unus* [...] *Ioannes Cornelius Utervius collegit. Hieronymus Tamburinus in lucem edidit* [...] (Bologna, Giovanni Battista Bellagamba: 1613); *Serpentum, et draconum historiae libri II. Bartholomaeus Ambrosinus* [...] *summo labore opus concinnavit* [...] (Bologna, Antonio Bernia, Clemente Ferronio: 1640).

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1612),[5] John Jonston (1650–1652), and Caspar Schott, S.J. (1662).[6] For example, in Änne Bäumers's *Geschichte der Biologie* (1991),[7] the big players of early modern zoology are hailed as champions of scientific progress and as precursors of modern biology: Gessner, Aldrovandi, and others for their empirical observations; Coiter for founding comparative anatomy;[8] and Wotton and Aldrovandi as forerunners of modern taxonomy. Taxonomy, the classification of animals based on evolutionary biology, is indeed of pivotal importance for modern zoology.[9] The fact that the English physician Edward Wotton dedicated a whole work to the classification of animals, *De differentiis animalium* (1552), was perceived as a sign of great scientific progress. For example, Änne Bäumer regarded Wotton as a founding father of modern biology.[10] Among Wotton's achievements are that he purged zoology from superstitious beliefs, monsters and animals of phantasy.[11]

This teleological approach, however, may turn out to be somewhat tricky, if not misleading. Its biggest drawbacks are its lack of historical sense, a certain blindness with respect to phenomena that do not fit the idea of progress, its lack of contextualisation, and an overall simplification that may lead to misinterpretations of phenomena. For example, it seems inadequate to understand 16th- and 17th-century zoology as a linear progression from a bookish to an empirical foundation of knowledge.[12] Empirical knowledge was surely there, but on the whole it played a less important part than some scholars suggest. In early modern zoology, the literary tradition was still the most important source

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5 *Historia animalium sacra* (ed. pr. Wittenberg, Zacharias Schürer – Johannes Gormann: 1612).

6 Schott Kaspar S.J., *Physica curiosa, sive Mirabilia naturae et artis Libri XII.* [...] *variis* [...] *disquisitionibus excutiuntur et innumeris exemplis illustrantur* [...] *Cum figuris aeri incisis* (Nuremberg, Moritz Endter: 1662).

7 *Zoologie der Renaissance—Renaissance der Zoologie*, in eadem, *Geschichte der Biologie*, vol. II (Frankfurt a.M. – Bern – New York – Paris: 1991).

8 Ibidem, 222 ff.

9 Cf. Enenkel K.A.E., "Zur Konstituierung der Zoologie als Wissenschaft in der Frühen Neuzeit: Diskursanalyse zweier Grossprojekte (Wotton, Gesner)", in idem – Smith P.J. (eds.), *Early Modern Zoology. The Construction of Animals in Science, Literature and the Visual Arts*, Intersections 7 (Leiden – Boston 2007), 2 vols., vol. I (15–74) esp. 22–32.

10 "Das erste zoologische Kompendium in der Zeit der Renaissance: Edward Wottons Schrift 'Über die Differenzen der Tiere'", *Berichte zur Wissenschaftsgeschichte* 13 (1990) (13–29) esp. 28.

11 Cf. Bäumer, *Geschichte der Biologie*, vol. II, e.g. 401: 'Wotton lehnte fast alle Fabeltiere als "blosse Erfindungen" ab'. Cf. however, below the section on Wotton.

12 Cf. my "Zur Konstituierung der Zoologie als Wissenschaft in der Frühen Neuzeit".

of biological knowledge. For the majority of topics, empirical facts were simply lacking. In many cases, one gets the impression that the zoological authors were not that interested in actively searching for new empirical facts, and even if they had empirical information at hand, the authority of authors from antiquity, such as Aristotle, Aelianus, Pliny, and Oppianus, frequently outshone the evidence of empirical observation.

As one may suppose, this feature of early modern zoology affected animal classification. To be sure, classification in itself does not equal scientific progress. In the 16th century Wotton and Aldrovandi were interested in an integrative taxonomy, but in the 17th century Franzius, Jonston in his *Thaumatographia naturalis* (1633), Kircher (1683), Caspar Schott (1662), and some others were less interested. Above all, it is important to understand that early modern classification was departing from paradigms that largely differ from the ones of the 19th and 20th centuries.[13] Morphology and physiology, of course, played a role; however, the most important subdisciplines of taxonomy were probably *philology* and *theology*. The tasks of philology and theology were to adequately use the most important sources of animal description, viz. the classical authors and the Bible. Other sources, such as empirical observations, were in many cases only used additionally. The importance of philology and theology was not restricted to few zoological works with a 'special' character. Änne Bäumer labelled a group of works as 'Biblical zoology' ('Biblische Zoologie');[14] however, theology, the use of the Bible as a major source, and philology characterise a big amount of other early modern zoological works as well.

These features of early modern zoology are connected with one of its most striking paradigms: a profound belief in *interspecific hybridisation*, i.e. mating of different animal species that produces offspring; *hybrid speciation*, i.e. cross-breeding that brings forth new species; and the real existence of all kinds of monstrous creatures. This belief has deep roots in the zoological writings of antiquity and of the Middle Ages, especially Pliny's *Naturalis historia*, books VIII–XI (1st century AD), and Albertus Magnus's *De animalibus libri XXVI* (13th century).[15] In both zoologies the attention

13 For a modern perspective cf. Mayr E., *Systematics and the Origin of Species from the View Point of a Zoologist* (Cambridge, Mass. – London: 1999); idem, *Animal Species and Evolution* (Cambridge Mass.: 1963).

14 *Geschichte der Biologie*, vol. II, 156 ff.: 'Teil 2: Spezielle zoologische Schriften. 11. Biblische Zoologie, Fortsetzung der Aelian- und Physiologus-Tradition'. She records in this group Hermann Heinrich Frey, Wolfgang Franzius, Heinrich von Hoevel, and Caspar Dornavius.

15 See below, the section "More Philosophical and Theological Explanations, and Early Modern Treatises on Monsters".

to interspecific hybridisation, hybrid speciation, and monstrous creatures depends on religious beliefs: Pliny had a philosophical belief in the unlimited, miraculous power and artistry of nature (*natura artifex*), and in his zoological descriptions he always stresses the wondrous or *mirabile*.[16] Albertus Magnus shows a similar attitude, but as one may expect, in his case everything is focused on God the Creator. Nature proves not only God's wisdom but, maybe even more importantly, his unlimited power. Both Pliny and Albertus Magnus were in their zoological works admirers and followers of Aristotle. Aristotle himself, however, was less optimistic about interspecific hybridisation and hybrid speciation than Pliny or Albertus were, and he formulated a number of serious limitations.[17]

The Creative Power of the New Aristotelian Taxonomy: Hybrids and Miraculous Creatures in Wotton's *De differentiis animalium* (1552)

The English physician Edward Wotton (1492–1555), son of the senior bedel of theology of the University of Oxford, represents an interesting case, since with his *De differentiis animalium* he authored the first zoology that offered an integrative classification of all *species*.[18] In this project, on which he worked for many years and in which he profited much from his excellent knowledge of Greek,[19] his medical expertise,[20] and his studies in Padua, he was clearly

16 For these features, cf. my contribution in the present volume, "Die antike Vorgeschichte der Verankerung der Naturgeschichte in Politik und Religion: Plinius' Zoologie und der römische Imperialismus", *passim*, and Beagon M., *Roman Nature. The Thought of Pliny the Elder* (Oxford: 1992), chapter I "Divina Natura: the Roots of Pliny's Thoughts" (26–54). According to Beagon, the stoic concept of *natura-artifex* is an "overall theme" of Pliny's *Naturalis historia* (Beagon, *Roman Nature* 131 and *passim*). Cf. also Caprotti E., "Animali fantastici, fantasie zoogoliche e loro realtá in Plinio", in *Plinio e la natura. Atti del ciclo di conferenze sugli aspetti naturalistic dell'opera Pliniana, Como 1979* (Como: 1982) 39–61.

17 See *infra*.

18 On Wotton's zoology, cf. my "Zur Konstituierung der Zoologie als Wissenschaft in der Frühen Neuzeit" (2007); Bäumer, "Das erste zoologische Kompendium in der Zeit der Renaissance" (1990); eadem, *Geschichte der Biologie*, vol. II, 32–41; Jahn (Hrsg.), *Geschichte der Biologie* 186; Hoeniger F.D. and J.F.M., *The Development of Natural History in Tudor England* (Charlottesville, VA: 1969). For Wotton's biography, cf. Pollard A.F., art. "Wotton, Edward (1492–1555)", in *Oxford Dictionary of National Biography* (Oxford: 2004; [http://www.oxforddnb.com/view/article/29999, accessed 8 Feb 2014]).

19 He had been the first reader in Greek of Corpus Christi College (after 1520; officially appointed in 1524); cf. Pollard, "Wotton, Edward".

20 He was a fellow of the College of Physicians from 1528 to 1555; cf. ibidem.

inspired by Aristotle, and he carefully used Aristotle's ground-breaking analyses of the morphology and physiology of animals[21] in order to construct his integrative classification. In his reconstruction—in fact, new construction—of an Aristotelian system of classification, Wotton collected a large amount of data on the species; although—as he said—he 'only' wanted to present to the reader a handy 'compendium' or companion, he ended up with a monumental zoology in 10 books that comprised the zoological knowledge of most Greek and Latin authors of antiquity. The most important feature is, of course, the systematic organisation of this new zoology. After an in-depth discussion of the criteria of his taxonomy, viz. of the relevant 'differences' (books 1 and 2), he applies Aristotle's categories of "animals with blood" (books 3–8) and "bloodless animals" (books 9 and 10). The "animals with blood" he divides, after the example of Aristotle, into the classes *homo sapiens* (book 4), viviparous quadrupeds (book 5), oviparous quadrupeds and serpents (book 6), birds (book 7), and fish (book 8). The "bloodless animals" he divides into the classes of insects (book 9), and *Mollia, Crustacea, Testacea*, and *Zoophyta* (book 10).

Let's have a closer look at the important Aristotelian class of the *viviparous quadrupeds*, to which Wotton dedicated a whole book (book 5). The viviparous quadrupeds are, in principle, mammals, and exclude oviparous quadrupeds, such as reptiles, toads, frogs, and turtles. Following Aristotle, Wotton construed this class on a morphological (four legs) and a physiological (viviparous) criterion.[22] Most interestingly, in his systematic taxonomical approach Wotton went much further than Aristotle. First, he divided the viviparous quadrupeds into three subcategories or larger groups: 1) *multifida* (that is, uneven-toed animals with three or more toes);[23] 2) *bisulca* (artiodactyls or even-hoofed animals);[24] and 3) *solipedes* (that is, odd-toed ungulates).[25] Second, he divided all three subcategories into certain families, in which he collected related species or subspecies; for example, the family of the "wolves" (consisting of about

21 On Aristotle's efforts with respect to animal classification, cf. Pellegrin P., *La classification des animaux chez Aristote* (Paris: 1982); Lloyd G.E.R., "The Development of Aristotle's Theory of the Classification of Animals", *Phronesis* 6 (1961) 59–81; Heck L., *Die Hauptgruppen des Thiersystems bei Aristoteles und seinen Nachfolgern, ein Beitrag zur Geschichte der zoologischen Systematik* (Diss. Leipzig: 1885); Hünemörder Ch., "Aims and Intentions of Botanical and Zoological Classification in the Middle Ages and in the Renaissance", *History and Philosophy of the Life Science* 5 (1983) (53–67) 53–56.

22 Cf. my "Zur Konstituierung der Zoologie als Wissenschaft in der Frühen Neuzeit" 30.

23 *De differentiis animalium*, book V, fol. 56v–71v.

24 Book V, fol. 72r–83v.

25 Book V, fol. 84r–88v.

10 different species or subspecies),[26] the family of the "lions" (also consisting of about 7 to 10 species or subspecies),[27] the family of the ferrets, martens, weasels, and small cats (consisting of about 8 species/subspecies),[28] the family of quadrupeds that live in the water (consisting of about 7 species),[29] the family of *Bovidae* (consisting of about 20 species/subspecies),[30] or the family of the deer or *Cervidae* (consisting of about 13 species/subspecies).[31] Wotton's families or related species are rarely identical to the families of modern taxonomy, and they are constructed by the application of different criteria. Sometimes they depart from very narrow species or even subspecies markers, such as in the chapter on the "dogs"; sometimes they are constructed around random morphological similarities, for example in the chapter on the "wolves" (which also contains *Felidae*); sometimes they bring together animals with a (seemingly) similar size; and sometimes they unite animals that live in the same habitat, for example the "viviparous quadrupeds that live in the water".[32]

With respect to the subcategories or larger groups, the most intriguing thing is that Wotton constructed his classification on the basis of *one single, clearly perceptible morphological detail*—one, two, or more toes. This means that, in

26 "De lupis", ibidem, fols. 62r–63r. The terms "species" and "subspecies" are used here in a modern sense. When one looks closer at Wotton's families (to which he normally dedicates exactly one chapter), it is sometimes hard to say whether a certain animal name represents a species or a subspecies; sometimes the species names he lists do not belong to the described family. In modern taxonomy, the relevant family here would be *Canidae* (species that resemble the dog); a species of this family would be the wolf (*canis lupus*): this species is divided into 39 subspecies, among them the domestic dog (*Canis lupus familiaris*), the Australian dingo (*Canis lupus dingo*), the Tundra Wolf (*Canis lupus albus*), the Steppe Wolf (*Canis lupus campestris*), the African Wolf (*Canis lupus lupaster*), the Eurasian Wolf (*Canis lupus lupus*), the Arabian Wolf (*Canis lupus arabs*), the Red Wolf (*Canis rufus*), and so on. When Wotton lists the *Lupus aureus* (Golden Wolf) of Asia Minor it is difficult to say whether this refers to a subspecies of the Wolf, to the species Wolf itself (*Canis lupus*), or to another species. Other "wolves" collected by Wotton certainly do not belong to the species *Canis lupus*, or even to the *Canidae*; for example, the *Lupus cervarius*, the *Thos*, the *Chaus*, and the *Lynx* all refer to the same *Felidae* species, the lynx (*Lynx lynx*). Also, Wotton's *Lycaon* represents a *Felidae* species, even a large feline, the cheetah (*Acinonyx jubatus*).

27 "De leonibus", ibidem, fols. 63v–64r. Cf. Enenkel, "Zur Konstituierung der Zoologie als Wissenschaft in der Frühen Neuzeit" 32–35; 57.

28 "De viverris, mustelarum generibus, et de fele", ibidem, fols. 67v–68v.

29 Ibidem, fol. 70r–v.

30 "De bove et boum generibus", ibidem, fols. 72r–75r.

31 "De cervis", ibidem, fols. 79v–81r.

32 Ibidem, fol. 70r: "De quadrupedibus aquaticis, ut de fibro, lutra, et quibusdam aliis".

principle, everybody could *empirically* observe and check whether the classification of a certain species was correct. As it seems, no misunderstandings were possible. In this taxonomical division, Wotton deliberately excluded other criteria: for example, whether the animals are carnivores, plant eaters, or omnivores (which, of course, would have morphological effects). In comparison, in modern taxonomy the difference between "even-toed" and "uneven-toed" species refers exclusively to ungulates, such as horses, goats, and deer; other viviparous quadrupeds (mammals) are not classified by the (main) criterion of the number of toes. By consequence, Wotton's group of *multifida* (more than two toes) is very big[33] and includes genetically different genera of animals: elephants (*Proboscidea*);[34] primates;[35] carnivores;[36] rodents (*Rodentia*), such as the mouse and the rabbit,[37] but also the mole (*talpa*) and the bat (*vespertilio*);[38] and even water animals, such as the *Vitulus marinus* (seal). The great variety of genera that constitute Wotton's *multifida* appears from a brief look at the modern stemma of the *mammalia*.[39]

Because of Wotton's concentration on a single, easily perceptible morphological detail, one may suppose that he made an effort to stress the importance of empirical observation. This, however, is questionable. In his entire book on viviparous quadrupeds, Wotton hardly ever talks about empirical observations, let alone autopsy.[40] Instead of personal observations, Wotton normally provides evidence by listing his most important sources from antiquity (names of authors and works) at the beginning of each section, by quoting them, often verbatim, in the main section, and finally by adding some details or remarks in footnotes at the end of each chapter.

Illuminating test cases with respect to his method of classification can be found among the species that he certainly did *not* see—e.g. because they do not exist, were described the wrong way, or live in faraway regions. For example, among the *solipedes* (odd-toed ungulates) and in the family of the horses (*equi*) Wotton classifies a horse with wings and horns, a hybrid species

33 Book V, fols. 56r–72r.

34 Book V, fols. 56v–57v.

35 Book V, fols. 57v–58v.

36 Book V, fols. 58v–68v, and 70v.

37 Book V, fols. 66v–67v; 68v–70r.

38 Book V, fol. 71r–v.

39 MacDonald D. (ed.), *Enzyklopädie der Säugetiere* (Königswinter: 2003; orig. Engl., Oxford: 2001) XVI.

40 Cf. Enenkel, "Zur Konstituierung der Zoologie als Wissenschaft in der Frühen Neuzeit", esp. 31–51.

that supposedly lived in Ethiopia (*Pegasus*).[41] As appears from his argument, Wotton considered it more correct to list this species among the viviparous quadrupeds than among the birds, and he obviously disagreed with writers who classified it in the latter category. Wotton's way of arguing implies that he did not doubt the winged horse's real existence.[42] But, of course, it is clear that he had never personally observed the animal. Instead of empirical observations, he gave Pliny's *Naturalis historia* as "the" authoritative evidence.[43] As the classification of the *Pegasus* suggests, Wotton's taxonomical method was largely based on philology, not on empirical knowledge.

An animal that represents a real species and lives in Europe—next door, so to speak—is the elk (*Alces alces*) [Fig. 2.1, elk].[44] The elk belongs to the family of the deer (*Cervidae*), and as such to the even-hoofed ungulates [Fig. 2.2, footprint of an elk].[45] Wotton, however, classifies it among the *solipedes* (odd-toed ungulates).[46] The reason is that Wotton relied solely on his source Pliny, who stated that, in general, the elk resembles the horse, except for his ears and neck.[47] Wotton took this misleading information literally, and thus attributed to the species odd-toed feet, such as horses would have. Another existing animal is the rhinoceros (family *Rhinocerotidae*, consisting of five species living in Africa and Asia).[48] Rhinoceroses have three toes, as Dürer had already depicted [Fig. 2.3], and therefore—in Wotton's system of classification—they should belong to the *multifida*. Wotton, however, struggled with this species.

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41 *De differentiis animalium*, book V, fol. 87r.

42 Änne Bäumer claimed that Wotton 'lehnte fast alle Fabeltiere als "blosse Erfindungen" ab' (*Geschichte der Biologie*, vol. II, 401). Her claim, however, does not correspond with the facts; see below.

43 *Naturalis historia* VIII, 72.

44 MacDonald (ed.), *Enzyklopädie der Säugetiere* 513. It is about the 'elk' in British English ('moose' in American English), not about the wapiti.

45 Ibidem 504–519.

46 *De differentiis animalium*, book V, fol. 87r.

47 *Naturalis historia* VIII, 39. Cf. Leitner H., *Zoologische Terminologie beim älteren Plinius* (Hildesheim: 1972) 15; Keller O., *Die antike Tierwelt*, 2 vols. (vol. I, Leipzig: 1909; vol. II, Leipzig: 1913; reprint, Hildesheim: 1963), vol. I, 281 ff. To be sure, in his description of the elk Plinius did not use the name of the species ('horse', *equus*), but the more general term 'iumenta', which primarily refers to donkeys and horses but may refer to oxen (and thus to even-hoofed ungulates) as well.

48 The rhino consists of five species: the Black rhinoceros (*Diceros bicornis*), and the White rhinoceros or Square-lipped rhinoceros (*Ceratotherium simum*), both living in the southern part of Africa; and the Indian (*Rhinoceros unicornis*), Javan (*Rhinoceros sondaicus*), and Sumatran (*Dicerorhinous sumatrensis*) rhinoceroses, all living in Asia; cf. MacDonald (ed.), *Enzyklopädie der Säugetiere* 476–481.

FIGURE 2.1 *The elk* (Alces alces), *grownup male.*

FIGURE 2.2 *Footprint of an elk* (Alces alces).

From his description it appears that he attributed to the animal the features of very different species: horse, deer, elephant, and wild boar.[49] In a first attempt,

49 *De differentiis animalium*, book V, fol. 71v: 'Sed atrocissimum monstrum monoceros est, quem cartazonon vocant: reliquo corpore equo simile, capite cerv[in]o, pedibus

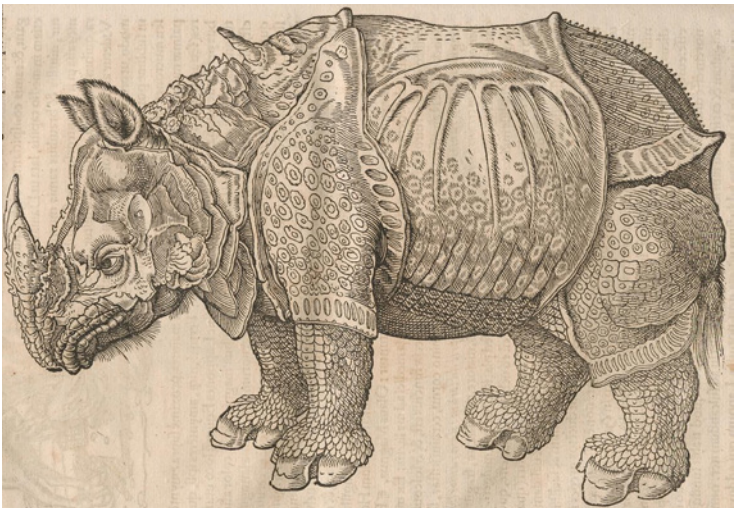

FIGURE 2.3 *Rhinoceros by Dürer. From: Gessner*, Icones animalium (*2nd ed., Zurich, Christoph Froschauer: 1560*), *p. 60.*

Wotton classified it among the *multifida*; he did not know for sure how many toes the animal had, but he stated firmly that its toes were not split, as he supposed was the case with the elephant (which, as one may know, is not correct). In another passage in his *De differentiis animalium*, however, Wotton classified the rhino among the *even-hoofed animals* (sic),[50] probably because this time he stressed the "bull-element" in the "composite animal" he offers in his description. In the relevant passage he states—maybe to the surprise of the reader—that the rhino is common in Germany, in the 'Hercynian Forest' to the north of the Danube (i.e. Bayerischer Wald and/or Oberpfälzer Wald). From Wotton's description it appears that he construed the German rhino as a *mixtum compositum* of wild boar and bull.[51] Although in this second classification the rhino has become a European animal as well, it is not likely that Wotton

elephanto (digitis scilicet indivisis), cauda apro, mugitu horrido; cornu unum nigrum e media eius fronte protenditur [...]' ('But the unicorn is an outrageous monster which is called cartazonon. With respect to its body it resembles a horse, its head a deer, its feet an elephant (because its toes are not split), and its tail a wild boar, and it produces a horrible sound. On the middle of its face rises a single black horn'). The 1552 printed edition, on fol. 70v, has 'cervino', which should be corrected to 'cervo'.

50 Ibidem, book V, fol. 75r: 'in Hercyna silva gignuntur: rhinocerota vocant et taurum Aethiopicum' ('it exists in the Hercynian Forest. It is called rhinoceros or Ethiopian bull').

51 Ibidem, book V, fol. 75v: '[...] magnitudo tauri est, forma vero apri, praeterquam quod a summis naribus, ut iam diximus, cornu est' ('[this animal has] the size of a bull, but the

ever observed the Danube rhino. Besides, rhinos with one horn exist only in Eastern Asia. One also wonders why Wotton has identified the Bavarian rhino with the 'Ethiopian bull' and why he has ascribed to the animal the capacity to kill elephants by tearing apart their soft belly with its sharp horn. Did Wotton think that there were elephants in Germany?[52]

The "unicorn" filiation in Wotton's attempt to classify the rhino leads to another puzzling problem of his zoology: the abundance of *unicorn species*. Besides the rhino, Wotton lists, among others, a species of unicorn horses in India (*equus Indicus*)[53] and one of Indian unicorn donkeys (*asinus Indicus*).[54] Interestingly, he ascribed the unicorns to different groups: some he classified among the *multifida*, some among the *bisulca* (even-hoofed ungulates), and some among the *solipedes* (odd-toed ungulates). For example, Wotton was well aware that the family of the '*Boves*' (*Bovidae* in modern terms) should be classified among the even-hoofed ungulates (*bisulca*), and that the '*Boves*' are even the "constituting" family of *bisulca*, as is also indicated by the title of the relevant chapter: "De quadrupedibus bisulcis, et primo de bove et boum generibus".[55] However, among the even-hoofed ungulates he classifies one species of unicorn 'Indian bulls' (*boves Indici*) and another one 'Aeonian bulls' (*boves Aeonii*), both of which are odd-toed ungulates.[56] The Aeonian bull bears a single horn, located 'in the middle of its head'.

In the same chapter, Wotton lists another species of unicorn bulls that was supposed to live in the 'Hercynian Forest' of Bavaria: this animal appears to be an even-hoofed ungulate, just like the "German rhino". Its single horn, however, has very strange features: it is much longer and is straighter than other horns, but on its top it has a rare ramification resembling the palm of a human hand.[57] The form of the horn suggests that the ultimate "source of inspiration" behind this composite animal or *mixtum compositum* was the elk [Fig. 2.1]; the

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shape of its body resembles a wild boar, except the fact that it has on the top of its nose, as we already stated, a horn').

52 However, from a footnote it appears that Wotton identified the 'Ethiopian bull' with the animal Solinus had called 'Indian bull' and Pierre Gilles (Gyllius) 'Wild bull'; cf. *De differentiis animalium*, book V, fol. 75r, footnote 9.

53 *De differentiis animalium*, book V, fol. 86v.

54 Ibidem, fol. 88r–v.

55 Ibidem, fol. 72r.

56 Ibidem: 'Sunt et Indici boves unicornes [...], solidis ungulis nec bifidis. Aeonii quoque boves solipedes sunt, singulaque habent cornua, et haec medio capite' ('There are also unicorn Indian bulls [...]; they are odd-toed, not even-hoofed. The Aeonian bulls are odd-toed as well, and they have a single horn in the middle of the head').

57 Ibidem.

elk (*Alces alces*), however, as was previously mentioned, was wrongly classified by Wotton among the odd-toed ungulates[58] because he interpreted Pliny's misleading information (that the elk almost entirely resembled a horse) in a literal sense. It is even more surprising that Wotton—after having classified at least four species of unicorn odd-toed ungulates—says all of a sudden, with respect to the 'Indian donkey', that he 'is the only unicorn species of odd-toed ungulates'.[59] A footnote reveals the background of this surprising move. It was a philological problem: Wotton was not sure whether 'bos Indicus', 'bos Aeonius', 'asinus Indicus', and 'equus Indicus' all referred to different species. His doubts were raised by Aelianus's *Historia animalium*, where 'equus Indicus' and 'bos Indicus' may mean the same animal.[60]

The method Wotton used in the classification of the Ethiopian winged horse, the elk, the rhino, and the various "unicorn" species indicates that—although he worked strictly along Aristotelian systematical lines—he was inclined to take over and incorporate the miraculous and strange animals described by Pliny and other ancient zoologists, and that he left the door open for hybrid species. If one looks closer at the *De differentiis animalium*, most of the hybrids mentioned by Pliny reappear: e.g. among the even-hoofed ungulates, Wotton classifies the Ethiopian *Leucrocuta*[61] [Fig. 2.4], a kind of hybrid of an even-hoofed ungulate (possibly a deer) and a lion, but resembling a hyena; the *Thos*, an interspecific hybrid of a (male) wolf and a (female) panther;[62] the *Eale*,[63] a strange animal with the features of a number of species (such as elephant, wild boar, horse, and bull) and equipped with the miraculous element of moveable horns, but according to Wotton a true 'equus fluviatilis' (*hippopotamus*), or a species closely related to the hippopotamus;[64]

58 Ibidem, fol. 87r.

59 Ibidem, fol. 88r: 'In solipedum genere unicornum asinus tantum Indicus est'.

60 Ibidem, fol. 88v, footnote no. 4.

61 Ibidem, fol. 81r.

62 Ibidem, fol. 62r: 'Thos lupus est Aethiopicus parvus et deformis, ex lupo et panthera prognatus, qui utrunque refert parentem, facie scilicet genitorem, reliquo corpore matrem' ('The Thos is an Ethiopian wolf, which is small and ugly; it is brought forth by mating of a [male] wolf and a [female] panther: by its face it resembles the father [sc. the wolf], by the rest of its body the mother [the panther]').

63 Ibidem. On the *Eale*, cf. in the present volume my "Die antike Vorgeschichte der Verankerung der Naturgeschichte in Politik und Religion: Plinius' Zoologie und der römische Imperialismus"; Pliny, *Naturalis historia* VIII, 73; Leitner, *Zoologische Terminologie beim älteren Plinius* 114.

64 *De differentiis animalium*, book V, fol. 81v: 'eale ut alias equus fluviatilis [. . .]' ('the Eale, or as it is called elsewhere, hippopotamus'); 'Hippopotamis comparatur, et ipsa sane aquis

the Ethiopian *Crocuta*,[65] an interspecific hybrid of a (male) hyena and a lioness,[66] but sometimes also a cross-breeding of dog and wolf;[67] the "leo minor", i.e. a smaller sort of a lion with curled short hair instead of a long mane, an interspecific hybrid of a (female) lion with another carnivore (maybe the panther),[68] as well as a similar smaller lion that completely lacks a mane, a cross-breeding of a panther and a lioness;[69] the *Bonasus*, with the features of horse and bull;[70] the *Chaus* or (in the Celtic language) *Raphius,* which somehow unites the features of a wolf and a panther;[71] the *Chaonis*, a cross-breeding of the male *Chaus* with a bitch;[72] the enigmatic Ethiopian *Cepus* or *Cephus*, presented in Rome by Pompey in 55 BC and probably a kind of monkey, but classified by Wotton as a carnivore with the features of panther (body) and lion (face);[73] moreover, another *Cepus*, with the features of a monkey (face), and a bear and a dog (body);[74] and the miraculous being *Mantichora*, a man-eater with a human face, the body and legs of a lion, and the tail of a scorpion (including a stinger) [Fig. 2.5].[75] Similar to the *Crocuta*, the *Mantichora* is able to imitate the human voice.

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fluminum gaudet' ('it is similar to the hippopotamuses, and indeed it likes the water of rivers'). Pliny, however, did not identify the *Eale* with the hippopotamus.

65 *De differentiis animalium*, book V, fol. 63v; cf. Pliny, *Naturalis historia* VIII, 72; Leitner, *Zoologische Terminologie beim älteren Plinius* 154.

66 *De differentiis animalium*, book V, fol. 63v: 'In Aethiopie parte [sc. hyaena] coit cum leaena, unde nascitur monstrum, cui crocutae nomen est; [...] in ore gingiva nulla, dens unus atque perpetuus [...]' ('In a certain region of Ethiopia the [male] hyena mates with the lioness and gives birth to a monster which is called *Crocuta*').

67 Ibidem: 'Crocutas etiam generat Ethiopia ex cane lupoque conceptos, omnia dentibus frangentes, protinusque devorata conficientes ventre' ('Ethiopia also brings forth *crocutae* that are brought forth by the mating of dogs and wolves; they break everything with their teeth, devour it, and digest it immediately in their stomach').

68 Ibidem, fol. 64v: '(leones) breviores et iubis crispi, plerumque ignavi [...]'.

69 Ibidem: 'at hi quos (leones) creant pardi, in plebe remanent iubarum inopes. Adulterinis enim coitibus degenerantur quandoque partus leaenarum [...]' ('but those lions that are brought forth by the mating with panthers remain vulgar and without a mane. Sometimes the kittens of lionesses who were created by the mating with another species, degenerate [...]').

70 Ibidem, fol. 74v; cf. Pliny, *Naturalis historia* VIII, 40.

71 *De differentiis animalium*, book V, fol. 62v; cf. Pliny, *Naturalis historia* VIII, 70.

72 *De differentiis animalium*, book V, fol. 63r: 'Ex Chao conceptas canes chaonidas nominari [...]' ('The dogs brought forth by the Chaus are called *Chaonides* [...]').

73 Ibidem, fol. 66r.

74 Ibidem, footnote 5.

75 *De differentiis animalium*, book V, fol. 71v: 'Apud Indos (si Ctesiae credendum est) belua gignitur, cui nomen Mantichorae: [...] magnitudo et aurium hircitudo et pedes leonis;

FIGURES 2.4 & 2.5 (*top*) *The* Leucrocuta ('Leucurcuta'), *and the* Martichora ('Martigora') (*bottom*), *by Matthaeus Merian. From: John Jonston*, Historiae naturalis de quadrupedibus libri, cum aeneis figuris [...] (*Frankfurt a. M., Matthäus Merian: 1652*), *Tab. LII.*

facies et aures hominis, oculi caesii, color rubricus; cauda scorpionis modo terrestris [...]' ('In India—if one may believe Ctesias—lives an animal called Mantichora: [...] its size, hairiness of its ears, and legs resemble a lion. It has the face and the ears of a man. Its eyes are greyish; its colour is red. Moreover, it has the tail of a scorpion'). In his account, Wotton suggests that his source is the *Indika* of the Greek physician Ctesias of Cnidos. However, he drew exclusively on Pliny's *Naturalis historia* VIII, 75: 'Apud eosdem nasci Ctesias scribit, quam mantichoran appellat [...], facie et auriculis hominis, oculis glaucis, colore sanguineo, corpore leonis, cauda scorpionis modo [...]'. The *Mantichora* origi-

If one considers Wotton to be a rationalist and empirical zoologist, one may be even more surprised by the fact that he has added to the Plinian ones more hybrids: e.g. the Horse-panther (*Hippopardium*),[76] a strange hybrid of horse and leopard; the Horse-deer (*Hippelaphus*, also called *Equicervus*),[77] a *mixtum compositum* of horse and deer [Fig. 2.6, *Hippelaphus*/*Tragelaphus Gesneri*]; and the *Hippager*,[78] a *mixtum compositum* of a horse and a goat. In his classification, Wotton has systematically united most of the cross-breedings of the horse in one family (chapter 97): "De hippelapho, de hippopardio, hippagro, hippopotamo, et eale" [Fig. 2.7].[79] Since horses are odd-toed ungulates, one is puzzled by the fact that in Wotton's classification all horse hybrids are described as *even-toed*, as if they were cows (*boves*)!

With the *Hippopardium* or Horse-panther Wotton—most remarkably—presents a case where a hybrid of an animal with five toes (the leopard) and an animal with one toe (the horse) brings forth a species with two toes ('bisulca').[80] This seems to be a true miracle of nature. However, it is clear that Wotton was not eager to present a mathematical construction of species. Strangely, in his system of classification Wotton did not give a sign that he had problems with this odd hybrid. In an extremely dry and casual way he tells us that the Horse-panther is not only even-toed, but also that he bears two horns![81] Obviously, he is not bothered either by the question of where the horns would come from: as everybody knows, neither leopards nor horses have horns. Aristotle had explicitly excluded odd-toed ungulates from animals bearing two horns, and—as it appears from the opening chapter of book V of *De differentiis animalium*—Wotton was very well aware of this statement.[82] The Ethiopian *Hippager* seemed to be even less of a problem for Wotton. He is described as an even-toed horn-bearer as well; only his behaviour seems special: when imprisoned, he commits suicide by refusing to eat. The Ethiopian *Leucrocuta* seems to be much more difficult to classify: Wotton describes it as 'even-hoofed, with the legs similar to a deer, extremely fast, but with his breast, neck and tail

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nates in the tales of Persia. It was called 'martiaxwar' (i.e. 'man eater') and was brought into Western culture by Ctesias, court physician of King Artaxerxes II, who rendered the Persian name in Greek as 'martichora'.

76 Ibidem, fol. 81v.

77 Ibidem, fol. 81r.

78 Ibidem, fol. 81v.

79 *De differentiis animalium*, book V, fol. 81v.

80 Ibidem.

81 Ibidem.

82 Ibidem, fol. 52r–v.

FIGURE 2.6 Hippelaphus *or* Tragelaphus Gesneri. *From: Gessner*, Icones animalium (*2nd ed., Zurich, Christoph Froschauer: 1560*), *p. 47*.

similar to a lion, and the head similar to a badger'.[83] Here again, as with the *Hippopardium*, a hybrid of carnivores and even-toed ungulates (thus plant eaters) occurs. In Wotton's description, the animal species has more miraculous features: instead of a set of carnivore teeth according to the carnivore tooth formula, it has two horizontal teeth in the shape of a knife; and moreover, the animal is able to imitate the human voice. Wotton locates this monster species in Scythia, thus northeastern Europe and the adherent parts of Asia.

83 Ibidem, fol. 81r: 'Cruribus cervinis et ungula quoque bisulca apud Aethiopes Leucrocuta est pernicissima fera, [...], collo, cauda, pectore leonis, capite melium [...]'.

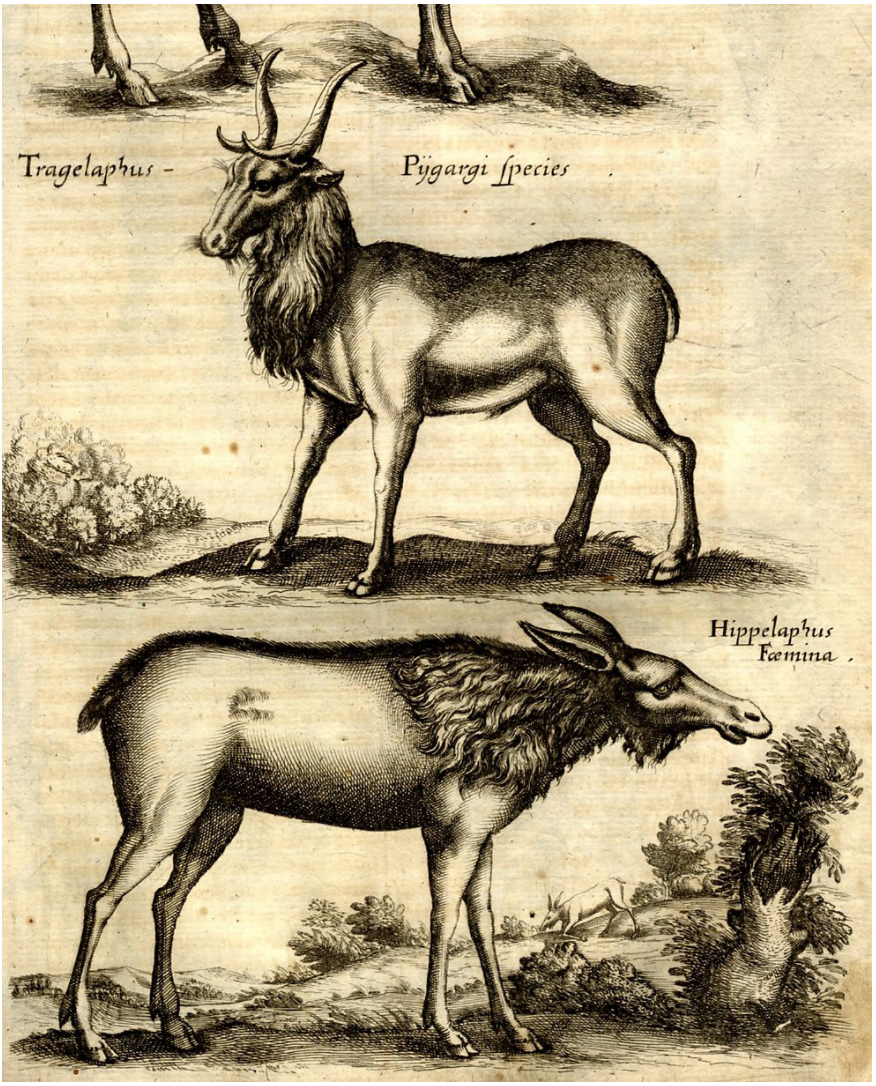

FIGURE 2.7 Hippelaphus *and* Tragelaphus. *From: John Jonston*, Historiae naturalis de quadrupedibus libri [...] (*Frankfurt a. M., Matthäus Merian: 1650*), *Tab. XXIV.*

While Wotton was credited with having purged zoology of fantastic elements,[84] his systematic order of species *abounds* with strange creatures, hybrids, and monstrous animals. It is clear that he did not do anything to reduce their number; on the contrary, he listed more hybrids than Pliny did. Most of them he

84 Cf. Bäumer, *Geschichte der Biologie*, vol. II, 401.

locates in far-off areas, such as Africa, especially Ethiopia, and Asia, especially India; but some of them—maybe to the surprise of the reader—are located in Europe, such as the Bavarian rhino and the Bavarian unicorn. The systematic application of taxonomy constructed after the example of Aristotle has not led to the elimination of miraculous animals. It is sometimes hard to say how Wotton imagined that a certain miraculous or monstrous animal came into being; which animals he considered as true species; which as the results of interspecific hybridisation; and which as singular phenomena or "accidents". In some cases, however, he makes it explicit that the animal is the result of interspecific hybridisation, for example with the *Thos, Crocuta, Chaonis*, and "leo minor"; in other cases, this seems highly probable, such as with the *Chaus, Lupus Cervarius, Cepus, Hippopardium*, and various unicorns. In all of these cases, it is not really clear whether Wotton would also think of hybrid speciation—i.e. whether he would regard the offspring of interspecific hybridisation as fertile and capable to initiate a new species. But since his zoology is devoted to the classification of species, it may go without saying that he regards the hybrids as representatives of species. But animals that are presented by Wotton as a *mixtum compositum* are certainly not necessarily the result of interspecific hybridisation. The majority of them he probably regarded as *independent species*. Sometimes this becomes explicit, for example with the *Eale*, which Wotton identifies as a *hippopotamus*. In general, Wotton must have considered it interesting to offer the reader miraculous creatures and hybrid species. The *mirabile* (wondrous) was dear to him, as it was to Pliny, and it was dear to him for more than one reason. Of course, it made his zoology more fascinating, more remarkable, and thus more precious; and of course the *Wunderkammer* function of the literary collection may have played an important role as well. But maybe above all, Wotton wanted to demonstrate the power of his integrative taxonomical approach. The fact that he was able to classify all those strange creatures proved his sublime *mastery of nature*. Whereas he applied to zoology a systematic Aristotelian method, the whole project was motivated and inspired by a Plinian theological attitude to nature.

The Exclusion of Hybrids from the Godly Created Species: The *Holy Zoology* of Franzius (1612[–1712])

If the reduction of hybrids, "composite animals", and monstrous creatures is identified with scientific progress, then one might ascribe a major accomplishment to Wolfgang Franzius (1564–1628), a Lutheran theologian from Wittenberg. Somewhat paradoxically, this tendency appears in a religious,

a 'holy' zoology—*Historia animalium sacra*, a work that was written for religious purposes and was primarily meant as a manual for Lutheran priests and Protestant students of theology,[85] especially for preaching and Bible exegesis. The *Holy History of the Animals* turned out to be an extremely successful work: it saw some 15 editions in the 17th century and was still used in the 18th century.[86]

In Franzius's zoology, most of the hybrids and "composite animals", of which Wotton's seemingly scientific order of species abounded, do not occur: the *Leucrocuta, Crocuta, Eale, Bonasus, Chaus, Chaonis, Lupus cervarius, Cepus, Thos*, winged Ethiopian Horse (*Pegasus*), *Mantichora*, etc. Franzius was not happy with those hybrid species, or with the idea that similar hybrid species could come into existence randomly, at any time and place. Also, he had difficulties accepting that they would belong to God's creation. Since the existing species were created by God, it cannot have been His will that they would be contaminated either by spontaneous mating or deliberate cross-breeding initiated by man, and, as Franzius proves with *auctoritates* from the Bible, God forbade cross-breeding. It is a kind of hubris and arrogance ('petulantia') if man

85 Cf. the title page of the first edition: '*Historia animalium sacra/ In qua plero/ rumque animalium/ praecipue proprietates in/ Gratiam Studiosorum Theologiae/ et Ministrorum Verbi ad usum* […] *breviter accommodantur,/ In Academia Wittebergensi ante annos aliquot dictata*/ a Wolfgango Franzio SS. Theologiae Doctore (Wittenberg, Zacharias Schürer-Johann Gormann: 1612). For this work, cf. Roggen V., "Biology and Theology in Franzius's *Historia animalium sacra* (1612)", in Enenkel K.A.E. – Smith P.J. (eds.), *Early Modern Zoology. The Construction of Animals in Science, Literature and the Visual Arts*, Intersections 7 (Leiden – Boston 2007), 2 vols., vol. I, 121–146; Bäumer, *Geschichte der Biologie*, vol. II, 159–164; eadem, "Biblische Zoologie (Hermann Frey, Wolfgang Franz, Heinrich von Hoevel)", in Kattensted H. (ed.), *"Grenzüberschreitung". Festschrift zum 70. Geburtstag von Manfred Büttner* (Bochum: 1993) 3–17.

86 *Historia animalium sacra* (ed. pr. Wittenberg, Zacharias Schürer – Johannes Gormann: 1612; ibidem, iidem: 1613; 1616; 1621; 1624; 1633; *editio quinta*, Wittenberg, Balthasar Mevius – Johannes Röhner: 1642; *editio sexta*, Wittenberg, Balthasar Mevius – Johannes Bauer: 1659; *editio septima*, Amsterdam, Johannes Jansonius: 1643; *editio octava*, ibidem, idem: 1653; *editio nona* ibidem, idem: 1654; *editio novissima*, Amsterdam, Johannes Ravenstein: 1665; […] *iam denuo emendatius et correctius edita* […] *novo etiam nominum propriorum indiculo adaucta* […], *praetermissa* […] *Augusti Buchneri praefatione*, Frankfurt a.M., Balthasar Christoph Wust d.J. – Martin Gabriel Hübner: 1671); *Historia animalium* […] *continuatio cum commentario et supplemento observationum ex recentiori historia naturali similitudinum, emblematum, hieroglyphicorum ad usum Oratoriae tum civilis tum ecclesiasticae, opera Joannis Cypriani* (Dresden, Martin Gabriel Hübner – Melchior Bergens Erben: 1687; Leipzig – Frankfurt, Martin Gabriel Hübner: 1688; Frankfurt – Leipzig, Gottofredus Leschius: 1712). The text is henceforth quoted after the first edition of 1612.

aims at "improving" and changing the godly created species by new 'mixturae'.[87] The biblical figure Ana (*Genesis* 36, 24) was (supposedly) the first man who invented the impious act of deliberate cross-breeding, and his invention, the mule, is morally condemned by Franzius.[88] Franzius insists on the conviction that 'cross-breeding is explicitly forbidden in the Holy Scripture, in *Leviticus* 19,19'.[89] Franzius morally condemns hybrids by comparing them to contemporary 'hypocrites' or 'neutrales': people who refuse to make a religious decision, and waver between Protestantism and Catholicism. In this way they never 'will receive fruit from the vineyard of God', 'will never be illuminated by the Lord'.[90]

Franzius, however, considered the problem of the 'hypocrite' hybrids important enough to devote a special chapter to them.[91] The theological mission of Franzius's zoology also seems to have brought forth other "progressive" zoological statements. For example, he was one of the few zoologists of his time who did not accept the concept of "spontaneous generation", the idea that animals can come into existence without coitus, out of dirt, earth, or 'putrefactio' (decomposition).[92]

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87 *Historia animalium sacra* (1612) p. 319.

88 Ibidem, pp. 319, 322, and 323.

89 Ibidem, p. 322: 'Levitici a 19. cap<ite>. expresse prohibetur, ne quis faciat brutum suum coire cum altero bruto'.

90 Ibidem, 323: 'Sicut muli sunt infoecundi, ita Hypocritae non illustrantur divinitus neque ornantur donis spiritualibus, et nullum faciunt fructum in vinea Domini' ('As the mules are infertile, the hypocrites will not be illuminated by God, nor will they receive the present of spirituality, nor will they ever receive fruit from the vineyard of God').

91 "De mixtis animalibus quadrupedibus", in ibidem, pp. 316–323.

92 Cf. Roggen, "Biology and Theology" 135–136. The idea goes back to antiquity, especially to Aristotle and his followers: cf. Balme D.M., "Development of Biology in Aristotle and Theophrastus: Theory of Spontaneous Generation", *Phronesis* 7 (1967) 91–104. It retained its relevance in the Middle Ages and the early modern period: cf. Hasse D.N., "Spontaneous Generation and the Ontology of Forms in Greek, Arabic and Medieval Latin Sources", in Adamson P. (ed.), *Classical Arabic Philosophy: Sources and Reception* (London – Turin: 2007) 150–175; Smith J.E.H., *The Problem of Animal Generation in Early Modern Philosophy* (Cambridge: 2006); Mendelsohn E.E., "Philosophical Biology versus Experimental Biology: Spontaneous Generation in the Seventeenth Century", in Grene M. – Everett E.E. (eds.), *Topics in the Philosophy of Biology* (Dordrecht: 1976) 37–65; Castellani C., "Le problème de la 'generatio spontanea' dans l'oeuvre de Fortunio Liceti", *Revue de synthèse* 89 (1968) 323–340; Nardi B., "Pietro Pomponazzi e la teoria di Avicenna intorno alla generazione spontanea nell'uomo", in idem, *Studi su Pietro Pomponazzi* (Florence: 1965) 305–319; Farley J., *The Spontaneous Generation from Descartes to Oparin* (Baltimore – London: 1974). Microscopic research in the second half of the 17th century led to a certain disbelief

Franzius's zoology, however, does not display a deep interest in taxonomy. Franzius is, of course, aware of the taxonomical achievements of his early modern predecessors, such as Wotton, Gessner, and Aldrovandi.[93] But the mastery of nature he aims to achieve does not depend on classification. So he uses the generally known large categories of animals for the overall structure of his zoology, viz. the quadrupeds (part I, pp. 31–323), birds (part II, pp. 324–583), fish (part III, pp. 584–705), and snakes and insects (part IV, pp. 706–888). With respect to the first part, however, he does not divide the species into viviparous and oviparous quadrupeds, nor does he differentiate (as Wotton and Aldrovandi did) between odd-toed and even-toed ungulates. If one looks closer at the description of the quadrupeds, Franzius uses a principle of ordering that very much resembles Pliny's: according to the species' size and strength, from big to small. Exactly like Pliny, he starts with the elephant (chapter 1), and he ends up with the smallest quadrupeds, such as the mouse and the mole (chapter 28).[94] To a certain extent, he even follows Pliny's ordering principle from exotic animals to domestic ones. As is the case with his predecessors, the notion of species ('genus') has different meanings. Similar to Wotton, he devotes to each species or 'genus' a single chapter; but sometimes 'genus' refers to a species in the modern sense, as is the case with the tiger[95] and the elk,[96] and sometimes it refers to a family of species, as is the case with

in and in the end to the abandonment of the *generatio spontanea*, e.g. by Darwin and his followers: cf. Ruestow E.G., "Leeuwenhoeck and the Campaign against Spontaneous Generation", *Journal of the History of Biology* 17 (1984) 225–248; Strick J.E., *Sparks of Life. Darwinism and the Victorian Debates over Spontaneous Generation* (Cambridge, Mass.: 2000).

93 Except, of course, Aldrovandi's volumes that appeared only posthumously and after the composition of the *Historia animalium sacra*: *Quadrupedum omnium bisulcorum historia* [...] *Ioannes Utervius Belga colligere incaepit* [...] *Thomas Dempsterus Baro a Muresk Scotus* [...] *absolvit*. *Hieronymus Tamburinus in lucem edidit* [...] (Bologna, Sebastianus Bonhommius: 1621; Frankfurt a.M., Caspar Röteli: 1647); *De quadrupedibus digitatis viviparis libri tres, de quadrupedibus digitatis oviparis libri duo Bartholomaeus Ambrosinus* [...] *collegit* [...] (Bologna, Antonio Bernia – Nicolao Tebaldeo: 1645); *De piscibus libri V et De cetis liber unus* [...] *Ioannes Cornelius Utervius collegit. Hieronymus Tamburinus in lucem edidit* [...] (Bologna, Giovanni Battista Bellagamba: 1613); *Serpentum, et draconum historiae libri II. Bartholomaeus Ambrosinus* [...] *summo labore opus concinnavit* [...] (Bologna, Antonio Bernia, Clemente Ferronio: 1640).

94 *Historia animalium sacra*, p. 310 ff.

95 Ibidem, chapter 9, p. 100 ff.

96 Ibidem, chapter 10, p. 106 ff.

the wolf,[97] goats,[98] and sheep.[99] Franzius's families, however, are in most cases not identical to the families of modern taxonomy: for example, he classifies among the family of the wolves the *Lynx* (a feline), the *Lupus cervarius* (also a feline), and the *Hyena*, which constitutes a family of its own (*Hyaenidae*, consisting of four species).[100]

In his critical chapter on the hybrids,[101] Franzius tries to limit interspecific hybridisation and hybrid species. He argues that due to God's providence, hybrids are often infertile. Franzius reduces the number true *hybrid species* to just three: the leopard, the giraffe, and the mule.[102] However, he admits that interspecific hybridisation by mating occurs more frequently: thus, offspring are also produced by bull and donkey,[103] fox and dog, dog and wolf, male wolf and female panther, goat and aries,[104] or tiger and dog.[105] But in his opinion, the offspring of these combinations are in most cases infertile, and do not lead to *proper hybrid species*. Franzius puts forward certain rules for interspecific hybridisation: 1) the mating species must be of the same size; 2) they must have the same duration of pregnancy; 3) they must have the same seasons of fertility; 4) they must be extraordinarily horny; and 5) They must be of a fertile age.[106] For example, man can never produce an offspring with a dog, nor a horse with an elephant, since the length of pregnancy of human beings is nine months, and that of dogs only three months.[107] Franzius does not give figures on the pregnancy of elephants, but he obviously was aware of the fact that their pregnancy lasts much longer than that of horses.[108]

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97 Ibidem, chapter 20, p. 209 ff.

98 "De capra et his cognatis", in ibidem, chapter 23, p. 250 ff.

99 "De ovibus", in ibidem, chapter 22, p. 235 ff.

100 Ibidem, p. 214; cf. MacDonald (ed.), *Enzyklopädie der Säugetiere* 140–145. Cf. in the present contribution infra, paragraph on Gessner.

101 *Historia animalium sacra*, pp. 316–323.

102 Ibidem, p. 321: '[…] mixtorum animalium non possunt constitui certa genera, et vix pauca sunt data: Leopardus, Camelopardalis, Mulus […]'.

103 Ibidem: 'ex tauro et asina'.

104 All ibidem, p. 317.

105 Ibidem, p. 320.

106 Bäumer, *Geschichte der Biologie*, vol. II, 163, surprisingly, mentions another criterion instead of increased sexual activity: that 'the mating animals must be mean and shrewish' ('Sie müssen trügerisch und verschlagen sein'). This is not part of the five criteria given by Franzius.

107 *Historia animalium sacra*, p. 319. These rules go back to Aristotle, and Della Porta's *Magia naturalis*, see below.

108 The length of pregnancy of elephants is almost 22 months (ca. 656 days), that of horses less than half of it.

The rules given by Franzius seem to make sense, even from a modern point of view.[109] But one wonders about the manner in which he himself has applied them. For example, he acknowledges that a dog and a tiger have produced offspring.[110] Both animals may be extraordinarily horny, but their sizes differ completely: a grown-up tiger is about three times as long as a dog (ca. 2.5–3 m vs. 60–90 cm), and about five to eight times as heavy (ca. 150–250 kg vs. 25–35 kg). Also, the duration of pregnancy differs considerably between the two: tigers give birth after ca. 103 days, dogs (and wolves) after ca. 61–63 days. The differences are even more spectacular in the case of the giraffe (*camelopardalis*), which Franzius acknowledges as a proper, i.e. fertile hybrid species, brought forth by the camel and the leopard. The camel is about six times as big as the leopard, and about eight to twelve times as heavy (ca. 450–650 kg vs. ca. 30–70 kg), and its pregnancy lasts about four times as long (13–14 months vs. 3–3.5 months). Of course it is not totally clear whether Franzius was aware of these differences. But the example he gives of the horse and the elephant suggests that he was able to think along these lines. Here again, it is important to understand that his manner of working was not guided by empirical observation, but primarily by theology and philology. He acknowledges the Tiger-hound as a hybrid of dog and tiger because he had authorities from antiquity which transmitted the story of the brave Tiger-hound owned by Alexander the Great.[111]

We also must take into account that Franzius's most important and most authoritative source was the Bible. Species that are not mentioned in the Bible suffer from a lack of authority and "evidence", so to speak, at least in Franzius's eyes. The *Leucrocuta, Crocuta, Eale, Bonasus, Chaus, Chaonis, Lupus Cervarius, Cepus, Thos, Pegasus*, and *Mantichora* do not occur in the Bible. Moreover, the Bible argued against hybrids. Thus, that alone could have been reason enough for Franzius to exclude these hybrid species from his zoology. On the other hand, all three of the hybrids he acknowledges as *hybrid species* are mentioned in the Bible: the leopard, the giraffe, and the mule. It is true that Franzius had no preference for "composite animals" or strange creatures. But, on the other hand, it is a telling detail that he acknowledges unicorn species (*Monoceros*).[112] The authority of the Bible alone was for Franzius conclusive evidence that the unicorn must exist in reality, especially because the

109 Cf. below.

110 *Historia animalium sacra*, p. 320.

111 Ibidem.

112 Chapter 11 "De Monocerote et Rhinocerote", ibidem, pp. 109–118.

unicorn was used as an image of Christ.[113] Empirical evidence may be used additionally; for example, Franzius quotes the eyewitness account of a friend of the polymath Julius Caesar Scaliger.[114] This friend also testifies to the fact that the unicorn and the rhinoceros are different species. Whereas the unicorn bears a single long horn in the middle of its head, the rhino has two horns: one smaller, and one longer and thicker at the top of its nose.[115] Small wonder that, in his otherwise critical chapter on the hybrids, Franzius would even be ready to accept as a fact of natural history that a crocodile had intercourse with a woman. The evidence was a mixture of philology and empirical knowledge: Franzius quotes Plutarch, who transmitted that a certain Philinus was an eyewitness to this monstrous act.[116] Furthermore, Franzius mentioned a hybrid of *homo sapiens* and a donkey.[117] But that relates to another story and has to do with another important scholar of natural history, to whom Franzius reacts in his chapter on the hybrids: Giovanni Battista della Porta.[118]

Hybridisation, or the Blessings of Man's Manipulation of Nature: Giovanni Battista della Porta's *Magia naturalis* (1558; 1589)

The south Italian nobleman Giovanni Battista della Porta (1535–1615) devoted his life to scholarship and science. He erected the *Accademia dei Segreti*, which was closed down by the Inquisition in 1578, and was one of the founding members of the Roman *Accademia dei Lincei*, to which Galileo Galilei also belonged.[119] Della Porta authored an extremely successful work on natural history, the *Magia naturalis*, which was translated into a number of languages

113 Ibidem, p. 109: 'Verum cum in Sacra Scriptura eruditas imagines *passim* ex natura Monocerotis sumptas usurpet et tum ad pios tum ad ipsum Christum accommodet cum singulari doctrina et consolatione, necesse est in rerum natura esse unicornem'.

114 Ibidem, pp. 109–110.

115 Ibidem, p. 110.

116 Ibidem, p. 317.

117 Ibidem.

118 Ibidem, p. 323, last line.

119 For Della Porta, cf. Piccari P., *Giovan Battista Della Porta. Il filosofo, il retore, lo scienziato* (Milano: 2007); Torrini M., *Giovan Battista Della Porta nell'Europa del suo tempo*, Atti del Convegno di Vico Equense (29 settembre–3 ottobre 1986) (Naples: 1990); Valente M., "Della Porta e l'Inquisizione. Nuovi documenti dell'archivio del Santo Uffizio", *Bruniana & Campanelliana* 2 (1999) 415–434; Brentano C., "Della Porta, Giovanni Battista", *Dizionario Biografico degli Italiani* 37 (1989); Baldini U. – Spruit L. (eds.), *Catholic church and modern science. Documents from the archives of the roman congregations of the Holy Office*

and was frequently printed in the 17th century.[120] Its augmented version of 1589 saw some 35 editions, either in Latin or in various translations.[121] Della Porta devoted the second book of the *Magia* especially to hybrid speciation.

For Della Porta, hybrid speciation and "spontaneous generation" were among the most important paradigms of nature, and he considered them to be the basic principles of genetic variation. He firmly believed in a kind of *unlimited fertility* or *generative power of hybrid creatures*, and he argued against 'the opinion of a certain philosopher' who thought that hybrids were generally infertile.[122] This philosopher was, of course, Aristotle. According to Della Porta, hybridisation brought forth animals with a 'natura tertii generis', with features different from both parents, i.e. new species.[123] Thus, he interpreted hybridisation as the "via regia" of genetic variation. The generative power of the new hybrid species ensures that they are 'preserved forever'.[124] Contrary to Franzius, he displayed an extremely positive and optimistic attitude toward hybridisation. Whereas Franzius emphasised that hybridisation was forbidden by God, Della Porta considered it to be completely legitimate, and a big and realistic chance to "improve nature". He even challenges his contemporaries to 'invent new species'.[125]

One of the basic thoughts of his *Magia naturalis* is that man is entitled to manipulate nature to his benefit. And it is this aim that determines the structure of Della Porta's chapter on the hybrids. It is not the strange exotic creatures (which were presented in Wotton's classification) that dominate his argument. In a marked difference, Della Porta's relevant chapter is in fact presented as

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and the Index, vol. I, Sixteenth-century documents (Rome: 2009) 1507–1564; Muraro L., *Giambattista Della Porta. Mago e scienziato* (Milano: 1978).

120 First version in four books: *Magia naturalis sive de miraculis naturalium libri IV* (ed. pr. Naples: 1558; Antwerp: 1562; Italian translation Venice: 1560). For its influence and reception, cf. Balbiani L., "La ricezione della *Magia naturalis* di Giovanni Battista Della Porta. Cultura e scienza dall'Italia all'Europa", *Bruniana & Campanelliana* 2 (1999) 277–303.

121 Much revised and augmented Latin edition in 20 books *Magiae naturalis libri viginti* (Naples: 1589; Frankfurt: 1607; Hanau, David and Daniel Aubry, Clemens Schleicher: 1619; 1644; Leiden, Pieter Leffen: 1650; German translation Christian Zieger: 1713). The Latin text is quoted after the Leiden edition of 1650.

122 *Magiae naturalis libri viginti* (1650), pp. 60–61.

123 Ibidem.

124 Ibidem: 'quum multa animalia nunc videantur ex diversis prognata generibus, quae gignant ab eisque generata alia generent, ut in perpetuum species illa conservetur' ('since many animals appear now that are born from different species, which are fertile and whose offspring brings forth new offspring so that this species is preserved forever').

125 *Magia naturalis*, book II, 5, p. 60.

a small manual on animal breeding. It first discusses the breeding of dogs (II, 6–7), and continues with mules (II, 9); goats and sheep (II, 10); birds (II, 13 ff.), especially various hybrids of chicken (II, 14); birds of prey (II, 15); and fish (II, 16). All these hybrid species are, of course, conceived as domestic animals. Della Porta's aim of hybridisation is always to emend the drawbacks of the parental species, and to get stronger, tougher, and braver animals.[126] He explains under which circumstances man can breed hybrids, and he also gives practical advice on how to increase the sexual drive of the animals, for example with the help of salt, pepper, myrrh, and perfumes.[127] One of his frequently applied methods is to combine a domestic species with a wild one in order to improve the domestic species with the advantageous properties of the wild one. For example, one can make dogs stronger and braver through hybridisation with tigers,[128] lions, and *Crocuta* (the *Crocuta* itself being a hybrid of dog and wolf);[129] faster and stronger through hybridisation with the *Thos*,[130] wolf,[131] and *Chaus*; faster through cross-breeding with foxes,[132] and so on. Mules will get faster if one 'mixes' donkeys with the *Onager*,[133] and stronger through hybridisation of a donkey with a bull.[134] The result of all of these hybridisations will be *new species*. Dog and tiger bring forth the Tiger-hound, *Mastinus*, or *Canis Indicus*;[135] dog and lion, the *Leontomix*, the *Canis Arcas*, and *Canis Tegaeates*.[136]

Only secondly does Della Porta discuss exotic and wild hybrids:[137] the leopard is brought forth from male panther and female lion; the *Crocuta* from male hyena and female lion; the *Lycopantheru*s or *Panther-wolf* from male wolf and female panther; the *Thos* from the same parents; the *Thos* also from male wolf and female hyena; the *Chaus* from the same parents; and the *Bactrian camel* (i.e. with two hummocks) from camel and wild boar. Regarding the exotic hybrids, Della Porta considers them all as fertile and as true *new species*.

126 Ibidem II, 6, pp. 63–67.
127 Section "Animalia ut ardentius ad coitum incumbent", in ibidem, II, 5, pp. 62–63.
128 Ibidem II, 6, pp. 63–65, section "Indicus canis fortissimus ex tigride".
129 All of them ibidem, II, 6, p. 66.
130 Ibidem, section "Canis ex Thoe fortis et velox".
131 Ibidem, pp. 66–67.
132 Ibidem, p. 67, section "Laconici canes veloces ex cane et vulpe generari possint".
133 Ibidem, p. 72, section "Mulae veloces ex onagro et asina generantur".
134 Ibidem, section "Ex tauro et asino fortissimi muli".
135 Ibidem, p. 63.
136 Ibidem, p. 66.
137 Ibidem II, 11, pp. 74–76.

Interestingly, Franzius had directly copied his rules of hybridisation from Della Porta's book II. In Franzius's case, these rules looked like limitations; Della Porta, however, has formulated them as positive precepts and practical guidelines for animal breeding. Similar to Franzius, Della Porta did not always keep to his rules: for example, camel and wild boar considerably differ with respect to size, weight, duration of pregnancy, and mating period. However, Della Porta more or less respected these rules. In comparison, Wotton did not limit his hybrids in this manner.

Interspecific Hybridisation and Hybrid Speciation in Modern Zoology

Nowadays it is clear that the number of interspecific hybrids, especially among mammals, is very limited. Moreover, in most cases, hybridity leads to sterility.[138] In general, only species with exactly the same number of chromosomes are able to bring forth fertile offspring.[139] This goes, for example, for some *Canidae*, such as wolf, dingo, coyote, dog, African wild dog (*Lycaon pictus*), and jackal. All of them have 78 chromosomes. But hybrids of *Canidae* with other *Canidae*, such as foxes, are infertile. Among the *Felidae*, only hybrids of some of the smaller species give birth to fertile offspring. The hybrids of the larger *Felidae* (tiger, lion, leopard, jaguar)—for them, names such as Liger, Tigon, and Jaglion were coined—are infertile. Cross-breeding of the two camel species of the Old World, *Camelus dromedarius* and *Camelus bactrianus*, produces fertile offspring, but if they mate with one of the camel species of the New World (guanaco, llama, alpaca), their offspring are infertile. As a general rule, the majority of hybrids are infertile and therefore cannot originate new species. The production of fertile offspring, of course, does not automatically lead to hybrid speciation, viz. the creation of a new species. Among animals, and especially mammals, hybrid speciation is a very rare exception, such as in the case of the American red wolf, which is a hybrid of grey wolf and coyote.[140]

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138 Cf. Keeton W.T., *Biological science* (New York: 1980) 800.

139 However, there may be exceptions, for example, sometimes with mules and hinnies. Cf. Rong R. – Chandley A.C. – Song J. – McBeath S. – Tan P.P. – Bai Q. – Speed R.M., "A fertile mule and hinny in China", *Cytogenet Cell Genet* 47.3 (1988) 134–139.

140 Cf. http://www.savingwildplaces.com/swp-home/swp-glecrocodile/8287793?preview=&psid=&ph=class%2525253dawc-148772.

Because of a number of reasons, cross-breeding is in general very limited: genetically and morphologically, the animals must be closely related, and the same goes for the length of pregnancy, the seasons of fertility, the size of the animals, and their mating behaviour. Because of these limitations, most of the hybridisations that appear so frequently in early modern zoology are impossible. But interestingly, as we have seen in the works of Della Porta and Franzius, some of these limitations were already known (viz. the same size, period of fertility, and length of pregnancy). The first and the third of these were no early modern inventions, but go back to Aristotle.[141] Nevertheless, these rules were applied in varying and creative ways (as we have seen in the zoology by Franzius and in Della Porta's *De magia naturali*), or even largely neglected (as in Wotton's *De differentiis animalium*). It remains to be seen to what degree hybrids appear in zoological treatises, what parameters caused their appearance, and the ways in which they were constructed.

Reductive Taxonomy Based on Philological Criticism: Conrad Gessner's *Historiae animalium de quadrupedis viviparis* (1551)

Gessner's biological works, among others his groundbreaking *Historiae animalium* (1551–1558),[142] were in various ways inspired by theology and fed by philology.[143] When he worked on the *Historiae animalium* he was teaching natural philosophy at the Zwinglian theological university of Zurich, the so-called

141 *De generatione animalium* II, chapt. 5

142 *Historiae animalium* […] 4 vols. (Zurich, Christoffel Froschauer: 1551–1558), vol. I *de quadrupedis viviparis* (1551; ed. secunda idem: 1560; Frankfurt a.M., Robertus Cambierius: 1603; Frankfurt a.M., Heinrich Lorenz: 1620); vol. II *de quadrupedis oviparis* (1554; facsimile ed. of vols. I and II Hildesheim: 2012; Frankfurt a.M., Johannes Wechel – Robertus Cambierius: 1586); vol. III *De avium natura* (Zurich, Christoffel Froschauer: 1555); idem, *Icones animalium quadrupedum viviparorum et oviparorum quae in historiae animalium* […] *libro primo et secundo describuntur* […] (Zurich, Christoffel Froschauer: 1553; ed. secunda idem: 1560); idem, *Thierbuch. Das ist ein kurtze beschreibung aller vierfüssigen Thieren so auf der erden und in wassern wonend* […] (Zurich, Christoffel Froschauer: 1563); idem, *Thierbuch. Ausführliche beschreibung und lebendige ja auch eigentliche Contrafactur und abmahlung aller vierfüssigen Thieren so auf der erden und in wassern wohnen* […] *durch den weitberühmten herrn doctor conrad gessnern* […] (Heidelberg, Johann Lancellot: 1606).

143 Cf. Leu U.B., "Theologia naturalis", in—, *Conrad Gesner als Theologe. Ein Beitrag zur Zürcher Geistesgeschichte des 16. Jahrhunderts* (Bern-Frankfurt a.M. – New York – Paris:

Prophezei: in the early 1540s as a lecturer, and from 1546 on as a full professor for "Physica".[144] In concreto it meant that almost daily he spent one hour conducting a philological close reading and careful explanation of Aristotle's works on natural history, among others, of course, the *Historia animalium*. According to Gessner, biology and natural philosophy, or *naturalis historia* were an indispensable part of a theologian's education, since the contemplation of nature leads directly to the contemplation of its creator; and the understanding of the creation to the cognition of the creator. Moreover, Gessner considered natural history to be of great value for exegesis of the Bible, especially for the book *Genesis*, which describes the creation of the world, man, and the species of plants and animals. A central piece in Gessner's theological thinking is the *admiration of God and His creation*; this goes for the biggest animals as well as the smallest, seemingly negligible beings, such as ants, lice, bees, flies, worms etc.[145] Man takes a pivotal position in nature: God created man as its administrator and contemplator. Man may use nature to his advantage, but just as important is the contemplation of nature: Gessner conceived it as a religious act, a kind of prayer. The *description* of nature, for example in a zoological work, is equivalent to the *praise* of God. In this sense, Gessner characterises main figures of the Old Testament as zoologists: Adam, the first "classifier of species" (the man who gave names to all the created animals); Noah, the saviour and preserver of the species during the Flood; and Solomon, the first author of a zoology.[146]

Gessner saw himself as a successor to these Old Testament zoologists and, just as importantly, to Pliny the Elder. Like Pliny, Gessner aimed at producing a compendious and complete description of the species; and, similar to Pliny, he emphasised the admirable force of nature, although his method was partly different. For example, Gessner aimed at undertaking a complete collection and evaluation of *all* available literary sources; moreover, he eagerly collected eyewitness reports from contemporary scholars and scientists, and, much more so than Pliny, he took into account his own empirical observations and eyewitness accounts as well. Unlike Pliny, he did not just go for the exotic and strange, but he tried to reduce it through plausible and rational explanations. For Gessner, admiration of nature did not necessarily depend on the exotic and miraculous. As a nomenclator of species, Gessner clearly surpassed Adam and Pliny: he collected *all available names* in *all languages* known to him: not only in Hebrew

1990; Zürcher Beiträge zur Reformationsgeschichte 14) 31–100; esp. "Zum Verhältnis von Naturwissenschaft und Theologie" 57 ff., and "Ad coginitionem Dei" 59 ff.

144 Ibidem 50 ff.

145 Cf. ibidem 61–62.

146 Ibidem 62; *Historia animalium*, I, fol. a 4v (preface).

and Latin, but also in Arabic, Syrian, Armenian, German, French, Italian, Spanish etc. In the description of each species, he devoted a full-scale section to the name of the species in the various languages. Animal classification in Wotton's sense, however, was not Gessner's goal in his *Historiae animalium de quadrupedis viviparis* of 1551. He did not describe the species in a system of categories, subcategories/classes, families etc., but in *alphabetical* order. This principle of order was not new or revolutionary: it goes back to Albertus Magnus's zoology and to Isidorus of Sevilla's *Etymologiae*. The alphabetical order, of course, only marginally referred to classification—to the main entry in Latin. As a classificator, however, Gessner experienced a certain development: in his latest publications (on fish, 1558 ff.) he used methods and means that show considerable differences from those in his first zoological book (on the quadrupeds, of 1551).[147] In the second edition of the *Icones quadrupedum* of 1560 he demonstrated much more attention to classification than he did in the publication of 1551.

Gessner's methods (and achievements) of animal classification in his book on the quadrupeds of 1551 are characterised by a number of means: first, by a full collection and philological discussion of all available names of the species (in as many languages as possible); second, by a critical attitude to species-splitting as suggested by ancient, medieval, and modern literature—Gessner aimed as much as possible at constructing single *homogeneous species*; third, by a certain common sense approach with respect to very rare features that occurred either in literature or in eyewitness accounts; fourth, by a flexible use of literary sources and empirical observations; fifth, by a combination of biblical sources with other literary and non-literary sources; and sixth, by a kind of self-confident attitude with respect to the greatest authorities of ancient zoology, such as Aristotle and Pliny.

For example, Gessner refused to split the species *lion/leo* (modern: *Panthera leo*) into different species, such as Aristotle, Pliny, and others had done.[148] In comparison, Wotton had tried to maximise the "splitting" of *Panthera leo* into 7 to 10 different species of lions, which, however, led to strange results.[149] Gessner does not hesitate to contradict Aristotle's authoritative remark that all species

147 Gessner, *Historia animalium*, vol. IV *De piscium et aquatilium animantium natura* (Zurich, Christoffel Froschauer: 1558); ed. secunda (Zurich, Christoffel Froschauer: 1560). For this later development, see the contribution by Sophia Hendrikx in the present volume.

148 Cf. Enenkel, "Zur Konstituierung der Zoologie als Wissenschaft in der Frühen Neuzeit" 56–57.

149 Cf. ibidem 32–35.

of lions had yellowish fur.[150] Of course, Gessner's approach did not automatically bring forth correct taxonomical descriptions. For example, he erroneously stated that melanism was a feature of the species *Panthera leo*.[151] But with respect to other larger *Felidae*, this was an important clue for taxonomy. In a number of cases, Gessner's methods lead to useful clarifications. Among other things, he was able to exclude the existence of a species of smaller (and weaker) lions without a mane. Gessner's "reductive" taxonomical approach of 1551 sometimes also led to a reduction of hybrids or hybrid species. For example, the fact that he did not accept a species of lions without a mane meant that he could leave out the Plinian and Aristotelian explanation of this species as hybrids from lion and panther.

An illuminating example of Gessner's methods is his treatment of the dangerous Indian carnivore *Mantichora*, a man-eater with a human face, three rows of extremely sharp teeth (like a shark), the body, feet, and reddish (or yellowish) fur of a lion, the tail of a scorpion (including a stinger), and the ability to run so fast that a man cannot escape it.[152] Its voice resembles a trumpet (or tuba). It had been described by the authoritative sources of Aristotle's *Historia animalium* II, 3 (501a 26) and Pliny's *Naturalis historia* (VIII, 75). Wotton had included it, albeit with some reluctance, under the section of "monstrous animals of India and Ethiopia".[153] Gessner, however, was not inclined to accept this remarkable *mixtum compositum* as a species *sui generis*. In doing so he was inspired by the author of a Greek traveller's guide from the 2nd century AD, Pausanias, who, however, called the animal *Martiora*.[154] According to Pausanias, the strange features of the *Martiora* were based on nothing but the pure fantasy of the Indian people, caused by their enormous fear of the animal. In Pausanias's eyes, the so-called *Martiora* was none other than the tiger (*Panthera tigris*): a man-eater with a kind of round face (in this respect 'human'). Gessner followed Pausanias's sceptical and rational approach but preferred to identify the *Mantichora* with the so-called *Leucrocuta*, which had been described, for example, by Pliny: 'of the size of a donkey, with the legs similar to a deer, extremely fast, but with his breast, neck and tail similar to a lion, with the head of a badger [...], with a huge mouth, and its jaws reaching

150 Cf. ibidem 57.

151 Cf. ibidem.

152 Gessner, *Historiae animalium* [...] lib. I *de quadrupedis viviparis* (1551) 631.

153 Cf. *supra*.

154 *Descriptio Graeciae* IX, 21,4; Ctesias, *Historia Indica*, in FGH (*Fragmenta Graecorum Historicorum*) 688 Frgm. 45d.

up to the ears [. . .]'.[155] So he came to the identification *Mantichora* = *Martiora* = *Leucrocuta*. With respect to the location of the animal, however, Gessner did not hesitate to contradict the authority of Pliny. Whereas Pliny defined it as an 'Ethiopian' animal,[156] i.e. living in Africa south of Egypt, Gessner preferred 'India'[157] as its home, following the ancient Roman scholar and geographer Solinus.[158] He came to this verdict by a philological comparison and harmonisation of sources, a method that took him another step further. Because in Pliny, *Naturalis historia* VIII, 107, the so-called *Corocotta* is described in a similar way as the *Leucrocuta* in VIII, 75, Gessner came to another reduction of species: *Mantichora* = *Martiora* = *Leucrocuta* = *Corocotta*. And critical observations of the text led him to even more identifications, and thus taxonomical reductions: he also identified Albertus Magnus's and Avicenna's species *Maricorion* or *Maricomorion* with the *Mantichora*; he regarded them as textual corruptions caused by scribal errors.[159] The same goes for Albertus Magnus's species *Leutrochoca*, which according to Gessner was caused by a transcription error from 'Leucrocuta'; and for Albertus's *Cirocrothes* or *Cirotrochea*, which in Gessner's eyes were textual corruptions from 'Crocuta'. *Crocuta* is in Greek written as 'Crocotta'. From this observation Gessner concluded that *Crocotta* and *Corocotta* also must refer to the same species. Thus: *Mantichora* = *Martiora* = *Leucrocuta* = *Leutrochoca* = *Corocotta* = *Maricorion* = *Maricomorion* = *Cirocrothes* = *Cirotrochea* = *Crocuta*. The reduction of six or ten animal species to only one may seem elegant; its underlying method, however, was not empirical observation, but philology. Gessner's taxonomical reductions resemble, in a sense, the *emendatio* and *coniectura* of textual criticism. In his argument, Gessner even uses the technical term of textual criticism ('coniiciam'): he says that he is willing to change his 'conjecture' if another zoologist comes up with a new and better solution.[160]

Gessner's philological and reductive approach, however, had certain limitations. If the identification *Mantichora* = *Martiora* = *Leucrocuta* = *Corocotta* =

155 *Naturalis historia* VIII, 72.

156 The paragraph VIII, 72, is devoted to 'Ethiopian' animals. For Pliny, Ethiopia means something like Africa south of Egypt.

157 Gessner, *Historiae animalium* [. . .] lib. I *de quadrupedis viviparis* (1551) 630–631.

158 Ibidem 631, line 1: 'Solinus capite 55 in descriptione Indiae'; cf. Solinus 52,34.

159 Ibidem 631, line 15–16: 'Albertus et Avicenna maricorion vel maricomorion vocibus corruptis habent [. . .]' ('Albert and Avicenna list with corrupted names a [species] *"Maricorion"* or *"Maricomorion"*').

160 Ibidem 631, line 49: '[Crocottam] [. . .] leucrocutam potius quam tigrin esse coniiciam, dum alius meliora adferat' ('I guess that it is better to identify the *Crocotta* with the *Leucrocuta* than with the tiger, until another [scholar] comes up with a better solution').

Maricorion = *Maricomorion* = *Crocuta* was correct, what kind of animal is it? According to most descriptions, the *Mantichora* had the face of a man, and the *Leucrocuta* one of badgers ('capite melium', according to Pliny) or camels ('capite camelino', according to Solinus), thus a *non liquet*. Another *non liquet* refers to the teeth: two horizontal teeth above in the shape of a knife (*Leucrocuta*; *Crocuta*), or three rows of sharp teeth in the whole mouth (*Mantichora*), or a tooth formula similar to the wolf or another species of *Canidae*, the badger, or one of the larger *Felidae* (lion, tiger). And what about its feet? Was the animal even-hoofed (*Leucrocuta*) or did it belong to the *multifidae* (*Mantichora*, lion)? Pliny defined the *Corocotta* as a hybrid, brought forth by a male hyena and a female lion,[161] and in a similar way defined the *Crocuta* as a hybrid of male wolf and female dog.[162] Gessner apparently preferred the first definition: he stated that the *Crocuta* comes forth from the mating of a male hyena and a female lion.[163] He does not further investigate the problems of this hybridisation; following one of Pliny's accounts, Gessner presents the animal with six to ten names as a close relative of the hyena, and the alphabetical locus of the **H** of 'Hyaena' is also the place where he inserts this dangerous and miraculous hybrid in his zoology.

The *hyena* itself (mod. family: *Hyaenidae*, consisting of four species: the Spotted Hyena/ *Crocuta crocuta*; Brown Hyena/ *Parahyena brunnea*; Striped hyena/ *Hyaena hyaena*; and the Aardwolf/ *Proteles cristatus*)[164] was conceived by the natural history of Antiquity as a monstrous creature with very strange features: it was supposed to be a man-eater, hermaphrodite (each animal having male and female sexual organs) or transsexual (for example, one year male and the other year female), lacking the vertebrae of the neck, able to imitate the human voice, having multicoloured eyes or bearing a precious stone in its eye or on his head, digging up dead bodies in graveyards, possessing magic powers, etc.[165] By taking into account the empirical observations of others, Gessner succeeded in excluding the hyena's hermaphroditic and transsexual nature, which he condemned as a lie.[166] By his sceptical approach he reduced

161 *Naturalis historia* VIII, 107.

162 Ibidem VIII, 75.

163 *Historiae animalium* [...] lib. I *de quadrupedis viviparis* (1551) 630; cf. also p. 626, line 38: 'Hyaenae coitu leaena Aethiopica parit crocutam'.

164 MacDonald (ed.), *Enzyklopädie der Säugetiere* 140–145.

165 Cf. e.g. Pliny, *Naturalis historia* VIII, 105–106; cf. inter alia Aristotle, *Historia animalium* VI, 32, 579b 15–16; *De generatione animalium* III, 6, 757a 2; Aelianus, *De natura animalium* I, 25; Diodorus Siculus XXXII, 12,2; Ovidius, *Metamorphoses* XV, 408 ff.

166 Gessner, *Historiae animalium* [...] lib. I *de quadrupedis viviparis* (1551) 626, line 15–16: 'Quod de hyaena fertur, genitale simul maris et foeminae eandem habere, commentitum est'.

the "imitative" quality of the species' voice to the sound of vomiting (as, for example, dogs do), although not rightly so.[167]

In a passage that illustrates Gessner's comparative taxonomical approach he presents the hyena as a close relative of the wolf (*Canis lupus*): 'The wolf and the hyena have much in common: they have the same size, colour, and appetite for meat, and they hunt other animals; the wolf sheep and goats, the hyena dogs and sometimes men; both have teeth like a saw, and similar genitals; [...] and both hunt in the night' [Fig. 2.8].[168] These are plausible observations or, even better, conclusions Gessner drew from his collected sources. If he had known the hyena from autopsy, he would have probably come to the same conclusions. Of course Gessner could not have known that the hyena does not belong to the *Canidae*, but to the *Feliformia*, among which the four *Hyaenidae* species constitute a family of their own. But it is even generally acknowledged nowadays that the *Hyaenidae* have certain things in common with the *Canidae*: for example, both hyenas and canines are 'cursorial hunters that catch prey with their teeth rather than claws; both eat food quickly and may store it, and their calloused feet with large, blunt, non-retractable nails'.[169] In fact, the family *Hyaenidae* consists of two branches: the 'lightly built dog-like hyenas and the robust bone-crushing hyenas'.[170] Nowadays the dog-like hyenas have almost died out, with the exception of the *Aardwolf* (East and South Africa), who lives on insects. Gessner could not have been aware of this, and he certainly did not know of the *Aardwolf*, which was not yet discovered by Europeans. His taxonomical definition of the hyena as a close relative of the wolf was based on literature. This was also the way he came to attribute to the hyena a rather strange morphological detail: that the animal would lack the vertebrae of the neck, and instead would have a single long neck bone. This, of course, does not correspond with the facts. The hyena has, like all *Carnivora*, seven vertebrae

167 This step is methodically correct, although "in re" wrong: The *Spotted hyena* (*Crocuta crocuta*) has an extremely wide range of vocal expressions; it produces many different sounds consisting of whoops, grunts, groans, lows, giggles, yells, growls, laughs, and whines. Cf. http://en.wikipedia.org/wiki/Hyena. Many of them could have been identified by as human-like.

168 Ibidem 625, line 58 ff.: 'Multa igitur lupo et hyaenae communia sunt: magnitudo et color, ut dixi, item voracitas, et insidiae, quae aliis animalibus moliuntur: ille gregibus ovium et caprarum, haec canibus et homini quandoque; dentes utrisque serrati, genitalia utrisque similia [...]; uterque noctu vagatur cibi causa [...]'.

169 Cf. http://en.wikipedia.org/wiki/Hyena.

170 Ibidem.

FIGURE 2.8 *Image of the hyena, not accepted by Gessner in 1560. From: Gessner,* Icones animalium *(2nd ed., Zurich, Christoph Froschauer: 1560), p. 75.*

of the neck. But Gessner found this odd information in Pliny and Solinus.[171] As a physician, Gessner probably was well aware that the dog—a close relative of the wolf—had seven vertebrae of the neck. But nevertheless, he considered the authority of the authors from antiquity as sufficient proof of the wolf's and the hyena's single long neck bone. And the same authorities testified to the hyena's potential to bring forth hybrids/hybrid species: its mating with lions and wolves would produce fertile offspring. Its mating with the wolf was another argument for the animals' close relationship. As their fertile offspring Gessner defined the *Thos*.[172]

This supposed hybrid, the *Thos*, Gessner described as a species closely related to the wolf, and consequently presented it in an appendix to the main entry "Lupus".[173] Again, via his method of comparative philology, Gessner came to a reduction of species: *Thos* (*minor*) = *Panther minor/pantherion* = *Lycopantheros* = *Lupus carnarius*.[174] On the other hand he clearly differentiated the *Thos* from another (supposed) 'cognate' of the wolf, the *Lupus cervarius* or *Lynx*.[175] In Gessner's antique sources the *Thos* appears as a hybrid, either of male wolf and female hyena (Hesychius and Varinus), or of male wolf with

171 Gessner, *Historiae animalium* [...] lib. I *de quadrupedis viviparis* (1551) 626, line 10 ff.

172 Ibidem 626, line 38 ff.

173 Ibidem 766 ff. "De feris illis quae lupo congeneres sunt. Et primum de Thoe, Panthere, Lupo carnario, Lycaone etc.".

174 Ibidem 766, line 51–52: 'Videtur autem thos minor, panther minor, lycopantheros et lupus carnarius idem omnino animal esse' ('It seems to me that the *Thos minor*, the *Panther minor*, and the *Lupus carnarius* refer to the same animal').

175 Cf. ibidem 769 ff.

female panther (Oppianus).[176] Agostino Nifo and Theodorus Gaza used the name *Lupus carnarius* because the animal would resemble a wolf, and Gessner anyway does not seem to disagree.[177] But why 'small panther'? This name of the animal appeared only in the Greek, not in the Latin sources.[178] One would suppose that there were a kind of misunderstanding or misconception. With respect to his reductive taxonomical method, however, Gessner considered the name 'small panther' useful in order to discern the species from the species *Panther maior*. The idea to split the *Thos* into two subspecies, a smaller one and a larger one, goes back to Oppianus's poem *On Hunting*.[179] Gessner's species *Thos* (*minor*) = *Panther minor/pantherion* = *Lycopantheros* = *Lupus carnarius*; however, it displays a very strange blurring of *Felidae* and *Canidae* features. In the end, it is almost impossible to identify the species. Which animal would have a body longer than the wolf but shorter legs, and would change its fur each season?[180] It cannot be true for the jackal (*Canis aureus, Canis adustus, Canis mesomelas*), which is not as long as the wolf and does not change its fur seasonally, or for any of the smaller *Felidae*, and hardly be true for the lynx, who may sometimes be as long as the wolf, but certainly not longer and usually quite a bit shorter. Moreover, Gessner emphasised that the species *Thos* was totally different from the species *Lynx*. Thus, again a manifold *non liquet*. The enigmatic *Thos* is another example from which it appears that Gessner's reductive taxonomical approach may create as many problems as it tries to solve.

New Efforts of Classification, Inclusion of New Eyewitness Reports: Gessner's *Icones animalium quadrupedum viviparorum* [...] (1560)

In the second edition of the *Icones animalium quadrupedum viviparorum et oviparorum* Gessner introduced many changes.[181] Different from the *Historia animalium* Gessner presented his zoological compendium this time not in alphabetical order, but based on a classification of the viviparous quadrupeds

176 Ibidem 768, line 37 ff.

177 Ibidem 767, line 59: 'itaque canarium dixi lupum (hoc prius fecerat Gaza) a canis similitudine' ('and therefore I call [the animal] "Lupus carnarius" because of its similarity to the dog (Gaza did the same before)').

178 Ibidem.

179 Ibidem 767.

180 Cf. König's and Winkler's remarks on Pliny, *Naturalis historia* VIII, 123.

181 [...], *editio secunda, novis eiconibus non paucis et passim nomenclaturis ac descriptionibus auctior* (Zurich, Christoph Froschauer: 1560).

into six classes.[182] From a taxonomical point of view, however, Gessner's system does not seem to be particularly strong: he divides the mammals into two large categories: I) domestic animals (*mansuetae*) and II) wild animals (*ferae*); the domestic animals (I) are divided into two classes, 1) horn-bearing animals and 2) animals without horns. As one may expect, the second class (of category I) is much bigger and much more diverse (horses, camels, cats, dogs, pigs, etc.) than the first class. Category II is subdivided in a similar way, into the classes 1) horn bearers and 2) animals without horns. The second class is subdivided into three groups: large animals without horns (II.2.1); animals of a medium size without horns (II.2.2); and small animals without horns (II.2.3). Behind this rather simplistic classification one again detects Pliny, who had presented the land animals from big to small, and had divided them into wild (+exotic) and domestic species.

Much more important than Gessner's effort to present his animal description in a now systematic order, was his eagerness to adapt and correct his former taxonomical definitions, and the animal descriptions and illustrations as well. This effort was admirable and led to manifold progress, especially since Gessner included new, recent eyewitness accounts. The question is, of course—with respect to each singular species—how he used eyewitness accounts and what conclusions he drew from them. Let's have a look at what happened to the species described above. An important new source was the traveller's account *Descrittione dell'Africa* by al-Hasan ibn Muhammad al-Wazzan al-Fasi or Leo Africanus (ca. 1494–ca. 1554), a highly educated Andalusian Moor who had worked as a diplomat and ambassador for Muhammad II, the Sultan of Fez. Leo Africanus had been captured by pirates in 1518 and sold to Pope Leo X, who baptised him in 1520.[183] The first edition of his *Descrittione dell'Africa* appeared in 1550,[184] and it was Conrad Gessner's brother Andreas who edited Florianus's Latin translation of the Italian version, which was made after the original Arab text (Zurich: 1559).[185] In this work Gessner found a description of an animal that in Arabic was called 'Dabuh' or 'Dabu', and in a local African

182 Cf. Ibidem 8 ("enumeratio ordinum [...]").

183 For Leo Africanus cf. Davis N.Z., *Trickster Travels: a sixteenth-century Muslim between worlds* (New York: 2007).

184 *Della descrittione dell'Africa et delle cose notabili che ivi sono, per Giovan Lioni Africano* (Venice, Giovanni Battista Ramusio: 1550).

185 Leo Africanus, *De totius Africae descriptione li. IX* [...] *recens in Latinam linguam conversi Ioanni Floriano interprete* [...]. *Arabice primum scripsit Author, deinde Italico sermone reddidit, Ioannes Florianus ex Italico Latinum fecit* (Zurich, Andreas Gessner: 1559).

FIGURE 2.9 *Gessner's Hyena from 1560* (*actually the baboon*). *From: Gessner*, Icones animalium (*2nd ed., Zurich, Christoph Froschauer: 1560*), *p. 76.*

language 'Jesef'.[186] This animal had the 'size and shape of a wolf, and feet and legs like a man; [...] it digs out dead bodies in graveyards and devours them [...]'.[187] Florianus rendered the *Dabuh* or *Jesef* in Latin with '*Hyaena*'. For Gessner this passage was an eye-opener because it ascribed to the hyena 'feet and legs like a man'. It led him to identify the hyena with the *Babuinus* or baboon (mod. *Papio hamadryas*): 'After I read this passage', Gessner tells us, 'I understood all of a sudden that the animal which is commonly called *Papio* or *Babuinus*, is precisely the *hyena*'.[188] Formerly Gessner had thought that the *Papio* or *Babuin* was the Monkeybear (*Arctopithecus*), an 'animal compositum' of monkey (*simia*) and bear (*ursus*). As pivotal evidence Gessner now adds a woodcut illustration of a baboon, drawn from an exemplar that was shown in 1551 in Augsburg [Fig. 2.9], and a description made by a German eyewitness who called the animal in German '*Pavyon*'. Apparently it did not bother Gessner that this animal appeared to have a strong prefer-

186 Ibidem, p. 503 (chapt. 41).

187 Ibidem: '"Dabuh" Arabica appellatione, Africanis "Iesef" dicitur: animal et magnitudine et forma lupum refert, pedes et crura homini similis. [...] humana corpora sepulchris evellit ac devorat [...]'.

188 Gessner, *Icones animalium* [...], *editio secunda* (1560) p. 76.

ence for fruit and bread, which of course did not qualify it as a carnivore. Gessner sent this illustration for a check to another eyewitness of a baboon, the Antwerp pharmacist Pieter Coudenberg, who approved it.[189] There was, however, another problem: on the same page as the hyena, Leo Africanus had mentioned the *Babuinus* as an African monkey species (*simia*). Gessner solved this problem by splitting the species *Babuinus* and *Papio*. He compared Leo Africanus's remark that the *Babuinus* lacked a tail with the Augsburg illustration where the animal had a short tail. He concluded that thus, the Augsburg animal called *Papio* cannot be a *Babuinus*. So he found another argument to identify the Augsburg *Papio* with the *Hyaena*. Thus Gessner proudly represented the Augsburg *Papio* as the archetypical image of the hyena: 'Because of these reasons I conclude that the *Papio* is the *hyena*, an animal whose form, real being and name were hitherto—for so many centuries—unknown even to the most learned men'.[190]

This new finding made Gessner rethink his taxonomical definition of the hyena's relatives as he gave it in the *Historia animalium* [...] *quadrupedum viviparorum* of 1551. He was no longer fully convinced of his ingenious species equation of *Mantichora* = *Martiora* = *Leucrocuta* = *Leutrochoca* = *Corocotta* = *Maricorion* = *Maricomorion* = *Cirocrothes* = *Cirotrochea* = *Crocuta*. Of course, the reduction of species based on the identification of transmission or scribal errors retained its value. But the finding of the Augsburg *Papio* was for Gessner proof that the ancient descriptions of the hyena were incorrect, or at least questionable: 'It seems that the ancients blurred in their descriptions the *Hyaena, Crocuta, Crocotta* (sic), *Leucrocuta*, and *Mantichora* or *Mantiora* (sic)'.[191] He used as a new clue Porphyrius's remark that 'the Indians call the hyena *Crocuta*'.[192] If the *Crocuta* is a hyena, and the hyena is the Augsburg *Papio*, the *Crocuta* cannot possibly be the same as the *Leucrocuta* and the *Mantichora* (or *Mantiora/Martiora*). And furthermore, there seemed to be certain differences between the Augsburg *Papio* and the ancient descriptions of the *Crocuta*.

Thus, Gessner rearranged his classification. He split the species *Hyaena* into two subspecies: 1) a smaller and less dangerous one he identified with the Augsburg *Papio* and located in Syria, and 2) a stronger and very dangerous one he ascribed to Ethiopia and India, and identified with the *Crocuta* or *Crocotta* (sic). This second subspecies he gave a new name: *Hyaena Indica* or *Hyaena Aethiopica*.[193] In the framework of this new taxonomical arrangement,

189 Ibidem, pp. 76–77.
190 Ibidem, p. 77.
191 Ibidem, p. 78.
192 Ibidem.
193 Ibidem.

Gessner was no longer convinced that the *Hyaena Indica* or *Hyaena Aethiopica* or *Crocuta* was a hybrid. He says that it is '*if it were* a composite animal from wolf and dog', which means: a species of its own. It is bigger, stronger, more cruel, and more voracious than both wolf and dog, with an extraordinary power of its jaws to crush bones.

Gessner still denies the hyena's ability to produce human sounds. But he now corrects his former erroneous morphological description, which stated that the hyena would lack vertebrae of the neck and would have instead a long, single bone. Gessner rightly states: 'I believe that all animals who have a proper neck, also possess vertebra's'.[194] Nevertheless, Gessner did not give up the idea that hyena hybrids or hybrid species existed. He (still) lists the *Thos* as a hybrid from female hyena and male wolf,[195] and adds even another hybrid: the *Onolycus* or *Monolycus*, brought forth from the same combination of species. In the second edition of the *Icones animalium*, Gessner does not add new information to the *Leucrocuta*, and *Mantichora* or *Mantiora*. This does not mean that he entirely abandoned these or similar hybrid species by now; it was probably caused solely by the fact that he had no new information, and no (new) image to offer. For example, in the second edition of the *Icones animalium* Gessner included a hybrid from man, cock, and carnivore that was caught in 1531 in the bisdom of Salisburg (Salzburg in Austria) [Fig. 2.21], or an ape-like monster called *Satyr* [Fig. 2.10].


pilis latiùs fusis à reliquis differunt.

CERCOPITHECI seu Cepi Satyríue genus, (nam & Satyri inter Simias sunt, & Cepi faciem esse tanquam Satyri Strabo scribit,) cuius imaginem ex Germanico quodam libro descriptionis Terræ sanctæ mutuati sumus.

GERMAN. Ein wunderbare Affen oder Meerkatzen art/welche wir also conterfetet gefunden haben in einem Teütschen getruckten bůch von dem Heiligen land/&c.

De hac aut simili bestia sensisse uidetur Cardanus, cum scribit: Est & formæ rarae Cercopithecus, magnitudine & forma hominis. cruribus siquidem, uirili membro, facie, dicas hominem agrestem, quia totus est pilo obsitus. Nullū animal perseuerat plus stando illo, homine solo excepto. amat pueros & mulieres, non secus ac homines suæ regionis: conaturq; cum uincula effugerit, palàm cum his concumbere, quod nos uidimus.

FIGURE 2.10 *Gessner's* Satyr=Cercopithecus=Cepus. *From: Gessner*, Icones animalium (*2nd ed., Zurich, Christoph Froschauer: 1560*), *p. 95.*

194 Ibidem.

195 Ibidem, pp. 77–78.

The New Species of the New World, Their Effect on Taxonomy, and Theological Problems Related to Them: Nieremberg and Kircher

Neither Wotton (1552) nor Franzius (1612) nor Della Porta (1558; 1590) included the newly discovered species of the Americas: Franzius because his main focus was biblical exegesis and preaching with biblical examples; Wotton because he focused solely on Aristotle and the ancient writers; and Della Porta because he offered a manual for cross-breeding for Europeans. However, the species of the New World were inevitably there, and to an increasing degree they found their way into contemporary geography, history, travel accounts, scholarly and other correspondence, and zoology.[196] In zoology, for example, Gessner had described and depicted a couple of them in his *Icones animalium* (1560), such as the llama [Fig. 2.11], armadillo, Sagoin (small Brasilian monkey), sloth [Fig. 2.12], guinea pig [Fig. 2.13], and *Su*.

FIGURE 2.11 *The llama* (Allocamelus Scaligeri). *From: Gessner*, Icones animalium (*2nd ed., Zurich, Christoph Froschauer: 1560*), *p. 43.*

196 Cf. Asúa M. De – French R., *A New World of Animals. Early Modern Europeans on the Creatures of Iberian America* (Aldershot: 2005); George W., "Sources and Background to Discoveries of New Animals in the Sixteenth and Seventeenth Centuries", *History of Science* 18 (1980), 70–104; Mason P., *Before Disenchantment: Images of Exotic Plants and Animals in the Early Modern World* (London: 2009); idem, *Infelicities. Representations of Exotic* (Baltimore – London: 1998); Morison S.E., *The European Discovery of America*. 2 vols. (New York: 1971–1974); Salas A.M., *Para un bestiario de las Indias* (Buenos Aires: 1985).

FIGURE 2.12 *The sloth* (Haut). *From: Gessner*, Icones animalium (*2nd ed., Zurich, Christoph Froschauer: 1560*), *p. 96.*

FIGURE 2.13 *Guinea pig* (Cuniculus Indicus). *From: Gessner*, Icones animalium (*2nd ed., Zurich, Christoph Froschauer: 1560*), *p. 106.*

For early modern Europeans, these new animals formed more than a little bit of a problem for animal classification. How should one define species that were hitherto unknown, and how should one explain their existence? According to the common Christian dogma, and the *communis opinio*, God was responsible for the species and had created them at the origin of all life, viz. when he had created heaven and earth and man (as it is described in *Genesis*); and he had created them in the Earthly Paradise, which was located in the "Old World", in Asia Minor. From this perspective, it was not easy to understand why the animals/species of the New World differed greatly from the Old World. People were not inclined to assume that God had created a whole set of animals a second time,

in another place. It was commonly accepted that the species originated from a single act of creation, and from the Paradise they spread all over the world. But obviously there were a large number of animals in the New World that did not appear in the Old World. How come? The concept of hybridisation was a possible answer, and so was the concept of *generatio spontanea*. Via interspecific hybridisation of the well-known "old" species, new species could come into being. If one argued along these lines, the miraculous thing was, of course, that a whole fauna of hybrid species opened up to eyes of the Europeans. The *generatio spontanea* was another means to explain the existence of the strange animals. *Generatio spontanea* could take place at any place, at any time, and it could bring forth animals that were hitherto unknown. Since the *generatio spontanea* was considered to be created by God, it was theologically acceptable. The problem was only that it normally related only to small and very small species, such as insects, toads, moles, and mice. It was difficult to believe that it brought forth animals such as the armadillo, jaguar, sloth, and llama. Another great problem was the big Flood, one of the major events of *Genesis*. According to the Bible God had decided to kill all life and to preserve only good man (Noah and his family) and pairs of the known animal species on Noah's ark. When the water receded, the ark landed on the mountain of Ararat (Ağrı Dağı) in Turkey, and the preserved animals procreated immediately (it was springtime) and spread themselves again over the whole earth. If God had created the rare American animals in his original creation, how did they get into Noah's ark, and then, after the Flood, back to South America? Almost all quadrupeds were unable to swim long distances, let alone over the ocean. If they were unable to cross the ocean, how could they have survived? It was generally accepted that no quadrupeds survived the Flood except the species taken by Noah into his ark. Possible answers were, again, hybridisation and spontaneous generation, but the problems remained the same as they were with respect to the original creation. There were even more problems with hybridisation: was it foreseen by God when he created the species? Did he not explicitly forbid it, as (seemingly) indicated in the Bible (*Leviticus* 19, 19)? If hybrids do not belong to God's creation, they must be "contra naturam". Were they sinful? Did they come into existence after the fall of Adam and Eve?

Angels, the Guardians of the American Species: Nieremberg's *Historia naturae, maxime peregrinae* (1634/1635)

Juan Eusebio Nieremberg, S.J. (1595–1658), a theologian, prolific author of devotional treatises and various scholarly works, and a professor who for many years taught natural history and humanities at the Colegio Imperial Royal at

Madrid,[197] wrote an impressive natural history focusing on exotic regions, especially the New World: *Historia naturae, maxime peregrinae*.[198] Nieremberg believed in both hybrid speciation and spontaneous generation.[199] In his opinion, neither was "contra naturam"; both were part of God's creation,[200] and hybrids were not sinful. His main argument is fertility. If hybrids are fertile, it is proven that they are part of God's creation.[201] Fertility is a gift of God and can only belong to the godly created nature. Accordingly, he was not inclined to believe that hybridisation was invented by man—for example, by Ana—as the Bible seems to tell us. Nieremberg uses Bible philology to contradict the widespread opinion that Ana was the inventor of cross-breeding. In a

197 For Nieremberg, cf. Calvo M.J.Z., "Muerte, alma y desengaño: las obras latinas del padre Nieremberg", *Revista de Humanidades: Tecnológico de Monterrey* 21 (2006) 15–121; Didier H., *Vida y pensamiento de Juan E. Nieremberg* (Madrid: 1976; original ed. in French 1974); and Pérez Goyena A., "Juan Eusebio Nieremberg y Otin", in *Catholic Encyclopedia* 11 (1913). Nieremberg joined the Jesuit order in 1614. Among the devoted treatises he composed before his natural history are *Sigalion sive de sapientia mythica* (Madrid: 1629); *De adoratione in spiritu et veritate* (Antwerpen: 1631)*; De arte voluntatis* (Lyon, Laurentius Anisson: 1631); *De la afición y amor de Jesus*, and *De la afición y amor de María* (both Madrid: 1632); *Vida Divina y Camino Real de Grande Atajo para la Perfección* (Madrid: 1633); *Libro de la vida de Jesús crucificado, impreso en Jerusalén con su sangre* (Barcelona: 1634). Among his works as a naturalist and natural philosopher are: *Prolusión a la doctrina e historia natural* (Madrid: 1629); *Curiosa Filosofía y cuestiones naturales* [. . .] (Madrid: 1630); *Oculta Filosofía* (Barcelona: 1645); *Curiosa y oculta filosofia: primera y segunda parte de las maravillas de la naturaleza, examinadas en varias questiones naturales* [. . .] *Tercera impression añadida por el mismo autor* (Alcalá, María Fernández: 1649); *Obras filosóficas del Padre Juan Eusebio Nieremberg* (Madrid: 1664).

198 *Historia naturae, maxime peregrinae* (Antwerp, Balthazar Moretus: 1635); for Nieremberg's zoology, cf. De Asúa – French, *A New World of Animals*, the passage on "Juan Eusebio Nieremberg and his *Historia naturae maxime peregrinae*" 162 ff.

199 *Historia naturae, maxime peregrinae*, esp. book V, chapt. 21, pp. 88–89; chapt. 24 "De adulterinis animalibus", pp. 90–91, and book VI, chapt. 8, p. 95 "De spontanea genesi animalium".

200 Ibidem, pp. 88–89.

201 Esp. book V, chapt. 21 "An ulterinae naturae a Deo conditae in prima productione": 'Mihi videtur lis simili dirimenda regula qua usus sum in sponte genitis animalibus: si quae omnino sterilia sunt, nulla naturae vi producere genus suum valentia, ista opinor tum non erupisse, cum divinae benedictionis, secundantis naturas, sint expertia; quae autem effeta visa, absque dubio effusa pridem a terra fuere [. . .]' ('In my opinion, this question should be solved according to the same principle I applied to the question of spontaneous generation. If certain animals are completely sterile, and are unable to procreate in a natural way, they were, as I think, no part of the creation, since they lack God's benediction which favours nature. Fertile animals, however, doubtless belong to the creation [. . .]').

Hebrew version the Bible has that Ana 'brought his donkeys to the horses (jemin)'; Nieremberg argues that the correct Hebrew text should not be 'jemin' ('horses'), but 'jamin' ('waterholes'); and that 'jamin' would make much more sense because Ana lived in the desert,[202] ergo: 'Ana brought his donkeys to the water holes'. Thus, cross-breeding is not an invention by man, but part of nature or of God's creation.

In this vein, Nieremberg welcomes a considerable number of "Old World hybrids" as part of God's creation: the *Leopard*, the *Lynx* (brought forth by male wolf and hind [*cerva*]),[203] the *Arcadian dog* or *Indian dog* (a cross-breeding of female dog and male tiger), the *Bactrian Camel* (*Camelus Bactrianus*, brought forth by camel and wild boar), the *Hippelaphus* (cross-breeding of horse and deer), and the *Leontomix* (brought forth by female dog and lion).[204] Their partly horrifying appearance is no proof that they were conceived in sin, although Nieremberg calls them 'adulterous animals'. Original sin is no prerequisite for hybridisation.

After this strong argument in favour of hybridisation one might expect that Nieremberg would primarily use this concept to describe the species of the New World. Interestingly enough, this is not the case. In general, he acknowledges the unknown and strange animals as *species in their own right* (!), without depicting them as a mixture of different parent species. This is, of course, a great achievement in the field of taxonomy. Nieremberg even installs them with a proper name, mostly more than one. This is because he normally first mentions their Indian name. In this way, a big number of new species with new, strange names occur: the *Ocotochtlo*, a smaller feline of South America; the *Ocelot* (rendered in Latin by Nieremberg as '*Pinuum dasypos*', mod. *Leopardus pardalis*);[205] the *Hoitzaquatzin* (one of the *Ererhizontidae* species);[206] the *Tlaquatzin*, a species of the large *Opossum* family (mod. family name: *Didelphidae*),[207] a large order of marsupials common in North and Central America; the *Aiatochtli* or *Tatou* (the Armadillo);[208] the Haut (Sloth);[209] and so on.

202 Ibidem, p. 89.

203 Both ibidem, p. 88.

204 All ibidem, p. 89.

205 Ibidem, IX, 1, p. 153. The ocelot lives in the rainforests of the middle and northern parts of South America, and further those of Central America, as well as some parts of Mexico, in 10 subspecies. Its length varies from 68 to 100 cm, its weight from 8 to 18 kg.

206 Ibidem, IX, 2, p. 154.

207 Ibidem IX, 4, p. 154.

208 Ibidem, IX, 6, p. 158 ff.

209 Ibidem, IX, 13, pp. 163–166.

According to Nieremberg, they were all part of God's creation. But if so, how did they come to South America? Nieremberg's answer is: they were brought by God's angels.[210] He points to the fact that not all animal species are present in all of the countries all over the world. For example, the *Sphinx*, the *Cepus*, the Giraffe, and the even-toed wild horses live only in Africa.[211] Thus, God's angels must have brought them from Paradise to their proper regions, in this case Africa. When the Flood came, the angels took action again and brought a number of exemplars of the various "regional" species to the ark. After the Flood was over, the angels flew them back to South America, Africa, and other faraway regions. In Nieremberg's zoology, angels function as a kind of powerful, large airplanes that unite the continents, especially to regulate the fauna and flora. Nieremberg calls the angels the guardians of the natural species ('angelos *specierum naturalium* custodes').[212] Without the angels, many species would have been extinguished. There is also a second variant, in which, however, the angels play the same role. This is connected to the climate theory, according to which different climatic zones bring forth different faunas and floras. In this variant, the South American species ori.ginated from the Old World species. The angels transported Old World species to America: under the influence of a totally different environment they changed into new variants, sometimes even new species. The angels would eventually offer the new species a return ticket to Noah's ark.

In taxonomy, the acknowledgement of a number of unknown South American animals as new species was an important development. But perhaps equally important is the fact that the unknown creatures sharpened Nieremberg's sense for *common elements* and stimulated him to construct *families* of animals, which united a number of *species*. For example, he brings together nine species of 'dasypodes' in one family:[213] the *Pactli, Elitactochtli, Tuitlatepolli, Tocanthochtli, Quanutochtli, Metochtli, Cacatochtli, Tuitlatepolli alter*, and *Hapaztochtli*. The same goes for, among others, the *Felidae*, of which Nieremberg constructs certain groups, such as "leones Indici", "animalia leoni affinia", or "leonum parvorum feliumque genus".[214] In a sense, the last family resembles the modern classificatory category of the *smaller Felidae*. But, of course, Nieremberg's "families" are not always similar to the families of

210 Ibidem V, 27, p. 91.
211 Ibidem V, 28, pp. 91–92.
212 Ibidem V, 27, p. 91.
213 Ibidem IX, 7.
214 Ibidem, IX, 21–22, p. 169.

modern taxonomy. The modern *Dasypodidae* family lists 20 or 21 *armadillo* species, whereas Nieremberg's 'dasypodes' primarily collect various relatives of the 'Cuniculus Indicus', or the guinea pig.

Interestingly, although Nieremberg frequently applied a classificatory system of "family" and "species", he nevertheless also used the concept of hybridisation for the description of certain New World species. This goes, for example, for the cougar (*Puma concolor*): Nieremberg interpreted this species as a hybrid of lion (mod. *Panthera leo*) and leopard (mod. *Panthera pardus*).[215] Here we get an interesting glimpse of his application of empirical evidence. Nieremberg narrates that a pregnant 'Indian lion' (i.e. cougar) was killed by Indians. When its belly was cut open it turned out that the cubs' fur had a stippled pattern similar to that of a leopard's. Nieremberg regarded this as proof that the father of the whelps was a panther, and thus proof of the animal's hybridity. Whereas Nieremberg classified the frequently misinterpreted giraffe and zebra as species of their own,[216] in his description of American species he included a number of new hybrids: the *Macamitzli*, a hybrid of lion and deer (Lion-deer); the *Cuitlamitzli*, of lion and wolf (Lion-wolf);[217] the *Tlalmitzli*, of a small wildcat and a lion; and the *Su*, a monstrous hybrid creature with the features of lion, man, and squirrel [cf. Fig. 2.14],[218] but possibly inspired by one of the *Opossum* species. The illustration presented in Nieremberg's zoology suggests that the *Su*'s whelps greatly resemble squirrels, whereas the grown-up animal more closely resembles the lion. This illustration of the *Su* had already been published in a zoology more 70 years earlier, in the second edition of Gessner's *Icones animalium* (1560), in the appendix ("additiones").[219] In the German edition of the *Icones animalium* of 1563, in the *Thierbuch*, it was even used as the title page illustration [Fig. 2.14].

215 IX, 21 "De leonibus Indicis", p. 169.

216 IX, 72, p. 191: "De graffa" [sic]. According to Nieremberg, the animal lived (only) on the island of Zanzibar; in chapter IX, 17, Nieremberg argues that the zebra could not be a mule-like hybrid, as many supposed, because the animal was extraordinarily fertile: 'parit quotannis, unde et maxima habetur copia' ('it [the zebra] gives birth each year, and that is why there is an enormous amount of them').

217 IX, 21, "De animalibus leoni affinibus", p. 169.

218 IX, 74 "De su animali", p. 189.

219 P. 127.

FIGURE 2.14 *The* Su. *From: Gessner, Title page of the* Thierbuch (*Zurich, Christoph Froschauer: 1563*).

The Flood and the Survival of the Species: Athanasius Kircher's *Arca Noe* (1675)

A major achievement of Nieremberg's *Historia naturae* was the inclusion of the American species in animal classification; a less strong point was the explanation of how the American species came to the ark and then went back to their continent (by God's angels). The Jesuit polymath and universal scholar Athanasius Kircher (1602–1680),[220] who had taught mathematics, physics,

220 On Kircher, cf. Findlen P. (ed.), *Athanasius Kircher: The Last Man Who Knew Everything* (New York: 2004); eadem, "Science, History, and Erudition: Athanasius Kircher's Museum at the Collegio Romano", in Stolzenberg D. (ed.), *The Great Art of Knowing: The Baroque*

and Oriental language at the Collegio Romano (from 1638 on), focused his zoological thinking on the problem of the ark. In his *Arca Noe* (1675) he tried to explain which species survived in which ways.[221] Kircher was not inclined to give to the animals of the New World an important status. His zoological thoughts, in fact, are more oriented toward the animals of the Old World. In general, his zoology is very much determined by a Europe-centred, imperialistic ideology. He was not interested in a differentiated taxonomical system like some of his early modern forerunners were, including Wotton, Aldrovandi, and Nieremberg; nor did he aim at a full description of the singular species as offered by Gessner, Aldrovandi, Nieremberg, and Jonston. With the quadrupeds, Kircher's way of ordering the animals very much resembles Pliny's: from larger to smaller species. Kircher starts with elephant and camel,[222] and ends with weasel, rat, hedgehog, and small monkeys (*cercopitheci*);[223] Pliny started with the elephant, and he ended with the mouse. Furthermore, Kircher divides the quadrupeds into a number of subcategories, such as carnivores vs. plant-eaters; land animals vs. water animals and amphibians; hybrid species;[224] and 'clean' ('mundi') vs. 'unclean' ('immundi') species. These subcategories, however, were not based on morphology or physiology, but according to their keeping on the ark. For example, it seemed wise to separate the plant-eaters from the carnivores, the small and harmless animals from the big and dangerous species, and the clean from the unclean species. For Kircher, taxonomy was

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Encyclopedia of Athanasius Kircher (Stanford – Fiesole: 2001); Godwin J., *Athanasius Kircher's Theatre of the World* (London: 2009); idem, *Athanasius Kircher. Ein Mann der Renaissance auf der Suche nach verlorenem Wissen* (Berlin: 1994); Fletcher E. (ed.), *A Study of the Life and Works of Athanasius Kircher, "Germanus Incredibilis": With a Selection of His Unpublished Correspondence and an Annotated Translation of His Autobiography* (Leiden: 2011); Merrill B.L., *Athanasius Kircher (1602–1680), Jesuit Scholar* (Brigham Young University Library: 1989); Leinkauf Th., *Mundus combinatus. Zur Struktur der barocken Universalwissenschaft am Beispiel Athansius Kircher, S.J. (1602–1680)* (Berlin: 1993).

221 *Arca Noe in tres libros digesta* [...] *quae omnia nova methodo necnon summa argumentorum varietate explicantur et demonstrantur* (Amsterdam, Johannes Jansonius: 1675, first and only edition); for Kircher's work, cf. De Asúa – French, *A New World of Animals* 170 ff., the passage "Athanasius Kircher: Noah's Ark, a Wonrous Museum and Animal Magnetism"; Cameron A.D., *The Legend of Noah: Renaissance Rationalism in Art, Science, and Letters* (Illinois U.P.: 1963), and for Kircher's palaeontological views, S.J. Gould, "Father Athanasius on the Isthmus of a Middle State: Understanding Kircher's Paleontology", in Findlen (ed.), *The Last Man Who Knew Everything* 207–238.

222 Ibidem, p. 57.

223 Ibidem, pp. 65–67.

224 Ibidem, pp. 49 and 56; hybrid species Kircher defines (p. 49) in the following way: 'quae ex diversarum specierum commixtione originem suam trahunt'.

not a goal in itself. Instead, he developed a number of strategies of zoological explanation that were connected to the ark and its logistics, and aimed at a certain efficiency with respect to the preservation of the species that were part of God's original creation. These strategies were, among others, a maximised *generatio spontanea*, maximised hybridisation and hybrid speciation, and an emphasis on climate theory.[225] If certain species were able to procreate via *generatio spontanea* or hybrid speciation, it was not necessary to take them into the ark.[226] For example, Kircher thought that all insects and most of the reptiles, but also mice, moles, frogs, and other small creatures, came into being via *generatio spontanea*. Thus, he excluded all insects and most reptiles from the ark.[227] Whereas the Bible had mentioned *expressis verbis* the *reptilia* as legitimate passengers, Kircher excludes most of them. He authorises this by 'experiments' of *generatio spontanea* he had presented in his work *De mundo subterraneo*.[228] According to Kircher, all parts of the body of snakes and reptiles contained sperm. If one cuts a snake into small parts, after a few days small worms will creep out of the flesh. The kind of proof he offers (experimental) seems to suggest scientific progress; his conclusions, however, do not point in that direction.

Furthermore, Kircher excluded from the ark species he identified as 'hybrid' (= 'ex diversarum specierum commixtione'). Interestingly, he considered the number of hybrids to be *unlimited*, and thought that India and the New World especially had an abundance of them.[229] He discussed only a relatively small number of them[230]—among others the giraffe,[231] the *Leucrocuta*,[232] the leopard, the *Tragelaphus*, the *Hippelaphus*,[233] and the Horse-panther or Panther-horse

225 On the climate theory, ibidem 49–50.

226 Cf. book I, chapt. 3 "De omnibus et singulis speciebus, Animalium Quadrupedum, quae in Arcam introduci debeant", ibidem, p. 47 ff.

227 On the exclusion of insects, ibidem, pp. 51–52; on the exclusion of reptiles and Kircher's idea that most of them procreate via *generatio spontanea*, ibidem, p. 52 ff.

228 Ibidem, p. 53.

229 Ibidem, p. 67: 'Cum infinitae propemodum animalium species sint ex promiscuo diversarum specierum coitu productae, illas omnes intra Arcam introductas non est verisimile […]' ('Because there are an endless number of species brought forth from the mating of different species, it is not likely that they all were taken into the Ark').

230 Ibidem, pp. 67–73.

231 *Arca Noe*, p. 68 'Animal ex pardo and camelo natum' ('An animal born from a panther/leopard and a camel').

232 Ibidem, p. 70.

233 All three ibidem, p. 68.

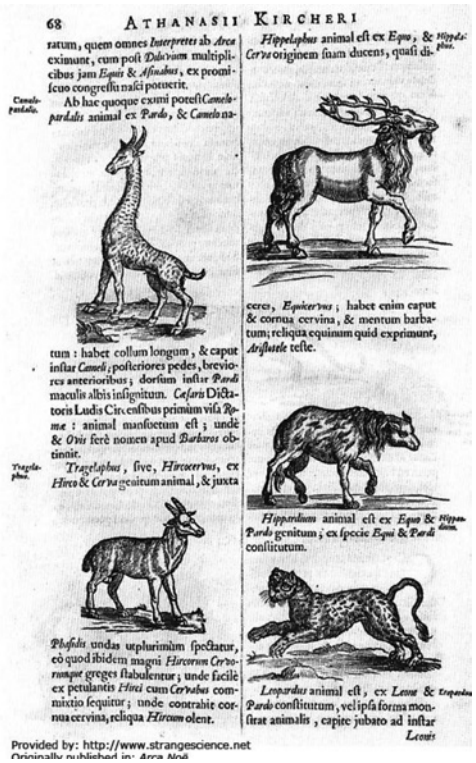

FIGURE 2.15 *Selection of Kircher's hybrids. From: Athansius Kircher,* Arca Noe (*Amsterdam, Johannes Jansonius: 1675*), *p. 68.*

(*Hippardium*)[234]—but he seems to have used them more or less only as a kind of exemplary evidence [Fig. 2.15]. Apparently he considered the kind and the number of combinations of species to be unlimited: carnivores might mate with plant-eaters, land animals with water animals, and very large species (such as the camel) with much smaller ones (such as the panther). Are hybrids "contra naturam", or are they part of nature? Kircher does not answer this question explicitly. But since he considered their number so big—before and after the Flood—it is clear that he must have accepted hybridisation as an important means of procreation, and thus of God's creation. What God created in this respect was, however, only the power and potential

234 Ibidem: 'Hippardium est animal ex equo et pardo natum' ('The Hippardium is an animal born from a horse and a panther/leopard').

to procreate "inter species", not the various hybrids themselves. According to Kircher, God has created exclusively 'pure' and 'perfect' species; the hybrids had come into existence later on, mostly 'per coitum'.[235] The manner of presentation also suggests that Kircher considered the hybrids as species (not as singular results of hybridisation), and thus to be fertile. It is a telling fact that Kircher considered a large number of the animals of the New World as hybrid species;[236] this was, of course, one of the instruments used to explain their existence, and at the same time a means to devaluate them as 'imperfect' and 'impure' species. For example, Kircher regarded the *Armadillo* as a hybrid of hedgehog and turtle (!), and the *Marmota* (*Alpine Marmot*) one of badger and squirrel.[237] Sometimes Kircher lists a New World animal among the hybrids, although he could not say what its different "species parents" were, for example the *Corcobado* (i.e. the American Bison, mod. *Bison bison*). In such cases, Kircher ascribes the strange, in his eyes degenerated, features of the animal to influences of climate and environment.[238]

Indeed, another way of reducing the new species to a minimum was the *climate theory*. According to this traditional model of biological explanation the climate zones were of pivotal importance to the fauna. Climate was supposed to influence the kind, size, and shapes of the animals. Kircher applied this stratagem in the following way: the "true" and real species belonged only to the moderate climate zone of the Old World; they originated in God's creation, which took place in the ideal climate of Paradise. God ordained to the animals to spread all over the world. In other, more extreme climate zones, however, the species took on different features: under the influence of different environmental and living conditions, the animals changed their features and habits.

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235 Ibidem, p. 67 ff.

236 Ibidem, pp. 69–70.

237 Ibidem.

238 Ibidem, p. 70: 'Ego sane non facile assererem, id ex diversae speciei congressu natum, sed esse bovinae speciei animal, vel coeli influxu peculiari, aut climatis locique natura, uti fere omnia animalia Americae, in hanc formam transmutatum fuisse' ('[In this case] I could not easily make plausible that the animal was brought forth by the mating of two different species, but rather [I could argue] that the animal [bison] belongs to the species of the *Bovinae*, and that it had changed its form either by the influence of the stars or by the character of the region or the climate, as have almost all the species of America'). Ironically, in the evolutionary history of the *Bison bison*, cross-breedings between various species of *Taurids* and *Bisonids* play an important role. Cf. "Maternal and Paternal Lineages in Cross-Breeding Bovine Species. Has Wisent a Hybrid Origin?", in Mbe.oxfordjournals.org. 2004-01-22; Groves C.P., "Systematic relationships in the Bovini (Artiodactyla, Bovidae)", *Zeitschrift für Zoologische Systematik und Evolutionsforschung* 4 (1981) 264–278.

For example, the cow, transferred to North America, became a bison, and in Scandinavia an elk; the European wolf, transferred to the high North, became a '*gulo*' (i.e. the wolverine, glutton, or skunk bear, mod. *Gulo gulo*);[239] in the New World, the dog (*canis*) lost its hair; the birds changed their colours; etc.[240]

In this way, Kircher frequently explains the new species of the New World as "adaptations" of the old, godly created species to a different environment. Therefore, he considered it unnecessary to take American species on the ark. However, Kircher does not give a positive judgement on the new species: it is true that they represent a kind of adaptation, but more for the worse than for the better. Instead of adaptation, Kircher frequently uses the term 'degeneration'. When the sheep came to the New World it changed its features in such a way that you cannot recognize the animal anymore: it 'degenerated' to such a degree that it got a bump.[241] When they came to the far North, many species became white. It is a telling detail that Kircher considered this clever adaptation of nature as *degeneration*, viz. a *loss* (of colour). For example, for a bear brown would be the appropriate colour; the Polar bear with his white hair Kircher considered to be a degeneration of the European brown bear. Since for Kircher adaptation also meant degeneration,[242] he did not consider it worthwhile to keep the mutated species. When the Flood came, at least in Kircher's zoology, all of the hitherto 'adapted' American species died. When the Flood was over, the old species wandered back into the Americas, and once more they underwent a metamorphosis into newly 'adapted' species.

But how did the animals reach South and North America? Here Kircher preferred a more "natural" explanation than Nieremberg's guardian angels. He combines three explanations: 1) by swimming from the continent to an island, and from one island to the other; 2) through land bridges or isthmuses; and

239 Ibidem, pp. 50 and 71. The wolverine or *Gulo gulo* indeed lives in the Northern hemisphere (Canada, Northern Europe, Russia). He belongs, however, to the family of the *Mustelidae* (weasels), not to the wolves (species *Canis lupus*) or to the family of the *Canidae*. Apparently Kircher did not know that the wolf (*Canis lupus*), especially in its subspecies the Eurasian wolf (*Canis lupus lupus*), also populated the most Northern regions of Europe and Russia, and that its population in the Northern regions in the 17th century was already much denser than it was in the mild or hot climate zones.

240 Ibidem, p. 49.

241 Ibidem.

242 For 'degeneration' in the species debate cf. Smith J.E.H., "Degeneration and Hybridism in Early Modern Species Debate: Towards the Philosophical Roots of the Creation-Evolution Controversy", in Wolfe Ch.T. (ed.), *Monsters and Philosophy* (London: 2005) 109–130.

3) brought by human beings on ships.[243] Of course, in 1675 the whole world was not perfectly mapped out, and it was still possible for new islands to be discovered. Obviously, Kircher thought that there might be more islands and land bridges than hitherto known.

Like those of many others, Kircher's zoological thoughts were inspired by and centred around theology. He tried to explain in which ways the Flood determined the species as they occurred in his time. Of course he was still far away from Darwin, and evolution was not yet one of the basic paradigms of zoology. Nevertheless, theological thinking brought him to the concept of 'adaptation' of species as an answer to environmental circumstances, which is fundamental to evolutionary theory. Also, the idea of migration of species via land bridges perfectly fits with modern zoology. For example, the *Felidae* are thought to go back to one single ancestor (*taxon*) who lived some 10–15 mio. years ago and originated in Asia; from there, he spread across continents via land bridges (e.g. the Panama land bridge), with the exception of Australia, of course. Would it be adequate to regard Kircher's zoology—in comparison with that of his forerunners—as progressive? This is not entirely plausible. First, one must take into account the importance he attached to the concepts of hybridisation, hybrid speciation, and *generatio spontanea*. Whereas some of his forerunners—such as Franzius, Aldrovandi, Nieremberg, and Jonston—did their best to restrict hybridisation and hybrid speciation, Kircher acknowledges 'countless' hybrid species. That he even lists the giraffe among the hybrids has more the flavour of an old-fashioned, outdated zoology. Whereas Franzius did not believe in *generatio spontanea*, Kircher maximised it as a relevant way of procreation. Whereas in modern evolutionary theory *adaptation* is seen as "the" means to make a species better, fitter, and stronger, Kircher devalued it as 'degeneration' from the supposedly "true", i.e. godly created, species. In sum, a mixed picture emerges that does not favour a teleological approach, if one looks at the history of early modern zoology. With respect to his main paradigms, Kircher has firm roots in medieval thought, especially with his emphasis on unlimited hybridisation.

243 Ibidem, p. 196. On Kircher's isthmus theory, cf. S.J. Gould, "Father Athanasius on the Isthmus of a Middle State: Understanding Kircher's Paleontology", in Findlen (ed.), *The Last Man who Knew Everything* 207–238.

Extended Range of Hybridisation: More Philosophical and Theological Explanations, and Early Modern Treatises on Monsters

So far, we have dealt with the paradigm of hybridisation via coitus, i.e. the mating of different species, and also marginally via *generatio spontanea*, and we have also observed in which ways Aristotle's limitation "rules" of hybridisation (only between closely related species, species of a similar size, and species with the same length of pregnancy) were applied, creatively adapted, or ignored. But in the early modern period, as well as in the Middle Ages, many naturalists went far beyond these Aristotelian limitations. Not in the least because of Aristotle himself, by his theory of *prenatal epigenesis*: the idea that the distinctive features of a species emerge only during the pregnancy, in the development of the embryo and foetus. Aristotle thought that the egg develops from formless *materia* to a complex, specific organism. In medieval scholasticism *prenatal epigenesis* was a widely respected theory. Most importantly, *prenatal epigenesis* allowed acceptance of a very broad spectrum of variants of organisms or hybrids.

Medieval thinkers and zoologists have elaborated much upon the reasons behind hybrids, monsters, and prodigies.[244] Albertus Magnus (d. 1280), the author of an important zoology,[245] gave a number of reasons:[246] poor disposition of the *materia*, which lacks corrective resistance and simply takes over the formative quality of the sperm; insufficient sperm, which fails to transmit its formative quality; inharmonious division of the humours (*improportionalitas qualitatum*); imaginations of the mother animal; or the influence of the

244 Verner L., *The Epistemology of the Monstrous in the Middle Ages* (New York – London: 2005); Williams D., *Deformed Discourse. The Function of the Monster in Medieval Thought and Literature* (Exeter: 1996); Wilson D., *Sign and Portens. Monstrous Births from the Middle Ages to the Enlightment* (London – New York: 1993); Kappler C., *Monstres, démons et merveilles à la fin du Moyen Age* (Paris: 1980); Cohen J.J., *Hybridity, Identity, and Monstrosity in Medieval Britain: On difficult Middles* (New York: 2006); idem, *Of Giants. Sex, Monsters, and the Middle Ages* (London: 1999); Gravestock P., "Did Imaginary Animals Exist?", in Hassig D. (ed.), *The Mark of the Beast. The Medieval Bestiary in Art, Life, and Literature* (New York: 1999) 119–135; South M. (ed.), *Mythical and Fabulous Creatures. A Source Book and Research Guide* (New York – London: 1987).

245 *De animalibus libri XXVI*; cf. Balss H., *Albertus Magnus als Biologe* (Stuttgart: 1947).

246 Cf. Roling B., *Drachen und Sirenen. Die Rationalisierung und Abwicklung der Mythologie an den europäischen Universitäten* (Leiden – Boston: 2010) (Mittellateinische Studien und Texte 42) 137–138.

stars.[247] Other naturalists also believed in the influence of demons. Albertus was convinced that the above-mentioned factors frequently led to hybridisation but denied that they automatically caused hybrid speciation.[248] However, Albertus Magnus's zoology, *De animalibus libri XXVI*, was full of hybrid species. Some of them went back to Pliny's *Naturalis historia*, but Albertus added a considerable number of new creatures as well: among others the *Martimorion* (cross-breeding of various species);[249] *Linciscus* or Dog-wolf (of male dog and female wolf);[250] *Hybris*, an hybrid of wild boar and pig; *Musinuo* ('ex capra et ariete'); *Cirinus* (of a woman and a billy goat);[251] *Onocentaurus* (of man and donkey);[252] *Orasius* (of deer and horse); *Pilosus* (of man and goat); and the *Papio* (of wolf and fox). In a marked difference to Pliny, Albertus also believed in hybrids of man and various animals, for example the Donkey-man (*Onocentaurus*), and the Goat-man (*Cirinus* and *Pilosus*). Albertus's *De animalibus libri* was widely used not only in the 13th and 14th centuries, but also in the age of Humanism, in the form of manuscripts and printed editions as well, and until the first half of the 16th century, it retained its status as an authoritative text. In the 15th and 16th centuries, it was available not only Latin editions, but also in vernacular translations, enriched with illustrations. It is a telling detail that on the title page of the 1545 edition two hybrids appear next to the "kings" of the animals (the eagle and the lion): the basilisk and a kind of Sea-wolf [Fig. 2.16]. Other medieval zoologists, such as the influential Avicenna[253] or Roger Bacon,[254] also believed in hybrids resulting from human beings and all kinds of animals. As a result, in scholastic physics hardly any limits in construing and describing hybrids remained. From the High Middle Ages on, almost every hybridisation was possible.

Interestingly, early modern zoology did not abandon the thoughts of the above mentioned Mediaeval thinkers, but continued to think along these lines. In the very period when early modern zoology flourished (1550–1675), there came into being a hype in the interest in monsters: a veritable science—

247 Albertus Magnus, *Physica*, ed. P. Hossfeld, 2 vols. (Münster: 1987), book II, tract. 3, cap. 3 (pp. 136–138).

248 Roling, *Drachen und Sirenen* 138–139: 'Keine neue Spezies entstand jedoch auf diese Weise, sondern [...] eine mangelhafte Kreatur [...]'.

249 Cf. *De animalibus*, Mantua 1479, fol. CCLXVIIr.

250 Ibidem.

251 All three ibidem, fol. CCLXVIr.

252 Ibidem, fol. CCLXVIIv.

253 *De natura animalium* (e.g. idem, *Opera philosophica* [Venedig: 1508]).

254 Roling, *Drachen und Sirenen* 139–140.

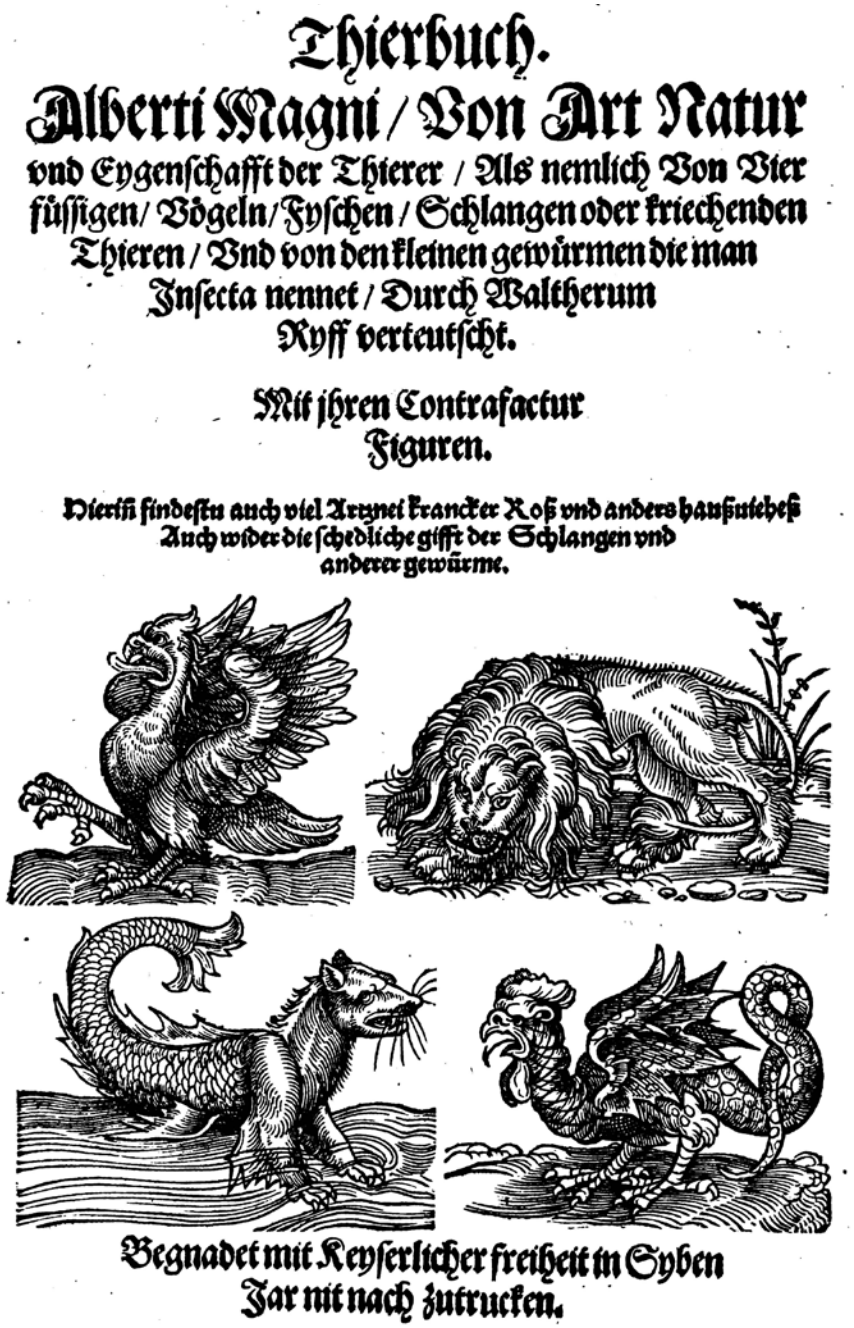

FIGURE 2.16 *The basilisk and the sea-wolf. Title page of Albertus Magnus*, Thierbuch (*1545*).

teratology—developed,[255] and extensive treatises on *monstra* were composed, e.g. Ambroise Paré's (1510–1590) *Le livre des monsters et prodiges* (1573),[256] Martin Weinrich's (1548–1609) *De ortu monstrorum commentarius* (1595),[257] Fortunio Liceti's (1577–1657) *De monstrorum natura, differentiis et caussis* (ed. pr. Padua: 1616),[258] or Ulisse Aldrovandi's (1522–1605) *Monstrorum historia* (1642–[1658])

255 Cf. Céard J., "Tératologie et Tératomancie au XVI[e] siècle", in Jones-Davies M.T. (ed.), *Monstres et prodiges au temps de la Renaissance* (Paris: 1980) 5–15; Calixte E., *Les monstres d'Ambroise Paré et la tératologie moderne* (Paris: 1946); Jones-Davies (ed.), *Monstres et prodiges au temps de la Renaissance*; Scarani P., "Aldrovandi e la teratologia", in Antonino B. (ed.), *Animali e creature monstruose di Ulisse Aldrovandi* (Milan: 2004) 44–55; Bates A.W., *Emblematic Monsters. Unnatural Conceptions and deformed Births in Early Modern Europe* (Amsterdam – New York: 2005); idem, "The Sooterkin Dissected: The Theoretical Basis of Animal Birth to Human Mothers in Early Modern Europe", *Vesalius* 9 (2003) 6–14; Caprotti E., *Mostri, Draghi e serpenti nelle silografie dell'opera di Ulisse Aldrovandi e dei suoi contemporanei* (Milano: 1980); Bithol-Hespériès A., "Monsters, Nature, and Generation from the Renaissance to Early Modern Period: The Emergence of Medical Thought", in Smith J.E.H. (ed.), *The Problem of Animal Generation in Early Modern Philosophy* (Cambridge: 2006) 47–64; Park K. – Daston L.J., "Unnatural Conceptions: The Study of Monsters in Sixteenth- and Seventeenth-Century France and England", *Past and Present* 91 (1991) 20–54; Park K., "Una historia de la admiración y del prodigio", in Lafuente A. – Moscoso J. (eds.), *Monstruos y seres imaginarios en la Biblioteca Nacional* (Madrid: 2000) 77–89; Ewinkel I., *De monstris. Deutung und Funktion von Wundergeburten auf Flugblättern im Deutschland des 16. Jahrhunderts* (Tübingen: 1995); Schumacher G.-H., *Monster und Dämonen. Unfälle der Natur. Eine Kulturgeschichte* (Berlin: 1996); Moscoso J., "Monsters as Evidence: The Uses of the Abnormal Body during the Early Eighteenth Century", *Journal of History of Biology* 31 (1998) 355–382.

256 *Les Oeuvres d'Ambroise Paré* (12th ed., Lyon, Jean Gregoire: 1664) pp. 644–701; modern edition by J. Céard (Geneva: 1971); cf. Calixte, *Les monstres d'Ambroise Paré et la tératologie moderne*.

257 Bratislava, Heinrich Osthaus: 1595.

258 Other editions appeared in Padua, 1634 (with illustrations), Amsterdam, 1665, and Padua, 1668; 1694; French trans. Leiden, 1708. For the work, cf. Bates A.W., "The *De monstrorum* of Fortunio Liceti: A Landmark of Descriptive Teratology", *Journal of Medical Biography* 9 (2001) 49–54; Zanca A., "Fortunio Liceti e la scienza dei mostri in Europa", in *Atti del XXXII Congresso nazionale della Società italiana di storia della medicina* (Padova-Trieste: 1985) 35–45; Roling, *Drachen und Sirenen* 140–146; for Liceti, cf. Agosto A. et al. (eds.), *IV centenario della nascita di Fortunio Liceti* (Rapallo: 1978); Ongaro G., art. "Liceti, Fortunio", in *Dizionario biografico degli Italiani* 65 (2005); Castellani C., "Le problème de la 'generatio spontanea' dans l'oeuvre de Fortunio Liceti", *Revue de synthèse* 89 (1968) 323–340; De Angelis S., "Zwischen Generatio und Creatio. Zum Problem der Genese der Seele um 1600—Rudolph Goclenius, Julius Caesar Scaliger, Fortunio Liceti", in Danneberg L. et al. (eds.), *Säkularisierung in den Wissenschaften seit der frühen Neuzeit* (Berlin – New York: 2002).

FIGURE 2.17 *Title page of Ulisse Aldrovandi*, Monstrorum historia [...] (*Bologna, Marcantonio Bernia – Nicolao Tebaldini: 1642*).

[Fig. 2.17].[259] These works were partly written by the same authors as the zoologies, by physicians and natural historians, and they belonged to the same discourse. Ulisse Aldrovandi held a professorship in Bologna, Fortunio Liceti held professorships for medicine and philosophy in Padua and Bologna, and

259 *Monstrorum historia cum paralipomenis historiae omnium animalium. Bartholomaeus Ambrosinus* [...] *composuit* (Bologna, Marcantonio Bernia – Nicolao Tebaldini: 1642 [–1658]); cf. Scarani, "Aldrovandi e la teratologia"; Antonino (ed.), *Animali e creature monstruose di Ulisse Aldrovandi*; Olmi G., *Ulisse Aldrovandi. Scienze e natura cinquecento* (Trento: 1976).

Ambroise Paré was royal surgeon to French kings.[260] The work on monsters demonstrated that the number of hybrid combinations was almost unlimited: they include hybrids of man and pig—or, more precisely, monk and pig [Fig. 2.18]; hybrid unicorns [Fig. 2.19]; the Calf-monk [Fig. 2.20]; and sometimes true *polyhybrids*, e.g. mixtures of man, bird, and carnivore [Fig. 2.21], or of donkey and bird [Fig. 2.22]. These works on *monstra*, of course, mostly deal with singular hybrids or teratogenic misfits and only rarely deal with new species, although some of them, such as the Calf-monk or Calf-man[261] and the Pig-man [Fig. 2.23], appeared more frequently. In the Middle Ages and the early modern period, most scholars ascribed to hybrids a greater fertility than is actually possible. Since Aldrovandi includes a number of monk hybrids, it may seem that he wanted to accuse them of immoral behaviour, and one may connect this with his Anabaptist sympathies. However, Aldrovandi was forced to renounce Anabaptist belief as early as 1549, and in his *Historia monstrorum* he actually interpreted the Calf-monk as a presage of Lutheran heresy.[262]

Newly discovered *monstra* appeared in works on zoology, and like those in the histories on *monstra*, they included well-known hybrid species or monstrous species of zoology, for example in Ambroise Paré's *Le livre des monstres et prodiges* from 1573, inter alia, the giraffe[263] [Fig. 2.24], the Sea-lion (described previously by Philippe Forestus),[264] the Sea-horse, Sea-elephant, and Sea-calf,[265] the crocodile,[266] whale,[267] ostrich,[268] and Chameleon,[269] but also newly discovered species, such as the *Huspalis* (also: *Upalis*) from Ethiopia, which—as it had been described by Thevet—somehow resembled the mysterious *Mantichora* or *Martiora*, and combined elements of monkey, man, and a carnivore;[270] the *Toucan*, the Bird of Paradise;[271] or the *Tanacth* from Haiti, a strange hybrid seemingly brought forth from man and a carnivore.[272]

260 Henry II, Francis II, Charles IX, and Henry III.

261 *Monstrorum historia*, p. 371; for the *calf-man*, cf. also Liceti, *De monstrorum natura* (Padua: 1634) p. 190.

262 *Historia monstrorum*, p. 372.

263 In *Les Oeuvres d'Ambroise Paré* (12th ed., Lyon, Jean Gregoire: 1664) p. 695.

264 Ibidem, p. 678.

265 For all three hybrid species, cf. ibidem, p. 679.

266 Ibidem, pp. 680–681.

267 Ibidem, p. 690.

268 Ibidem, pp. 691–692.

269 Ibidem, p. 698.

270 *Les Oeuvres d'Ambroise Paré*, p. 694.

271 For both species, cf. ibidem, p. 693.

272 *Les Oeuvres d'Ambroise Paré*, p. 696.

FIGURE 2.18 *Pig-monk. From: Ulisse Aldrovandi*, Monstrorum historia cum paralipomenis historiae omnium animalium. Bartholomaeus Ambrosinus [. . .] composuit (*Bologna, Marcantonio Bernia – Nicolao Tebaldini: 1642*), *p. 438.*

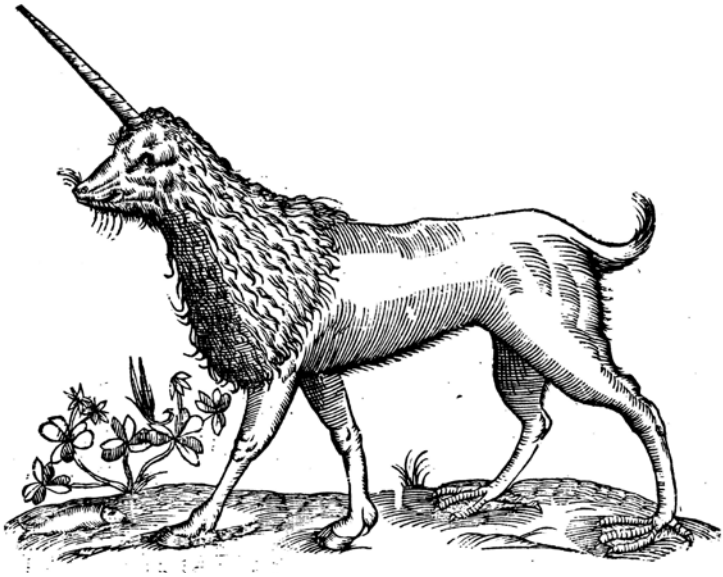

FIGURE 2.19 Unicornu Aldrovandi. *From: Ulisse Aldrovandi,* Monstrorum historia cum paralipomenis historiae omnium animalium. Bartholomaeus Ambrosinus [. . .] composuit (*Bologna, Marcantonio Bernia – Nicolao Tebaldini: 1642*).

FIGURE 2.20 *Calf-monk* (Vitulomonachus Sorbini). *From: Ulisse Aldrovandi*, Monstrorum historia [...] (*Bologna, Marcantonio Bernia – Nicolao Tebaldini: 1642*), *p. 371.*

FIGURE 2.21 *Polyhybrid. From: Ulisse Aldrovandi*, Monstrorum historia [...] (*Bologna, Marcantonio Bernia – Nicolao Tebaldini: 1642*), *p. 577; the same illustration as in Gessner*, Icones animalium (*2nd ed., Zurich, Christoph Froschauer: 1560*), *p. 95.*

FIGURE 2.22 *Another polyhybrid from: Ulisse Aldrovandi*, Monstrorum historia [. . .] (*Bologna, Marcantonio Bernia – Nicolao Tebaldini: 1642*), *p. 377*.

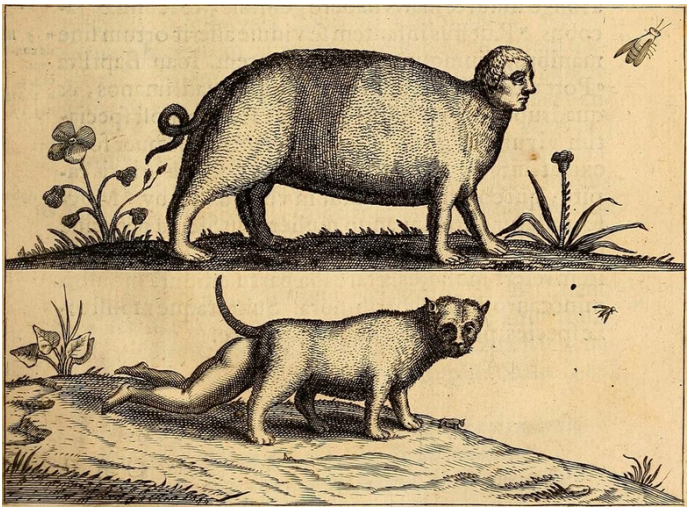

FIGURE 2.23 *Pig-man by Fortunio Liceti. From: Fortunio Liceti*, De monstrorum natura, differentiis et caussis (*Padua: 1616*).

FIGURE 2.24 *The giraffe. From Ambroise Paré*, Le livre des monstres et prodiges (*1573*).

The *Upalis* reappeared with the same features, inter alia, in Aldrovandi's *De quadrupedibus digitatis viviparis* of 1645 [Fig. 2.25].[273] In the same zoology are found the monstrous *Cercopithecus* or *Barbilias*, which was thought to live in China [Fig. 2.26];[274] the *Lupus Marinus or Sea-wolf* [Fig. 2.27];[275] and the small Panther (*Panther minor*) or *Pardalion*, which was conceived as a hybrid.[276] The last three monstrous creatures were already present in Gessner's *Icones animalium* of 1560, which also contained more animals that the naturalist from Zurich characterised as 'monstra', such as the *Su*, a 'horrible' 'monstrous' hybrid with the features of man, lion, and squirrel [Fig. 2.28].

An important element in Paré's *Le livre des monstres et prodiges*, as in the zoologies from Gessner on, is the massive presentation of visual evidence. In fact, almost all of the *monstra* discussed by Paré were proven by intriguing woodcut illustrations to be animals that really existed. This massive collection of visual evidence is even more important for Aldrovandi's *Monstrorum*

273 P. 261.
274 P. 249.
275 P. 176.
276 P. 68.

FIGURE 2.25 *The* Upalis. *From Ulisse Aldrovandi,* De quadrupedibus digitatis viviparis [. . .] (*Bologna: 1645*), *p. 261* (*private collection*).

historia (1642): in this work the existence of hundreds of monstrous hybrids is backed by carefully carved woodcuts.

The Visual Evidence and Hybrids—A Shift from Verbal Description to Animal Illustrations: John Jonston and Matthaeus Merian (1650 ff.)

The *Historia naturalis animalium* in five volumes by the Scottish physician John Jonston (1603–1675) [Fig. 2.29], published in Frankfurt by the Heirs of Matthaeus Merian the Elder, 1650–1653,[277] was used as a zoological manual

277 *Historiae naturalis de quadrupedibus libri, cum aeneis figuris* [. . .] (Frankfurt a.M., Matthaeus Merian the Elder: 1650; Amsterdam, J.J. Schipper: 1657); *Historiae naturalis de avibus libri VI cum aeneis figuris* [. . .] (Frankfurt a.M., Matthaeus Merian the Elder: 1650; Amsterdam, J.J. Schipper: 1657); *Historiae naturalis de insectis libri II, de serpentibus et draconibus libri II, cum aeneis figuris* (Frankfurt a.M., Matthaeus Merian the Elder: 1653; Amsterdam, J.J. Schipper: 1657; idem: 1665); *Historiae naturalis de exanguibus aquaticis libri IV, cum figuris aeneis* [. . .] (Amsterdam, J.J. Schipper: 1657); *Historiae naturalis de piscibus et cetis libri V, cum aeneis figuris* [. . .] (Amsterdam, J.J. Schipper: 1657); niederländ. Übers. dieser Werke (Amsterdam, J.J. Schipper: 1660); *Theatrum universale omnium animalium, piscium, avium, quadrupedum, exanguium, aquaticorum, insectorum et anguium* (Amsterdam, R. and G. Wetstein: 1718); *A Description of the Nature of Four-footed Beasts*

FIGURE 2.26 *The* Cercopithecus *or* Barbilias. *From Ulisse Aldrovandi*, De quadrupedibus digitatis viviparis [. . .] (*Bologna: 1645*), *p. 249* (*private collection*).

FIGURE 2.27 *The* Lupus Marinus. *From Ulisse Aldrovandi*, De quadrupedibus digitatis viviparis (*Bologna: 1645*), *p. 176* (*private collection*).

FIGURE 2.28 *The* Su. *From: Gessner*, Icones animalium (*2nd ed., Zurich, Christoph Froschauer: 1560*), *p. 127*.

FIGURE 2.29 *Andreas Gryphius, Portrait of John Jonston. Engraving.*

until the end of the 18th century. With respect to taxonomy, Jonston's work was systematical but not very original: In his *De Quadrupe*[*t*]*dibus Libri IV* he used a system of classification very similar to Wotton's *De differentiis animalium* (1552), and in fact the same as Aldrovandi in his posthumously edited *Quadrupedum omnium bisulcorum historia* (Bologna: 1621; Frankfurt a.M.: 1547)

with their Figures Engraven in Brass (London, Moses Pitt: 1678); for John Jonston cf. Miller G., "Beasts of the New Jerusalem: John Jonston's Natural History and the Launching of Millenarian Pedagogy in the Seventeenth Century", *History of Science* 46 (2008) 203–243.

and *De quadrupedibus digitatis viviparis* (Bologna: 1645). Jonston's three books on the viviparous quadrupeds were divided into odd-toed ungulates (= book 1), even-hoofed ungulates (= book 2), and 'quadrupedes digitati' (= book 3), which is the same as Wotton's category 'multifida', which brought together all quadruped species with more than two toes. Jonston's fourth book is dedicated to the oviparous quadrupeds.

In Jonston's zoology many of the above-mentioned hybrids reappear, albeit partly in another way. In his verbal descriptions, Jonston is sometimes not very explicit about the traditional hybrids. Sometimes he seems to be a bit reluctant to take responsibility for these species. In such cases he says: 'According to author X or Y, species Z looks like [. . .]/ has [. . .]/ lives in [. . .]'. However, he does not take a theoretical stand against hybridisation or hybrid speciation, and in a number of cases he explicitly acknowledges hybridisation. For example, he clearly incorporates in his classification the hybrids of the lion with various other species: *Leopardus* (female lion with Panther/*Pardus*); the smaller, weaker and maneless lion (female lion with Panther); the *Crocuta* (female lion with male hyena); and the Lion-dog.[278] Furthermore, there are hybrids stemming from female Panther (*pardus*) and male lion, wolf, or dog,[279] much in the same way the hybrid 'smaller Panther'.[280] There are other "composite animals" or hybrids that occur in Wotton that Jonston does not characterise as hybrids, such as *Equus Indicus*,[281] *Asinus cornutus*,[282] *Mantichora* (presented as a tiger),[283] and elk;[284] there are some he does not mention at all, such as the *Eale* and *Hippelaphus*.

In a striking contrast, on the high qualilty copperplate engravings made by the famous engraver (and publisher) Matthäus Merian the Elder

278 *Historiae naturalis de quadrupedibus libri IV* [. . .] (Frankfurt a.M., Heirs of Matthias Merian: 1652) 115: 'Elapso primo anni tempore maribus ob nimium calorem coire non valentibus leaneae cum pardis—unde leopardi; Pantheris—unde foetus non iubatus; Hyenis [sic]—unde Crocuta, miscentur. Et ipsis cum cane commercium'.

279 Ibidem, p. 119: 'Congreditur [sc. pardus] saepe cum leone, [. . .], aliquando cum cane, nonumquam cum lupo [. . .]' ('[The panther] mates often with the lion, [. . .] sometimes with the dog, and sometimes also with the wolf').

280 Ibidem, p. 156.

281 Ibidem, p. 20.

282 Ibidem, p. 37.

283 Ibidem 124: 'Equidem refert ex Ctesia Pausanias esse apud Indos Mantichora dictum animal, cui triplex dentium sit in utraque maxilla ordo, missiles in cauda aculei, idque Tigrim quidam opinatur'.

284 Ibidem 97: 'ungula bifida, ut bobus'.

(1593–1650),[285] who was born in Basel but worked in Frankfurt a.M., almost all of the traditional hybrids reappear, and they provide overwhelming evidence of their existence: among others are the *Leucrocuta* and the man-eating but human-like *Mantichora* (Tab. LII) [Fig. 2.5]; the Horse-deer (*Hippelaphus*) and Goat-deer (*Tragelaphus*) (Tab. XXXIV) [Fig. 2.6]; the *Eale* (Tab. XXIV) [Fig. 2.30]; the *Bonasus* (Tab. XVIII–XIX); and so on. In a marked difference from Wotton, the *Leucrocuta* is depicted as an even-hoofed species, just as it was described by Pliny [Fig. 2.31]; obviously, Jonston and his illustrator "corrected" Wotton's misconception. The elk is presented in the illustration as a strange creature with an idiosyncratic horn, just as Wotton had described him (Tab. XXXVI) [Fig. 2.32], albeit not odd-toed;[286] but, surprisingly, on another illustration the elk resembles a kind of goat (Tab. XXX) [Fig. 2.33]. In Merian's illustrations, however, the number of unicorn species is even higher than in Wotton's *De differentiis animalium*: in total, eight species of unicorns are depicted (Tab. X–XII) [Figs. 2.34–35, Tab X and XII]. As in the classification by Wotton, the majority of the unicorns are even-toed species (the six on Tab. X

FIGURE 2.30 *The* Eale*, by Matthaeus Merian the Elder. From: John Jonston*, Historiae naturalis de quadrupedibus libri IV (*Frankfurt a. M., Heirs of Matthaeus Merian: 1652*), *Tab. XXIV.*

285 Wüthrich L.H., *Matthaeus Merian d. Ä. Eine Biographie* (Hamburg: 2007); idem, *Das druckgraphische Werk von Matthäus Merian d.Ä.*, vols. 1–2 (Basel: 1966), vol. 3 (Hamburg: 1993); vol. 4 (Hamburg: 1996).

286 Ibidem 97: 'ungula bifida, ut bobus'.

FIGURE 2.31 *The* Leucrocuta (here 'Leucurcuta'), *by Matthaeus Merian the Elder. From: John Jonston*, Historiae naturalis de quadrupedibus libri IV (*Frankfurt a. M., Heirs of Matthaeus Merian: 1652*), *Tab. LII.*

FIGURE 2.32 *The elk, by Matthaeus Merian the Elder. From: John Jonston*, Historiae naturalis de quadrupedibus libri IV (*Frankfurt a. M., Heirs of Matthaeus Merian: 1652*), *Tab. XXXVI.*

FIGURE 2.33 *Another elk, by Matthaeus Merian the Elder. From: John Jonston*, Historiae naturalis de quadrupedibus libri IV (*Frankfurt a. M., Heirs of Matthaeus Merian: 1652*), *Tab. XXX.*

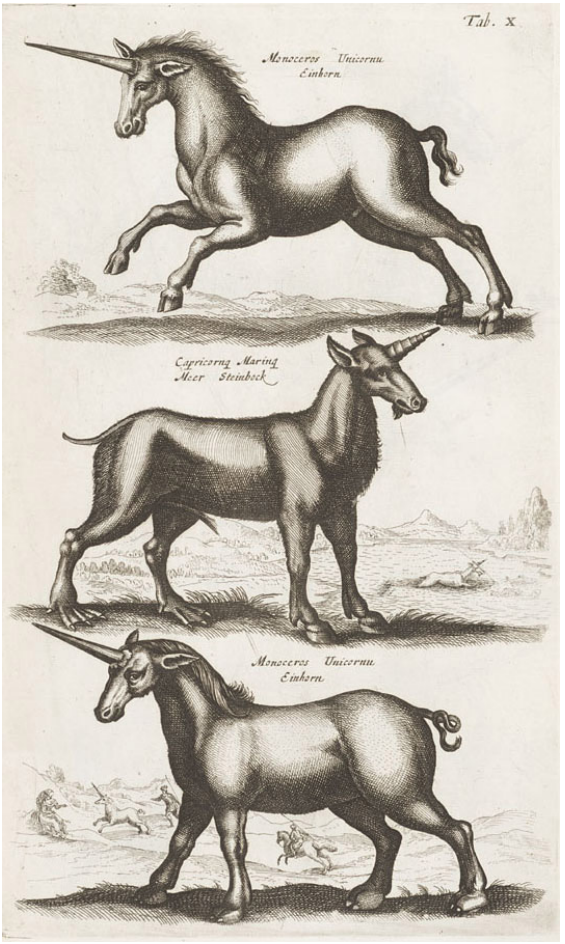

FIGURE 2.34 *Unicorn species, by Matthaeus Merian the Elder. From: John Jonston*, Historiae naturalis de quadrupedibus libri IV (*Frankfurt a. M., Heirs of Matthaeus Merian: 1652*), *Tab. X.*

FIGURE 2.35 *Unicorn species, by Matthaeus Merian the Elder. From: John Jonston*, Historiae naturalis de quadrupedibus libri IV (*Frankfurt a. M., Heirs of Matthaeus Merian: 1652*), *Tab. XII.*

and XI, and one on Tab. XII), but one is odd-toed: the *Onager* on Tab. XII. And there are a number of hybrids in the illustrations that are not at all described in the text, such as the Lion-goat ('*Lea Capra*') (Tab. XLV) [Fig. 2.36], the Camel-deer (Tab. XXIX), or the *Gryphus* (Tab. XLIX).

How should one explain the contrast between text and images? In Jonston's zoology, with respect to the hybrids, the illustrations took over the presentation of evidence. The text does not contain the same argument as the images. Whereas in the text certain hybrids are not even mentioned, they are demonstrated in the images. It could very well be that for the publisher it was interesting to present these images to the reader as a way to sell the book—as eye-catching curiosities or *miracula*—and the author could have had some interest in coming up with a spectacular collection, a kind of *Wunderkammer*: the reader may admire the curious creatures, whereas for the author it was not necessary to testify to their real existence in the text.

FIGURE 2.36 Lea Capra, *by Matthaeus Merian the Elder. From: John Jonston*, Historiae naturalis de quadrupedibus libri IV (*Frankfurt a. M., Heirs of Matthaeus Merian: 1652*), *Tab. XLV.*

Zoology Between New Thaumatography and Neo-Scholastic Theology: Caspar Schott's *Mirabilia naturae* (1662)

For the German Jesuit Caspar Schott, S.J. (1608–1666)—as for the majority of the early modern naturalists—zoology was a religious and theological exercise. Zoology was directed toward the essential task of man, i.e. to contemplate and to admire God's creation, as Schott argues in the preface of the zoological books (VII–X) of the *Physica curiosa sive Mirabilia naturae et artis Libri XII* (1662).[287] In this respect, not a single godly created species exists that would be essentially useless. Therefore, zoology is a discipline which is not only praiseworthy from a moral point of view, but approved by God, without any restrictions.[288] God only, and nothing else, inspired the zoologists to engage in such a seemingly endless workload that demanded such scrutiny and such an amount of scholarly knowledge. Among his godly inspired forerunners, Schott lists the ancient writers Aristotle, Pliny the Elder, Aelianus, Oppianus, and Plutarch; the church fathers Basilius Magnus and Ambrosius; the scholastic theologian Albertus Magnus; and the early modern zoologists

287 Schott Caspar S.J., *Physica curiosa, sive Mirabilia naturae et artis Libri XII.* […] *variis* […] *disquisitionibus excutiuntur et innumeris exemplis illustrantur* […] *Cum figuris aeri incisis* (Nuremberg, Moritz Endter: 1662), VII, p. 772; on the New World animals in this work cf. De Asúa – French, *A New World of Animals* 178 ff.

288 Ibidem, book VII, pp. 772–773.

Gessner, Aldrovandi, Nieremberg, Jonston, Guillaume Rondelet (1507–1566), Pierre Belon (1517–1564), Wotton, the Wittenberg professor Johann Sperling (1603–1658),[289] the author of the *Zoologia physica*; furthermore, there are the Italian physician, mathematician, and universal scholar Gerolamo Cardano (1501–1576); the Dutch physician and naturalist Willem Piso (Pies, 1611–1678),[290] author of the famous *Historia Naturalis Brasiliae*; and the Leiden physician Jacob de Bondt (Bontius, 1592–1631), who worked for the Dutch East India Company as ambassador in Jakarta and authored the *Historiae naturalis et medicae Indiae orientalis libri VI*.[291]

Schott does not want to repeat the huge amount of work done by his esteemed forerunners, but limits himself to the miraculous and rare aspects ('rariora et curiosiora') only. For the present purpose, Schott decided to leave out the categories of reptiles and insects, probably because these would cause a lot of work, while the results would be less spectacular. He kindly asks the reader not to insist on autopsy as the only valid source of knowledge. There is no contradiction between admiration and truth, and no reason to distrust the ancient and modern zoologists.[292] In this vein, Schott praises the eagerness and assiduity of Aristotle, Pliny, and Aelianus. The first zoologists, however, were God, who invented the species, and Adam, who gave names to all species according to their nature.[293] God was the first magister in zoology, Adam his

289 Johannes Sperling, *Zoologia physica* (posthumously edited by his former pupil, the polymath Georg Kaspar Kirchmaier, Leipzig: 1661; Wittenberg, Heirs of Johann Berger: 1669). Sperling was a naturalist, physician, and zoologist. In Wittenberg he had studied philosophy, theology, medicine, and physics, and had been a professor of physics in Wittenberg.

290 Willem Piso partook in the Brazilian expedition of Prince Maurits of Nassau (1637–1644), and authored (together with Georg Marcgrave) the *Historia Naturalis Brasiliae* (Leiden, Joannes de Laet: 1648).

291 Posthumously edited by Willem Piso (Amsterdam: 1658).

292 Ibidem, VII, p. 774: 'Nec est quod testium, quos proferam, fidem habeas suspectam, Plinii, Aeliani, aliorumque tum antiquorum tum recentium, eorum praesertim, qui novissime de Indiarum animalibus scripsere. Causa nulla subest, cur eos aut fallere voluisse aut falsos esse credamus' ('There is no reason why you should doubt the trustworthiness of Pliny, Aelianus, and the other sources of antiquity and of more recent age, and especially not that of those who very recently wrote about the animals of the Indies. There is no reason why we should think that they would have intended to cheat on us or give us wrong information').

293 Ibidem, VII, p. 776: 'En Adami sapientiam et scientiam, qui singulorum animalium naturas novit eisque congrua indidit nomina' ('Look at the wisdom and scientific knowledge of Adam, who knew about the nature of the singular animal species and gave them names according to their nature').

pupil. The inventor of animal classification was Moses, who divided the species according to their habitats in 'Aquatilia', 'Volatilia', and 'Terrestria'.[294]

Schott had been educated at the Jesuit college in Würzburg and had studied philosophy (including mathematics) and theology at the University of Würzburg (1629–1631), and theology at Caltagirone and Palermo in Sicily (1633–1636).[295] He had joined the Jesuit order in 1627, and had been ordained a priest in 1637. From 1652 on he worked as the assistant of professor Athanasius Kircher at the Collegio Romano. In 1655 he returned to Würzburg, where he composed and edited monumental works on physics (including optics, acoustics, hydraulics), mathematics, and occult philosophy, among others his four volumes on *Magia universalis naturae et artis* (1657–1659),[296] which contained a great number of physical experiments; his *Mechanica hydraulico-pneumatica* (Würzburg: 1657); *Technica curiosa* (Würzburg: 1664); and his *Physica curiosa sive Mirabilia naturae et artis Libri XII* (1662).

Schott turned out to be one of the fiercest defenders of hybrid speciation.[297] In his chapter on the 'adulterous species' ('animalia adulterina ac bigenera'), he gives one of the fullest lists of hybrid species offered by early modern zoologists:[298] the mule ('mulus', 'mula', 'hinnus'); the *Tityrus*, a crossbreeding of billy goat and female sheep; the *Musmus*, of ram and female goat; the *Hybris*, of (male) wild boar and female pig; the *Lynx*, of male wolf and hind ('cerva'); the *Thos*, of male wolf and female dog; the *Crocuta*, of male wolf and female panther; the Arcadian or Indian dog, of dog and tiger (*Panthera tigris*); the *Leontomix*, of dog and lion; the Spartan dog (*Canis Laconicus*); the *Alopex*, of dog and fox; the *Lupus carnarius*, of female wolf and male dog; the smaller and weaker lion, of female lion and male panther ('pardus'); the leopard; the *Camelus Bactrianus*, of wild boar and camel; the Bull-horse, of bull and mare; the Horse-deer, of male deer and mare; etc. Although his list is quite extensive, Schott presents it only *exempli gratia*. He thinks that the number of

294 Ibidem, VII, chapt. 2 "De differentiis animalium", p. 777; cf. *Genesis* 1, 20 und 24.

295 For Caspar Schott, cf. Duhr G., *Geschichte der Jesuiten in den Ländern deutscher Zunge*, vol. III (Munich – Regensburg: 1921) 589–592; Backer A. de – Sommervogel K., *Bibliothèque des écrivains de la Compagnie de Jésus*, 7th ed. (Paris: 1896), 904–912; Léger St., *Notice des ouvrages de G. Schott* (Paris: 1765).

296 *Magia universalis naturae et artis sive recondita naturalium et artificalium rerum scientia, cuius ope per variam applicationem activorum cum passivis, admirandorum effectuum spectacula, abditarumque inventionum miracula, ad varios humanae vitae usus, eruuntur* (Würzburg, Johann Gottfried Schönwetter: 1657–1659); vol. I *Optica*; vol. II *Acustica*; vol. III *Mathematica*; vol. IV *Physica*.

297 Schott, *Physica curiosa, sive Mirabilia naturae*, book VII, chapt. 12 "An animalia adulterina fuerint a Deo in Mundi exordio producta", pp. 821–825.

298 Ibidem, p. 821.

hybrid species is in fact unlimited. All kinds of animal species may mate with each other, and almost anything is possible. He is not bothered by the well-known limitations introduced by Aristotle (same size, same length of pregnancy, closely related species) or extended by early modern zoologists, such as Franzius (same seasons of fertility; "parent species" must be extraordinarily horny). He does not care that the deer is much bigger than the wolf, has a pregnancy almost four times as long as the wolf (ca. 230–240 vs. 61–63 days), and is a plant-eater while the wolf is a carnivore; he is not bothered by the fact that the camel is about six times as big as the wild boar and 8 to 10 times as heavy. With respect to his optimism concerning the range of possible hybridisations Schott resembles Della Porta, although his focus is not on animal breeding, but on wild species.

A most important theological decision is that he ascribes the hybrid species to God's creation and that he regards them in fact as 'perfect animals'. Since he considers them all to be fertile, Nieremberg's limitation is not relevant for him. Schott presents his argument in the form of a scholastic "quaestio": he puts to the fore three arguments contra and three pro, and then takes a clear decision, as a scholastic magister would do. As Schott points out, hybridisation cannot be an invention of man, since wild hybrids occur both all over the world and in any period of history. Of course, Bible philology plays an important role in this respect. Similar to Nieremberg, Schott argues that it is not at all certain whether *Genesis* 36, 24 indeed proves that Ana is the inventor of the mule;[299] that the Vulgate reads that 'Ana invented hot water in the desert'; and that it is not at all plausible if the 'Hebrew Rabbis' want to read 'jemin' instead of 'jamin'.[300] But even if the rabbis were right and Ana was the inventor of the mule, what relevance would it have for the whole of hybridisation? Who would be the inventor of all the wild hybrid species? And there are more arguments belonging to the field of Bible philology or Bible exegesis. Benedict Pereira, a Jesuit theologian, Bible exegete, and natural philosopher (1536–1610) born near Valencia but later teaching in Rome,[301] and Ascanio Martinengo, the author of the *Glossae magnae* to *Genesis* (+ ca. 1600), emphasised that according to *Genesis*, chapter 1, God created all the animals, and thus the hybrids as well.[302]

299 Ibidem, pp. 823–824.

300 Ibidem, p. 824.

301 On Pereira, cf. Blum P.R., "Benedictus Pererius: Renaissance Culture at the Origins of Jesuit Science", *Science & Education* 15 (2006) 279–304; and idem, *Studies on Early Modern Aristotelianism*, chapter 9: "Benedictus Pereirus: Renaissance Culture at the Origins of Jesuit Science" (Leiden: 2012) 139–182.

302 Schott, *Physica curiosa, sive Mirabilia naturae,* p. 823; cf. Peirera Benedict, *Commentariorum et disputationum in Genesim tomi quattuor* (Rome: 1591–1599); Martinengo Ascanio,

Leviticus 19, 19, on the other hand, is not relevant for animal breeding, but directed against the idolatry of Egyptian religion, which venerates hybrid animals as gods.[303]

Most interestingly, Schott takes a totally different stand on hybridisation than his former master, Athanasius Kircher. Kircher excluded the hybrids from God's creation and he severely devalued them by regarding them as 'degenerations' of the 'perfect', i.e. the godly invented species. Schott emphasises that the hybrid species are certainly not worse than the pure species. They are in no way monsters. For Schott hybridisation is more proof of the outstanding quality of God's creation, and of its admirable, in fact unlimited variety: the more variety, the more admiration, the bigger the praise God deserves. In this sense, Schott's Neo-Scholastic Bible exegesis is connected with his new "thaumatography". His zoology is meant to bring together the wonders of God's creation.

This attitude is in fact relevant for the whole presentation of his zoology. Although he is well aware of the taxonomical categories of Aristotle (and of most of his early modern forerunners), he is not inclined to base his zoology on an integrative system of animal classification—such as Wotton, Aldrovandi, or Jonston did—in his *Historia naturalis animalium.* In doing so, he wanted to maximise the admirable variety of nature, and in this he followed, for example, Pliny, Aelianus, Gessner, Franzius, and Jonston in his *Thaumatographia naturalis* of 1633. This also refers to the description of the singular species. Primarily, that is also the reason why Schott presented the species in alphabetical order, as Gessner, Franzius, and Jonston (in his *Thaumatographia*) did. Sometimes it adds to the maximisation of the "admirable" to present the species in question as a scholastic "disputatio": putting together various, contradicting *auctoritates* of both antiquity and recent times.[304] Sometimes, if the animal is in itself strange and exotic, Schott considered it enough to quote one or two descriptions of the species.[305] A likewise differentiated approach goes for animal illustrations: Schott in fact only adds illustrations if the animal has remarkable or amazing features, or if its appearance is doubtful. He would not illustrate, for example, horse, cat, donkey, pig, lion, wolf, etc.; but he illustrates the sloth (*'Ignavus*

Glossae magnae in sacram Genesim [. . .]*: tomus primus* [. . .] *authore D. Ascanio Martinengo brixiano* (Padua, Laurentius Pasquatus: 1597).

303 Schott, *Physica curiosa, sive Mirabilia naturae*, p. 824.

304 This is the case, for example, with the elk (VIII, 1, pp. 899–906); the sloth or *Ignavus* (VIII, 2, pp. 907–910); the *Armadillo* (VIII, 3, pp. 911–916).

305 As in the case of the *Bison* (VIII, 11, p. 937), *Dabuh* (VIII, 29, p. 1009), Ocelot (VIII, 30, p. 1010).

FIGURE 2.37 *The bison and the* Bonasus. *From: Caspar Schott, S.J.*, Physica curiosa, sive Mirabilia naturae et artis Libri XII. [...] variis [...] disquisitionibus excutiuntur et innumeris exemplis illustrantur [...] Cum figuris aeri incisis (*Nuremberg, Moritz Endter: 1662*), *Iconismus XXXVIII.*

maior' and *'Ignavus minor'*),[306] elk,[307] *Bison* [Fig. 2.37],[308] anteater (*Achaus, Tamandoa*),[309] Camel-deer (*Camelo-cervus*, in fact the llama) [Fig. 2.38],[310]

306 Schott, *Physica curiosa, sive Mirabilia naturae*, Iconismus XXV, ad. p. 907.
307 Iconismus XXIV, ad. p. 902.
308 Iconismus XXVIII, ad p. 937.
309 Iconismus XXVII, ad. p. 917.
310 Iconismus XXXII, ad p. 953.

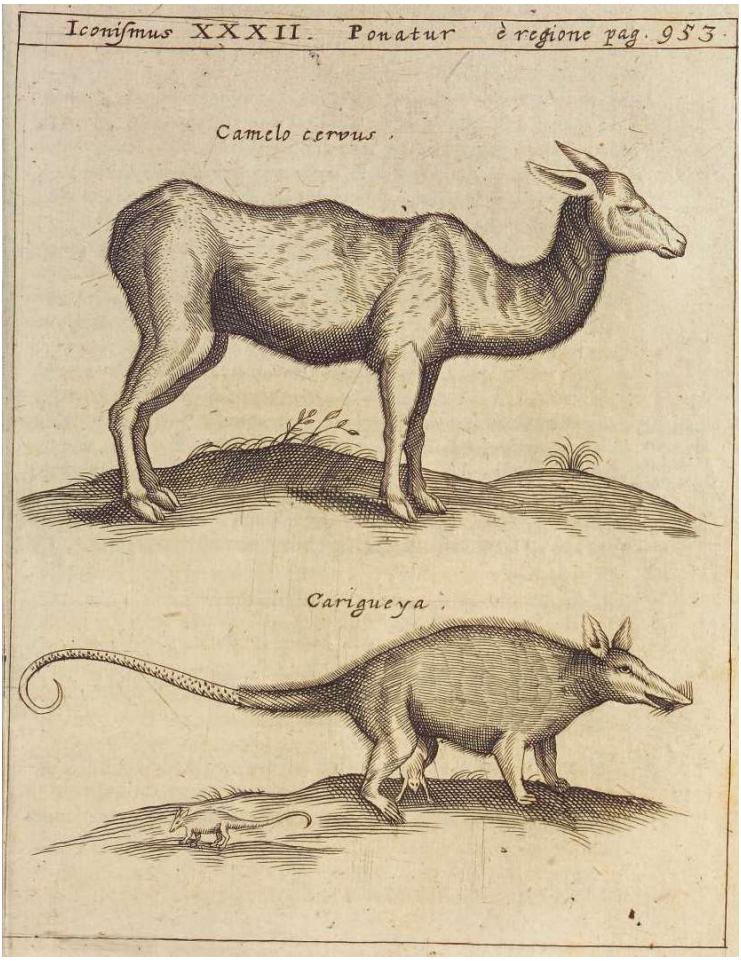

FIGURE 2.38 *The* Camelocervus (*llama*) *and the* Carigueya (*opossum*). *From: Caspar Schott, S.J.*, Physica curiosa, sive Mirabilia naturae et artis Libri XII. [...] variis [...] disquisitionibus excutiuntur et innumeris exemplis illustrantur [...] Cum figuris aeri incisis (*Nuremberg, Moritz Endter: 1662*), *Iconismus XXXII.*

Ichneumon,[311] *Carigueya* (*Opossum*) [Fig. 2.38, same as llama],[312] Jaguar,[313] *Su*,[314] *Armadillo*,[315] etc.

311 Iconismus XLI, ad p. 1045.
312 Iconismus XXXII, ad p. 953.
313 Iconismus XLI, ad p. 1045.
314 Iconismus XLVIII, ad p. 1088.
315 Iconismus XXVI, ad p. 911.

As in Nieremberg's, in Schott's zoology the American species play an important part. In the book on the land animals (all quadrupeds), Schott describes in total ca. 80 species or families; some 10 of them are South American species. Most of them he considers as species in their own right and, similar to Nieremberg, he also gives their name in the local language(s). In a marked difference from Kircher, he does not classify the majority of the American species as hybrids or other forms of degenerations. And because he considers them to be species in their own right, he is convinced that they took a place on Noah's ark. Concerning the question of how they got to the ark and back from Mount Ararat to South America,[316] he seems almost to polemicise against Kircher, whose opinion he might have heard in Rome, 1652–1655. He considers it impossible for them to have made it by swimming or via land-bridges, or where just brought by man, thus refuting Kircher's three explanations. Schott is convinced that the New World was inhabited by animals long before the Europeans discovered it and brought European animals with them by ship, and that these animals were created by God. And Schott considered it totally improbable that the animal species, one after the other, would have found the few land-bridges that man did not discover for so many thousands of years. Thus, with a meticulous Neo-Scholastic argument, he proves in the end that Nieremberg's guardian angels of species were the only possible means for the South American species to have survived.[317]

Conclusion

In the 16th and 17th centuries zoology was a flourishing field of science, with an amazing number of substantial works, and even more in-depth and intriguing discussions. The methods and discourses of early modern zoology, however, were very different from the established science of the 19th–21st centuries. The most important disciplines and discursive formations of early modern zoology were philology and theology. Authors that belonged to different parts of the religious spectrum engaged in zoology, Protestants and Catholics alike. There is no clearly discernible, progressive development, either from bookish scholarship, based on the authority of texts, to empirical science, or in another sense. Taxonomy and species description of the 17th century is no more centred on empirical observation than that of the 16th century. Taxonomy and species description develop in the 16th and 17th centuries as a subtle art that takes into account various and heterogeneous facts. New findings were sometimes, but not

316 Cf. chapt. VII, 15 "Quomodo homines et caetera animalia, in novum orbem insulasque a continente remotas delati fuerint", pp. 834–841, esp. 839–841.

317 Ibidem, pp. 840–841.

always, based on empirical observations; many new solutions that may represent "progress" from a modern perspective were brought forth either by philological improvements—for example, by advanced textual criticism, increased knowledge of Greek, and successful close reading—or by theological argumentation, which was sharpened by the religious conflicts of 16th and 17th centuries, especially by Confessionalisation. The seemingly strange phenomenon of hybrid speciation functions as an important paradigm for the production and procession of zoological information, in both the 16th and the 17th centuries.

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