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SOURCES AND BACKGROUND TO DISCOVERIES OF NEW ANIMALS IN THE SIXTEENTH AND SEVENTEENTH CENTURIES

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In the fifth century BC, in the *Histories*, Herodotus described the fauna of the world as he knew it. Some of his information was first hand, some the result of "extensive inquiries". He described the Nile hippopotamuses and crocodiles, and recorded three kinds of mice in Libya: *dipodes* (jerboas), *zegeries* (gerbils), and *echines* (spiny mice). Otters and beavers were recorded on the banks of a "great lake" in Scythia, the Caspian Sea. And from "the furthest inhabited country towards the south-west, Ethiopia", Herodotus recorded huge elephants and gold.[1]

Herodotus does not always say what kind of extensive inquiry he made, but it may be assumed that, in addition to verbal inquiries ("I don't vouch for this, but merely repeat what the Libyans say"), he would have had access to some local chronicles written in Greek. He may have seen pictures of animals or models like the Egyptian hippopotamuses, hedgehogs and ibises that have survived from at least 2000 BC. And he certainly saw many of the animals he describes in their native lands. Other, stranger, animals he may even have seen in animal parks like the one that existed from time to time over many centuries in Alexandria.[2]

Gathered together as part of the *Histories*, the information about different faunas became available to a wider public. And this process of gathering new information about animals by a variety of means and incorporating it into general works gradually extended zoological knowledge. In addition, there were of course the specialist books like Aristotle's *Historia animalium*.

As time went on, the number of animals known in the world showed a slow but steady increase. By the fifteenth century, there was an informed public in Europe. The popularity of works with animals in them may be judged by the number of illustrated bestiaries that circulated in England alone in the twelfth and thirteenth centuries.[3] And camels and elephants were no strangers to western European royal parks.[4] The known fauna was basically European, with the addition of some of the more spectacular, useful, or easily tamable animals of the East and of Africa.

But, at the end of the fifteenth century, there was an explosive increase in knowledge of far-away faunas. The discovery of the New World and the

extension of the spice-trade routes in the East brought stories of completely new animals to Europe and sometimes the animals themselves. Curiosity was aroused and the new animals provoked awkward questions in the minds of the writers of natural histories.

New Animals from South America

The sources of information on the New World animals were similar to those of earlier centuries. The first news was usually recorded in letters or journals of the explorers themselves. The first illustrations were often to be found on the maps of the time. More complete descriptions of the fauna usually came later: from residents in the country, governors, or missionaries. The specialist animal encyclopaedias were slow to include New World animals even though some specimens of the animals were brought to Europe by the earliest explorers: live ones to be exhibited in royal collections, dead ones for museum collections. Armadillos and feathers, for example, were more durable than opossums and catfish as museum specimens and, consequently, had more influence on the compilers of natural histories and animal encyclopaedias.

Already from the first voyage that Columbus made to the West, in 1492–93, came news of animals.[5] The islands of the Antilles have few big animals but they have several that are spectacularly different from anything known in Europe. Members of the crew saw long-tailed parrots (macaws), blunt-nosed alligators (caimans), aquatic turtles, and mermaid manatees. They killed a crested iguana lizard and, in a letter to his royal patrons King Ferdinand and Queen Isabella of Spain, Columbus wrote that he was bringing home the skin. There were also "great Rats", although these figured more prominently on Haiti where Columbus landed on his second voyage.

Dr Chanca, the fleet surgeon on the second voyage, described these great rats: ". . . the size of a young rabbit, has a long tail and hind and fore feet like those of a rat. These animals climb trees and many who have eaten them say that the flesh is very good."[6] These are the Haiti hutias, big rodents with prehensile tails. They are related to the South American guinea pigs and coypus. They would have been the most conspicuous mammals on the Caribbean islands and strikingly different from any mammal known in Europe.

In March 1494, the long-tailed parrot reached Europe. Antonio de Torres, returning from Hispaniola to Cadiz with specimens from Columbus's trading post, brought sixty parrots,[7] parrots described by Pedro Cabral from Brazil six years later as "of different colours which are an arm and a half long".[8]

The parrots were quickly exploited by mapmakers for illustrating the colourful character of the New World fauna and for differentiating it from the Old World fauna; on the Portuguese Cantino planisphere, made for Ercole d'Este in 1502 and based on the early discoveries of Cabral, there are macaws in brilliant red and blue in Brazil in contrast to the grey parrots and green Senegal parrots on the other side of the Atlantic.[9] (Parrots from the East had, of course, been known in Europe for hundreds of years and had figured in bestiaries and on mediaeval maps.)

When Columbus reached the coast of the South American mainland on his third voyage in 1498,[10] he saw huge troops of monkeys. Soon, South American capuchin monkeys reached Europe and became as popular pets as monkeys from Africa. By 1513, South American monkeys had been depicted on the Piri Re'is map.[11]

The known fauna of South America was again extended when Columbus reached the shores of the Isthmus of Panama on his fourth voyage, in 1502. He himself described a peccary hunt and birds with feathers like wool which may have been curassows. But perhaps the most exciting zoological discovery at the turn of the century was the animal described by Captain Vincente Pinzon from among the trees of Venezuela: an animal "under whose belly hung a great Bag, in which it carry'd the young, which they drop not, nor forsake till they can feed themselves".[12] This was the small marsupial opossum. One of these opossums survived the journey back to Spain, though it lost its three young on the way. In 1516, Martin Waldseemüller illustrated the opossum in a woodcut on his *Carta marina*.[13] This woodcut became the model for many later illustrations of the *simivulpe*, the apish fox or fox monkey.

When the Swiss Conrad Gesner came to compile his encyclopaedia, *Historia animalium*, in 1551, the simivulpe of Pinzon was included but the illustration had become subtly changed from the Waldseemüller woodcut by the addition of sucking young.[14] But on both versions of the illustrated opossum the peculiar hanging bag was evident. A pouched or marsupial mammal was becoming widely known. Gesner acknowledged Pinzon as the source of his information. This was the only New World mammal included in the 1551 edition. But differences between the fauna of this New World and that of Europe were becoming obvious to all who voyaged west. Amerigo Vespucci writing to the King of Portugal in 1500 described the "infinite variety of the sylvan animals", and commented that most were different from those of Europe.[15]

The new discoveries were becoming assimilated. Macaws and monkeys continued to make an impression by their number and variety. A spectacular variety of South American monkey was described by Antonio Pigafetta who accompanied Magellan on his voyage round the world. Writing a description of this voyage which was first published in French

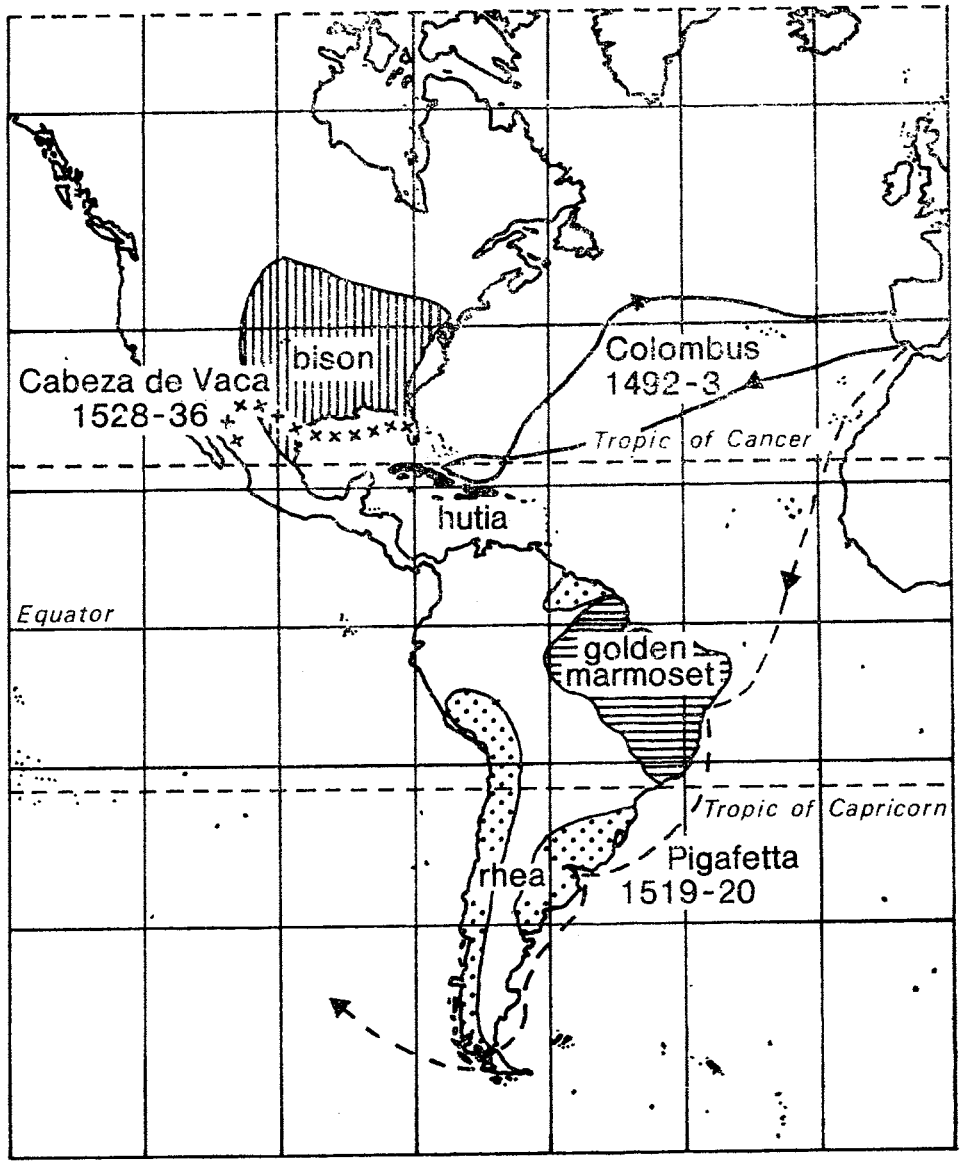

FIG. 1. The routes taken by Columbus, Pigafetta and Cabeza de Vaca and the distribution of some of the animals they reported.

as *Navigation et descouvrement de la Indie Superieure* in 1525, followed by an English translation in 1555, Pigafetta included many new animals that delighted him. There were the golden marmosets that live in the forests of eastern Brazil, monkeys "that look like lions, only yellow and very beautiful".[16]

Pigafetta also saw llamas being used as pack animals and made the perceptive observation that they had "the neck and body of the fashion of a camel". In the next few years, as explorers reached the southern and western parts of South America, more reports of llamas reached Europe.

Vasco Numez de Balboa had made sketches of llamas and had shown them to Pizarro, and Pizarro saw llamas for himself in Peru in 1528.[17] Only twelve years later there was a picture of a llama in the widely circulated *Islario general* of 1540. In this atlas Alonzo de Santa Cruz had a map of America with llamas in the *Tierra del Peru.*[18] On 19 June 1558 a live llama arrived at Middleburg in Zeeland according to later editions of Gesner and the 1563 *Thierbuch* translation. This was the model for the illustration of the *allocamelus.*[19]

Sailing south with Magellan where no one had been before, Pigafetta saw 'ostriches' (rheas) and penguins. He did not describe his 'ostriches' but a big flightless bird was illustrated on a map of the world seven years later by the Portuguese cartographer Diogo Ribeiro, and it formed part of the fauna of South America.[20] Rheas are big grazing birds that live on the southern campos and in the high Andes of South America (Figure 1). Penguins, too, are flightless but live an aquatic life round southern coasts. Pigafetta described penguins: "they do not fly and live on fish. Their beak is like that of a crow."[21]

In the meantime a great work on the natural history and geography of the world had been published. This was the *Suma de geographia* by the Spaniard Martin Fernandez Enciso, first published in 1518 and translated into English with modifications by Roger Barlow in his *Brief summe of geographie* in 1540–41. Enciso had drawn on the works of Pliny and Strabo and other early natural histories and geographies for much of his information of the world, but he had voyaged to Paria (on the coast of Venezuela) in 1510 and 1513 in search of gold. He could describe the fauna of northern South America from direct experience.[22] He was the first to give a recognizable description of a humming bird: "no bigger of bodie than the toppe of a man's thumb but thei have the goodliest colored feathers that ever man might see." He had seen tapirs: "beastes that be as bigge as an oxe or a cowe and be of grey colour . . . with long eares." And, for the first time, an accurate description of that extraordinary armoured beast, the armadillo, became available. It is a mammal but "all covered saving his eares with a shell moche like the shell of a turtuga". Illustrations of armadillos became popular. Ribeiro put an armadillo on his 1529 map.[23] In the appendix to the second volume of *Historia animalium*, published in 1554, Gesner described and illustrated a nine-banded armadillo. The illustration, he tells us, was made from a sketch he had been sent with modifications based on a skin, tail and claws that accompanied the gift. He also mentions a description given by Pierre Belon of an animal in Turkey and others that had reached France.[24] There is another illustration of an armadillo in Pierre Belon's *Portraits d'oyzeaux, animaux, serpens, herbes, arbres, hommes et femmes d'Arabie et Egypte* of 1557. In later editions of Gesner's work, three species of armadillo were differentiated.

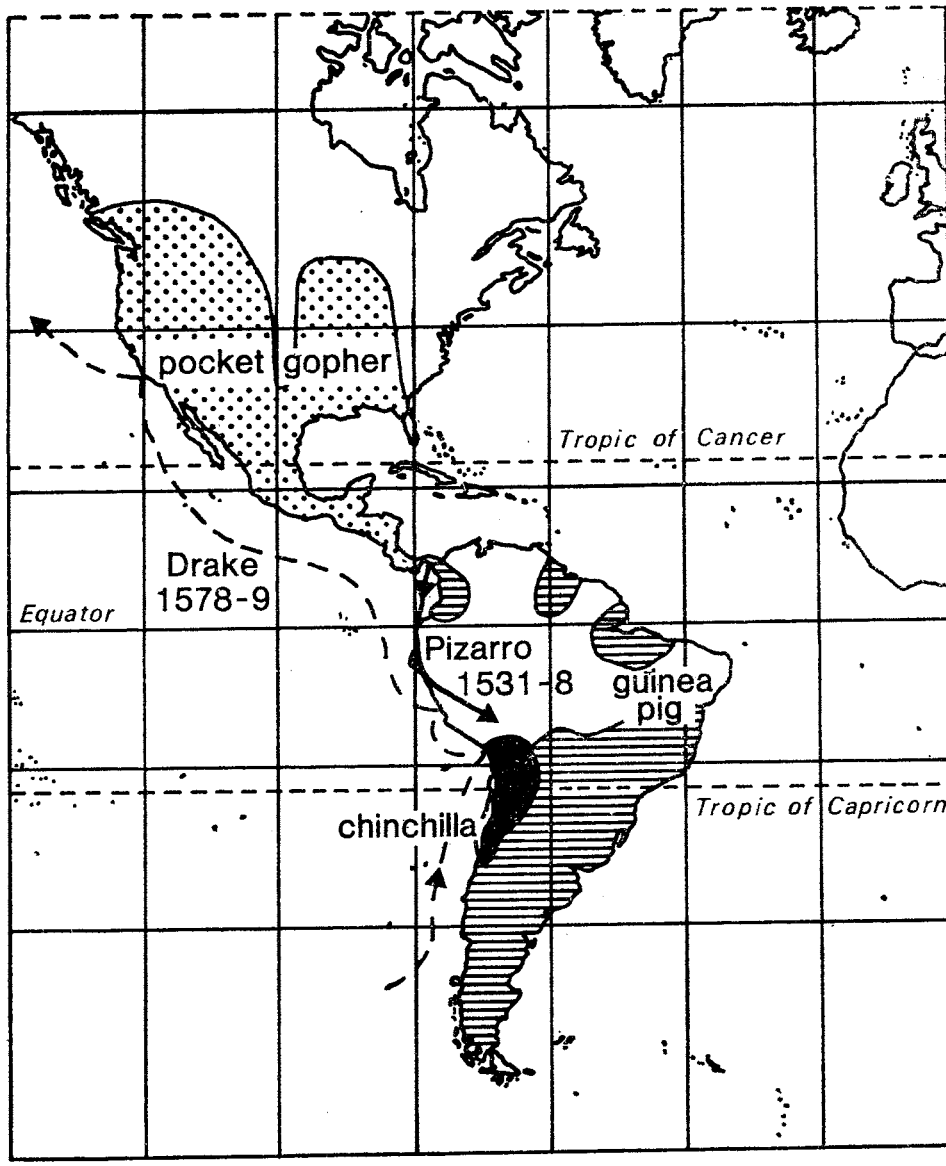

FIG. 2. The routes taken by Pizarro and Drake and the distribution of three American rodents.

By the time Gonzalez Fernando de Oviedo, Governor of Santo Domingo and official chronicler of the Indies, wrote his *Sumario de la natural historia de las Indias* most of the conspicuous animals of the South American fauna were known. Oviedo added the great South American anteater and the sloth. The first part of the work was published in Seville in 1526, and translated into English in 1535 by Richard Eden. In this version of Oviedo the sloth is described as: "one of the slowest beastes in the worlde, and so heavy and dull in mowynge that it cannot scarcely go fyftie pases in a hole day."[25] From this description and an illustration by André Thevet

in 1556,[26] the *arctopithecus* was included in the *Thierbuch* of 1563 and in later Gesner editions.[27]

Fifty-five years later, another great work on South America was published. This was *Historia natural y moral de las Indias*, published in Leon in 1589, the work of the Jesuit missionary, José de Acosta. It was widely read. An Italian edition was printed in Venice in 1598, French and Dutch versions followed soon after, and a German translation appeared in 1601. It was translated and published in English in 1604.

Acosta consulted the works of his predecessors, and, like Oviedo, he described from direct experience. He spent about five years in Peru and travelled as far North as Mexico. Acosta thus had the opportunity to study the animals of the West over an extensive area. He added more unique South American rodents to the known fauna: chinchillas and vizcachas.

Acosta knew the small grey chinchillas of the rocky outcrops of the Chilean and Bolivian Andes that "have marvellously soft fur, and the skin is taken for giving as a present and as a wholesome cover for the stomach and for parts where it is necessary to keep a moderate heat, also they make coverings, of blankets of the fur of chinchillas".[28] He recognized the related but bigger vizcachas of the South and the guinea pigs, "which the Indians consider very good food and in their sacrifices use them as offerings". The first recognizable description of a guinea pig is ascribed by Gesner to Pietro Martieri although they are found in Colombia, in Venezuela, and in the dry parts of Brazil (Figure 2), and must have been known to the early visitors. They might have been some of the "coneys" that were described by, for example, Juan de Ayolas: "rabbits like rats but tailless."[29] Their importance as a food animal is greater in the Andes than on the eastern pampas, which may account for the lack of a precise description in the early chronicles. But by 1554 Gesner had obtained two live guinea pigs from his friend Johannes Munzinger, and a picture of another one from a friend in Paris. He was thus able to include a description and an illustration of the Indian little Pig-Cony in the second volume of *Historia animalium* (Figure 3).[30]

Another of the big South American rodents had been drawn on a map of the world in 1546 by Pierre Descelliers, one of the most famous of the French cartographers working in Dieppe.[31] This was the capybara *Hydrochoerus*. Cabeza de Vaca had reported that capybara had been seen by Juan de Ayolas in 1538: "a sort of waterboar, half hog, half hare." Cabeza de Vaca's *Relacion* was published by Oviedo in the third edition of part of the *Historia general* in 1547. The capybara lives in groups along river banks from Panama to Peru and Brazil, and would have been familiar to many of the sixteenth century explorers.

Around 1526, Pietro Martieri had reported another remarkable South American rodent, the wide-ranging agouti: from Guyana come "conies

like unto hares both in coloure and bignesse".[32] *De orbe novo decades* by Pietro Martieri was translated into English by Richard Eden in 1555. An agouti was painted from a live model towards the end of the century by the Italian Jacopo Ligozzi.[33]

There was one more peculiar South American rodent to add to the list, the New World porcupine, or coendou, with a prehensile tail. Vasquez de Coronado, a Spanish nobleman in the colonial government of Mexico, recorded porkespickes in 1540. His account of native animals was published in Richard Hakluyt's *Principall navigations traffiques and discoveries of the English nation* in 1589–98. Hakluyt published in full many of the letters and journals of the explorers, and so his work is an important source of information on the new faunas. Coronado seems to have shown a great interest in the Mexican fauna, or, more likely, he was instructed by his government to report on it: "I commanded them that they should paint mee out a cloth of all the beastes which they knowe in their country: And such badde painters as they are, forthwith they painted mee two clothes, one of their beastes another of their birds and fishes."[34]

By the end of the sixteenth century, after the comprehensive natural history of Acosta, six of the ten families of unique South American rodents had been *clearly* identified (degus, tuco tucos, pacas and casiraguas cannot be identified from such descriptions as "rats not like ours" or just "conies").

Acosta had also extended the knowledge of llamas by describing the two wild species, the vicuna and guanaco, from which the domestic llamas and alpacas had been bred. In 1550, Juan de Sarmiento had visited Cuzco in Peru and had described in detail the round-up of wild guanacos and vicunas. He described the shearing of the vicunas for their fine wool and their subsequent release, and he described the slaughter of male guanacos for food. But Juan de Sarmiento's *Relacion* remained unpublished and unknown in Europe.[35] It was, therefore, Acosta who provided his readers with descriptions of the wild relatives of the llama. Furthermore, he noticed a difference in the distribution of the two species and commented on it. He knew that vicunas live "but in Peru and Chile which are countries joining one another", while guanacos are widespread on the pampas of Argentina.[36]

In addition to the new mammals they discovered (the marsupial opposssum, monkeys, marmosets, giant anteaters, sloths, armadillos, tapirs, peccaries, guanacos and the peculiar rodents), European observers found animals that were the same as those at home (deer, dogs, rabbits and mice).

A number of conspicuous South American birds had also been seen and described: humming birds, rheas and penguins, for example. In 1555, a toucan's beak appeared as an illustration in Pierre Belon's *L'histoire de la nature des oyseaux:* "bec d'un oyseau aquatique apporté des terres neufes."[37]

By 1585, a whole toucan had appeared in Gesner and, by the end of the century, there were toucans on Dutch maps of the New World (de Jode, 1593, for example).[38]

In Europe, the discovery of the South American fauna was an exciting event but the new animals did not supplant the native and traditional animals in the important animal encyclopaedias of Gesner, Belon, Aldrovandi and Topsell. In late editions of Gesner's work, as in the *Thierbuch* translation of 1563, there were only nine South American mammals: opossum, sloth, llama, armadillo, guinea pig, giant anteater, marmoset, cebid monkey and possibly the peccary; a mere 9% of the total mammal entry.[39] Only the opossum had been in the 1551 edition.

In 1637, in Ulysses Aldrovandi's *De quadrupedibus digitatis viviparis*, published in Bologna, there were illustrations of five different South American rodents as well as the more obvious armadillos and opossums. In addition to the guinea pig, there was an agouti, an acouchy, a spotted paca, and a kangaroo rat.

General works often described and sometimes illustrated the New World animals to add a few marvels to the text. "How pleasant and profitable it is to attempt new Discoveries", wrote Captain George Best in his 1578 account of Frobisher's voyages, " . . . for the sundry sights and shapes of strange beastes and fishes, the wonderful workes of nature . . .".[40] Or, such sights were there simply "pour contenter l'esprit de l'homme curieux

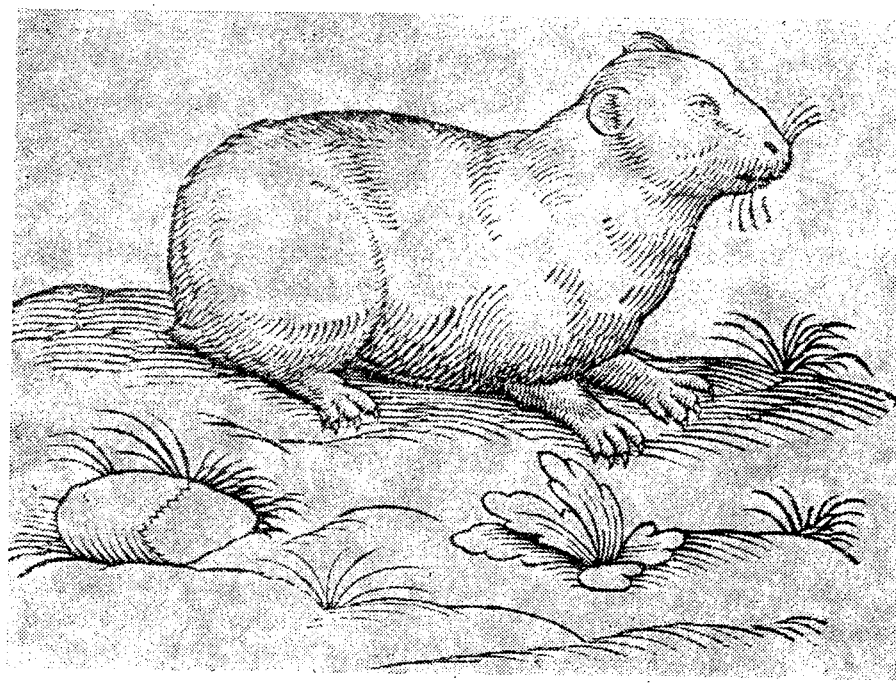

FIG. 3. The Indian Little Pig-Cony or guinea pig from *Historia Animalium* by Conrad Gesner 1621.

de toutes choses", according to the monk, André Thevet, in *Cosmographie universelle* in 1575.[41] Sometimes a knowledge of animals was considered, like that of plants, to contribute to medical knowledge. This was a reason de l'Ecluse gave for describing the animals and plants of Ethiopia, America, and India in his *Exoticorum* of 1605.

Thus, through the years of discovery of South America, the information about its peculiar fauna came primarily from the journals and letters of those who visited the strange land. Numbers of live mammals and birds were brought home and became important models for illustrations. Information from these sources was usually collated first by those, often temporary residents in the New World, who wrote general histories. Illustrations appeared early on maps, and indicated the distribution of animals.[42] It seems to have been these sources that stimulated the curiosity of the philosophers, the men like Sir Thomas Browne who, in *Religio medici* in 1635, asked why there were no native horses in America.[43] The specialist animal encyclopaedias contributed little. They were slow to include the new animals and restricted in their range.

New Animals from North America

Meanwhile, the northern continent was being explored and colonized and its fauna was being described. The fauna of North America is not spectacularly different from that of Europe, and so the explorers were less astonished at what they found there. Some did not consider it necessary to comment on the similarities, though Leif Eiriksson had described bears and foxes from what may have been Labrador or Baffin Island in 1000.[44] It was five hundred years before more was heard of the North American fauna.

Again, it was the explorers' journals that were the original sources of descriptions of new animals and, again, it was often the mapmakers who provided the first illustrations. Amerigo Vespucci, who may have visited the coast of Florida in 1497, described cougars (or pumas), wolves, hares, rabbits and stags.[45] An early map reported the discoveries of the first fifteenth century European who is known to have touched the North American shore. Sebastian Cabot's map of 1544 had an important inscription alleging that his father, John Cabot, had seen polar bears, big caribou, and peregrine falcons when he touched Newfoundland in 1497.[46] The Cabot map also had *el tigre*, the jaguar, which had been reported from the Texas area. Clearly, Sebastian Cabot was drawing on other sources than his father's expedition for information about the fauna. A letter from the Italian diplomat in Lisbon, Alberto Cantino, confirmed, for example, that Gaspar Corte Real had seen caribou "with long hair", wolves, foxes, "tigers" (pumas), sables, and peregrine falcons as he coasted Newfound-

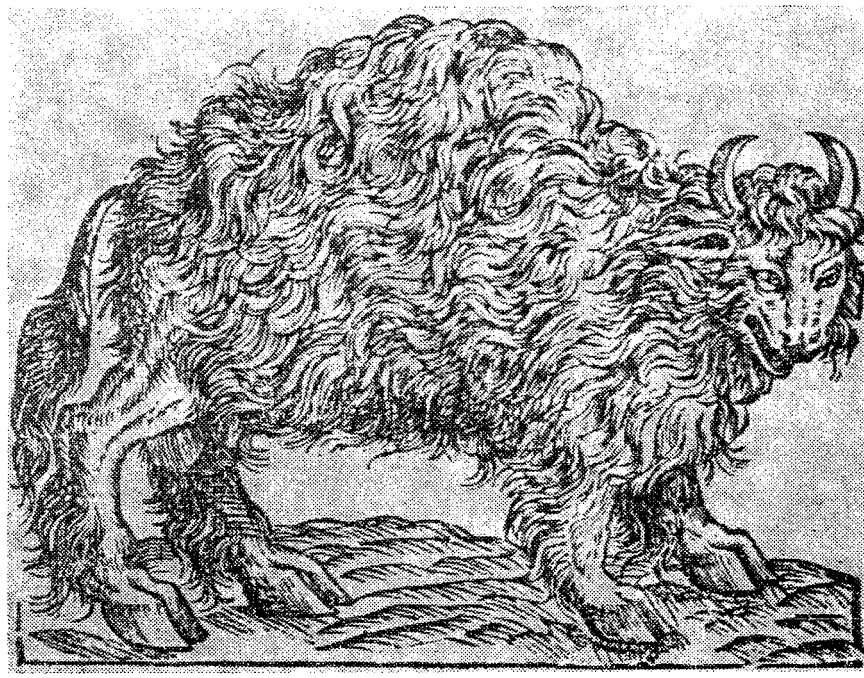

FIG. 4. A bison from *Les Singularitez de la France Antarctique* by André Thevet.

land in 1500.[47] By 1520, the great auk or "penguin" was well known to sailors.

Towards the southern end of the North American continent, Cabeza de Vaca was exploring Florida, Texas, and Arizona between 1528 and 1536 (Figure 1). In 1532, he saw one of the most typical of all North American animals, the bison. "They have small horns like the cows of Morocco; the hair is very long and wooly like a rug. Some are tawny, others black. . . . They come as far as the sea coast of Florida from a northerly direction ranging through a tract of more than four hundred leagues and throughout the whole region over which they run, the people who inhabit near, descend and live upon them."[48] Cabeza's *Relacion* was published in Oviedo's *Historia general* in 1547. In 1551, Sancho Guttierrez drew a map of the world and put a bison in North America.[49] A woolly bison appeared in 1558 in André Thevet's *Les singularitez de la France antarctique* (Figure 4). Thevet had travelled in North America. It has been estimated from the accounts of early settlers that as many as fifty million bison once roamed the central North American prairies. Many Indian cultures were based on bison herds and their migrations.

Jacques Cartier's diary, during a voyage to India that ended in Canada, was brief in its reference to the natural history. He seems to have been impressed by sea birds, the auks and the puffins. It was not until the following year, 1535, that he reported land birds (most of them like those of

France), and some land mammals. He feasted off muskrats, and reported seeing a number of small carnivores, some rodents (including beavers), rabbits, and hares.[50]

Further south the fauna was different. Cortes had seen domesticated turkeys during his expedition to Mexico in 1519–20.[51] He called them peacocks. The mistake is understandable because they were almost certainly ocellated turkeys *Agriocharis ocellata* that live in the lowlands of Yucatan. Each of the long rounded tail feathers has red and blue eye spots and the body feathers have a green-bronze sheen. Turkeys belong to a family of birds unique to North America and Mexico. The common wild turkey *Meleagris gallopavo* became known in the 1540s to travellers in southern North America. "There are a great many native fowl in these provinces and cocks with great hanging chins", wrote Pedro de Castenada, describing the adventures of the Coronado expedition between 1540 and 1542.[52]

The introduction of the domestic turkey was an event that directly affected the lives of Europeans. Archbishop Cranmer found it expedient to ration the clergy's food in 1541, and issued an order that no more than one of the "greater fowls" should be served in any one course. The greater fowls were crane, swan, and turkey. By 1551, the price of turkeys in London markets had been fixed at six shillings.[53] Twenty years later, turkeys had become a thriving business in the Rhineland. According to the zoologist Thomas Pennant, turkeys became a Christmas bird in England in 1585.[54] From the middle of the sixteenth century, turkeys were found regularly in the descriptions of North America: Thomas Hariot's report on Virginia in 1586, for example.

Although the turkey had been brought to Europe soon after its discovery, illustrations of it were slow to appear in print. Between 1523 and 1532, William Strickland of Yorkshire incorporated a turkey cock in his family coat of arms.[55] The first 'zoological' illustration seems to have been the 1555 Gesner illustration in *Icones avium* which looked like a domestic bird that had lost some of its tail feathers.[56] But, in the same year, Pierre Belon had produced a magnificent woodcut of domestic turkeys.[57] But both these distinguished zoologists were unaware that turkeys came from the New World. Gesner thought the turkey came from India, although his written description is that of an African guinea fowl. Belon realized that the description fitted the guinea fowl and he doubted whether Gesner had ever seen a turkey. Belon had made his woodcut from live birds, but he, too, was unaware that they had come originally from North America. And yet already, in 1550, there was another type of illustration that associated the turkey with that part of the world. In the margin of a manuscript map in the British Museum by Pierre Descelliers there is a good representation of a wild turkey at the latitude of Central America.[58]

But many of the more exciting endemic animals of North America are found in the west, and so they were discovered only by the later expeditions to the New World. However, the existence of herds of pronghorn antelope and bighorn sheep in the west had been briefly reported by Francisco Coronado in April 1540.[59]

The first full description of the pronghorns seems to be that of the Spanish Pilot Ferrel, who, with Captain Juan Cabrillo, landed at San Diego Bay in September 1542:

> animals like flocks of sheep, which were together by the hundred or more, which resembled in appearance and movement Peruvian sheep [llamas], and with long wool. They have small horns of a span in length and as thick as the thumb, and the tail is broad and round and of the length of a palm.

Another unique North American mammal was found by Francis Drake (Figure 2): "great numbers of species of rabbit about the size of a Barbary rat; their tails like that of a rat, and their feet like the paws of a mole. Under their chins on each side they have a bag into which they gather their meat when their bellies are full, to feed their young, or save themselves another time." These are gophers that occur on the west coast from 54°N to Central America. The eastern genus lives between the Mississippi and the Rocky Mountains, and it is curious that neither this one nor the western one was described by any of the inland travellers like Coronado, de Soto, or Cabeza de Vaca who trekked over the country in the 1530s and 1540s.

Thomas Hariot was impressed by the vast numbers of ground squirrels, black bears, and tortoises and, with considerable perception, realized that the deer, although superficially like those of Europe were, in fact, different: " . . . their tailles are larger and the snags of their hornes looke backward."[62] These are the mule deer, a different subfamily from the common European fallow deer and red deer.

Thomas de Bry's *America* was published in Germany in 1590, and, in the sections on Virginia and Florida, a number of birds and mammals were described and some were illustrated. Part I on Virginia consisted of Thomas Hariot's *Briefe and true report of the new found land of Virginia*, and it was illustrated with engravings made from John White's water colours.[63] These had been painted between 1585 and 1586 by John White, governor of the colony, on the express instructions of Raleigh, because the Spaniards used to send "a skilfull painter . . . to bring the descriptions of all beasts, birds, fishes, trees, townes, etc.".

Returning to the North of the continent, William Baffin seems to have been the first to find trace of the great musk ox in Greenland, "whose foote was bigger than the foote of a great oxe". This was not until 1612.[64]

News of North American flying squirrels and opossums followed. By 1640, when John de Laet published his comprehensive treatise *L'Histoire du nouveau monde*, skunks, mink, and raccoons were known.[65]

By the beginning of the seventeenth century, most of the big mammals and birds of the North American fauna were known. Again, it was mainly from travellers' writings and a few general works that the animals became known. North American mammals and birds—with the exception of the turkey—did not attract the animal encyclopaedists. In this case, it was the cartographers who displayed their knowledge of a fauna, and who must have been responsible for spreading this knowledge.[66] The printed maps of Willem Blaeu and his sons and copiers had an enormous circulation. In 1635, Blaeu's *Novus atlas* showed North America with turkey, beavers, foxes, ferrets (? mink), cranes, deer, rabbits, bears and polecat.[67]

By this time, too, the North American mammal fauna had become economically important. The fur trade had begun in the middle of the sixteenth century when the French moved into the Gulf of St Lawrence. Beaver, muskrat, and bear skins were brought out in quantity and provided clothing and covering for the people of Europe. It was observed that these animals produced good furs because they were adapted to the cold climate: "they have thicker skinnes than any in England have: for as that country is colder, so nature provided a remedy thereunto."[68]

New Animals from Australia and the Malay Islands

Exploration towards Australia was slow although, by the middle of the fifteenth century, spice traders had advanced beyond Wallace's line (the zoogeographical demarcation line in the Malay Archipelago between the oriental region and the australian). In 1444, the Venetian Nicolo de Conti wrote an account of his travels in the Malay Archipelago and, in 1579, it was translated into English by John Frampton. In the account of his travels, de Conti described three sorts of parrot from the island of Banda (southwest of the western tip of New Guinea). Among them was the characteristic white cockatoo of the region: "there be other white ones as bigge as hennes, named Cachos . . . ."[69]

In the early years of the sixteenth century, the Portuguese visited the Moluccas, the Aru Islands and Timor. In 1526, they reached New Guinea. The Portuguese ambassador-elect to the city of Canton, Tomé Pires, visited the Aru Islands between 1512 and 1515. His *Suma oriental* was published in Venice in an abridged version in Giovanni Ramusio's *Navigazione* in 1557, and published in full by Cortesao in 1944. Pires saw birds of paradise, and offered the first description of them: "birds which they bring over dead, called birds of paradise, and they say they come from heaven and that they do not know how they are bred."[70]

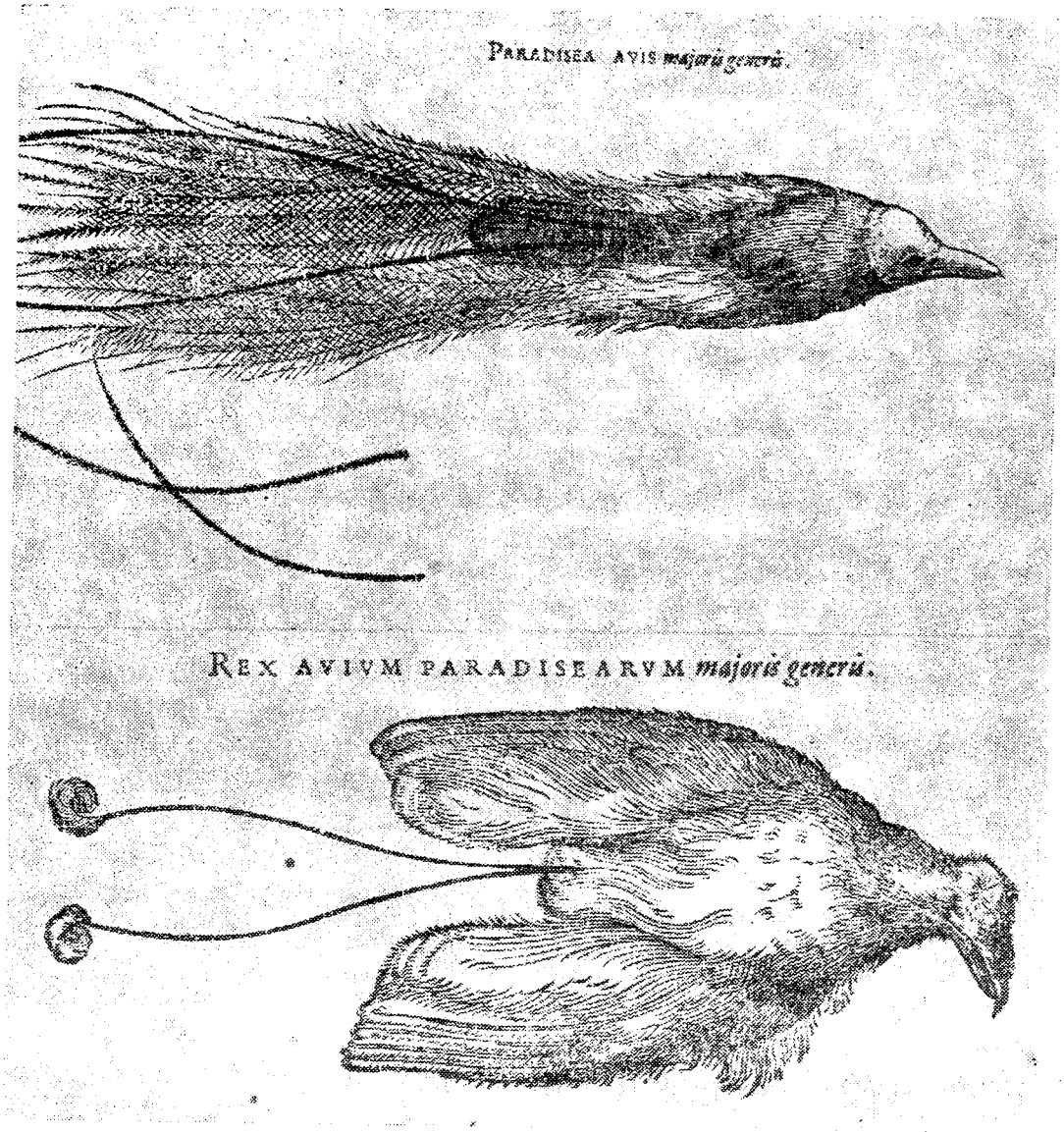

FIG. 5. The Great Bird of Paradise and the King Bird of Paradise from *Exoticorum* by Charles de l'Ecluse 1605.

Throughout the sixteenth century, spice island adventurers described birds of paradise. They described preserved specimens that had been brought by natives from the interior. The natives stuffed the dead birds with spices and chopped off the feet and the wings and even the heads. They sold these mutilated specimens to the visitors. Captain Elcano, returning to Spain in the last surviving ship of Magellan's fleet, brought such specimens with him in 1522. As a result, descriptions and illustrations of the Great Bird of Paradise are variously unlifelike. Gesner illustrated *Paradisea avis* from a specimen that had no wings or feet. Otherwise, it was

well preserved.[71] In 1594, Petrus Plancius drew a bird of paradise on his map of *Magellanica*. This bird had wings but no feet, nor did it have the two striking long tail feathers.[72]

Dried specimens reached Europe and Pierre Belon, for example, saw many different specimens in collectors' cabinets. He described the birds as balls of feathers without head or feet. He supposed that they hung from the branches of trees by the long tail feathers. He wondered how the female laid her eggs on the living twigs of the male's back.[73] By the beginning of the seventeenth century, more than one species of bird of paradise was known to the compilers of encyclopaedias, but in all cases they were known only from dead specimens. In *Exoticorum*, de l'Ecluse published illustrations of two birds of paradise without feet: *Paradisea avis*, the Great Bird of Paradise, that had no wings either; and *Rex paradisea*, the King Bird of Paradise (Figure 5).[74]

John Tradescant's *Collection of rarities* (1656) includes "Birds of Paradise or Manucodiata whereof divers sorts, with some without legs". These were part of the collection that found its way through Elias Ashmole to the University of Oxford. But Olaus Worm had a bird of paradise in his museum at Leyden that had the skeleton of its legs and feet well preserved;[76] birds of paradise were coveted collectors' pieces, and it is arguable that, in this case, this specimen gave as much information to naturalists as explorers' descriptions. No one had seen a live bird of paradise until some specimens were brought back successfully at the end of the eighteenth century.[77]

Parrots and pigeons continued to make an impression on visitors but a bird had been discovered that resembled the big flightless birds of Africa and South America. This was the cassowary that lives on some of the islands off the north coast of Australia. In 1537, Antonio Galvano described the cassowary from the Moluccas: "there is here a bird the size of a crane, which cannot fly, not having wings sufficient for flight, but they run like a stag."[78] Eggs, a beak, a leg and a claw of a cassowary were in Tradescant's collection: the remains of a live cassowary that had been at St James's, Westminster.

By the end of the sixteenth century, megapodes, or brush turkeys, and flying foxes, or fruit bats, and mice, and dingo dogs, had been reported. But the typical Australian mammals, the pouched marsupials, were not reported until Captain Diego de Prado y Tovar described in his *Relacion* how the crew landed on the south eastern tip of New Guinea (or was it on the offshore islands of North Queensland?)[79] and killed and ate an animal the shape of a dog, smaller than a greyhound, with a scaly tail and testicles that hung from a thin cord (marsupial testes hang in front of the penis).[80] This may have been one of the small scrub wallabies, *Thylogale*.[81] Prado y Tovar said they ate the animal because it was full of ginger leaves.

The only non-marsupial mammals of comparable size in that area are dingo dogs which are, of course, carnivores. Another wallaby, a female with a pouch this time (and probably the Tammar *Thylogale eugenii*), was seen by the Dutchman Franz Pelsaert when he was shipwrecked on Houtman's Abrolhos Island off the west coast of Australia in 1629.[82]

But the descriptions made no impact on those who read the journals in Europe. No one recognized the fact that pouched mammals existed in the australian region, as well as in South America. As late as 1763, Buffon doubted that pouched mammals existed in Australia, even though William Dampier had described the Banded Hare-wallaby, *Lagostrophus fasciatus* (striped like a racoon, he wrote), which he had seen on islands in Shark's Bay, western Australia, in 1699.[83] The fact was not recognized until James Cook's expedition captured, described, and drew a whip-tail wallaby, *Wallabia cangaru*, in 1770.[84]

New Animals from Africa

The fauna of Africa had, of course, been known from the early days of Mediterranean travel. African elephants, rhinoceroses (for centuries confused with Indian rhinoceroses), lions, ostriches, and crocodiles had been imported for the Roman games. Roman mosaics depicted wild animal hunts for elephants, antelope, camels, hippopotamuses and rhinoceroses.[85] A captive elephant was paraded at Aix-la-Chapelle in AD 797 by Charlemagne together with the more usual lion and bear of royal collections in western Europe.[86] But most of these animals came from northern or coastal parts of Africa. Few were known from the interior until the eighteenth and nineteenth centuries. But there were some discoveries in Africa during the intervening years.

In 1597, the Friar Joanno dos Sanctos visited east Africa and saw an aardvark which he described:

> they live upon ants, putting their tongue (two spannes and a half, like a wax candle) into the ant-holes (which they scrape with their claws)—the snout very long and slender, long eares like a mule, without haire, the taile thick and strait of a spanne long, fashioned at the end lyke a dystaffe.[87]

Another discerning traveller, Father Francisco Alvarez, recorded not only the animals that he saw but also the animals that he did not see. His *Verdadera informaçam dos terras do Prester Joham dos Indias* was first published in Lisbon in 1540, and then by Ramusio in his *Viaggi* in 1557. Father Alvarez listed the animals he saw and his list included great troops of monkeys, elephants, lions, civet cats, porcupines, warthog, gazelle, ostriches, and guinea fowl. But, he writes, he did not see any bears or rabbits.[88]

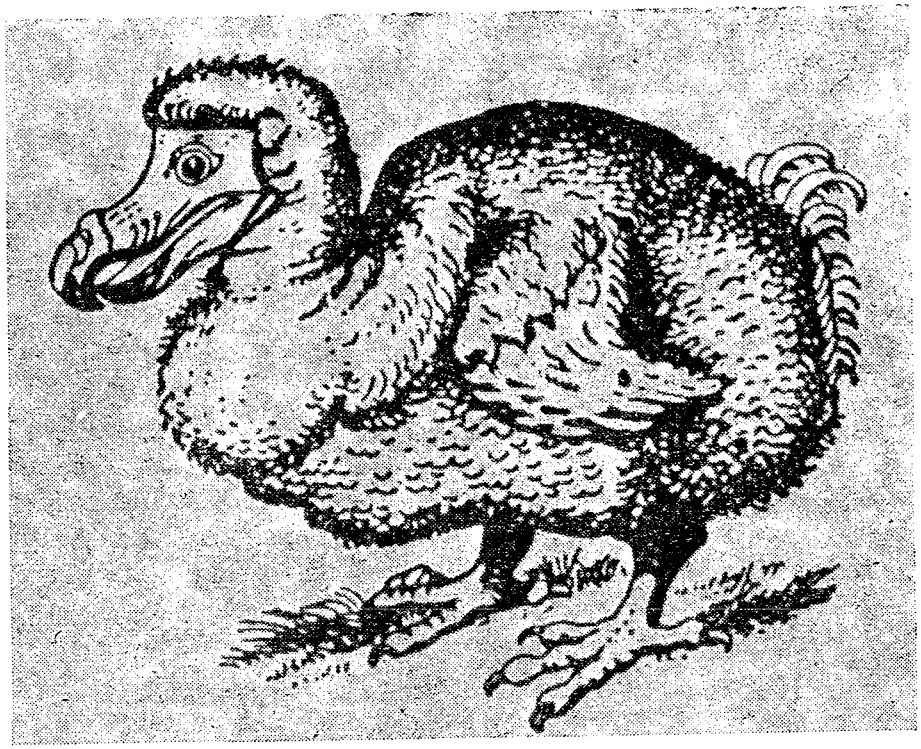

FIG. 6. A drawing of a Dodo by Roelandt Savery.

Like Aristotle, Alvarez had recognized an absence of familiar animals: he was wrong about the rabbits but correct about no bears. In 400 BC, Aristotle had noticed the absence of deer in Africa.[89]

A very strange bird was reported from the island of Mauritius in 1598 (Figure 6) by Admiral Jacob van Neck. He was the first to describe the flightless dodo, which survived only some hundred years after its discovery. Admiral van Neck described dodos as larger than swans, with huge heads covered with skin, without wings, and with a short tail of soft curly feathers.[90]

Dodos both alive and dead were brought frequently to Europe. A live one was exhibited in a show in London in 1638, and John Tradescant had a stuffed dodo in his collection: "from the island of Mauritius, and it is not able to flie being so big."[91] It was displayed in Oxford until 1755, when it was burnt by order of the Vice-Chancellor. Some bits were rescued from the fire and put in an obscure corner of the University Museum, when it opened in 1860. Today, the bits are in the main corridor on the ground floor below John Savery's painting of a dodo of 1651 (or 1635).

The result of travels in Africa, even if limited, was an increase in knowledge of the African fauna. Even compared with Roman knowledge of African animals there was an improvement. In *Historia animalium*, Gesner

had described some 118 different species of mammals, and, among these, twenty-six were typically African, though, like the elephant, not necessarily exclusively African. Gesner had brought back Herodotus's jumping mice and spiny mice, with illustrations. The African striped ground squirrel was described and illustrated and a big "mouse" with a woolly tail was illustrated: a crested rat, perhaps. There were now three kinds of hyena instead of one, and many kinds of monkeys including two recognizable species of baboon: the anubis and the gelada.

New Animals from India

There were a few discoveries in India and southeast Asia during the sixteenth and seventeenth centuries but there were only sixteen entries for Indian mammals in Gesner's *Historia animalium.* This is a surprisingly small increase over the eleven entries for Indian mammals in a typical twelfth century bestiary.[92]

At the end of the sixteenth century, Jan Huygen Linschoten described a pangolin in his *Itinerario.* The Dutchman had spent several years in Goa, and knew the animals of the region. Linschoten's pangolin was alive: "It was in bignes as great as a middle-sized Dogge with a snout like a hogge, small eies, no eares, but two holes where his eares should be . . .

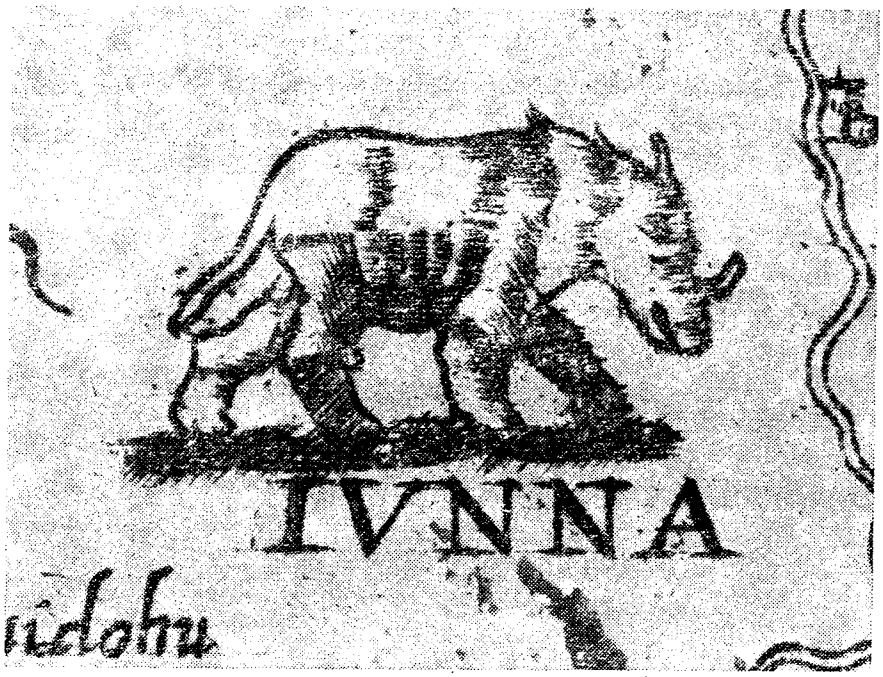

Fig. 7. A single-horned Indian rhinoceros from a map of China in *Itinerario* by Jan Huygen van Linschoten 1598.

The whole body, head taile and legs covered with scales of a thumb breadth, harder than iron or Steele. . . ."[93] According to de l'Ecluse, a Leyden apothecary had a pangolin skin in 1604, and there is a drawing of the skin in *Exoticorum.*[94] Pangolins had already been drawn on maps. The first was on the Descelliers 1546 world map.[95] Whether the *Lamia* of classical literature and of Gesner's *Historia animalium* should be considered as a scaly anteater, or pangolin, is impossible to decide. Gesner's illustration could have been constructed from a pangolin skin but as he makes no reference to a specimen it seems unlikely.[96]

The elephant and the rhinoceros retained their popularity. Even though there was confusion over the number of horns on an African rhinoceros, the Indian rhinoceros was stabilising as a single-horned animal (Figure 7).

At the turn of the seventeenth century, the Jesuit Father Canelli described a tarsier: "a small long-tailed monkey" from the Philippines. It was sketched by the Englishman Petiver in 1702.[97]

New Animals from Europe

European animals had been the most popular of the animals depicted in animal encyclopaedias through the ages. They were familiar to many, and, as a result, they were often very well drawn in the illustrations.

In 1547, an elephant-like animal was depicted on a map of Finland in the Vallard Atlas,[98] and, three years later, on the 1550 world map of Pierre Descelliers.[99] It has been suggested that it was a reconstruction of a mammoth based on a knowledge of mammoth tusks. But the trade in mammoth tusks from Siberia is thought not to have begun before 1583.[100]

In 1555, *Historia de gentibus septentrionalibus* by Olaus Magnus was published in Rome. It was translated into English in an abridged form in 1658.[101] The work includes a splendid survey of the natural history of Scandinavia and it is accompanied by a map giving a dynamic rendering of the fauna.[102] There are lynx and aurochs, bears, foxes, squirrels, beavers, hares, and mice. There are wild horses and pigs and domestic reindeer. There are otters, martens and sable (Figure 8). Birds range from pelicans to hawks. There are snakes and there are fish. The glutton or wolverine that appeared on this map was described by travellers to Russia in the sixteenth century.[103]

The Advance of Biology

During the sixteenth and seventeenth centuries the rapid growth in knowledge of the world's animals was spectacular. The New World fauna was discovered and there were glimpses of the Australian.

FIG. 8. Part of the *Carta Marina* by Olaus Magnus 1572.

The first descriptions of new animals usually came in letters or published journals from the travellers themselves, and this has been by far the most important source of zoological information. Columbus not only described the New World but also described South American lizards. The information was often disseminated to a wider public when it was incorporated into general histories of the world, or accounts of voyages of exploration. Oviedo and Hakluyt were important as chroniclers of events and discoveries. The writers of animal encyclopaedias were slow to incorporate the new knowledge, though their delayed descriptions of strange animals were often based on specimens, dead or alive, brought back by travellers. However, these specimens were more important as models for illustrations. Both Gesner and de l'Ecluse had collections of their own. Live specimens were models for many of Pierre Belon's illustrations. Many of his models were in animal parks which were popular places to visit. Pepys reported a visit to the zoo at the Tower of London,[104] John Evelyn went to the zoo in Rome,[105] and Belon saw porcupines, lions and lynxes in a menagerie in Constantinople.[106] Live specimens, or sketches from life, were often models for the many illustrations of local faunas that were found regularly on maps of the time. Waldseemüller's opossum had its origin in the one brought to Europe by Vincente Pinzon. The map pictures were often important sources of information, for not only did they show

the form of a particular animal, but they often showed a complex fauna and, equally important, they showed which country the animals inhabited.

But the new discoveries had remarkably little effect on biological theory. For example, the new animals were pushed into the traditional classifications. They took their place in the alphabetical treatment of Gesner, or the hoof and claw arrangement of Aldrovandi.[107]

But some men pondered on the amazing discoveries and became aware that an explanation was needed for the striking differences between the Old World and the New World, between island and mainland faunas. Many had observed, for example, that carnivorous mammals were rare or absent from American islands. An anonymous chronicler of a 1539–41 expedition through the Straits of Magellan wrote: "there were many foxes on shore . . . which shows that the part from which we had come, was on the mainland."[108]

José de Acosta assumed that all animals came from the Ark, but he wondered how animals had travelled to South America from it. He rejected swimming as an explanation and postulated a northern land connexion round the world. And such thoughts raised other problems. Why did some animals go in one direction and others in another?

> We must then say, that though all beasts came out of the Arke, yet by a naturall instinct and the providence of heaven, diverse kindes dispersed themselves into diverse regions, where they found themselves so well, as they woulde not parte. . . . For if we shall looke precisely into it, we shall finde that it is not proper and peculiar alone to the Indies, but generally to many other Nations and Provinces of Asia, Europe, and Affrike, where they say there are certaine kindes of creatures that are not found in other regions. . . .[109]

And, in 1689, Richard Simson in *Observations made during a South Sea voyage with Captain John Strang*, wrote:

> As to the antiquity of these foxes, as they cannot fly, and it is not likely they should swim so far as from America, nor again is it probable that any would be at the pains of bringing a breed of foxes so far as Hawkin's Island is from any other land, it will follow that there has either been two distinct creations, or that America and this land have been formerly the same continent.[110]

More commonly, differences in climate were considered an adequate explanation of faunal differences. A voyage to the Straits of Magellan in 1587 convinced T. Fernandez that "the climate is too cold for any such snakes to breed".[110] Others seem to have had a more ecological explanation in their minds. "It is here also to be noted", wrote Geret de Veer in 1596,

> that although in this land which we esteeme to be Greenland, lying under 80 Degrees, and more, there groweth Leaves and Grasse and that there are such Beasts therein as eate Grasse, as Harts, Buckes and such like beasts as live therein [one of the northern races of caribou], yet in Nova Zembla under 70 Degrees, there groweth neither Leaves nor grasse nor any Beasts that eate Grasse or Leaves live therein, but such Beasts as eate Flesh as Beares and Foxes: and yet this land lyeth full 4 Degrees from the North Pole, further than Greenland aforesayd doth.[111]

But the conservatives were in the majority, and removed the problem, like Walter Raleigh, by denying the differences:

> And whereas by discovering of strange lands wherein there are found divers beasts and birds differing in colour or stature from those of these northern parts, it may be supposed by a superficial consideration, that all those which wear red and pyed skin or feathers are differing from those that are less painted and wear plain russet or black: they are much mistaken that so think. And for my own opinion, I find no difference, but only in magnitude, between the cat of Europe, and the ounce of India. . . .[110]

There was little progress in the theory of animal distribution in the sixteenth and seventeenth centuries. It was left to men like Buffon to reopen the question fifty years later, when he supposed that the explanation of distribution as he saw it was to be found in the assumption that "the continents and the oceans must have been differently arranged in the past".[113] But it was the middle of the nineteenth century before Charles Darwin and Alfred Wallace produced the intellectual explosion that made sense of two thousand years of accumulated knowledge.

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