A History of Livestock and Wildlife

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Animal Wealth and Human Usage

By

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PREFACE

The ratio of wild to domesticated animals is a prime index of human intervention in the environment. Over the past 10,000 years the biomass of wild mammals may have fallen by 83 per cent. It now comprises only four per cent of the mammalian total, whereas livestock (mainly cows, pigs and sheep) comprise 60 per cent and humans 36 per cent. The figures are cited by the University of Sussex zoologist, Dave Goulson.[1] The *Economist* also offers some global figures, which, although any such numbers can be only the grandest approximations, are also suggestive.[2] Measured by weight, domestic animals total 700 million tonnes, compared with 300 million tonnes of humans and fewer than 100 million tonnes of large wild beasts. 1.3 billion people raise farm animals, accounting for one-third of world agricultural GDP. More land is devoted to feeding animals than to any other use. Nor is pastoralism environmentally benign. One-fifth of the world's pasture has supposedly been damaged by over-grazing. In poor countries, zoonoses transmitted by farm stock cause one-fifth of all premature deaths.

The close and enormously significant involvement of humans with animals has changed substantially over time. This book approaches the interaction from a number of directions, largely progressing through time and in the event discovering unexpected relationships. It draws on world-wide examples of the contribution of animal life to human economies, concentrating on Britain, north-western Europe, North America and Australia during and after the economic growth of the early modern period. Emphasis is placed on the massive upsurge in slaughtering animals and birds – the Great Extermination - and the importance of the organic products obtained from them. The accession of all these additional resources was a booster rocket helping to propel economic growth. Reliance on organic materials continued during the nineteenth century, despite the arrival of industrial products, such as coal-gas lighting as early as 1800, which has tended to dazzle scholars. Moreover, the use of organic products has sometimes survived right to the present alongside the development of synthetic alternatives.

Animals and their products were used for food and a variety of functions such as transportation and traction. Alongside the unbridled exploitation of animal life once Europeans began to explore – and ravage – the outer seas and foreign lands, they initiated equally massive exchanges

of animals. The translocations reshaped the ecology and production possibilities of much of the world, especially the temperate neo-Europes where people from Europe settled and began to farm. A mid-nineteenth century surge in this process introduced an almost bizarre range of species to the British Empire and to the neo-Europes which were often Imperial colonies.

In that and many other respects the Victorian era, especially perhaps the third quarter of the nineteenth century, stands out as when alterations in world ecology were most intensive. Available literature focuses on the deliberate movement of wild animals by the acclimatisation societies of Queen Victoria's reign but from an economic point of view newly-established livestock industries were in the end more important. In reality, wild animals and livestock formed a continuum, with both categories being moved around the world and occasionally ending up competing with one another. To illustrate the scope and consequences of Victorian translocations this book offers case studies of the Antipodes and the less well-known example of fish.

In the European core, the narrative of economic history pivots on winter feed for livestock. In countries with cold winters or dry summers, fodder shortages can become seasonally acute. Reserves of types of natural forage that are often forgotten today were carefully husbanded and efforts made to supplement them with new sources of fodder. In addition to its overseas resource grab, the improvement of agricultural resources was a feature of north-western Europe during the early modern period. Indeed, parallel overseas expansion and domestic agricultural intensification had much to do with the fact that modern industrialisation began in the northern hemisphere. The domestication of cattle has been called the most important step in the exploitation of the natural world, with emphasis placed on the continual attention it required of farmers.[3] In prehistoric times a domestication frontier had spread north-west across Europe and the uses and managerial practices then established were to prevail throughout subsequent ages. In this old settled region the rather gradual development of good sources of winter feed was history's next stage, raising livestock production to the level above basic domestication. It was largely an early modern phenomenon, enhancing the supply of animal products crucial to human well-being.

The mere presence of domesticated animals would have remained of limited effect without a reliable supply of winter feed. Too few plough animals could have been kept, and kept in good condition, to provide traction for cultivating the cereal harvest, nor would other tasks requiring animal power have been manageable. The same applies to all the

economic functions of livestock: transportation, product contributions (meat, milk, wool, butter, cheese and leather), and another vital service that is less often acknowledged: the provision of animal dung with which to maintain soil fertility.

Some of these themes may be quite unfamiliar, the reason being a methodological quirk which recurs throughout the literature. It is that economic, environmental and agricultural historians typically proceed by tracing back the history of features either present in modern farming or at least well attested in early writings. But early agricultural authors were usually 'improvers' who paid little attention to minor animals, crops or practices. This bias is rectified here by investigating local sources which reveal the indispensable role of animal feed. The topic is given space because of its intrinsic importance and partly because the methodological approach that has concealed the point has concealed other points too.

With rising human populations, more beasts were needed for transporting people and goods, as well as for traction, above all for ploughing. The production of livestock was expanded. Through time and around the world, an astonishing range of species has been corralled for these tasks but in practice only a tiny proportion was much used, mainly horses, oxen, donkeys, and camels. To feed animals, the balance in Western countries was tipped away from plants on which beasts could forage for themselves towards sown fodder crops. The emphasis on 'new' crops such as turnips and clover, valuable though they were, has however obscured the roles of unsown fodder supplies such as tree hay and salt hay. More generally, there was competition for grazing between livestock and wildlife and between the owners of various breeds of livestock. This motif, too, recurs throughout Western history, becoming intense during and after the early modern period.

Where humans impinged on the animal kingdom the standard narrative is the history of the victors. The big battalions get most of the billing. Instances include the sidelining of Cincinnati in favour of Chicago, despite the former being the original 'Porkopolis'. This is of a piece with forgetting the 'Great Appalachian Hog Drives', which were larger and of longer duration than the famous driving of cattle to Abilene, Kansas. The large-scale droving of pigs is even less remembered in England. There and in the United States some scholars assert that pigs are flatly incapable of being driven. The error rests on the undoubted difficulty of herding blocky modern pigs whereas the long-legged pigs of the past most certainly could be driven. Recovering these episodes reinforces the fact that pigs driven to London and fed there on distillery waste further reduced the costs of producing pork already achieved by incorporating the 'new'

fodder crops in English farming systems. Falling costs put pressure on high-cost wheat growing in the clay vales, which were less suited to such crops. Despite protests by Protectionist farmers, this led to a gradual realignment of English agriculture in the seventeenth and eighteenth centuries and produced a vital change in comparative advantage even before the classic agricultural revolution.

The management of animals was improved. Pasturage and markets were connected via transhumance and other remarkable long-distance movements of stock. Species, breeds and products became intricately adjusted to regional environments. Through the blur of local initiatives may be seen frequent small organisational innovations that fall under the heading of greater allocative efficiency; the point is made in several chapters of this book. Similarly, many minor technical inventions and innovations were made and spread, as may be seen especially in the chapter on salt hay. They too added to the picture of cumulative late pre-industrial developments. It is one of the main aims of this book to insist that economies were already stirring vigorously on the threshold of the industrial revolution and did not sit waiting to spring suddenly into life at the clarion call of steam and rail. The history of animals, indeed agricultural history in general, shared energetically in this momentous seventeenth- and eighteenth century prelude. Another major aim is to emphasise the special intensity of the use of animals, wild and farmed, during the mid-late nineteenth century, which might otherwise be thought to have been solely a phase when manufacturing industry reached a novel and unaided crescendo.

Regional redistributions in the livestock sector, coupled with sourcing products from wildlife, illustrate the Smithian Growth which was reaching an influential level before the classic industrial revolution. The counter-argument that pre-industrial growth was constrained because the supply of land was fixed by nature may be formally correct but does not allow enough latitude for the gains secured via agricultural intensification and the re-sorting of land use. Evidence of rising living standards, with all allowance for distributional distortions, is provided by calculations that English agriculture's non-food contribution was already outstripping population growth before either the classic agricultural revolution or the industrial revolution.[4] Fixed area or not, more intensive use and reallocations of production were conspicuous in the immediately preceding period.

The way in which humans exploited the most minor animal species by 'farming' them close to settlements is tackled in a later chapter, as is the limiting case of human-animal interaction through the keeping of pets.

General considerations relating to the use of animals are discussed, together with the inadvertent rewilding of former farmland in the north-eastern United States and the recovery of raptorial species in lowland England: the 'Great Rebound', which offers some compensation for the exploitation of animals throughout history and some slight hope for the future.

Notes

[1] Dave Goulson, *Silent Earth: Averting the Insect Apocalypse* (London: Vintage, 2022).
[2] *Economist* 18 Jan 2014.
[3] D. C. Davis and A. A. Dent, *Animals that changed the world* (London: Phoenix House, 1966), p.65.
[4] E. A. Wrigley, 'The transition to an advanced organic economy: half a millennium of English agriculture', *Economic History Review* LIX/3 (2006), pp.435-480. How the changes worked out on the ground is illustrated by Michael Wood, *The Story of England* (London: Viking, 2010) where local and national are exceptionally well integrated.

INTRODUCTORY

CHAPTER 1

INTERACTIONS

Studies of the history of wildlife and livestock are fragmented and keep themselves largely distinct. Zoologists usually resign farm animals to agricultural specialists who return the compliment by ignoring wild nature. A number of books with titles combining the words 'animals' and 'man' rarely mention farming, although in periods when manufacturing and trading animal products was more visible a handful did acknowledge the continuity between livestock, wildlife and the economy.[1] Economic historians are inclined to cut the Gordian Knot by ignoring the whole issue. Among economists, interest in ecology is most likely to be found in the sub-discipline of development economics, whose practitioners are confronted by stark poverty in poor countries and sometimes comment on the environmental implications.

From far back in prehistory, humanity has accidentally or deliberately interfered with the distribution and population densities of wild animals, taming a handful of species and turning them into farm livestock. In the course of these changes an enormous, mostly unpredictable, array of interactions occurred among animals and between the animal kingdom and the humans who hunted animals as sources of protein. Species that had never before encountered one another were brought into contact by being introduced to new lands. Humans themselves long lived in the wild, in the sense that their settlements were scarcely more than islands amidst the forest, and were vulnerable to events that took place in the woods. The events concerned animals, which transmitted the consequences to humans. The links were energising or dire but either way they were seldom avoidable. They still are. It is neglectful to think that economic life is not embedded in the kingdom of the animals.

In this chapter, after a discussion of approaches to the historical study of animals, some key episodes when humans and animals engaged are described with the aim of underlining the reach and importance of the interactions. One aspect concerns the endemic search for protein, which involved the exploitation of the animal kingdom by most human societies. Next follows the early modern search for biological resources outside

Europe's borders, the success of which made available unprecedented additions to inputs, transformed the world distribution of economic activity and changed the growth equation. A separate section considers the increased use of organic products and their surprisingly slow replacement by synthetic materials. Finally, to show that despite the economic gains, all was not sweetness and light (it rarely was for animals) and to reiterate the sensitivity of humans to the animal kingdom, this introductory chapter concludes by discussing the transmission of animal diseases to human society.

Incorporating the study of animals

Popular methodological choices combine to side-line the historical study of animals. They inadvertently echo eighteenth-century proposals to abandon livestock production altogether on the grounds that arable land generated more food, a cereal-centred fantasy which conspicuously neglected the provision of manurial fertiliser and draught power.[2] Crops may supply more food immediately but are less efficient at meeting protein requirements. Livestock are more varied, more mobile, harder to count, and give rise to manifold products. It is perhaps not surprising that when an eighteenth-century historian of Gloucestershire circularised the gentry for information on such complicated matters his questions about livestock were simply ignored.[3] An extended account of other livestock services would embrace employment, revenue, financial collateral and insurance. Historically, draught power for cultivation and transport was of great importance, not to mention leather (the fourth largest industry in mid-nineteenth century Britain), and tallow for candles. A less remarked advantage of producing livestock is that they can be moved away from floods, something impossible for crops in the soil, although problems with feed and water did mean that the livestock sector as a whole was more susceptible to drought than was the wheat crop.[4]

Livestock may be comparatively underrated but there is an enormous absolute volume of material about them. This led the bibliographers, Lean and Campling, to remark that, 'the central importance of all aspects of animal agriculture to mankind is reflected in the extremely wide range of publications available from scientific, national, government and international sources.'[5] Work on the histories of livestock and wildlife is scattered among academic specialisms and dispersed by period, location and species. 'Standard texts on cattle, sheep and pig production,' continue Lean and Campling, 'are usually written in relation to the local environments of their authors. Consequently, it is often not possible to cite

international authoritative texts…' The history of animals was more of a totality than the literature implies. Alongside farming, attention ought to be given to the upwelling of animal exploitation among the immediate precursors of industrial agriculture and the concomitant siphoning of products from the wild. These phenomena are linked, even though the ratio of their economic importance has changed so markedly over time.

Occasionally, work in history and economic history appears which adopts a 'persistence' approach, tracing modern phenomena from incredibly ancient roots, as though particular events in the past directly determine the present and do not merely display a premonitory resemblance. Path dependence is assumed rather than demonstrated. In economics and the natural sciences, the opposite 'recency bias' is commoner. In the field sciences, specimens from the natural world are sometimes prioritised according to their aesthetic appearance. Edgar Anderson criticised the tendency of botanists to work on rare orchids in cloud forests instead of influential weeds on their doorstep.[6] A study of practices in botany shows that pretty coloured plants are investigated more than less attractive ones, paralleling a bias among zoologists towards large, showy animals.[7] The botanical study searched a database called the *Web of Science* for papers published only since 1975, a misleadingly recent date convenient for permitting authors to claim they are uncovering something new. It is better to look earlier and steer a middle course between persistence and recency.

An attempt at universal coverage has been made by Daniel Headrick in an encyclopaedic volume of environmental history.[8] Beth Shapiro provides a remarkable palaeontologist's or geneticist's global survey.[9] The equivalent in agricultural history is Giovanni Federico, *Feeding the World,* but this restricts itself to work defined by method rather than substance and deals primarily with the nineteenth and twentieth centuries.[10] The secondary literature on livestock history, broadly conceived, is thinnest in the centuries between the ancient and medieval worlds, which excite the interest of archaeologists, biologists, classical historians and (obviously) medievalists, and the better documented nineteenth and twentieth centuries, which appeal more to present-minded economists and economic historians. The early modern period is accordingly the weakest link.

The volume of material covered by compendia like Headrick's book is laudable, even astonishing, but the analysis in works of that type rests on sifting secondary sources and cannot easily escape being defined by existing knowledge. The results weave together themes which were picked out by the early commentators or trace back features visible in the present. Given the innumerable sources begging to be read, the approach can miss

activities which were significant in the past but have dropped 'beneath the radar'. A counter to any lament about limited treatment might be that twenty-first century historians have been experimenting with an 'animal turn' on a sufficient scale for the label to be widely applied. It is most conspicuous in the United States, although Arthur Macgregor from the Ashmolean Museum in Oxford was quick off the mark in 2012 with an extensive synthesis of the secondary English literature, called *Animal Encounters.*[11] Nevertheless most 'animal turn' works are general histories without special attention to economic implications.

The quest for protein

The quest for protein from wild animal flesh should not be passed over. Poor Africans and Chinese were not alone in seeking it throughout history. We shall see in a later chapter how natural sources were urgently sought in recent centuries by the English poor, who were driven to scrabble for low-yielding items such as the 'vermin pie' – house sparrows and the like – which farmers were willing to allow because taking them was pest control passed off as sport and supplementary income for the lower classes.

Anything and everything was taken from somewhere in the countryside somewhere in the world – fish from oceans, lakes and streams, elvers (young eels) from the Severn, catfish from American rivers, golden plover from Dutch marshes, honey from wild bees on African cliffs – the list is almost endless. Any naturalist can think of examples. The take became multitudinous, intense and often damaging when demand for novelties and exotic tastes unfolded among the middle classes of the nineteenth century. To reiterate the basic point: in what seems a bewildering, disparate and obscure set of particularities, involving every family of birds and animals, spanning the centuries and crossing all continents, the uses and demands made of wildlife, above all the search for protein, form a unifying, enduring, historical complex.

The topic offers a thread which runs through history: the search for animal protein was ceaseless and sometimes desperate. It bound together and unified a large number and wide range of measures by which animals and birds were killed and eaten in society after society and from one century, or one millennium, to the next. Desperate is not an exaggeration: consider the risks taken by the climmers (climbers) of Bempton Cliff in Yorkshire.[12] Local men hung on ropes far down the vertical cliff to collect eggs from huge seabird colonies, using some for local consumption, but by more commercial Victorian times selling others to city restaurants and to the leather industry which employed the whites (albumen) in

manufacturing patent leather. The annual take of eggs was estimated to be 130,000 in the nineteenth century and the practice continued until The Wild Birds Protection Act was passed in 1954.

Searching for biological resources

The first resources that Europe drew from distant regions were luxury goods brought along the Silk Road from China, later supplemented by spices brought by sea from Indonesia, by camel trains of gold across the Sahara from Timbuctoo, and by white gyrfalcons and walrus ivory traded to the Middle East from the sub-Arctic. Minerals and precious stones came too. From the end of the Middle Ages, transoceanic sources of supply were added but for centuries the preponderance of imports to Western Europe remained either extreme luxuries or utilitarian foodstuffs and raw materials for clothing from Russia, Eastern Europe and the Mediterranean.

Import trade and simultaneously greater domestic output expanded processing and consumption within north-western Europe. Despite many studies of individual topics, the biological resources involved are seldom treated as a unified category, which means their overall significance has been underplayed. Metals were more alluring; it was not only sixteenth-century Spaniards who were over-impressed by gold and silver. Historians feel the same attraction. In reality early wealth in north-western European economies derived more from exploiting farm livestock, wild animals, birds, fish and whales at home and abroad. Centuries of growth were rooted in consuming more of the world's organic profusion.

Gold and silver did not build comparably productive economies. Fewer people could be fed or made richer than via the mundane products of farming, fishing, whaling and lumbering, which retained much of their significance into Victorian times and beyond. As a striking indication of the value of resource industries, the revenue obtained from lumber along the Saginaw Valley, Michigan, in the nineteenth century was one billion dollars greater than from gold in California, while Bay City, Michigan boasted more millionaires per capita than either New York or San Francisco.[13] The boom on the white pine frontier may not have lasted but nor did that produced by Californian gold.

At the bottom end of the income distribution, natural products went on being collected and processed in rural parts of the developed world into the twentieth century. Poor English families, the labour of whose wives and children had a low opportunity cost, were obliged to scour the hedges and ditches for plants that could be eaten or used as medicine, and for anything that might be used as fuel, even twigs blown down from rooks'

nests. They snared rabbits and poached any gamebirds they could find. Protein was at a premium and a species as small as the house sparrow was routinely trapped for food. A simulacrum of this historic intensity persists in the Amish country of Lancaster County, Pennsylvania, which is tightly tilled using horses (and wind and water power), with people constantly moving about the fields and little birdlife other than feral doves. The Amish may be an extreme case in the survival of their ecosystem, which exceeds anything in England or Western Europe.[14] They show that a vision of the preindustrial landscape as picturesque scenery, after the fashion of romantic Victorian paintings, is unrealistic. In the past as much land as possible, excluding elite European hunting preserves and ornamental parks, was devoted to growing food, as the Amish country still is. Wildlife was not spared. Landscapes were barren by modern standards, home to commensal species that lived on the scanty waste left by the human population. Low yielding, hard scrabble, farming did not take place amidst a Garden of Eden.

One great and enduring consequence of European exploration and trade was transforming the environment by mixing plant and animal species from around the world. The process is best summed up as the Columbian Exchange.[15] The syncretic ecosystems created could not now be restored to a supposedly original state by any conceivable 'rewilding'. At the start of the process, Iberian navigators began to bring back as pets what to them were exotic species, canaries for instance. Other Europeans actively transferred to Europe – and from Europe – species of greater economic value. In England, garden herbs and flowers were not merely imported but thoroughly acclimatised as early as the second half of the sixteenth century.

Much damage was done to extra-European environments and the denizens of the seas by the initial scouring of the biological world.

Subsequent losses derive from exploitation so transformative it can mask the earlier activity. The current distribution of vertebrates – encompassing farm stock too – is more closely related to past than present land use. Only a few per cent of the earth's surface is likely to carry the same flora and fauna as five hundred years ago. Ecosystems were altered by disturbance in prehistoric times, but the past three or four centuries provide more precise information about the stronger forces involved and deserve to be put in the foreground.

The aim throughout the present book is to highlight the contribution of animals, farmed, wild and semi-wild, during vigorous phases of economic growth. Chronologically, most attention will be paid to the seventeenth- through nineteenth centuries, which includes the early modern and early

industrial periods, with additional comments about modern extensions of relevant themes. It is not certain that information about the present day is necessarily superior to historical sources. As one investigator concluded, data are themselves a product of agricultural policies.[16] The issue of *World Economics* in which his observation may be found deplored the limited agricultural data of less-developed countries and noted that pastoralism is often excluded altogether. Nevertheless in practice we are obliged to proceed on the assumption that available global estimates fall at least within an order of magnitude of reality.

Estimates of the world populations of farm and wild animals do result in extraordinarily large numbers. Seventy per cent of global bird biomass are domestic poultry.[17] In 2009 1.9 billion chicken were thought to have been raised in Europe, outclassing the continent's estimated total of all wild birds (1.6 billion). Admittedly, strict efforts at precision would be futile, among other reasons because new species of wildlife are continually being added to a taxonomic total which itself alters according to struggles to agree scientific classifications. As late as the twentieth century much energy was expended by zoologists in attempts to identify the unicorn![18] Not only is the grand total of species of living organisms unknown but 99 per cent have been only sketchily described.[19] If the economic relevance of this embarrassing fact is doubted, we should pause and contemplate the coronaviruses. Humility is also required because quite large species continue to be discovered. In India 176 animal species unknown to science were discovered in 2014 alone. Despite such accessions, the ratio of farmed to wild animals has changed dramatically in favour of the former. Suffice it to say that estimates of world populations of lions are approximately 40,000 and elephants 500,000, against which at the other extreme there may be one billion domesticated pigs.

The world's huge pig population is not as fixed as this suggests. It fluctuates according to disease outbreaks and episodes of drastic culling, superimposed on world commodity cycles and the well-known pig or hog cycle produced by oscillating investments in pig-farming.[20] Fluctuations are especially marked in China, the premier pig producer where half the world's 'average' population of one billion pigs is farmed and about half of the world's pork is consumed. (For comparison, Denmark, accepted as another porcine giant, houses only 30 million pigs). China is still switching from production on small holdings, which accounted for 95 per cent of its pigs in the 1980s but fell to 20 per cent over twenty-five years. During that period vast facilities began to take over, some of them able to produce 100,000 animals per annum. During fourteen months in 2018-

2019 pig numbers in China fell by 45 per cent, the output of pork may have sunk by half, and prices rose by 170 per cent.

The oscillations in Chinese pig numbers were the effect of African swine fever, which was spreading through Southeast Asia too. But livestock of several species are kept in unhealthily crowded, disease-ready conditions and their total numbers vary more proportionately than the shrinking overall figure for wild animals. Despite some instability, present-day livestock populations always surpass the wild element. It was not always so. Into the modern era, the prodigious number of wild animals found in the world was a reserve from which western society drew the resources to kick-start economic growth.

Organic products

Beyond foodstuffs, the great compilers among the Victorians gave a great deal of attention to organic commodities, which were prominently used in their time. Take John Yeats's *The Natural History of Commerce*.[21] Yeats, a Glasgow Ll. D and London headmaster, taught history and geography. He had worked in Switzerland and the Netherlands, and was inspired by the comprehensive books of instruction available there and in Germany for pupils who were training to become merchants. His sympathies were wide and he was presumably a free trader, at least he dedicated another volume, *A Manual of Recent and Existing Commerce* (1872), to that great opponent of protectionism, John Bright. Yeats's work, pioneering in the case of Britain, was encyclopaedic as far as imports were concerned. It delved into the commercial value of products which are no longer used today, including goods that highlight a greater dependence on organic materials than exists in the modern world. An example is 'pounce', which was sawdust obtained from Nuremburg for the purpose of drying ink, now an outmoded requirement.

Reliance on organic materials survived later and bulks larger than may be thought. As far as animals are concerned, the labelling of wildlife by agriculturists as pests or by sportsmen as targets simply does not cover the case. On the contrary, Yeats and his fellow compilers described many commodities supplied straight from nature alongside those derived from orthodox farming, none of them originating as synthetics from the chemical industry as might rather blithely be expected in modern times. As an illustration, thousands of horseshoe crabs are still caught every April in South Carolina (650,000 in 2020), and bled by pharmaceutical companies because the blood is the only substance known to contain an extract which detects a particular dangerous bacterium.[22] The process harms the crabs,

the population of which in Delaware Bay has fallen by 90 per cent in fifteen years. In Europe a synthetic alternative is at last replacing crabs' blood but the United States has been slower to change.

Other natural commodities have so often been replaced that current dependence on a biological ingredient like this surely comes as a shock. Substitutions occasionally began early, for example whale oil started to give way to coal gas right at the beginning of the nineteenth century, showing the competitiveness of an economy where the new gas companies could overcome the established power of the 'Greenland interest'. But gas-lighting the streets necessitated investment in infrastructure and gas was not suitable for hand-held lights. The replacement of whale oil by other forms of lighting, via say kerosene, awaited the industry that originated after the sinking of Colonel Drake's well in Pennsylvania in 1859. The chronological overlap between modes of lighting and other functions was very wide, although some awareness of the precariousness of natural supplies formerly taken for granted dawned in the pivotal third quarter of that century. Ivory is a case in point. Elephant tusk was used to make billiard balls from the sixteenth- to the twentieth centuries, elephants being killed in droves to provide the ivory. But by the 1860s the supply threatened to dry up and a substitute was eagerly sought, with a prize being offered in the United States. One alternative was Sorel cement, a magnesium compound, which was invented in 1867 and marketed as artificial ivory. This was followed by Celluloid in 1870.

The dates when synthetic fibres were created may surprise: Joseph Swan, who invented filament bulbs, first produced them in the 1880s and synthetic textiles appeared a decade later.[23] Polyester was patented only in 1928 and Du Pont came up with nylon in the 1930s. Even now half of all fibres are said to be naturally-sourced. How superior synthetics are to natural materials is actually questionable. Their merit may be that they can be manufactured more cheaply in bulk, with less labour, meaning their advantage may lie in price rather than quality. Tim Severin, famous for the 'Brendan Voyage', instigated a series of tests and experiments to see how well medieval materials would stand up to an Atlantic passage.[24] Oak-bark leather, natural greases, leather thongs, and flaxen thread all performed more than satisfactorily. Substitutes may have been introduced less for their demonstrable superiority than because natural commodities are labour-intensive and harder to collect at scale. For most of history they were all the world had to offer. To restate the point, it was by amassing a great share of biological resources that Europe first levered itself onto the path to growth.

Animal diseases and humans

To provide a chilling illustration of how close is the connection between wildlife and humans we can consider the topic of zoonoses, which are diseases spread by animals. They are the greatest single threat posed by the animal kingdom. Some of the diseases are comparatively minor, such as the toxoplasmosis communicated by domestic cats, but comparatively is the key word: when diseases burst into epidemics the results can be so deadly and on such a scale as to render the term 'devastating' thoroughly inadequate. Diseases harboured by mammals, notably bats, that are the hosts of insect- and viral disease vectors have caused and continue to cause ghastly outbreaks, such as Ebola and, so it appears, COVID-19. It is usually supposed that human encroachment on the territories of wild animals has involved excessive propinquity, the link being so-called bush meat, that is to say flesh or captive animals from the edges of settlement, sold ready to be killed for the table (as many animals were in Victorian cities). Bush meat is cheap protein, eagerly sought by poor populations for whom consuming wild animals is traditional. It remains a threat because new disease organisms evolve in the wild ahead of attempts to identify, monitor and control them.

Before the coronavirus pandemic, the most extensive plague and one with a high case-fatality rate, was the fourteenth-century Black Death, most recently described in scientific and historical detail by Bruce Campbell.[25] Too well known to require elaboration, it was spread by fleas carried by commensal rats. Less appreciated is that it had been preceded a few decades earlier by a massive panzootic with a similar Asian origin. To this, north-western European cattle had no immunity. In the way of such events, 'antidotes', writes Campbell (p.227) in a terse summary, 'were unknown, individual responses mostly counter-productive, and institutional counter-measures non-existent.' The Black Death that followed, 'wrought prodigies of destruction upon human populations throughout the greater part of western Asia, Asia Minor, the Middle East, North Africa and most of Europe.' (p.228)

The species of rat responsible for this deluge of death and destruction was the black rat. This, in turn, was replaced by the brown rat, which although it has not created a human holocaust on the same scale as its predecessor, has been troublesome enough and the source of economic losses for almost three hundred years.[26] It causes crop damage (sugar cane is especially vulnerable), competes with humans for stored food (with a predilection for grain silos and cheese racks), damages mine infrastructure, and can spread disease to humans. Elusive and hard to exterminate, the

brown rat's population is difficult to census although a single anti-rat campaign in London during the winter of 1943-1944 accounted for 650,000.[27] After programmes of poisoning, dead rats can certainly be counted but many bodies are likely never to be found. Projections can be made from the number of corpses to compute the total kill (and total survivorship) and these are needed to decide when the damage crosses what is known as the 'economic threshold', the line above which the losses outstrip the costs of control.

We should not think of this and other human-animal interactions as two initially static realms grinding against one another. The situation is vastly more dynamic. The animal and human kingdoms both constantly evolve and have histories of interaction, like the fourteenth century cattle plague, that are seldom well known. Knock-on effects can be unexpected, extraordinary and unfathomable. Among the connections of note, humanity inadvertently facilitated the arrival of the brown rat, because the rat hitchhikes on trade and shipping. To a degree, the brown rat is therefore as much an anthropogenic creation as are livestock that have been consciously nurtured and intentionally translocated. A fresh niche for the brown rat – innumerable niches for so plastic a species – has been created by humanity. Spreading from Asia, as the black rat did centuries earlier, the brown rat ousted its competitor just as vigorously and even more completely than when the American grey squirrel drove the red squirrel out of most of its British range.

Crossing to North America, the brown rat followed settlers west across the continent, although presumably because it finds better food close to humans it seems not to have outrun settlement in the way that horses, white clover and bees did. The spread of these more visible species indicates the transformations brought about by humans but extending beyond their control. Details are contentious, yet no-one can doubt that the ecosystems in which the economy of white settlement in North America nested had in any case been modified in advance by the indigenous population, who were not always as tender or conservation-minded as the noble savage myth supposes.[28] American agriculture was obliged to adapt to an already somewhat altered environment.

The two species of rat, black and brown, were immigrants to the Western world, carried by trade. They had benefited from assisted passages like some of the stray birds that cross the Atlantic to vex spotters of rarities. The brown rat can have reached America only on shipboard. Arrivals like these underline the mutability of environmental history and the interactions which in these cases, as with infinite others, can prove so very expensive. No-one could have anticipated the scale of the costs or

done much about it. It has to be recognised that, however inadvertent the effects were, they were outcomes of human activity – self-inflicted wounds, so to speak. Humans have gained much, stolen much if you like, from their engagement with the animal kingdom but it was and remains a perilous ride.

PART ONE:

THE GREAT EXTERMINATION

CHAPTER 2

MARINE SPECIES

Every possible means of destroying wildlife has been practiced somewhere at some time. The consequences have been simplifications and distortions of ecosystems on such a scale that it is now possible to obtain only glimpses of the world as it was two or three centuries ago. More information is available on the means and episodes of transformation – hunting and killing and taking to market - than on the habitats which were modified, because few people took the trouble to describe the situations they were in the business of altering. The uses to which the wildlife 'harvested' were put will be more explicitly discussed in later chapters; in the following sections of the present chapter the emphasis is on large-scale episodes of the slaughter itself. Even here the purposes mostly tended to be commercial.

The picture is not a pretty one but it should be stressed that without animal bloodshed and captivity, modern economies, societies, settlement and agriculture might not have emerged as they did. The choice of whether to exploit the world of animals to the hilt or neglect much of the prospect for economic growth is an unenviable one, but historically-speaking the question is purely hypothetical. Occasional early conservationists may have dissented but humans as a whole pressed on regardless, seldom with much sense of the cumulative effects of their actions and apparently without being willing to forego the benefits for the sake of conserving environments for their descendants.

As people saw it, and as many see the situation today, habitats had to be cleared for farming, predators on livestock suppressed, organic goods consumed, and humanity become rich enough to form markets for the eventual slow replacement of traditional industries with the inorganic products of the factory. Ecologists and conservationists have laid out parts of the tale, always deprecating the losses and seldom if ever acknowledging that large, rich human societies arose precisely from the seizure of resources from the natural world, besides manipulating them via the farming of livestock. The biologist, Marston Bates, called the process, a 'drunken spree'. On the other hand the economist, John Hicks, took the instrumental, human-centred view when he referred to it as a 'secular

boom'. Hicks did not contend that the process could have gone on for ever; it would have been enough for him that the spree, if it should be so-called, launched the economy on an upward path which it could continue to follow by other means – what might teasingly be called under its own steam. Whether the whole global environment has been irreparably damaged and the upward momentum is unsustainable is the focus of great current debate. We concern ourselves here first, more mundanely, with Bates's spree as a tale of damage.

It has to be insisted that the counterfactual of treating the animal kingdom with maximum tenderness would have been immensely smaller and poorer human societies in which life remained nasty, brutish and short. What follows in this chapter, and this volume, is a tale of the concentration of biological resources in the hands of one species, *Homo sapiens.* To repeat, it is not a pretty tale. No doubt some of the worst excesses might have been avoided (as a naturalist I might often agree), although that could have been achieved only with the benefit of hindsight and by spending immediately on conservation the wealth they helped to create. To explore that ideal would be unhistorical; it rarely happened. In practice, people hurried to accommodate the demands of our own species. Their blind efforts, even their blood-lust, supported the ascent to where we are today. The narrative deserves to be seen as a fundamental thread in world economic history.

As was proclaimed by an advertisement for an Animal Study Group book called *Killing Animals,* 'though not often acknowledged openly, killing represents by far the most common form of human interaction with animals.' It has long been so. Finds in the Upper Thames gravels of mammoth skeletons associated with stone tools suggest human predation on the megafauna over two hundred thousand years ago.[29] We need not, however, reach back to the circumstantial evidence of pre-agricultural archaeology to consider whether the toll from direct killing was or was not exceeded by the indirect losses from habitat change. Both assaults have remained powerful forces altering and diminishing the populations of wildlife. The large-scale killing of animals for food has lasted into modern times, as has killing them for sport and other trivial purposes. Writing in the 1960s, John Hay and Peter Farb remarked that sealskin was in fashionable demand for skiing jackets and for this needless end the harp seal was still being energetically hunted.[30] A population of three millions in 1951 had been reduced to one-and-a-quarter millions by 1960.

Fish

'Start with an earthquake', said Sam Goldwyn, 'and build up to a climax.' The earthquake here was the way Western Europe burst out across the Atlantic, finding and grasping the ocean's resources. The climax was the economic growth this promoted back home. While we cannot compute the total impact, the results are plain in the commerce of port towns, the increasing size of national fleets, and the efforts of governments to expand their share of ocean fishing. 'He that hath the trade of fishing becomes mightier than all the world', reported the Admiral of the Narrow Seas to James I of England.[31] Less clear are the effects of the catches on natural resources, for no baseline exists for fish populations before the Europeans arrived. Fish were undoubtedly plentiful at first and it was not until the nineteenth century that complaints began to be heard about widespread over-fishing and the excessive toll on other marine species. Early that century it was feared that cities and homes would become dark again, once mass killing had exterminated the whales and ended the supply of whale oil for lighting.

Fishing industries were felt to be so important, especially to the remarkable early modern rise of Holland, that nations contended about rights to them, as did political philosophers, starting with Grotius' book, *Mare Liberum.* Dutch success was commonly explained by an autonomous migration of herring from the Baltic to the more conveniently placed North Sea. The deeper secret was a relentless reduction of costs by the Dutch, employing any conceivable means as long as it did not impair the quality of the product. A zealous combination of cheaply-built specialised boats, and minute governmental regulations about catching, curing, barrelling and branding, was responsible for the growth of their deep-water herring fishing. In the second quarter of the sixteenth century, the number of English fishing vessels fell off and the Dutch were even landing herring in east and south-east England. Ultimately Dutch dominance was reversed, just one of the several fluctuations in international competition. The North Sea was more or less home waters for the English and they soon added the seas off Iceland. The positive economic shock administered by fishing – and the reverse shock to fish populations – now came from expansion across the Atlantic.

Governments were interested in the potential of fisheries for taxation, for reserves of seamen, for employment in the ports, and rather less urgently for the addition of cheap protein to the diet of their citizens. Fish are more liable to spoilage than meat or eggs and require a lot of effort to cure or smoke them, creating work for many hands. Few people were