

History of Ornithology

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Advanced article

Article Contents

- Introduction
- Two Strands of Ornithology: Systematics and Natural History
- Darwin
- Natural History of Birds

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Before the seventeenth century, interest in birds centred largely on folklore and their symbolic significance. Ray and Willughby's encyclopaedia, the *Ornithology of Francis Willughby* (1676 and 1678) marked a turning point in the study of birds by rejecting folklore and focussing especially on biology. Following Ray's *Wisdom of God* (1691), which addressed ultimate causes, the study of birds developed along two separate strands: (i) systematics, nomenclature and faunistics (inspired by *Ornithology*) and (ii) natural history (inspired by *Wisdom*). The first of these endeavours dominated ornithology for the next 250 years, and were the main focus of the ornithological Unions founded in the 1800s. The two strands were reunited in the 1920s (central Europe) and 1940s (the UK and the USA). After World War II not only the expansion of higher education resulted in a huge increase in both the number of professional ornithologists, but also our knowledge of avian natural history and evolution.

Introduction

Our definition of ornithology is that of Newton (1896): 'the methodological study and consequent knowledge of birds with all that relates to them'. Similarly, Haffer (2001) defined an ornithologist as someone who studies birds from a scientific point of view, writes up and publishes their results.

Birds have always had a privileged place in human culture, mainly through myths and legends, such as that of Leda and the swan, and Aesop's fables (sixth century BC). It was only a matter of time until curiosity prompted studies

of the natural history of birds, which was duly undertaken by Aristotle (fourth century BC). His *History of Animals* not only contains many insightful comments based on accurate observation, but also some errors (such as certain birds hiding rather than migrating). Aristotle's works were considered authoritative by naturalists well into the nineteenth century (Stresemann, 1975). The Roman writer Pliny elaborated on Aristotle's writings to create his own extremely successful *Natural History* (AD 77). After this, the study of birds did not blossom again until the Renaissance, some fifteen centuries later. **See also:** [Aristotle of Stagira](#)

During the Middle Ages, apart from several bestiaries (see White, 1954), only two authors on birds are worth mentioning – the Emperor Frederick II (1194–1250) and Albert the Great (c. 1200–1280) – and both wrote mainly on species involved in the aristocratic pursuit of falconry. Frederick II's *De Arte Venandi cum Avibus* (*The Art of Falconry*) remains famous for its originality and reliability because Frederick was a keen falconer and based his work solely on his own observations (Wood and Fyfe, 1943). Frederick's treatise disappeared and was published only in 1596. Even then it was overlooked until 1788 (Stresemann, 1975). Albert the Great's contribution was an extended version of Aristotle's *History of Animals* (see Kitchell and Resnick, 1999).

The ornithological encyclopaedia was a creation of the Renaissance. At a time when Aristotle's works were being rediscovered (Stresemann, 1975), and voyages to the New World were bringing to light numerous new species of animals and plants, educated naturalists strove to find order in the chaos of the natural world. Mainly physicians, they studied the entire natural world, writing treatises on plants, mammals, reptiles and birds (Delaunay, 1962). They established a network of correspondents throughout Europe, exchanging information as well as specimens, collecting new species and creating their own museums and cabinets of curiosity. Steeped in Renaissance and classical learning, most early naturalists tried to articulate their works according to a classification of animals, relying loosely on Aristotelian principles. In the standard avian hierarchy of the period, raptors and birds of prey came first, the eagle being the king of birds; the most courageous and noble. Then came various groups, based on morphological (webbed feet), behavioural (dust bathing) and environmental criteria (coastal birds living next to fresh or salt water). More important, thanks to the advent of print,

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these early naturalists were able to publish their works, making them accessible to the wider public and to other naturalists. These encyclopedias were enriched with woodcut illustrations that helped the reader identify particular bird species (see Ashworth, 1985). As a result, these first ornithological encyclopedias, all published in the second-half of the sixteenth century, were very similar, dependent both on the works of Aristotle and Pliny, and on one another, freely borrowing each other's information and illustrations (Stresemann, 1975; Charmantier and Birkhead, 2008).

Especially enduring were the encyclopedias of the naturalists William Turner (1544), Pierre Belon (1555), Konrad Gessner (1555) and Ulysse Aldrovandi (1599–1603), whose ornithological treatises attempted to include all known species of birds. These works were in Latin, except for Belon who wrote in his native French. Turner and Gessner shunned Aristotelian classification in favour of an alphabetical organization of birds. Aldrovandi's work, largely copied from previous writers, epitomises Renaissance ornithology in that his three hefty volumes (each approximately 800 pages; **Figure 1**) contain everything then known about birds: from their natural history to their cultural significance through proverbs, myths and legends, and their role in food and medicine. Although Renaissance natural history is often considered by today's biologists as excessively wordy and full of useless information, it was a necessary step in the history of ornithology since it enabled naturalists to come to terms with a new, ever expanding natural world, to compare it with the works of the ancients and to impose some sort of order on it. **See also:** Aldrovandi, Ulysse; Gesner, Conrad (Konrad)

The same curiosity and aspiration to classify nature to understand it continued into the seventeenth century in the literature of exotica, which concentrated on birds seen and collected in newly discovered lands. Further works on birds were inspired by the final flourishes of Renaissance encyclopedism, such as Jonston's (1650) *De Avibus* and Charleton's (1668) *Onomasticon Zoicon*.

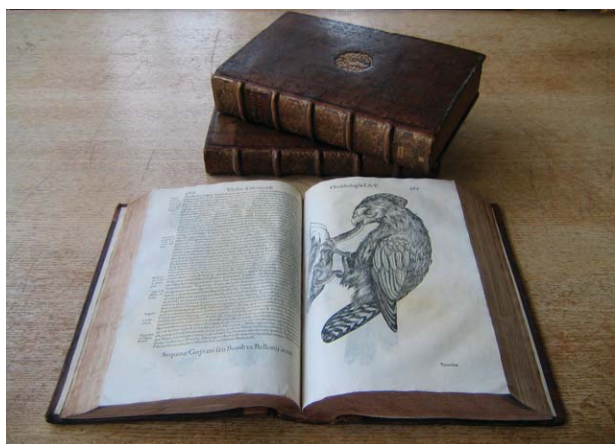


Figure 1 Aldrovandi's three-volume *Ornithologiae* published in 1599, 1600 and 1603. Photo: I Charmantier.

The foundation of scientific academies – such as the Accademia dei Lincei in Italy (1603), the Deutsche Akademie der Naturforscher Leopoldina in Germany (1652), the Royal Society in England (1660) and the Académie des Sciences in France (1666) – had an important effect on natural history. In ornithology, the work of John Ray (1627–1705) benefited from the Baconian influence of the Royal Society. Ray's *Ornithologiae Libri Tres* (1676), translated into English two years later as *The Ornithology of Francis Willughby* (1678), was the last of these early modern encyclopedias to try and encompass all known species of birds. The influence of Francis Bacon and his inductive reasoning is palpable in the *Ornithology*, as Ray promoted empirical observation and as he said: *omitted what we find in other authors concerning homonymous and synonymous words, or the divers names of birds, hieroglyphics, emblems, morals, fables, prefaces, or ought else appertaining to divinity, ethics, grammar, or any sort of humane learning: and present (the reader) only with what properly relates to their natural history* (Ray, 1678; Preface). By departing so radically from earlier treatises John Ray heralded a new phase in the history of ornithology (Raven, 1942; Birkhead, 2008). **See also:** Bacon, Francis

Two Strands of Ornithology: Systematics and Natural History

Willughby and Ray (**Figure 2**) conceived *Ornithologiae* together in the 1660s, but following Willughby's early death in 1672, it was completed by Ray. These authors were the first to use the term 'ornithology' and their book stands out for its arrangement (i.e. classification) of birds, based on morphology, and its focus on factual observations and accurate descriptions. There has been much debate over which of them deserves the credit, but the main ideas seem to have come from Ray, and his later volume, *The Wisdom of God* (Ray, 1691), confirms his genius. Though the *Ornithology* focussed on 'what' – arrangement and descriptions of all known birds (**Figure 3**), *Wisdom* focussed on the question 'why'. Ray's concept of physico-theology (later named natural theology), provided an explanation for why organisms were designed in a particular way – essentially adaptation, except that for Ray the fit between an organism and the environment was evidence of God's wisdom. Notwithstanding his religious focus, Ray identified important biological questions, asking why, for example, different birds breed at different times of year? And why some birds lay a clutch of one while others lay 10 or more? In several instances Ray also provided ingenious answers, anticipating evolutionary explanations of the twentieth century (Birkhead, 2008). **See also:** Ray, John

Together, Ray's *Ornithology* and *Wisdom* mapped out the future of ornithology, albeit in two separate strands. The *Ornithology* inspired a long-lasting interest in systematics, nomenclature and faunistics, whereas *Wisdom*,

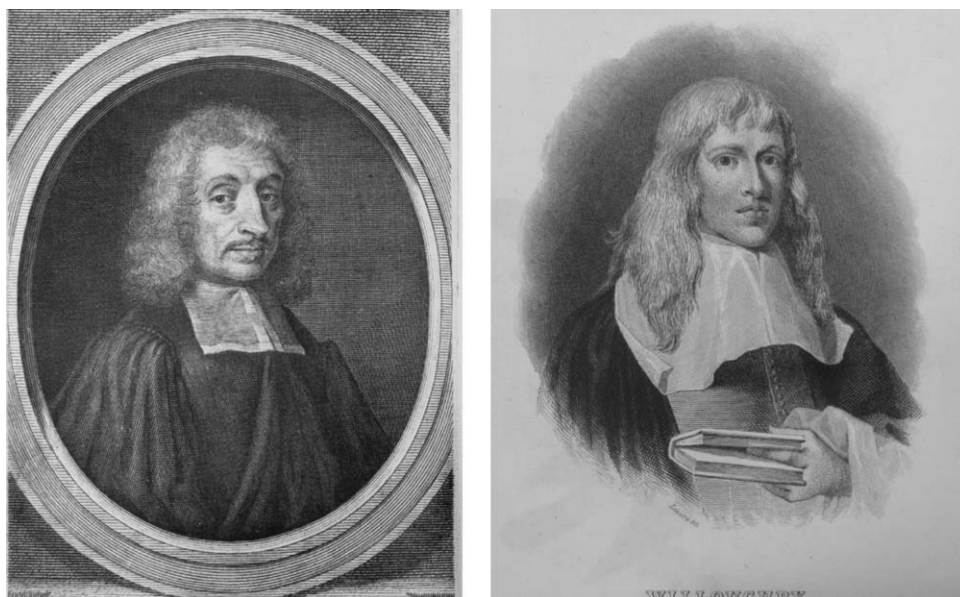


Figure 2 Portraits of John Ray (left: from Raven, 1942) and Francis Willughby (right: from Jardine, 1843).

inspired an interest in natural history, ecology, behaviour and what we now call adaptation.

The systematics strand, which remained dominant until the 1900s, was continued during the 1700s most notably by Carl Linnaeus (1707–1778), who, building on Ray's foundations, continued the construction of a natural system of classification based on 'the laws of nature'. Linnaeus's *Systema Naturae* was published in 1735, and its focus was primarily the genus rather than the species. It was not until 1753 that he conceived the idea of adding a single Latin word to a genus to designate a species, first for plants and, in 1758 for birds and other animals. This binomial system minimized ambiguity, imposed order and was especially valuable for categorizing the new species that explorers were starting to bring back, both dead and alive, from different parts of the World. Such specimens contributed to the increasingly fashionable scientific cabinets – forerunners of museums – that then played such a central role in the study of birds. Classification meant the division of nature, and led to specialization, reflected by the publication of books dealing with particular groups of birds, rather than attempting to cover all known bird species (Stresemann, 1975). **See also:** [Classification](#); [History of Taxonomy](#); [Linnaeus, Carl \(Linné\)](#); [Systematics: Historical Overview](#)

A contemporary and arch-rival of Linnaeus was George Louis Leclerc (1707–1788), later Comte de Buffon, whose interest in natural history was inspired by Ray's physico-theology. Like Linnaeus, Buffon also had bold ideas about the way the natural world was arranged, but unlike Linnaeus he was not constrained by God. He did not believe in fixed, perfectly adapted types, but instead imagined a system in which species might change, as a result of local differences in climate or diet, for example. He

also anticipated the idea of evolutionary change, imagining groups of similar species as the diverse descendants of an original stock. Buffon's monumental *Histoire Naturelle, générale et particulière* (36 volumes and 973 colour plates) was published between 1745 and 1788, with the 9 volumes on birds depicting 1239 species completed between 1765 and 1783. It was a literary masterpiece and a huge success. Those later writers that dismissed Buffon because of his accessible style, overlooked the fact that his main goal was to answer fundamental biological questions. He was especially interested in the natural history of birds: where they lived and how they behaved. *Histoire Naturelle* was among the most popular books in eighteenth-century France, and one of the most important in popularizing science during the Enlightenment (Roger, 1997). **See also:** [Buffon, Georges Louis](#)

Once there was some semblance of order in classifying birds attention shifted to their geographic distribution. The first regional avifauna appeared in 1721 and was Polish. This was soon followed by several for Germany: one by JL Frisch (1666–1743) published between 1733 and 1763; *Gemeinnützige Naturgeschichte Deutschlands* (*General Natural History of Germany*) by J Bechstein (1757–1822) whose bird volumes were published between 1791 and 1795; JA Naumann's (1744–1826, father) beautifully illustrated ornithology of northern Germany (1795–1817) and JF Naumann's (1780–1857, son) comprehensive natural history of the birds of Germany (*Naturgeschichte der Vögel Deutschlands*, 1820–1844). The latter work was described by Alfred Newton as 'by far the best thing of its kind yet produced' (Newton, 1896 p. 17); H Seeböhm (cited in Haffer, 2001 p. 30) said: 'Had this work only been translated into English, half the nonsense that subsequent ornithologists have written on birds would never have appeared'.

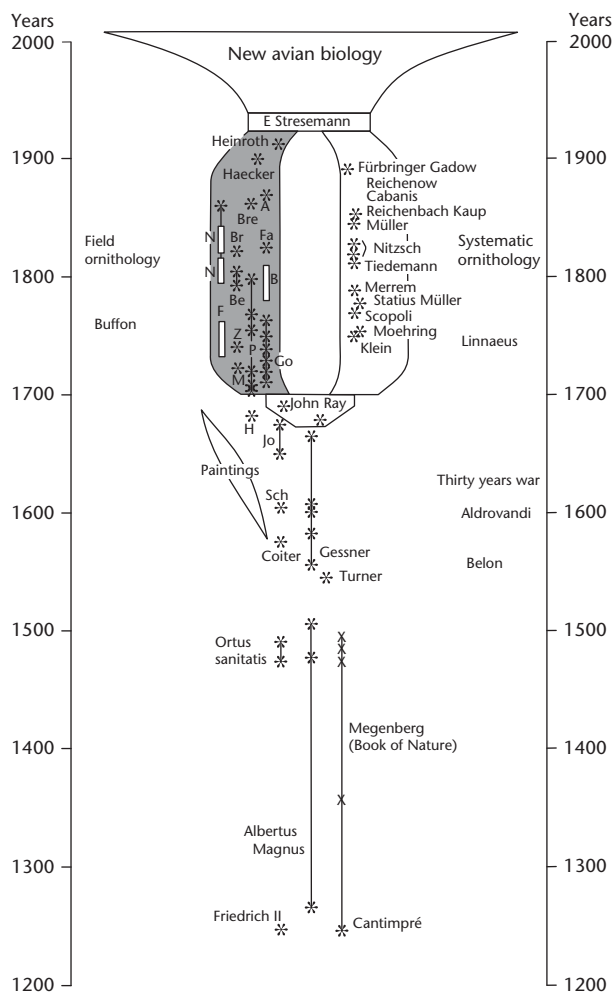


Figure 3 Schematic representation of the development of ornithology in central Europe from the Middle Ages to 2000, showing the bifurcation, after Ray's publications, between field ornithology (left) and systematics (right), and Stresemann's unifying position in the 1920s. Reproduced from Haffer (2007), with permission from Springer.

In Britain, exotic species continued to mesmerize. This focus on foreign birds was epitomized by the publication of large, expensive, lavishly illustrated volumes (see Lysaght, 1975; Stresemann, 1975) on exotic species. Despite this, the late eighteenth century produced three figures that were especially influential in popularizing the study of British birds: Gilbert White (1720–1793), Thomas Bewick (1753–1828) and George Montagu (1751–1815). White's *Natural History of Selborne* (1789) has sold more copies of any book in English other than the Bible, but from a scientific standpoint was limited. Bewick's *History of British Birds*, like many of today's bird books, sold largely on the strength of its inspirational illustrations. Montagu's *Ornithological Dictionary* (1802 with a supplement in 1813) was more substantial, set new standards of accuracy and its alphabetical arrangement allowed readers to easily locate information (Montagu, 1802, 1813, 1831). Scottish

academic James Rennie (1787–1867) produced a revised and enlarged edition of this work in 1831 that includes a useful review of historical ornithological publications.

Throughout the late 1700s and early 1800s, the number of known bird species continued to increase, but after the end of the Napoleonic wars in 1815 the flow became a torrent. For Britain, France and the Netherlands this was a time of colonial expansion. Expeditions routinely included amateur or professional natural historians who returned with biological specimens, drawings and live animals – and birds in particular. Permanent preservation was paramount as ornithologists began to recognize the need for 'type specimens' – essential for identifying and characterizing new species. Initially all this new material went into private collections, but the concept of public national museums was developing. In Paris, the Jardin de Roi became the Muséum in 1793. In Germany, the Berlin University Museum was founded in 1810, and, in London, the British Museum in 1820. By 1830, Britain, France, Germany and the Netherlands all had major national bird collections, reflecting the dominance of systematics and faunistics in ornithological circles (Haffer, 2008). Museums started later in North America – The American Museum of Natural History in New York was founded in 1869 – but their bird collections soon became internationally important (Barrow, 1998).

As the study of birds became increasingly specialized it also became more international, rigorous and professional. In 1815, Temminck (1770–1858) produced his *Manuel d'Ornithologie* – the first overview of European birds. Though he was not an ornithologist, Cuvier (1769–1832) also had a profound effect on the continuing search for a natural order in birds thanks to his discovery that internal anatomy, in addition to external features, could serve as a taxonomic tool. Charles Lucien Bonaparte (1803–1857), a wealthy nephew of Napoleon, visited North America and many bird collections to produce the most comprehensive systematic treatment of birds to date, *Conspectus generum avium*, a catalogue of all 7000 known species or forms (Farber, 1982 p. 11). However, Bonaparte died before completing it. Bonaparte anticipated Darwin in recognizing that extinct species were the ancestors of contemporary ones (Allen, 1951; Farber, 1982).

During the period between 1700 and 1900 the study of avian natural history had only a few proponents, such as Baron Pernau (1660–1731), Johann Frisch (1666–1743) and Johann Zorn (1698–1748). Keeping birds, especially song birds, in captivity became increasingly popular through the eighteenth and nineteenth centuries, and provided a few astute observers (Johann Bechstein (1757–1822) and Daines Barrington (1727–1800)) with unparalleled opportunities for observing behaviour at close range. Yet their important writings – on song acquisition and migration in particular – were ignored by the ornithological establishment because they fell outside the boundaries of ornithology of that day, and their significance was not recognized until much later (Birkhead and van Balen, 2008).

Darwin

Until the mid-1800s, ornithology lacked any general, unifying theory. Charles Darwin (1809–1882) provided that theory. Although not an ornithologist – his interests were much broader – Darwin used information on birds to test his theories and he knew or corresponded with all the important ornithologists of his day. His revolutionary ideas influenced ornithology, and the rest of biology, in many ways. His theory of common descent finally began to make sense of the centuries of avian systematics; his ideas – together with those of Alfred Russell Wallace (1823–1913) – provided explanations for the geographic distribution of birds; and the concept of natural selection provided explanations for numerous features in the lives of birds. When Darwin was at Cambridge studying for the church, William Paley's (1743–1805) *Natural Theology* (1802) – largely plagiarized from Ray's *Wisdom of God* – was required reading and Darwin was inspired by its notion of adaptation. Later Darwin wrote: *The old argument from design in nature ... which formerly seemed to me so conclusive, fails, now that the law of natural selection has been discovered*. Finally, Darwin's concept of sexual selection (comprising male–male competition and female choice) was an ingenious explanation for the longstanding problem of why male and female birds so often differ in appearance and behaviour. **See also:** [Adaptation and Natural Selection: Overview](#); [Darwin and the Idea of Natural Selection](#); [Darwin, Charles Robert](#); [Wallace, Alfred Russel](#)

The discovery of *Archaeopteryx* in 1861 provided good evidence for Darwin's idea of common descent, and in 1868 TH Huxley (1825–1895) produced the first genealogical tree for birds. Systematists now had the task of revealing true evolutionary relationships rather than merely those they felt were intuitively logical, and it was naively assumed that the taxonomy of birds would soon be resolved. It was not, partly because ornithologists overlooked the fact that unrelated species can appear similar because they have similar lifestyles (i.e. convergent evolution). Instead they assumed that all differences and similarities between bird species mirrored true taxonomic relationships.

The main ornithological unions were formed in the nineteenth century. The Society of German Ornithologists (Deutsche Ornithologen-Gesellschaft, DO-G) was established in 1850; the British Ornithologists' Union (BOU) in 1858. Alfred Newton (1829–1907) was a key figure in the BOU and his monumental *Dictionary of Ornithology* (1896) attested to the dominant role of systematics in ornithology, as does its 120 page 'Introduction' which provides an excellent history of systematic ornithology. The BOU's journal is *The Ibis*. The American Ornithologists' Union (AOU) was founded in 1883 by Elliot Coues (1842–1899), William Brewster (1851–1919) and Joel A Allen (1838–1921) with the *Auk* as its journal (Barrow, 1998). In a similar mould, the Royal Australasian Ornithologists' Union (RAOU) (now known as Birds Australia) was founded in 1901 with the *Emu* as its journal (Robin, 2001). The first International Ornithological

Congress (IOC) took place in Vienna, Austria, in 1884 and since 1950 has been held every 4 years.

Natural History of Birds

One of the first to test Darwin's idea of sexual selection was English amateur Edmund Selous (1858–1934). Among the first real field ornithologists, Selous wrote extensively (though sometimes obtusely) about the behavioural observations needed to test sexual selection theory. His observations of lekking ruffs *Philomachus pugnax*, for example, provide clear evidence for sexual selection. Vehemently opposed to the shooting of birds by museum ornithologists, Selous signalled the way for ornithological field work, urging others to go out with binoculars and notebook, prepared to see and think. Eliot Howard (1873–1940), inspired by Selous, discovered the biological significance of territory. In North America, pioneer field ornithologists included AA Allen and Francis H Herrick (Barrow, 1998). Professional museum ornithologists, who held key positions in the ornithological Unions of Britain and North America, were 'united in a common hatred and contempt for the field naturalists' (Haffer, 2008). However, field ornithology in the UK was further promoted when HF Witherby (1873–1974) launched the journal *British Birds* in 1907, and FB Kirkman (1869–1945) published *The British Bird Book* in 1910–1913. The first attempt to unite the systematists and naturalists occurred in the early 1900s when Oskar Heinroth (1871–1945) suggested using behaviour patterns as a clue to phylogenetic relationships, an area later developed by Konrad Lorenz (1903–1989).

The two strands of ornithology, separated since the seventeenth century, were finally reunited in the 1920s in Germany by Erwin Stresemann (1889–1972), whose innovation was to expand the boundaries of traditional museum-based ornithology by adding new topics such as physiology, functional morphology, ecology and behaviour (**Figure 3** and **Figure 4**). Stresemann recognized that birds were eminently suitable for the study of these different disciplines. Stresemann's vision was the outcome of an invitation in 1914 to write the section on birds for a *Handbook of Zoology*. Delayed by World War I, he did not start writing until 1919, but his contribution, *Aves* (Stresemann, 1927–1934), summarized the entire knowledge of bird biology and laid out his vision for a new ornithology. Stresemann became curator of ornithology at the Natural History Museum in Berlin in 1921, and in the same year became editor of *Journal für Ornithologie (JfO)* transforming it into the premier ornithological journal of the day. By the 1930s it was far in advance of its English counterpart, *The Ibis*, which continued to be obsessed by descriptive faunistics and systematics. Aged just 40, Stresemann was elected president of the VIII International Ornithological Congress held in Oxford in 1934. He invited Margaret Morse Nice (1883–1974) to Germany and published the results of her song sparrow studies in *JfO*, in German, long before the significance of her work was recognized in either North America



(a)



(b)

Figure 4 Three key twentieth century figures in the history of ornithology: (from left to right) (a) Ernst Mayr and Erwin Stresemann and (b) David Lack all at the International Ornithological Congress, Oxford 1966. Courtesy of the Eric Hosking Charitable Trust.

or Britain. By the end of World War II, with Germany in ruins and the museum now in the Soviet controlled sector of Berlin, Stresemann's ornithological optimism evaporated. He became increasingly pessimistic as his international ornithological leadership was challenged by modern schools of ornithology that developed in Oxford, the UK and the USA. Nonetheless, Stresemann's re-unification of systematics and natural history meant that, as Ernst Mayr wrote: 'No one in the last 100 years has had as profound an impact on world ornithology' (Mayr, 1997, p. 855 in Haffer, 2001 p. 58; Haffer, 2004; **Figure 4**).

The modernization of ornithology in Britain and the USA in the 1940s and 1950s was driven by those involved in the conceptual unification of evolutionary thinking – the modern synthesis. They included Ernst Mayr (1904–2005), Julian Huxley (1887–1975), Charles Elton (1900–1991), David Lack (1910–1973), Reginald Moreau (1897–1970), HN (Mick) Southern (1908–1986), Niko Tinbergen (1907–1988) and WH Thorpe (1902–1986).

Somewhat earlier in the twentieth century there began a period of experimental ornithology, exemplified by William Rowan's (1891–1957) work on photoperiod, migration and reproduction, and Charles Kendigh's (1904–1986) on metabolic physiology. Migration studies also flourished following the introduction of bird ringing (banding in North America) in the 1890s. This period also saw the beginning of a more quantitative approach and the use of statistical analyses in ornithology.

In the mid-twentieth century, Mayr's (see **Figure 4**) biological species concept – developed from the earlier work of Stresemann and Bernhard Rensch (1900–1990) – transformed this once intractable topic into an exciting area of biological research and provided the foundation for current understanding of the origin of species (Haffer, 1992, 2007; Price, 2008). **See also:** [Mayr, Ernst Walter](#)

The study of animal behaviour emerged in the late 1800s with the English zoologist C Lloyd Morgan (1852–1936) asking whether behaviours such as nestling begging and migration could be instinctive. These were novel and exciting questions for ornithologists. On the continent Heinroth and Lorenz – both strong supporters of Stresemann's new ornithology – were pioneers in the study of bird behaviour, as was Tinbergen, who consolidated the field by recognizing four fundamental types of question concerned with the (i) ontogeny, (ii) causation, (iii) evolutionary history and (iv) function or adaptive significance of behaviour.

Elton is considered the father of animal ecology, and of those he influenced, David Lack (see **Figure 4**) played a pivotal role in the modernization of ornithology. In the 1930s, Lack wrote (with his father) a critical review of Howard's territory concept; made a detailed field study of the European robin *Erithacus rubecula* and, in 1938–1939, conducted a landmark study of Galapagos finches. In August 1941, Lack was frustrated by the conservative attitude of the journal *The Ibis* (edited by Claude Ticehurst (1881–1941)) so wrote to Mayr, who replied: *There are a number of good young men in England who could change all this radically, but they never seem to have made an attempt to 'Oust the old guard'. If you can round up sufficient members ... you will not have any trouble instituting a new deal* (Johnson, 2004). In 1942, Lack became assistant editor of *The Ibis*, and, in 1945, director of the Edward Grey Institute of Field Ornithology (EGI) at Oxford where he brought about a revolution in ornithology by introducing a new wave of biological studies (Johnson, 2004). Lack's many achievements embraced systematics as well as the behaviour and ecology of individual species and a sharp focus on natural selection (and countering group selection: see Borrello, 2003) both in his empirical research and in his broad overviews of ornithology (Lack, 1966, 1968; **Figure 5**). **See also:** [David Lack and the Development of Field Ornithology](#)

Ornithology (and indeed the whole of science) expanded enormously during the twentieth century. The number of universities increased dramatically after World War I and again after World War II, and courses in bird biology were

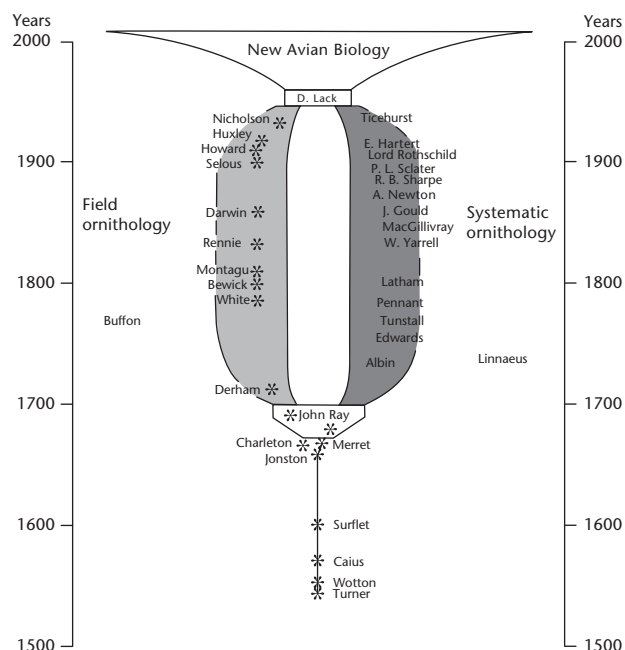


Figure 5 Schematic representation of the development of ornithology in Britain from the 1550s through to 2000, showing the bifurcation after Ray's publications and David Lack unifying field ornithology and systematics in the 1940s. Reproduced from Haffer (2007), with permission from Springer.

popular in North American universities as early as the 1930s. In Britain the few professional ornithologists were employed mainly in museums, and even in the late 1950s the idea of a career in ornithology was almost unthinkable (Anon, 1958). However, the expansion in higher education and increased research funding for universities in the UK in the 1960s, combined with increasing scientific respectability of studying birds, resulted in a massive increase in the opportunities for would-be ornithologists.

The 1970s witnessed further increase in the scientific respectability of ornithology. During this period of scientific expansion, competition for research funding also increased and, to be competitive, ornithologists elevated the relevance of their work by testing theories of general biological applicability. Nowhere was this more obvious than in the new field of behavioural ecology that emerged in the 1970s (Birkhead and Monaghan, 2009). The combination of behaviour and ecology within an individual selection perspective provided a strong theoretical framework and an enormous impetus to those studying birds. During the 1970s and 1980s, major advances in ornithology included the study of pre- and post-copulatory sexual selection and mating systems (enhanced by the development of molecular parentage techniques), group living and cooperative breeding, and foraging behaviour. Molecular developments not only provided new opportunities for the study of avian phylogenies (started by Sibley and Ahlquist, 1990; Hackett *et al.*, 2008), both in their own right, but also as a basis for conducting comparative analysis of behaviour, ecology and morphology. One of the consequences of

these developments is that those studying birds professionally are less likely to refer to themselves as ornithologists, and rather than publishing their findings in ornithological journals, select more general biology journals to disseminate their research.

Amateur ornithologists have played an important role in the development of ornithology in several different ways, including monitoring studies, such as censuses and breeding biology; taxonomy – by refining identification characters; and avian behaviour, by publishing in ornithological journals anecdotal observations that eventually reveal general patterns.

As avian research continues to embrace other areas of modern science – including quantitative genetics, genomics, neurobiology, endocrinology, physiology, immunology, life history strategies, ecology, conservation, behaviour and evolution, our knowledge of birds has increased enormously. But it is also true that the more we know, the more we realize how little we know. There are many areas of ornithology that remain to be investigated.

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