Foreword

A Brief History of Classifying Birds

"Everything that proceeds from the mind or the hands of man, is, in the universal sense of the term, artificial*; for what is* produced *by the exertion of the human mental faculties, or the human corporeal organization, cannot be* natural*, cannot be,* ipso facto*, what* exists in nature*. But when nature is observed by man, and when man expresses in language or by visible signs, his conception of what he has thus observed in nature, the logical or predicative system, or assemblage of observed truths, so produced, is in the language of science,* the natural system*."*

William Swainson (1831)

The quest for a natural system to classify birds absorbed the interests of many writers over centuries before Swainson made this observation in a reply to criticisms of the Circular or Quinary System, a method of grouping five taxa at each level (order, family, genus, species) into circles. To show relationships, the larger or smaller circles touch or overlap with each other in various ways (O'Hara 1988). Swainson became a fanatical adherent of the scheme and promoted or defended it at every opportunity, and he was convinced that the long-sought goal of finding a "natural system" of classification of living things finally had been attained. Although applying it broadly in classifications, his main interest was ornithology and the reply in question was part of a review of a book on British birds whose editor/author had strong views on classifications, too (Rennie 1831; Swainson 1831). Swainson did not initiate the scheme but he seized its perceived potential so firmly that he soon fell out with its original proponent, an entomologist by the name of W. S. MacLeay, as well as with fellow supporters in ornithology. The year 1831 was in the middle of a period of active interest in the classification of birds, and philosophical writings on natural history were merging with anatomical and other investigations as never before (Barber 1980; Ritvo 1997). Within a few years the fallacies of Swainson's much-loved system had become apparent, forcing him out of the mainstream of ornithology. Nevertheless, variations lingered in Europe, where they competed with other schemes in attempts to resolve the same problem: how to classify birds.

To illustrate the historical progress of the classification of birds the Order Passeriformes is often highlighted. Recent studies have been very revealing in a group that has both perplexed and confused many earlier attempts to unravel their relationships. Collectively known as passerines (the song birds, or perching birds), they represent the most species-rich order of birds, containing nearly 60% of all bird species. They are conventionally divided into two main groups, the Suboscines and the Oscines, and their coverage in HBW begins with this volume. An important focus here is on the higher classification of birds, above the level of genus. The historical development of species concepts is another story (see Haffer 1997), although the two strands are obviously interconnected. The study of species underpins everything, but their grouping into higher categories – families, superfamilies, suborders, etc. – is problematical. The boundaries of bird groups were blurred or confused in the earliest works dating back to antiquity. By the late seventeenth century a workable classification of birds began to take shape, but the patterns we are familiar with today began to emerge only in the eighteenth century. However, these were also periods of increased activity and there was much competition and rivalry amongst the proponents of different classification methods and philosophies, a situation that would persist in one form or another for a good long time, as Swainson found in the 1830s.

After a brief account of the early history of birds and their classification, I have divided the remainder of this survey into three main sections. These represent three extended periods of activity dedicated towards working out the higher classification of birds (beta taxonomy, or macrosystematics: Storer 1971; Mayr & Ashlock 1991; Bock 1992). The first two ended in brief lulls when the goal of an acceptable classification was thought to have been achieved, before renewed investigations and reassessments, particularly using new techniques, started the process off all over again. I have called them "waves", and today we are in the middle of the third wave. Although the periods defined for each wave may seem to be somewhat arbitrary, they are clearly marked by significant and influential publications on bird classification. The lulls between waves do not mean that nothing happened on the study of classification, but merely a temporary shift of focus when the goal of a working classification seemed to be a lesser priority. Of course, such complacency never lasted for long.

The beginnings of classifying birds: the search for a natural system

Birds feature in the earliest records of human cultures. Modern species can be identified from prehistoric cave paintings; also on frescos, pottery, and the like, with some familiar images dating from Ancient Egypt (Houlihan 1996). In one way or another, the earliest cultures also classified the natural world around them. In surviving cultures that still follow traditional lifestyles, the results of anthropological research support the ancient evidence. For example, in New Guinea, classificatory systems matching the details obtained from modern taxonomic studies reveal the extent of the intimate knowledge of the local bird life within individual communities. Diamond (1966) examined results obtained from one village and found that of 120 bird species identified in the area, 110 had local names. While this meant that a few similar species shared the same name, others which can be difficult to identify in the field, such as scrubwrens (*Sericornis* spp.), were identified separately. On the other hand, species with distinctive males and females had separate names. Although many names were based on colour, calls or certain habits, others were said to have no meaning.

From what we know of the written records that have come down to us from classical antiquity, the various schools of natural philosophy shared a desire to understand and interpret the world around them. The earliest known works come from Ancient Greece, beginning with Anaximander (611-546 BC) of the school of Ionian philosophers; he described the results of his scientific researches in an influential poem, *περι φυσεως* (*On Nature*). Anaximander was a student of Thales of Miletus (c. 625-547 BC), the earliest philosopher whose writings are known today. However, none of what survives of Thales's work demonstrates the interest in biology shown by his pupil. Anaximander's students and disciples, and later others, continued to research and expand their views on the natural world.

The earliest known comprehensive study of birds dates from the writings of Aristotle (384-322 BC). He was a disciple of Plato (429-347 BC), who in turn had been a disciple of Socrates (c. 469-399 BC), demonstrating the succession of important philosophers who maintained and developed the ancient traditions, while also taking them in new directions. Tutor to Alexander the Great (356-323 BC), Aristotle spent several years travelling and living in various places before he settled in Athens. These travels provided him with opportunities to make observations that later found their way into his writings. In his *περι τα ζωα ιστοριαι* (*On the History of Animals*), he presented the results of his attempts to study all animal life known to him, supplying many details, notably about their external appearance, internal structure and habits. He also attempted the first classification of birds. He used two main systematic categories, the *genos*, a large group, and the *eidos*, the individual animal forms, roughly equivalent to the modern terms of order and species. The *genos* Ornithes was divided into five smaller groups: 1. Gamsonyches (birds of prey); 2. Steganopodes (swimming birds); 3. Peristeroides (pigeons and doves); 4. Apodes (swifts, swallows and martins); 5. all others not included in the four divisions. With the exception of the swallows and martins, all passerines were lumped together, along with forms such as woodpeckers. In spite of his detailed work, many of the 170 kinds of bird he listed remain unidentifiable.

Although Aristotle's works greatly influenced his successors and followers, later Greek philosophers moved away from studying nature in such detail. Eventually Aristotle's works were virtually forgotten and a focus on developing a workable classification system moved to the world of Ancient Rome where summarizing knowledge in an encyclopaedic form was well established. Gaius Plinius Segundus (AD 23-79), better known as Pliny the Elder, followed this trend and amassed everything he could into a series of 37 "books" collectively entitled *Historia Naturalis*. Birds were covered in the

tenth book, where he placed great importance on the structure of the feet as the basis of his arrangement, but his texts were a disorderly collection of information, with details from folklore, magic and superstition mingled amongst general information, including personal observations. Recipes and medical cures also featured in early works covering birds and, along with everything else, such details were repeated for centuries.

This compendium, generally unreliable from a zoological perspective, was very influential on the writings of the later Roman and early Christian times. In fact, for almost 1500 years, Pliny's encyclopaedia, in particular, was highly regarded and it was copied, extracted and adapted over the centuries. However, in other areas Pliny's work was only one of various sources used, and only when they could be reconciled with Christian morality. Around the year 370 Christian teachers, most probably based in Alexandria, sought religious significance in bird and animal stories to present allegories supporting the doctrines of the Scriptures. The resulting compilation from Greek, Egyptian and Jewish sources, marrying natural history with moral theology, was known as the *Physiologus*, and it was widely translated. In the meantime, other allegorical works appeared, which were collectively known as Bestiaries. With some updating from time to time, these were the sources for information on animals through the period known in Europe as the Dark Ages.

The philosophical differences between religious doctrine and scientific thought continued in the Eastern Roman Empire, where the Emperor Justinian I (483-565) decided in 529 to close all Greek schools in order to suppress competition with those of the Christian church. This movement against secular learning spread. In Spain, Isidore (570-636), Bishop of Seville preserved what he could from the censorship of ideas contrary to Christian teaching in an encyclopaedic work where classical learning could serve the needs of the students of the church. The result was *Etymologies sive origines*, or simply the *Etymologia*. Birds were treated in Chapter 7 of his Book XII on animals. For birds he established the term "aves" because birds travelled by pathless ways or roads (viae). Misinformation dominates the chapter, showing the deterioration of knowledge of the natural world after several centuries.

Aristotle had not been completely forgotten, and Boetius (480-524), a keen collector of Greek documents, was the first to translate some of his writings into Latin, but this had little influence. Scholars in Syria, beginning with Porphyry (233-c. 304), had also extensively translated and commented on his works, and by the period 800-1100, most of Aristotle's works had been translated into Arabic. The Arab scholars were mainly based in Baghdad, where Greek science and philosophy were widely studied. The two best known translators around this time, who also put their own interpretations on his works, were Avicenna (980-1037) and, particularly, Averroes (1126-1198), who lived in Spain, then occupied by Moslems, after their invasion in the eighth century.

The Aristotle that became influential in European universities of the time owed much to the philosophical views of Averroes. Around 1230 the polyglot scholar Michael Scot (1175-1232) travelled to Spain, where he could read Aristotle in the original Arabic of both Averroes and Avicenna. He subsequently translated Averroes's work into Latin. Frederick II of Hohenstaufen (1194-1250) was keenly interested in birds and invited Scot to his court to share his knowledge of Aristotle. Frederick found Aristotle's *Historia Animalium* to be inadequate when compared to his own knowledge of birds, which he put in a book, *De arte venandi cum avibus.* It was much more than just a book on hunting with birds, as it also included a classification of birds based on ecology and diet. This enlightened work was well ahead of its time. However, it was ignored by the ecclesiastical naturalists of the period because of Frederick's excommunication by the Pope. Although a version was eventually printed as late as in 1596, its value to ornithology only began to be appreciated in 1788. A complete version, based on all available sources, finally appeared only 60 years ago (Wood & Fyfe 1943).

The re-emergence of Aristotle continued when two Dominicans rediscovered his work and wrote commentaries. Albert von Bollstädt (1193-1280), better known as Albertus Magnus, a teacher of theology, used Scot's translation and later wrote commentaries on it in *De Animalibus*, between 1260 and 1270 (first printed in 1478). His disciple, Thomas de Cantimpré (c. 1210-1293) had already done this in *De Natura Rerum*, between 1233 and 1248. A century later, *De Natura Rerum* gained wider circulation when selected parts of it were translated into German by Conrad von Megenberg (c. 1309-1374) as *Das Buch der Natur*, first published, with wood cuts, in 1475. These works originated as attempts to separate philosophy and theology in understanding the natural world, but they still carried much misinformation. Times were slowly changing, however, and even Albertus and later scholars of the period, notably William of Occam (1270-1347), were able to reconcile natural and church philosophies so that Aristotle could stand as a representation of the views of the church.

The spread of what became known as the Renaissance movement began in the fifteenth century, through the effects of several major events. Those of significance to the classification of birds included: the exile of Greek scholars in Europe, from as early as about 1430 but particularly after the fall of Constantinople in 1453; the invention of printing; and, later, the discovery of the New World. One Greek scholar, Theodorus Gaza, brought Aristotle's works with him and as early as 1476 published in Latin the *Libri de Animalibus,* with a Greek edition appearing in 1495. Printing made books widely available, with the ancient texts and knowledge reaching a much broader readership. The beginnings of extensive global exploration provided new insights for understanding the diversity of the natural world.

It was at this point in history that the man later called the Father of Ornithology appeared. William Turner (c. 1500-1568) was a widely travelled naturalist both in his native England and in Europe, often not by choice but because of religious differences. He turned his interest in philology to classical natural history and sought to make an accurate interpretation of the names in the works of Aristotle and Pliny, publishing his results in his little book *Avium præcipuarum, quarum apud Plinium et Aristotelem mentio est, brevis et succincta historia* (1544). He also included many of his own extensive observations, making it the first bird book treated in a scientific spirit. In his lifetime, he published 31 books on plants and animals, all praised for their accuracy, and indeed he is also known as the Father of English Botany (Mullens 1908a). Turner concluded his studies by hoping that a new Aristotle would emerge to revise and update what was known about natural history. He did not have long to wait.

Conrad Gesner (1516-1565), based in Switzerland, was a great assembler and organizer of information. He was assisted in his work by several correspondents, including Turner, whose work he greatly admired. Birds were covered in the third volume of his *Historia Animalium* (1555), popularized by reprintings, in Germany in particular, for over a century. In this work he discussed and illustrated 217 different birds, including those of mythology, even though he did not believe they existed, but because he thought it would be of interest to the public. Gesner's work has been credited as representing the starting point of modern zoology. His earlier bibliographical studies have given him the name of the Father of Bibliography, and he also wrote an account of 130 known languages, with the Lord's Prayer given in 22 of them. He was also perhaps the first person to collect natural history objects and house them in a museum. As classification was poorly understood, he decided to present his encyclopaedic coverage of birds alphabetically. He died when plague ravaged his home city of Zurich.

Pierre Belon (1517-1564) travelled widely in Greece, Asia Minor, Egypt and Arabia, and wrote a popular account of his travels, including natural history (1553). He lived in various parts of Europe, as he was dependent on patronage. All these travels allowed him to embellish his reworking of the old authors in *L'histoire de la nature des oyseaux, avec leurs descriptions, et naifs portraicts, retirez du naturel* (1555). Although his work was generally ignored in his day due to the dominance of Gesner's publications - indeed he had been accused of plagiarism, even though his book appeared in the same year - it was well regarded by later writers. His classification was derived from Aristotle and Pliny. Like them, he separated birds on ecological and morphological principles into raptors, waterfowl with webfeet, fissiped marsh birds (including kingfishers and bee-eaters), terrestrial birds, large arboreal birds and small arboreal birds (including swallows). His book was also important for his attempts to understand anatomy, including a comparison of a human and a bird skeleton. In addition to his work on birds, Belon wrote on fish, and he was a keen botanist, with an interest in establishing exotic plant species in France, to which end he helped establish two botanical gardens. He was working on a book on plants when he was murdered one night while walking to his home in Paris.

Ulisse Aldrovandi (1522-1605) had contributed to Gesner's work but wanted to outdo him, and produced his encyclopaedic *Ornithologia* (1599-1603) in three volumes. In his youth he had been imprisoned as a heretic, as indeed for various reasons had Gesner, Belon and Coiter; in later life Aldrovandi taught botany. His first book was a treatise on drugs, which was to be of great use to later works on pharmacy, but ornithology was his main interest. The compilation, begun in the 1560s, was the most comprehensive of its kind up to that time. He criticized Gesner for using an alphabetical arrangement, and proceeded to follow a classification based on Aristotle. Birds were grouped by having a hard and powerful beak (raptors, parrots, ravens, woodpeckers, treecreepers, bee-eaters and crossbills); those that bathe only in dust or in dust and water (pigeons and buntings); songbirds (finches, larks and canaries); waterfowl; and shorebirds. As he put everything he could find into his work, including plagiarizing Gesner and Belon, its real value was sometimes considered to belong in the earlier works of those authors. He was also criticized for including few of his own

observations. However his work was judged, it was popular in its day and was continued for other animal groups after his death in his native Bologna, Italy, by several of his faithful students.

Volcher Coiter (1534-1576), born in the Netherlands but spending his working life in Italy and Germany, was the first person to base a classification of birds on structure instead of function. He devised a natural system following the guidelines of Aristotle and Pliny, based on morphology, in *De avium sceletis et præcipuis musculis* (1575). The section of this work entitled *De differentiis avium* contained the first diagram showing the relationships of birds. It also summarized his knowledge of the anatomy of birds in an interpretive way, resembling a key, or perhaps something approaching a cladogram (see Allen 1951a, 1951b). Although like Pliny he used form (i.e. morphology) with divisions based on the characters of the feet, his observations in the text demonstrate their relationships to function. His subdivisions followed the shape of the claw and the placement of the toes. No matter how it is viewed, his tabulation represents the beginnings of an attempt to derive a natural classification of birds based on morphology. In this way he anticipated the ideal "natural system" envisaged nearly 200 years later by Linnaeus – who had been influenced by the better-known attempt at a morphological classification a century later by Willughby and Ray.

Caspar Schwenckfeld (1563-1609), in Germany, was a follower of Aristotle and the works of Gesner and Aldrovandi, and made useful observations on the biology of birds. He is the author of the first regional bird list, in *Aviarium Silesiæ*, the fourth volume of his *Theriotropheum Silesiæ* (1603). He provided useful details of about 150 species found in his district, making a valuable early contribution to ornithology. He tried to classify birds according to their habitat, mobility, foot structure, food and colour, but finding these criteria unsatisfactory, he followed Gesner's alphabetical arrangement. His inclusion of unreliable material from Gesner and Aldrovandi with his original observations represented a trend continued by some later writers.

John Jonston (or Johnstone), also Johannes Johnstonus (1603-1675), a Pole of Scottish descent, produced a compilation on birds from Aldrovandi and other earlier writers, but with nothing original, in his *Historiæ naturalis de avibus* (1650). Its value was in its illustrations, mostly reworking those of Gesner and Aldrovandi but also adding some new ones. It became popular and was widely distributed, translated, printed and used for over a century, last appearing in 1773. Arguably one of the least reliable or original books of the first flowering of modern ornithology became the most popular.

Christopher Merrett (1614-1695) provided the first printed list of British birds, *Aves Britannicæ*, in his *Pinax rerum naturalium Britannicarum* (1666, reprinted in 1667 because most copies were destroyed in the Great Fire of London). This was later considered by some to be a poor work by an author with little field experience. In classifying the birds, he mostly based his identifications on Aldrovandi and Jonston. Mullens (1908c) reviewed the list of 165 birds, demonstrating Merrett's attempt to link his identifications with earlier works rather than using his own observations. Even at this late date the bat was still listed amongst birds! Around this time and later in Britain a number of local and county natural histories also appeared. Although such compilations had an earlier history dating back in printed form to at least 1486, their coverage of birds was incidental before Merrett compiled his list (Mullens 1908d). The only one that sought to provide some detail was that of Richard Carew (1555-1620) in his *The Survey of Cornwall* of 1602 (Mullens 1908b).

Walter Charleton (1619-1707), in his *Onomasticon zoicon* (1668, revised 1671), sought to provide a systematic classification of all birds. For familiar birds, he based it on Aldrovandi, with two main divisions, of waterbirds and landbirds. Waterbirds were further divided into palmipeds, fissipeds (fish-eaters and insect-eaters) and plant-eaters. Landbirds were further divided into meat-eaters (including bats!), seed-eaters (dust-bathing, dust- and water-bathing, and singing), berry-eaters, and insect-eaters (non-singing and singing). Passerines, like other groups, are scattered amongst these divisions, though mostly in the landbirds. When Charleton had to consider unfamiliar, exotic birds he put them in an appendix under either "Terrestres" or "Aquaticæ". This was the last serious attempt to classify birds following Aristotelian principles. A new system was needed and it was soon to appear.

Francis Willughby (1635-1672) and John Ray (1627-1705), both English clergymen, met at Cambridge, where they developed a plan to record and describe all animals and plants according to their own natural philosophy of the world. Willughby worked most intensively on birds and insects, as well as other animals, and Ray principally on plants. They travelled widely together in Britain and Europe, collecting and recording all they could find. Willughby's early death from pleurisy left his works unfinished, but he had made financial arrangements for Ray in his will, allowing Ray to edit and publish them (Raven 1942). The Latin *Ornithologiæ* appeared in 1676,

followed by a revised edition in English, *The Ornithology of Francis Willughby*, in 1678. Although the amount of Ray's contribution to this work has been disputed, the final results obviously benefited from their close collaboration (Mullens 1909b). However the issue is interpreted, this important book founded the beginnings of scientific ornithology. It not only summarized material from older works, with an attempt to separate fact from fiction, but also included much new information; although the main focus was on descriptions of plumage and structure, some details of habits were added. To present this summary of ornithology, a strictly morphological classification was devised, based on beak form, foot structure, and body size. The triumph of form over function, already seen in the then little known work of Coiter, finally replaced the confusion of earlier attempts at creating a natural system of birds. The groupings of species began to resemble bird families recognized today. For example, amongst the passerines, finches, thrushes and crows were placed together.

Ray prepared a new summary of birds in the 1690s but it was still unpublished at the time of his death. As before, new information from the results of recent voyages and travels was added. Two notable collections used were those of Sir Hans Sloane (1660-1753) from Jamaica (1687-1689) and of Paul Hermann (1640-1695) from India and Ceylon (1672-1680). After Ray's death, the manuscript was revised by his friend William Derham (1657-1735), who expanded Ray's coverage of exotic birds by appending a manuscript on the birds of Madras*, Avium Maderaspatanarum,* the first regional list of Indian birds, which had been passed on to him by James Petiver (1663-1718). At the time, Petiver maintained one of the earliest natural history collections in England and corresponded with potential collectors for both illustrations and specimens of plants and animals. One was Georg Joseph Camel (1661-1706), a Jesuit based in Manila, whose interest in birds resulted in his *Observations de Avibus Philippensibus* (1703), the earliest regional paper on Asian birds. The Madras list, from an Edward Buckley, was also incorporated by Derham into Ray's glossary of foreign bird names and is notable for passerines as the source of the name "pitta", a local name for "bird", but subsequently associated with the members of the family Pittidae. This revised summary of *The Ornithology* appeared in the *Synopsis Methodica Avium & Piscium* (1713). The original folio of just over 300 pages had been reduced to an octavo, but with additions it still extended to 200 pages. While the natural system of Willughby and Ray was not received favourably by all at the time, it was the most comprehensive and complete of its kind then and for at least another 50 years. It also became an important influence on Linnaeus when he applied his natural system to birds; indeed, he did not improve on it overall.

Johann Ferdinand Adam von Pernau (1660-1731) was interested in the comparative behaviour of birds. He had been influenced by the studies of Schwenkfeld in devising a classification system of birds based on behaviour, but he recognized more categories, and he confined the results of his ideas to his own observations. While he may not have had much success with classification from a systematic perspective, his research produced other valuable results such as the discovery of territory in birds, instinctive behaviour, such as feeding at the nest and why birds migrate, and remarks on the role and meaning of bird song. He elaborated his ideas in his *Unterricht, Was mit dem lieblichen Geschöpff, denen Vögeln, auch ausser dem Fang, nur durch Ergründung deren Eigenschafften und Zahmmachung oder anderer Abrichtung man sich vor Lust und Zeitvertreib machen könne* (1707, revised 1716, supplement 1720). However, interest in bird behaviour as opposed to systematics, i.e. popular *vs* scientific ornithology, diverged for about 200 years before the importance of the interrelationships of these aspects of ornithological study was fully appreciated (Fisher 1954; Davis 1994).

Carl Linnaeus (1707-1778), or von Linné from 1761, disappointed his family by refusing to join the clergy, and he eventually studied medicine in Uppsala, Sweden, but with a great interest in botany. In 1735, after adventurous travels in Lapland, he went to the Netherlands to further his studies. He was already interested in devising a new system of classification and soon found inspiration from the many natural-history collections he saw there. He also inspired interest in his system, with its sequence of Classis, Ordo, Genus, Species and Varietas, and was sponsored for the publication of the first edition of his *Systema Naturæ* (1735), then only consisting of several large sheets. His hierarchical concept of categories of relationship was the real improvement on Willughby and Ray, who had used Genus in the sense of Aristotle so that it was interchangeable with the refined Linnaean categories from Class to Genus. Over the next 20 years, inspired by the work of friends and the fame generated by the appearance of his simple but useful method, he developed and refined his natural system. By the sixth edition of *Systema Naturæ* (1748), the diagnoses of genera and species were much improved. The real inspiration of Linnaeus was developing a simple but workable system, and this was its great appeal. For birds he recognized six orders, using the

beak and foot as points of reference: 1. Accipitres (birds of prey, owls, parrots); 2. Picae (woodpeckers, hornbills, cuckoos, hoopoes, and also crows and crow-like birds); 3. Anseres (swimming birds); 4. Scolopaces (fissiped waterfowl); 5. Gallinae (ratites, pheasants, bustards and coots); 6. Passeres (all other passerines, but also pigeons, hummingbirds, etc.). The old division of landbirds and waterbirds was gone. The system as we know it today was finally published in the 1750s.

To some naturalists and zoologists in the mid-eighteenth century the attraction of the Linnaean system was not so much his classification as his strict methodology, which could be varied and played with. Also at this time, several large works illustrating birds in colour but in no particular system became popular. Prominent amongst these were the *Natural History of Carolina, Florida and the Bahama Islands* (1731-1743) by Mark Catesby (1682-1749), the first major work on North American birds, and *A Natural History of Birds* (1743-1751) by George Edwards (1694-1773), both authors enjoying the patronage of Sir Hans Sloane (Feduccia 1985; Mason 1992; McBurney 1997). Pierre Barrère (1690-1755) combined these developments by offering a confusing system in his *Ornithologiæ specimen novum…in classes, genera et species, nova methoda, digesta* (1745). His approach, mixing large and small birds, worked well as a method for fitting different-sized birds into cabinets! Others, like Barrère, using Linnaeus as the point of reference, could produce different results, such as the *Historiæ avium prodromus* by Jacob Theodor Klein (1685-1759) in 1750, and *Avium genera* by Paul Heinrich Gerhard Möhring (1710-1792) in 1752, but these publications did not detract from the progress of Linnaeus. Also, collections were increasing in importance (Mearns & Mearns 1998), most famously that of Sir Hans Sloane, willed to the nation on his death in 1753 and forming the genesis of the British Museum, first opened in 1759 (Stearn 1981; MacGregor 1994). The search for a natural system was gaining pace and seemed to be in sight at last.

The first wave: philosophy and typology (1758-1850)

The natural system of Linnaeus, as we know it today, dates from the tenth edition of his *Systema Naturæ* (1758), published when Linnaeus was at the height of his powers. The tenth edition is also the starting point for zoological nomenclature, when the binomial (or binominal) method, a single name each for genus and species, was first consistently applied to all animal groups, although universal acceptance was not to come till over a century later, after much controversy and debate. Linnaeus's inspiration for using only two names came to him when he was preparing an index. He had first tried the method for several animal groups, including birds, in his *Museum Adolphi Friderici Regis* in 1754, after successfully applying it to plants in his *Species Plantarum* in 1753 (eventually the official commencement date for botanical nomenclature). Linnaeus still retained six orders for birds, but by the tenth edition he had rearranged some of the genera within them, such as moving parrots and hummingbirds to Picae, and ratites and bustards to Grallae (formerly Scolopaces). Although Linnaeus's manic depressive personality became increasingly pathological in his later years, he maintained a high opinion of his achievements, reinforced by the responses to his works. He considered his *Species Plantarum* "the greatest in the realm of science" and his *Systema Naturæ* as a "masterpiece that can never be read and admired enough", and he even published anonymous reviews of his own works (Goerke 1973). Linnaeus also saw his system as the greatest representation of nature as God's creation, but he could also react against his work by feeling that hate and envy were his rewards (Lindroth 1994). The first to spread the new wave of the natural system of "God's registrar" were his students, starting as early as 1745; all were sent with orders and instructions, and they were designated by Linnaeus as his "Apostles" (Koerner 1999). Some produced important works, while others perished in remote corners of the globe. The most famous student was Daniel Solander (1733-1782), who was one of the naturalists on the first great voyage of exploration by Captain James Cook (1728-1779) in 1768-1771 (Duyker 1998); this was also the first important expedition for natural history. Linnaeus is best known today for his botanical works (the "Prince of Botanists"), as his deficiencies in zoology are apparent, but his real legacy is the workable and adaptable system of binomial nomenclature still used today.

The ripples of the new wave of classification using the binomial system soon spread out from Sweden. For birds it was adopted as early as 1763 by Erik Pontoppidan (1698-1764), in an appendix of his *Dansk Atlas*; in 1764 by Morten Thrane Brünnich (1737-1827) in his *Ornithologia Borealis*; also in 1764 by Peter Simon Pallas (1741-1811) in his *Adumbratiunculæ* to A. Vroeg's *Catalogue raisonné;* and others such as Johann Reinhold Forster (1729-1798) from 1767, and both Thomas Pennant (1726-1798) and Giovanni Antonio Scopoli (1723-1788) from 1769. Marmaduke Tunstall

(1743-1790) was the first to apply Linnaean names to British birds in his *Ornithologia Britannica* (1771), but he kept Willughby and Ray's division of land- and waterbirds. The acceptance of the system in Germany was popularized by Philipp Ludwig Statius Muller (1725-1776) in a German edition of Linnaeus's *Systema Naturæ* appearing from 1773, including a supplement in 1776. This supplement contained the first large application of binomial nomenclature to species known but not yet incorporated into the Linnaean system. Mathews (1925) pointed out that "Sharpe suggested he was colour blind", no doubt due to a number of unidentifiable birds named. However, he may not be entirely to blame, as he merely translated his descriptions of new species into German from a 1772 Dutch abridgement of Linnaeus by Pieter Boddaert (1730-1796), who only gave Dutch names to those birds additional to Linnaeus (Cassin 1864). As Cassin demonstrated, one needed to consult Boddaert for the exact source of names from Buffon, as Statius Muller simply stated "Buffon", if based on that work (see below).

Mathurin Jacques Brisson (1723-1806) was the curator of the large French private museum of natural-history objects, including not only bird specimens but also nests and eggs, belonging to René Antoine Ferchauld de Réaumur (1683-1757), who published important works on insects. In working out the arrangement of this diverse collection, Brisson sought to adapt Linnaeus's system, which he first applied to mammals in 1756, but its simplified approach made him all too aware of its deficiencies in characterizing groups and species. In 1760 he published his *Ornithologie* in such detail that it filled six volumes and 4000 pages. It was a comprehensive summary of all known species, based not only on previous sources and de Réaumur's extensive holdings, but also on material studied in several other private collections in France. Much of interest was offered by de Réaumur's correspondents, notably Pierre Poivre (1719-1786), who also sent some specimens to other private French collectors. He collected in India, South-east Asia and Madagascar during clandestine missions to smuggle spice plants from the Dutch East Indies to Mauritius in 1751-1756, in spite of losing his right arm in 1745 during an earlier voyage to South-east Asia (Stresemann 1952; Ly-Tio-Fane 1994). Of some 1500 species described, Brisson was able to add 320 determined as new from the specimens examined. Brisson, influenced by de Réaumur, could not reconcile his classification with the brief, but broader definitions of Linnaeus and increased the number of orders from 6 to 26, with subdivisions where required, and defined a large number of new genera. He kept his key characters simple, particularly the beak and claw, to minimize errors. With care and attention to detail he made few mistakes and provided a classification nearer to modern ones than anything in the following 80 years.

For all his attention to detail, Brisson did not adopt the binomial nomenclature system of Linnaeus's tenth edition but instead had been using the sixth edition. By the time he could use the tenth edition, four volumes of his work had already been printed and, although he was able to indicate his awareness of the tenth edition in the last part of the work, it was too late. He was not a strict follower of other systems, but instead created his own elaborate classification of birds, which was criticized and was not followed, because, unlike that of Linnaeus, it was hard to learn. While he delineated his higher categories and species descriptively, he used a single term for his well-defined genera. These were eventually recognized and accepted after much doubt and debate not only about the problem of the non-binomial nature of Brisson's work but over the exact number of genera that could be used (Allen 1910; Bock 1994). Meanwhile, de Réaumur had willed his collection to the *Académie Royal des Sciences*, in order to keep it out of the hands of his great rival, the Comte de Buffon. Nevertheless, by 1760, Buffon's influence was such that he ensured de Réaumur's collection made a valuable addition to the *Cabinet du Roi*, of which Buffon was in charge; in truth, this transfer made sense because the *Académie* did not have the facilities to manage such a large collection. As a result, Brisson was out of a job and soon left ornithology after such a brilliant debut (Farber 1982), later becoming a teacher of physics. Linnaeus subsequently incorporated Brisson's new species into his system, in his twelfth edition (1766).

George-Louis Leclerc (1707-1788), Comte de Buffon from 1772, became the leading natural historian in France in the second half of the eighteenth century. He began his rise in scientific circles, as was typical of the day, by currying favour over potential rivals, in this case, by assisting with a blackmail scheme against the ex-husband of a duke's wife. Later, in 1749, he began his great work, the *Histoire naturelle, générale et particulière*, reaching 36 volumes by his death in 1788, though the series eventually finished with 44 in 1804. These included the nine volumes (Vols 16-24) of his *Histoire naturelle des oiseaux*, which appeared from 1770 to 1783. They were supplemented by 973 of the 1008 coloured plates of what became known as the *Planches enluminées,* issued from 1765 to 1783 in 42 parts and two sizes (Heilbrun 1952) and which gained

great popularity. Buffon had been director of the *Cabinet du Roi* since 1739 and his great work, with some of the text and all of the plates contributed by members of his staff, was originally intended to provide a catalogue to the collection. Although the collection was small when he began, he had a very different philosophical approach to his subject. He opposed the nomenclatural systems as exemplified by Linnaeus. Instead, he saw the task ahead as surveying the great relationships of nature, beginning with the development of the earth and all life but not hindered in his interpretations by the hand of God and traditional doctrines, i.e. the fixity of species (typological species concept). In seeking other explanations, including hints of evolutionary ideas mixed with Aristotelian theory, his writings may have seemed impressive but their superficiality was apparent to many who read his explanations. His attempts to interpret the influence of time, climate and diet on species required groupings of clearly unrelated species around the world, which then had to be climatic varieties. Pierre Sonnerat (1748-1814) was an early critic who in 1776 observed that he could not reconcile Buffon's ideas to what he had seen on islands in the Philippines. On the other hand, the Italian Jesuit, Giovanni Ignazio Molina (1740-1829), in his *Saggio sulla storia naturale del Chili* (1782), followed Buffon's ideas by considering many birds in Chile as varieties of European species.

Buffon, with his holistic approach to an understanding of nature, placed great importance on an understanding of the habits of animals in the wild; he was labelled as the "French Pliny" by some later workers. He developed a network of correspondents, bestowing them with honorific titles, and reaping the benefits for his collection and volumes. As he ordered his system from the most to the least interesting of animals to man he used this approach in organizing the classification of mammals and continued with this method for birds. By the time he was planning his volumes on birds in the 1760s the de Réaumur collection arrived at the right time to supplement the meagre holdings of the *Cabinet du Roi*. Several correspondents of de Réaumur now supplied material to Buffon and enhanced his existing, extensive network. Others were encouraged to go out and gather information from exotic locations, fulfilling a role similar to Linnaeus's "Apostles". For example, Charles-Nicolas Sigisbert Sonnini de Manoncourt (1751-1812) based himself in Cayenne and sent a large collection with notes. The Scottish explorer James Bruce (1730-1794), also supported by Buffon, was eager to share his findings from his Ethiopian adventures when passing through Paris in 1773 (Bredin 2000).

Even his critic, Sonnerat, supplied him with material from his Asian travels, beginning in 1771-1772 when Sonnerat's godfather, Pierre Poivre, sent him to New Guinea, as part of a new secret mission for spice plants. In spite of his own useful records on birds he could not resist adding others from elsewhere to enhance the value of his work. Amongst such embellishments were specimens and drawings from the naturalists on Cook's first voyage, obtained when he met them in Cape Town in 1771, and others from Philibert Commerson (1727-1773), the naturalist who accompanied the circumnavigation of the globe by Louis Antoine de Bougainville (1729-1811) in 1766-1769 and later remained on Mauritius. This material included three penguins, which Sonnerat claimed to have seen in New Guinea waters, whence the Gentoo Penguin is named *Pygoscelis papua*. The most famous addition, however, was the Australian Laughing Kookaburra, thus named *Dacelo novaeguineae*, although never recorded from New Guinea (Ly-Tio-Fane 1976). The great popularity of Buffon's works led to numerous editions and translations, stimulating an appreciation of nature in many quarters, notably in Italy. He wrote for the dilettante and was enamoured of his own style (over substance), although this was to some extent understandable: the available material was limited, so he felt he had to pad out his writings with speculations on the significance of as much as he could highlight. He had some interesting ideas but these were not greatly developed and were mixed with misinformation. All things considered, he was doing what he could with what was on hand and, as he was trying to cover everything, the criticisim of superficiality is understandable (Roger *et al*. 1997). On its own merits, Buffon's work on birds may have contained more deficiencies than Brisson's, but, as noted in an earlier period, the best work is not necessarily the most popular. Although Buffon's ideas on classification continued to survive, they were increasingly overshadowed by Linnaeus's natural system. When later Linnaean authors named birds based on Buffon's work, the focus was on the plates rather than the text, although the information in the relevant text was acknowledged. Therein lies the lasting value of Buffon, as the plates are the types for a large number of bird names.

Thomas Pennant, a prominent English naturalist, was well known for *The British Zoology* (1761-1766, and later editions). He was familiar with the work of Linnaeus but preferred to use English names and, as in his *Genera of Birds* (1773), he was a follower of Willughby and Ray (Mullens 1909a). He was also a friend and corre-

spondent of Linnaeus and had experimented with Linnaean names as early as 1769 in the *Indian Zoology*, using selected paintings brought to England in 1759 by Joan Gideon Loten (1710-1789), a former Dutch governor of Ceylon (Allen 1908). However, after a single part of 12 plates and text was issued, Pennant lost interest and passed the material to Forster who produced a German version with names after Linnaeus in 1781. After his *Arctic Zoology* (1784-1787), Pennant revised the Indian work, based on Forster, with Linnaean names, in 1790. Forster then revised his own edition again in 1795 (Hoare 1976). Pennant's inclination and influence was to keep an interest in England in the classification system of Willughby and Ray, but the influence of Forster, in particular, led him to combine it with the classification of Linnaeus. This mix of systems could not continue for long.

John Latham (1740-1837) dominated ornithology in England for 50 years. With access to museum collections and other resources, he first attempted a summary of all the birds of the world in *A General Synopsis of Birds* (1781-1785), including much new material recently arrived from voyages, notably those of Captain Cook. In this, he retained the basic classification system of Willughby and Ray and used English names (Allen 1951a). As with the influence of Buffon in France, the English were not yet completely ready to accept the new methodology. Like Pennant, Latham also dabbled with Linnaeus. In a tabular list of British birds, added in the first supplement to his *Synopsis* in 1787, he listed names in the Linnaean system. Latham's reluctance to embrace the Linnaean system fully had its consequences. Linnaeus himself set the precedent when he claimed the new species of Brisson in 1766, a trend duly followed by Statius Muller in 1776, using mostly Buffon. In the 1780s the pace increased, first with Forster in 1781 in his list of Asian birds appended to his revision of Pennant's *Indian Zoology*. In 1783 Boddaert latinized the names in an index of Buffon's plates, but his delay in applying the Linnaean system to the new species meant that Statius Muller took the credit for those covered in his earlier work of 1772. In 1786 Scopoli did the same for the birds listed only by French names in Sonnerat's two voyage reports, but he found it difficult to make them all fit in and this led to some odd combinations, such as a quail named in the genus for orioles. Lastly, Johann Friedrich Gmelin (1748-1804), an "industrious but indiscriminate and incompetent compiler", according to Coues (1880), pulled it all together in his so-called thirteenth edition, actually the fourteenth if associated with Linnaeus (Iredale 1958), of *Systema Naturæ* (1788-89), augmented by the many new species from Latham's volumes.

Realizing what was happening, Latham tried to make up for lost time with his own Latin summary of his work in 1790 with his *Index Ornithologicus,* delayed to include new discoveries, most notably the Emu (*Dromaius novaehollandiae*), from the new colony in Australia. Latham enjoyed access to the earliest discoveries coming from Australia, but the next batch to arrive went to his rival at the British Museum, George Shaw (1751-1813). While in his *Index* he reluctantly had to acknowledge Gmelin's names, he did not accept them all, but the names used today that date from the *Index* are for the additions since his *Synopsis* was published. A decade later, particularly with all the new material arriving from Australia, Latham could once more outdo his rival so he decided to update his work with a second supplement, in English and Latin editions. This time the Latin edition appeared first, in 1801, but the English edition apparently was delayed until 1802 (Browning & Monroe 1991), with the remarkable Superb Lyrebird (*Menura novaehollandiae*) arriving just in time. Latham had apparently learned his lesson. From the 1790s Linnaeus's system was widely used in England, although the Willughby and Ray division of land- and waterbirds lingered. In his 80s Latham again attempted to summarize all known birds, an increasingly difficult task, in his *A General History of Birds* (1821-1828), but the revision of the Latin *Index* was still unfinished when he died at 96 in 1837 (Mathews 1931). It was the last vestige of the Willughby and Ray system. Latham's reversion to his old methods once more allowed new species to be latinized by others, and this time it was James Francis Stephens (1792-1852) in the later volumes continuing his late rival Shaw's *General Zoology* (1816-1826), who claimed a large share of them.

The death of Buffon in 1788 encouraged the emergence of followers of Linnaeus in France (Spary 2000). Within a year the botanist René Louiche Desfontaines (1750-1833) had taken the first steps by naming several new species collected on his travels in the Barbary States (Algeria). The Abbé Joseph Pierre Bonnaterre (1747-1804) began the *Tableau encyclopédique et méthodique: Ornithologie* in 1790 but with the disruption of the French Revolution this work was not completed until the 1820s (by Vieillot). The great comparative anatomist Baron Georges Leopold Chretien Frederic Dagobert Cuvier (1769-1832) followed Linnaeus in his conservative classifications, beginning in 1798, but birds were not of any particular interest to him. In 1799 Bernard Germain Étienne de la Ville-sur-Illon, le Comte de Lacépède (1756-1825), using the beak-foot approach, changed the 6 orders and 81 genera of Linnaeus to 10 "divi-

sions", 51 "orders" and 130 genera. However, this system had no lasting influence, as it created the same types of anomalies as found in works before Willughby and Ray. François Marie Daudin (1776-1804), in his *Traité élémentaire et complet d'ornithologie, ou histoire naturelle des oiseaux* (1800), attempted to provide a complete handbook of ornithology. He provided a Linnaean framework and combined it with the best ideas of Buffon in seeking to understand the whole bird, with much useful information on anatomy and behaviour incorporated, including indications of possible new directions of research, especially in behaviour.

In Germany, Pallas, famous for his Russian explorations supported by Catherine the Great (1729-1796), had already tried to create a synthesis of the Linnaean and Buffonian schools in his later work, particularly in his major faunal study of Russia (1811-1814). Johannes Hermann (1738-1800) in his *Tabula affinitatum animalium* (1783) introduced to birds the concept of showing the relationships of genera by their degree of affinities, expressing the results by linking them in horizontal or vertical rows. Hermann's work had little influence, although followed for a time by Johann Friedrich von Brandt (1802-1879), working in Russia. Blasius Merrem (1761-1824) planned to develop a true natural classification of birds by studying their internal and external characters, as well as their entire life histories. In 1788 he only got as far as introducing and demonstrating his ideas in his *Versuch eines Grundrisses zur allgemeinen Geschichte und natürlichen Eintheilung der Vögel.* Later, he was able to apply some of his ideas to a classification in his *Tentamen Systematis naturalis Avium* (1816). However, in 1788 Germany was not yet ready for such new methods. There were other, philosophical influences, as well as another rise in the popularity of well-illustrated books. In Germany and England, for example, this meant multi-volume works on local birds, but in the France of Napoleon, attention turned to colourful, exotic birds. This time there were attempts at systematically arranging birds for their presentation.

François Levaillant, or le Vaillant (1753-1824) was the most famous ornithologist at the turn of the nineteenth century, commencing three large, illustrated works simultaneously in 1801, including the first major monograph on any bird family, the parrots (Bruce 1991). His fame rested on explorations in southern Africa, culminating in an incomplete *Histoire naturelle des oiseaux d'Afrique* (1796-1813), the first comprehensive regional work on birds outside Europe. In spite of the many excellent observations provided in this work and his two travel books, they were marred by the inclusion of species recorded by Levaillant but later shown to be either not southern African, artefacts (faked, composite specimens), or completely fictitious (Sundevall 1857). This was blamed on his use of other writers or editors to embellish the text: apparently his father edited the first book and the second was entrusted to Casimir Varon, a man of letters, who "permitted himself greater liberties…than Vaillant Sr had done" (Bokhorst 1973). Although branded a liar by later workers in South Africa, it was not unusual at the time for an author to take advantage of what was available to enhance his work, as noted above for Sonnerat. In Levaillant's case, based on his own work and the opinions of others, he was "a vainglorious man who considered he had been unjustly neglected by the learned world of his day" (Winterbottom 1973). The classification used in his works was modelled on Buffon's methods as Levaillant despised the Linnaean system. He thus offered the last great field of bird names to be harvested by followers of Linnaeus, further undermining the credit due to his important contributions (Rookmaaker 1989).

Louis Jean Pierre Vieillot (1748-1831) was frustrated by his slow progress in the scientific world, so he emigrated with his young family to the French colony of Santo Domingo (Hispaniola) to seek new business opportunities and pursue his interest in birds. When the French Revolution began in 1789 he went to the USA for several years to avoid military service, returning to Santo Domingo in the 1790s. He originally planned to gather material to offer to Buffon, but the latter advised him to perform his own studies. He set out for France with his family in 1798, but lost his wife and three daughters to yellow fever on the way and arrived alone. He soon began working with several artists and, mostly using his own material gathered in North America and the West Indies, produced a series of large illustrated works from 1800 to 1809 (Ronsil 1957). In the last of these, the *Histoire Naturelle des oiseaux de l'Amérique septentrionale* (1807-1809), he began to use the Linnaean system. These publications also provided him with his first opportunity to develop his own ideas on classification. With the help of Charles Dumont de Sainte-Croix (1758-1830), who provided him with an income, he further developed his ideas in the then popular series of dictionaries of natural history, to which Dumont was also a contributor.

Bernhard Meyer (1767-1836), a court councillor to the Prince of Isenburg, was also a doctor who found more time for ornithology by taking over an apothecary business. He became a leading figure in the study of German birds and in a series of

works from 1810, began applying his ideas on using strict Linnaean principles. At this time of great activity for German ornithology, this influence was important because it was also an influential time for the school of German "natural philosophy", whose leading proponent was Lorenz Oken (1779-1851). Oken summarized these ideas in his *Lehrbuch der Naturgeschichte: Zoologie* (1815-1816), but the concepts deriving the natural world from the intellectual, with all designs and levels of nature graduating towards the ultimate ideal, the human form, were taking the concept of "artificial" *vs* "natural" systems back to the Middle Ages. There were critics, but also followers, and Oken also used his journal, *Isis*, to develop his ideas further, although it finished in 1848, when Oken could no longer continue it.

Johann Carl Wilhelm Illiger (1775-1813), originally working in entomology, became involved with ornithology when new collections from the recently opened country of Brazil arrived in Germany (Stresemann 1950). One of his concerns was establishing the correct terminology of classifications and for birds this was provided in his *Prodromus systematis mammalium et avium* (1811), where he attempted to rework Linnaean principles for classifications at all levels. He was the first to seek precise order in nomenclature, even going as far as to propose to outlaw names he considered as barbarisms, a practice that gained a few followers, particularly in Germany. The practice lingered for many years, with the last vestige as late as 1890 (Heine & Reichenow 1882-1890), in spite of the famous attack on the subject by Allan Octavian Hume (1829-1912) in his review of a parrot monograph; this was *Die Papageien*, published by Friedrich Hermann Otto Finsch (1839-1917) in 1867-1868. Hume complained about "a certain section (chiefly Continental) of naturalists" who would change names because they were not classically formed, thus cheaply creating new names for themselves: "Let us treat our author as he treats other people's species. "*Finsch!*" contrary to all rules of orthography! What is that "s" doing there? "*Finch!*" Dr. *Fringilla*, MIHI! Classich gebildetes wort!!" (Hume 1874a). Hume was in turn attacked for his attack, but Finsch changed his ways and the two of them soon established friendly exchanges (Hume 1874b).

Illiger further developed his ideas in 1812 with a paper entitled *Tabellarische Uebersicht über die Vertheilung der Vögel über die Erde*, where guidelines on delineating the relationships of birds were demonstrated, but it was not published until 1816. It was also the first biogeographical study of birds. He was also seeking to develop a new method in opposition to what he saw was happening in France, where the considerable influence of Cuvier was later consolidated in the first of his two editions of his *Le règne animal* (1816-1817, 1829-1830); this work was later expanded by his "disciples" from four to 17 volumes (1836-1849), and also translated into English, German and Italian (Farber 1982). Illiger recognized 7 orders, 41 families and 147 genera. He was the first to establish the concept of the family category for birds as we know it today, although after being refined and standardized by later workers (Bock 1994). Illiger, dogged by illness for years, tragically succumbed to a haemorrhage at an early age when he had barely begun his work, but his concern not to overload the Linnaean system with names was ignored by all but a few followers.

Coenraad Jacob Temminck (1778-1858), a member of a wealthy Dutch family, was first influenced by Levaillant in developing his ideas in ornithology, as he came to know Levaillant through the sponsorship of his explorations by his father, Jacob Temminck (1748-1822). During his honeymoon in Germany, in 1804, he stayed with Meyer, who influenced his ideas and encouraged him to adopt the Linnaean system. His first book was a catalogue of his collections, in 1807, in which he followed Linnaeus (Stresemann 1953). He was also working on monographic studies of pheasants and pigeons. By chance, at this time in Paris, Pauline de Courcelles (1781-1851), a gifted artist, planned to paint pigeons and needed someone to write a text. Temminck agreed and began at once, with the first part of what became a sumptuous, illustrated, but incomplete volume, *Les Pigeons* (1808-1811), appearing within months. The artist became Madame Knip in 1808 and decided to swindle him by claiming credit for the whole work, beginning with the title of the ninth part. She wanted to win favour with the new empress and succeeded. Temminck was sent some copies with the correct title, but he found out about the swindle when he visited Paris (Coues 1880; Mees 1975). The two parted in anger, although they eventually reconciled some years later. Temminck abandoned the larger project and instead published his monographs in a cheaper version, the three-volume *Histoire générale des pigeons et des gallinacées* (1813-1815), with an explanation of what happened. The influence of Meyer's work, amongst others, also inspired Temminck to produce the first edition of his *Manuel d'ornithologie, ou tableau systematique des oiseaux qui se trouvent en Europe* (1815). His classification of birds followed the Linnaean system which was expanded in the second edition of his *Manuel* (1820, supplements 1835, 1840). These were very influential and became the standard work on European birds for many years. In 1820 he

was also inspired to begin another large, illustrated series as a supplement to the work of Buffon, and this was to make up five volumes by its end, in 1839 (Dickinson 2001). This work mainly illustrated some of the new birds arriving at his museum at Leiden, but Temminck's pace slowed and much material went unstudied for many years, as he locked away many specimens that he never found time to study.

In the meantime Vieillot, apparently ignorant of Illiger's reforming work, had developed a new classification of birds to express their natural relationships as early as 1813 but delays meant that he finally rushed his *Analyse d'une nouvelle ornithologie élémentaire* into print himself in 1816 to antedate Cuvier's forthcoming work. In it he recognized 5 orders, 57 families and 273 genera, including the merging of the Picae and Passeres into his "Sylvicolæ"; some of his new genera were also named by Cuvier, but too late. In response to criticisms, this classification was reworked in his numerous articles in the second edition of the *Nouveau dictionnaire d'histoire naturelle* (1816-1819), where many new species were named using earlier works, particularly on South American birds, and also collections in Paris from the recent French scientific voyages; as the museum staff in Paris refused to help him, he took his descriptions of new birds in the collection from the public galleries. These numerous articles were collected and revised when he resumed work on Bonnaterre's *Tableau encyclopédique*, which had been incomplete when it ceased in 1791, the new edition appearing in three volumes in 1820-1823. Although Vieillot was seeking a natural classification, he was immediately criticized by Cuvier and also by Temminck, who presented his views in a pamphlet, *Observations sur la classification méthodique des oiseaux, et remarques sur l'Analyse d'une nouvelle ornithologie élémentaire par L. P. Vieillot* (1817). Temminck considered it vague and artificial, particularly because of the emphasis on foot structure and overlooking Illiger and other recent works, especially his own. Of Vieillot's numerous new genera, Temminck complained of his pillaging and plagiarizing of many of those of Illiger and Cuvier in particular, and concluded by urging others like him to abandon this sterile work.

Temminck elaborated on his views in the first volume of his revised *Manuel* (1820), where his attacks on Vieillot were also extended to Vieillot's dictionary articles, including his criticisms of Temminck in response to his pamphlet. These were regarded as puerile in view of his pretentious work, an overreaction to his own faults, displaying an ignorance of German works and embarrassing for his unnecessary and badly created names, stealing many already given by Illiger and others. However, Temminck's focus, too, was on developing a natural classification. As a result, apart from his reactions to Vieillot, he attempted to bring together everything yet published of worth, disregarding Illiger's concerns for nomenclatural purity, and finding problems with more than just Vieillot's classifications. His bile towards Vieillot was also extended to Gmelin's "miserable compilation" unworthy of association with Linnaeus. In spite of such concerns, Temminck was committed to developing a carefully constructed classification out of the increasing chaos of the time and in this he anticipated Strickland's later concerns. His natural system contained 16 orders and 201 genera, with the family category almost ignored. While he reluctantly accepted some of Vieillot's new names, he gave preference to Cuvier's later names in some cases and because of the influence of this classification, Temminck also created a little chaos of his own. While the younger Temminck would achieve success, Vieillot spent his last years blind and in poverty (Olivier 1965). In spite of the hostility he endured in his lifetime, he succeeded in publishing much useful work that was greatly appreciated in later times.

Christian Ludwig Nitzsch (1782-1837) was the first of a group of anatomists to make important contributions by studying particular characters and how they affected the relationships of various groups and of the higher categories of birds. He is best known for his studies on pterylography, from as early as 1806, but his major work on the subject was published posthumously (1840, translated into English 1867). He also wrote, for example, on osteological characters and the nasal glands, and in his extensive study of the carotid arteries, *Observationes de Avium arteris carotide communi* (1829), he used his findings with other characters to propose his natural classification; this was later modified in his work on pterylography. Henri Marie Ducrotay de Blainville (1777-1850), Cuvier's successor, began his studies of the sternal characters of birds in 1815 to find a natural classification. His rearrangements of the higher categories were influential, and he split passerines into "true" and "false" groups, and importantly, he separated *Menura* from the gallinaceous birds (1821). Felix Louis L'Herminier (1779-1833), from the island of Guadeloupe, was a pupil of de Blainville and further developed the study of sternal characters, but also combined them with other anatomical data in developing his natural classification (1827). There are some similarities in how L'Herminier and Nitzsch worked out their higher categories and they may have developed some of their ideas together. There may, too, have been some influence from the 1816 classification of Merrem, also using anatomical data.

The main results of these and other anatomical investigations of this period of activity were in developing the restructure of higher categories closer to those recognized today. For example, in 1829 Nitzsch separated swifts from swallows, placing them nearer the hummingbirds.

Nicholas Aylward Vigors (1785-1840), a politician by profession, was at the heart of ornithological activity in London. He was influential to many at the time, notably helping to start John Gould (1804-1881) on his way to producing his famous bird folios (McAllan & Bruce 2002). This influence also took some ornithologists in a different direction for a while, when he developed a classification for birds based on what became known as the Circular or Quinarian System. This system was introduced by William Sharp MacLeay (1792-1865) in *Horæ Entomologicæ* (1819-1821), when he found that philosophical ideas of the time on the concept of divine order in the universal chain of beings could be expressed geometrically and numerically. As with the German natural philosophers of this period, who also had influenced MacLeay, old ideas were new again. Vigors took MacLeay's ideas further in applying them to birds in articles published from 1824 to 1830, particularly his 1825 essay, *Observations on the Natural Affinities that connect the Orders and Families of Birds*. Here it could be shown that all natural groups form five circles of equal rank, with each subdividing into five, thus five orders, five tribes [suborders], five families (O'Hara 1988, 1991). He also applied his ideas to a major report on Australian birds, in 1826, containing many new species, but only the first part was published (Vigors & Horsfield 1827). His classification may be ignored but he certainly helped standardize family names for birds.

William Swainson (1789-1855) developed an early love of natural history through his father's interest in insects. He wanted to travel and managed to visit various parts of the Mediterranean during military service in the latter years of the Napoleonic wars (1807-1815). As Brazil had recently opened to foreigners, he visited several areas to study and collect birds and other natural history objects in 1816-1818. He began publishing on birds and wanted to apply his drafting skills to illustrating birds. He was encouraged to try the new process of lithography and produced and published the first lithographic plates of birds in 1820, subsequently continuing with several series, mostly of birds and shells (Jackson 1975). Through Vigors and his work on the subject, Swainson became acquainted with the new circular system and embraced the concept with much enthusiasm. He supported and defended it at every opportunity with such fervour that by 1827 he had fallen out with Vigors (and later claimed credit for some of Vigors's new names) and MacLeay. Like Vigors he adapted and modified the scheme, but, while the circular arrangements were still placed in groups of five, he refined them with subdivisions of three and two to make the five. To Swainson the natural system meant finding the appropriate placement of each species or higher category according to their affinities and analogies (Knight 1981). In cases where he determined that there were gaps in the groups of five, these were to be filled later by an as yet undiscovered taxon. With failed investments, the death of his wife in 1835, and five children to raise, as well as his missing out on a coveted position at the British Museum, he turned to hack writing for a living, and quickly contributed volumes to two popular series of the day. These works gave him a great opportunity to develop his version of the circular system. He summarized his ideas on birds in his *On the Natural History and Classification of Birds* (1836-1837), and last wrote on the subject in *Flycatchers* (1838). After 1838 his critics in England had finally won the field, and Swainson's authority and reputation as an ornithologist were seriously damaged, if not completely destroyed. In defeat and dire financial straits, Swainson emigrated to New Zealand, an embittered man, in 1840 and, although he lived another 15 years and retained his interest in birds, he published nothing further on them. In New Zealand he had a slight influence, however, both good and bad, on a young Walter Lawry Buller (1838-1906), later to become the great authority on the birds of New Zealand (Galbreath 1989).

Hugh Edwin Strickland (1811-1853) was a geologist by profession and the son-in-law of Sir William Jardine (1800-1874), a well-known ornithologist, who, amongst other things, produced the first bird journal in England. Strickland is known for his reports on developments in ornithology, was a stern critic of the philosophically based classifications, and played a major role in the defeat of the Quinarians. However, in spite of the success of eliminating the Quinarians from England, similar philosophical classifications continued in Germany for another twenty years, although with little influence. Meanwhile, Strickland continued with his strong views on classification and nomenclature until his tragic early death: hit by a train, while inspecting a rock cutting near the railway line. His most important contribution towards bringing order out of chaos was his development of the first modern code of nomenclature in 1842, based on the twelfth edition of Linnaeus of 1766, but with some compromises to appease the critics. It was revised in 1866, while other codes emerged. By the 1870s

there was strong support for fixing nomenclature on the tenth edition of Linnaeus of 1758 and this became the new starting point, beginning with the code of the American Ornithologists' Union (1886). However, in Europe, particularly England, the twelfth edition as the starting point lingered for 20 years in most standard works. One of Strickland's compromises was the acceptance of Brisson's genera, even though they were published in 1760. This was influential in moving opinion towards the tenth edition, as this would not require any exceptional cases (there was also the problem of Brisson's mammal genera of 1762). In 1895 the attempt to unify the competing codes began, with the first international rules appearing in 1905, and the first code as we know it today, the International Code of Zoological Nomenclature, eventually appearing in 1961, with the fourth edition coming out in 1999. So far, only categories up to the level of family name are covered by the code. After being in and out of favour over many years, Brisson's bird genera were finally accepted in 1955 (Bock 1994; Melville 1995; ICZN 1999).

Johann Jacob Kaup (1803-1873), unsuccessful as an assistant to Temminck in 1825, returned to his home town of Darmstadt in Germany and spent his career at the local museum (Heldmann 1955). He published a preliminary classification of birds as early as 1829, and presented his views in more detail in his *Classification der Säugethiere und Vögel* (1844). He followed the philosophy of Oken and also used the mystical number five, where the systematic categories were based on their developments from one each of five anatomical characters, five sense organs and five areas of the body. Instead of circles he used pentagrams, and he maintained these ideas in later works. Amongst several attempts to develop philosophical rules of classification, the most significant work in addition to Kaup's was carried out by Heinrich Gottlieb Ludwig Reichenbach (1793-1879) who produced a series of publications from 1834 to 1863 known under the general title of *Das Natürliche System der Vögel* (see Meyer 1879). He followed Oken more closely and retained the division of categories according to the number four. In following this method, he could claim that his systematic works were the most complete natural histories of the successive groups covered. Leopold Fitzinger (1802-1884), primarily working in herpetology, adapted Kaup's philosophy in his *Über das System und die Charakteristik der natürlichen Familien der Vögel* (1856-1865) and placed birds amongst the other vertebrate classes in five parallel rows for a continuous series from lowest to highest forms. This was considered to be the only way to make a natural classification and marks the passing of any serious efforts to create a philosophically based natural system.

Johann Wagler (1800-1832), based at the recently established museum in Munich, followed the developments and influence of Illiger. After studying various European collections, he began work on preparing the first detailed summary of all known birds since Latham, but only the first part of his proposed *Systema Avium* appeared in 1827, providing monographic coverage of 49 genera. This work was also an attempt to refine the nomenclature of birds. In 1830 he included a summary classification of birds in his *Natürliches System der Amphibien mit vorangehender Classification der Säugethiere und Vögel*, but his early death from the effects of a stray shot on a hunting trip curtailed further work on his ideas. René Primevère Lesson (1794-1849) had participated in the voyage of the *Coquille* around the world (1822-1825) and reported on the birds. His interest in ornithology led to the publication in 1828 of his little *Manuel d'ornithologie*, and the appearance of this work may have caused Wagler to discontinue his *Systema* project. Lesson later extended his classification with his *Traité d'ornithologie* (1830-1831) and published other systematic reviews, most comprehensively on hummingbirds, and also updates of Buffon's works. These classifications, like many of this period, had little or no lasting value and such works are mostly known today for the many genera and species named within these attempts to achieve a natural system.

Constantin Wilhelm Lambert Gloger (1803-1863) applied anatomical details to his partial classification in his uncompleted book *Vollständiges Handbuch der Naturgeschichte der Vögel Europa's* (1834). This study is notable for dividing the passerine order on the basis of the syrinx (i.e. clearly demonstrating the need to separate the old Pico-Passeres into passerines and picarian birds). Gloger began further studies on classification in *Gemeinnütziges Hand- und Hilfsbuch der Naturgeschichte* (1841-1842) but this work ended after one volume and is best known for various new genera proposed. Edward Blyth (1810-1873) wrote a series of six articles on the classification of several groups of birds in 1838. Blyth covered the passerines, and his results were notable for his attempts to use anatomical characters in some detail and apply the influences of geographical distribution. Blyth took his enlightened ideas to India, where he spent 21 years (1841-1862) as Curator at the Asiatic Society of Bengal Museum in Calcutta, producing a long series of papers, forming a solid foundation for Indian ornithology (Grote 1875). William Macgillivray (1796-1852) applied sev-

eral anatomical characters in his classification attempt in his famous *The History of British Birds* (1837-1852), considered the best work of its kind during that period (Mullens 1909c). He also contributed important details to the *Ornithological Biography*, vols 4-5 (1838-1839), of John James Laforest Audubon (1785-1851), wherein amongst other things he noted the distinctness of the tyrant-flycatchers (Tyrannidae) due to their syrinx, but he did not realize the implications. This work formed the text to the famous plates of *The Birds of America* (1827-1838), with Macgillivray's contributions replacing those of Swainson, who had fallen out with Audubon (Ford 1964).

Graf Alexander Friedrich Michael Lebrecht Nikolaus Arthur von Keyserling (1815-1891) and Johann Heinrich Blasius (1809-1870) looked at the syrinx and tarsal scutellation of some passerines in 1839. Their paper, *Über ein zoologisches Kennzeichnen der Ordnung der Sperlingsartigen – oder Singvögel,* described consistent patterns suggesting that these potentially useful characters needed further investigation. These studies were preliminary to their book *Die Wirbelthiere Europa's*, but only one volume was published, in 1840. Johannes Peter Müller (1801-1858) provided the results of his detailed study of the structure of the syrinx in his *Über die bisher unbekannten typischen Verschiedenheiten der Stimmorgane der Passerinen* (1847, translated into English 1878). He established the major division of passerines into the oscines and suboscines, and this conclusion has survived to this day as the first important study of the modern classification of passerines. Jean Louis Cabanis (1816-1906) was the curator at the museum in Berlin (1849-1892) and founding editor of the oldest ornithological journal still running, the *Journal für Ornithologie*; he was editor from 1853 to 1892, and as such had great influence in Germany. He was stimulated by Müller's work and applied the latter's findings to his study using external characters, such as the tarsal scutellation and number of primaries, in his influential interpretation of passerines in an essay known simply as *Ornithologische Notizen* (1847). These ideas were expanded in detailed family summaries presented in his catalogue *Museum Heineanum* (1850-1863), also a source of criticism of nomenclature and an attempt to eliminate barbarisms.

George Robert Gray (1808-1872) produced *A List of the Genera of Birds* in 1840, revised in 1841, updated in 1842, greatly expanded into three large volumes as *The Genera of Birds* (1844-1849), and summarized in 1855. All of these works were important in the fixing of type species to genera and had a great influence. Gray's three-volume effort was a standard work in its day. Alfred Newton (1896) praised it as a work of genius, although acknowledging Gray as "a thoroughly conscientious clerk" and only an ornithologist by accident. The work not only listed about 2400 genera and had many illustrations, but also provided lists of species for each genus. In spite of the increase in the number of genera and species by the 1840s, the basic Linnaean system still had to be made to accommodate them, especially after the Quinarians were discredited. When Gray later summarized every known name given to genera and species up to that time in his famous *Handlist* (1869-1871), he provided a wealth of detail in what became an important new classification. For an accidental ornithologist, Gray's contributions are all the more remarkable as being the cornerstone of all subsequent work on classification, as well as nomenclature.

Hermann Schlegel (1804-1884), Temminck's patient and long-suffering assistant and eventual successor, made an important contribution to the classifying activity in Europe in 1844. In both his *Kritische Übersicht der europäischen Vögel* and the first part of the *Aves* portion of *Fauna Japonica* he developed the first attempt at consistent use of trinomial nomenclature. He intended these names to be used to understand local variation of species in the way subspecific names are used today. This was also perhaps a more practical interpretation of the variety category in the Linnaean sense, which was applied in different ways by earlier workers. While Schlegel's ideas gained some followers, particularly in Germany (Haffer 1992), it would take another 50 years before this idea began to have serious influence on bird systematics. In 1844 there were still many problems interpreting classifications as fixed entities, although the implications of variation, in a more scientific sense, beginning with studying species, continued to intrude.

Charles Lucien Jules Laurent Bonaparte (1803-1857) began his studies in Europe under the influence of Temminck's *Manuel*. His work later developed with American birds, after his family was forced into exile and moved to Philadelphia, and he supplemented the pioneering work of Alexander Wilson's (1766-1813) *The American Ornithology* of 1808-1814 (Cantwell 1961). Bonaparte's interest in the classification of birds began in 1831 in association with an interest in all vertebrates. Plans at the time to collaborate with Swainson in a review of all known birds fell through because Swainson demanded too much money in order to be involved. His ornithological interests were combined with political activities in the 1840s, and eventually he planned to proceed with his review of all the birds of the world. Political events decided the

outcome, and in exile in the Netherlands from his family in Italy in 1849 he began his project with the support of Temminck and Schlegel at the museum in Leiden. This was to be his *Conspectus Generum Avium*, the first volume appearing in 1850 after intensive efforts. His punishing schedule was spurred on by assassination attempts on his family in Italy and fears for his own safety, and his work was completed shortly afterwards, in Paris, when he was finally allowed to return to France. The first volume included passerines but with a conservative classification, as Bonaparte's focus was on delineating genera and species.

This work marks the end of the first wave as it became the standard reference in its day for a summary of world birds, especially with its clear format and brief diagnoses of species. However, it needed a second volume to complete the coverage of all birds, and Bonaparte continued his work on it in Paris, as before also visiting other collections. He also later published an extensive series of papers, featuring the development of his higher classification of birds. He placed his families in parallel series, including tabulations of nearly all groups as he worked through them, creating many new families as well as genera and species in the process (e.g. Bonaparte 1853, 1854). His intensive activity continued through the 1850s as he worked with a sense of urgency due to his deteriorating health. He told a visiting friend, "The more I have to put up with, the more I work", when found writing in his bathtub (Hartlaub 1858). Although he distributed portions of the second volume of his *Conspectus* from 1854 almost up to his death in 1857, it was incomplete (Stroud 2000). Coues later commented: "I regard Bonaparte's services to the science of Ornithology to have ceased in 1850", and that all his later classifications were "not only a worthless but a pernicious aggregate", before launching into an attack on the eccentricities of his nomenclature, using hummingbirds as an example (1880). In some respects, Bonaparte's naming methods, so distasteful to Coues, were similar to the German school of classical purity criticized earlier by Hume. However, Bonaparte often applied his sense of humour to his naming and certainly did not appear to seek purity in his choices. In his last years Bonaparte also intuitively revealed an evolutionary interpretation of birds, as by then he was one of the few ornithologists familiar with world birds, and he had developed these ideas from this detailed familiarity.

Other developments after 1850 were influences or extensions of classifications established before 1850, such as the review of North America birds by Baird *et al*. (1858). Charles Darwin (1809-1882) finally brought out his *On the Origin of Species* in 1859 and the influence of this work in ornithology was soon apparent (e.g. Tristram 1859). Evolutionary ideas had been around for some time in one guise or another but it was Darwin who pulled it all together and crystallized the concept in a way that enabled it to be applied to systematic studies as never before (Mayr 1991; Gould 2002). The application of the theory of natural selection would soon begin to be applied to the classification of birds. Then, all the old philosophies and misguided ideas would be jettisoned, and Alfred Russel Wallace (1823-1913), an important influence on Darwin, hoped "that the chaos which has so long existed in ornithology will soon give way to a truly natural system which must obtain general acceptance" (1864). Blyth considered such chaos "as unmitigated heresy, to be repudiated by every devout ornithologist" (1866). But amongst the earlier works on bird classification there were still many good ideas and developments that would need to be reworked just to show that, while evolutionary studies would eclipse what went before, there had already been a number of ornithologists with insight and genius to pave the way.

The second wave: evolution and adaptation (1867-1934)

While there was resistance in some quarters to the impact of Darwin's book and its effect on how classifications had been worked out, it was also seen as a way, at last, to make serious progress in the quest to find the natural classification of birds. The second wave of activity in bird systematics was thus launched with a real sense of purpose and the differences between homology (affinity) and analogy took on completely new meanings. Thomas Henry Huxley (1825-1895), "Darwin's Bulldog", presented the first reinterpretation of birds in this new evolutionary light. In his paper *On the classification of birds* (1867) he devised his arrangement of the higher categories using the structure of the bony palate – "the great palatal subdivision". Huxley was soon criticized for applying only one character to his study (Newton 1868), and, while the choice of the palate seemed arbitrary, he was limited by the available material, where skulls were commoner than whole skeletons. This classification was very influential on subsequent developments in the investigation of anatomical characters and their potential taxonomic value. Although based on earlier principles, Huxley later used his classification as evidence of evolution (di Gregorio 1984). It was still to require a few more

years of investigation before the intimate relationship of the form of a character and its function was understood sufficiently when assessing its value in classifying birds.

Carl Jacob Sundevall (1801-1875) was based at the Natural History Museum in Stockholm for 32 years (1839-1871). He was long interested in the classification of birds and, as well as reports on collections, notably those of Swedish explorers in Africa, he wrote critiques on several earlier works, such as that noted above of Levaillant. He brought together all of his accumulated ideas on classification in his *Methodi naturalis avium dispondarum tentamen* (1872-1873, translated into English 1889). However, he considered it a mere new edition of his 1836 classification, so that in many ways it was already out of date. He used internal and external characters in creating his classification and considered both types to be of equal value. In spite of his old bias towards external characters he made extensive use of characters of the muscles of birds. His separation of most passerines was based on the absence of a vinculum between the deep flexor tendons of the toes. In spite of the flaws in his classification, the timing of its appearance gave it far more influence than it apparently deserved.

Philip Lutley Sclater (1829-1913) was closely following these new developments. During his 43 years as Secretary of the Zoological Society of London (1859-1903) he was at the centre of ornithological activity in England and encouraged many people to collect birds for the society, often writing the reports of discoveries himself. He was possibly the most prolific ornithologist of his day with the majority of his 1287 titles by 1896 on birds (Goode 1896), and he was editor or co-editor of the famous ornithological journal *Ibis* for all but a few years from its beginning in 1859 until 1912. He initiated a new series of anatomical studies in 1872 and, when reviewing progress in 1880, he also proposed his own classification, although he had already experimented with one earlier for his area of special interest, the Neotropics (Sclater & Salvin 1873). With the encouragement of Huxley, who wanted an anatomist working at the society, Sclater had already created the position of Prosector (a title made up by Huxley) in 1865 (Evans 1913). A succession of four anatomists, Murie, Garrod, Forbes and Beddard, held the post and published a large number of studies on birds over the next 50 years. Although this core of material had an impact on later developments in bird systematics, the classifications used during the period were still carrying much baggage from those of the previous century, partly thanks to Sundevall. Also, the last part of the most complete list of the birds of the world at the time had recently been completed (Gray 1869-1871). It bore the legacy of the beak-foot-feather school of systematics, yet evidence of Gray's characterizations of families can be seen in classifications ever since.

Alfred Henry Garrod (1846-1879) studied several characters, including the nasal bones, the carotid arteries, the tracheal and syringeal structures and the deep plantar tendons (Forbes 1881). His study of the muscles of the thigh, particularly the ambiens muscle, led to the development of his influential "pelvic muscle formula" for defining the higher categories of birds, and he presented his ideas in his paper *On certain muscles of birds and their value in classification* (1874). Like Huxley, his failure to understand fully the relationship of form and function created anomalies. His assistant and successor, William Alexander Forbes (1855-1883), reviewed Garrod's findings and studied additional characters and taxa, particularly in a series of papers on passerines (Beddard 1885). The tragic early deaths of Garrod, from a lung condition, and Forbes, from dysentery during a visit to Nigeria, prevented further development of the potential in ideas that both had demonstrated.

Elliott Coues (1842-1899) was one of the great figures in nineteenth-century American ornithology. He was a prolific writer and observer, producing some of the classic works of American ornithology, including a famous bibliography series, but he also wrote in many other areas and became embroiled in various controversies of the time, from sparrows to spiritualism. He later edited historical accounts of early exploration, but his incessant activity caught up with him and he succumbed to various illnesses on Christmas Day 1899 (Cutright & Brodhead 1981). His interest in classification came early, with his first important systematic publications appearing when he was only 19. He began to reconcile the old classifications with recent developments as early as 1872, in the first edition of his influential *Key to North American Birds.* As in England, the position of the passerines in the overall sequence (whether placed first or last), was an issue, and the preferred option varied amongst the classifications proposed. In 1872, Coues placed the passerines last but he changed them to first in 1874, in *Birds of the Northwest*, and there they stayed up to the first edition of the AOU Checklist (1886). In England, Sclater preferred passerines first, even after Coues visited England in 1884 to promote his views. This led to the situation where the second edition of the BOU Checklist (1915) was still "passerines first", in spite of the recent appearance of a British list adopting the new classification principles, with passerines last (Hartert *et al.* 1912). Ernst Hartert also used this book to promote the acceptance

of trinomial nomenclature in Britain. The influence of what Coues and others had been doing for the AOU had taken root in the Old World, but was still resisted in some quarters (Barrow 1998).

Richard Bowdler Sharpe (1847-1909) was the most famous ornithologist at the turn of the twentieth century. Much of this fame rested on the monumental *Catalogue of Birds in the British Museum* in 27 volumes (1874-1899). Although the task of its preparation was too much for one man, Sharpe managed to write about half of it and edited the remainder. In planning the work in 1872, Sundevall's classification was influential and formed a basis for the classification adopted, although parts were modified as it progressed, particularly from the anatomical work of Garrod and others. Also, Gray's *Handlist* of 1869-1871 was of obvious importance in resolving the fate of masses of names in need of coverage by the *Catalogue* classifications, although not all of them actually found their way into these volumes. In the *Catalogue* the birds of prey and owls came ahead of the passerines (Vols 3-15, 1877-1890). Sharpe's fame also rested on the many papers and books he wrote, particularly in later years with ten growing daughters to support, when he most famously completed the last of Gould's great folios (Fagan 1910; Ogilvie-Grant 1910). Moreover, he was possessed of a great sense of humour, and was friendly and supportive to everyone who came his way, so his sudden death on Christmas Day 1909, after a short illness, was a great shock at the time. But there was one person he did not get along with: Henry Eeles Dresser (1838-1915), a former collaborator of his, who wrote a major work on European birds. He was even known to try and lock Dresser in the museum overnight (Ingram 1966).

Anton Reichenow (1847-1941), son-in-law and successor to Cabanis at the museum in Berlin, developed his "logical" system as early as 1882, in his *Vögel der Zoologischen Garten*. He was, and remained, under the influence of the strong opposition in Germany to Darwinian ideas (Haffer 2001). His arbitrary system reflected the remnants of German nature philosophy with its roots in the sixteenth century. Reichenow became the leading authority on African birds in his day, describing many new species, as well as writing several important reference works. William Robert Ogilvie-Grant (1863-1924), Sharpe's assistant and later successor at the British Museum, complained about Reichenow's taxonomy. When discussing a particular species he opined that "this is only one of the many instances in which this author has relegated very distinct forms, which he has never examined, to the synonymy of some allied species" (1907). This may be a result of Reichenow's philosophy, but it has also been noted that "he dislikes the English and takes no pains to conceal it" (Meinertzhagen 1959). Opposition in France lingered, too, so that Léon Olphe-Galliard (1825-1893) did not see any need to change his 1857 classification in his major work, *Contributions à la faune ornithologique de l'Europe occidentale* (1884-1891). Nevertheless, as in England, the influence of the old guard was nearing an end.

Leonhard Hess Stejneger (1851-1943), a Norwegian, was advised to pursue his interests in birds in America, and he became associated with the Smithsonian Institution for 58 years, later working more extensively in herpetology. He was invited to contribute on birds to a popular work, and used the bird volume of *The Standard Natural History* (1885) to develop a detailed classification with much attention to anatomical, as well as external, characters, and in which he placed the passerines last. Stejneger provided detailed diagnoses of the higher categories and revised their nomenclature, bringing it close to current terminology, such as in the subdivisions of the passerines. The initial influence of this work was limited in Europe, as it appeared in a popular American work, but its favourable press brought it to the attention of Sharpe and Gadow, who were then reviewing and developing new classifications of birds.

Maximilian Fürbringer (1846-1920) was a comparative anatomist with an interest in birds. Working in the Netherlands, he investigated the evidence of previous classifications and, with a clear eye on the interrelationships of form and function, he produced two large volumes of 1750 pages under the title of *Untersuchungen zur Morphologie und Systematik der Vögel*, in 1888 (reviewed by Gadow, 1888). His study covered living and fossil birds and also attempted to trace the evolutionary origins of the Class Aves. His refinement of the higher categories of birds was well in advance of anything that had gone before, and he recognized 45 orders (his "Gentes"). Amongst other classification reforms, he abolished the traditional division of birds based on the absence (Ratites) or presence (Carinates) of a keel on the sternum (introduced by Merrem in 1816). The splitting of the ratites into several orders has been a feature of a large number of classifications ever since. At the other extreme, the passerines, placed near the end of his sequence, were considered to be so morphologically uniform that he placed them all in only two families.

Henry Seebohm (1832-1895) worked in the steel business, but in later years was able to devote more time to ornithology, with expeditions to Asia Minor and Russia to study birds also found in Europe in the field. He wrote books on British and Japanese

birds, shorebirds and thrushes, and through these he developed an interest in the higher classification of birds which he first summarized in *Classification of Birds* (1890, updated 1895). He recognized 14 orders and 36 suborders, all provided with brief diagnoses. Although his classification scheme was criticized, it was largely accepted by Sharpe in his *A Review of Recent Attempts to Classify Birds* (1891), an address to the Second International Ornithological Congress in Budapest. Sharpe's classification, with diagnoses of categories and placing the passerines last, was based mainly on Seebohm and Stejneger. In presenting his views, he used the image of the ideal museum exhibition, where each display presented the next part of his classification. He sent a copy to Huxley, who replied: "I wish something like it had existed a quarter of a century ago when I was trying to find my way through the chaos of Ornithological Classification. It would have saved me a world of labour, which I am glad to find was not altogether in vain." (Fagan 1910). Sharpe retained his 1891 classification in his last great work, the five-volume *A Hand-list of the Genera and Species of Birds* (1899-1909) because, as he noted in the introduction to volume one: "I have seen no reason to modify the conclusions there recorded in any material degree." However, when he reached the passerines (Vols 3-5), a few modifications were in fact made.

Hans Friedrich Gadow (1855-1928), a close friend of Fürbringer sharing his background in anatomical studies, was working in England as the Curator of the Stricklandian Collection and as a lecturer in vertebrate morphology, at Cambridge University. He also shared an interest in the classification of birds and developed his own scheme, the two having also contributed to each other's ideas. Apart from this collaboration with ideas and data, Gadow also reviewed all previous classifications since Huxley. His conclusions differed from Fürbringer's in several respects and he felt the need to apologize for publishing yet another classification of birds, first in his paper *On the classification of birds* (1892), and then in more detail in the section on bird systematics in Bronn's *Klassen und Ordnungen des Thier-Reichs* (1893). No apology was necessary. In reviewing earlier work, particularly synthesizing the mass of detail provided by Fürbringer, the classification he presented is the true parent of all higher classifications in use ever since.

Alfred Newton (1829-1907) was a distinguished professor of Cambridge University and a leading figure in ornithological developments for over 50 years (Wollaston 1921). He was also a friend and colleague of Gadow, and wrote a masterful and erudite essay on the history of ornithology down to 1896 in the introduction to his famous *A Dictionary of Birds* (1893-1896), with anatomical contributions by Gadow. He concluded his introduction by providing a thorough review of developments up to Gadow. After finally discussing the problems with classifying the oscine passerines, he remarked: "A perusal of the foregoing can hardly fail to confirm the doubts already expressed…as to the validity of any Systematic Arrangement of Birds as yet put forth. Still the history of ornithology, as here sketched, gives hope of the ultimate attainment of the object sought by so many earnest students of the Science, though a long time may yet elapse before that end is reached."

Frank Evers Beddard (1858-1925) followed through with the earlier plans of Garrod and Forbes to provide a handbook on avian anatomy, even though the recent publications of Fürbringer and Gadow made him feel the need for such a work was no longer there. Beddard, however, undervalued the usefulness of his *The Structure and Classification of Birds* (1898). It is a valuable summary for English-speaking ornithologists and anatomists and its utility for details of anatomical characters remains today; for example, it was the basis for diagnoses of orders and families in Sibley & Ahlquist (1990). Beddard focused on form in his book and William Plane Pycraft (1868-1942), in his *The History of Birds* (1910) was a critic of this approach, arguing that "habits precede structure". Arthur Humble Evans (1855-1943), working in collaboration with Gadow and following his classification, had already provided a valuable companion work to Gadow and Beddard with his volume on *Birds* in *The Cambridge Natural History* series (1899).

The arrival of the twentieth century coincided with a decline in interest in the higher classification of birds. It seemed that a natural classification of birds had been achieved, in spite of the views of Newton, but a trickle of publications continued for a while to tidy up some of the details. When two major regional works began, they also shared the view that only a few details needed to be sorted out because the new focus was on the systematics of genera and species, and on the development of the recently arrived subspecies, accepted after much debate. In fact, both works ensured a secure place for trinomial nomenclature. Robert Ridgway (1850-1929) began his great work on *The Birds of North and Middle America* in 1901 with the passerines, not as a statement on classification sequence of orders, but because the smaller birds were more readily available to study in the overcrowded museum collections. Ernst Johann Otto Hartert (1859-1933) began his great work *Die Vögel der Paläarktischen Fauna*

in 1903. He also started with passerines, because "conditions of work and space (not scientific reasons!) induced me to start with the higher forms". This made a notable contrast to Hartert's focus on the latest developments at and below the level of genus, so that in effect, like Ridgway, Hartert's higher classification became one of convenience so that he could focus on other matters. In view of this it is notable that in the fourth part of Volume 1 (1907), he proposed an enlarged Muscicapidae (including Sylviidae, Timaliidae and Turdidae) because he thought there were too many intermediate characters.

Waldron DeWitt Miller (1879-1929), an Associate Curator at the American Museum of Natural History, was interested in the higher categories of birds and studied taxonomic characters such as pterylography, the digestive tract, carotid arteries, thigh and shoulder musculature, plantar tendons and foot structure, amongst others. He was an obvious choice to join the committee for the preparation of the classification to be used for the proposed fourth edition of the AOU Checklist and was appointed to the project in 1924 in association with Frank Alexander Wetmore (1886-1978). They jointly published a classification of North American birds in 1926, but their collaboration ended when Miller tragically died from his injuries, when his motorbike collided with a bus during a field trip; he left much important work unpublished (Lanyon 1995). The checklist came out in 1931.

Alexander Wetmore began his career in Washington, DC, with what later became the National Biological Survey, in 1910, and moved to the Smithsonian Institution in 1920, where he remained, later becoming Secretary and continuing his research there after retirement. His extensive taxonomic and other work covered both living and fossil birds. Through these studies and his work on the AOU Checklist he continued with his interest in the subject of higher classification and extended his investigations to cover the birds of the world. He published his first attempt in 1930, with slight updates in 1934, and reprinted in 1940. Gadow's classification was the starting point, particularly for the non-passerines. While Gadow recognized only seven families of suboscines, Wetmore listed 16. For the oscines Gadow came up with a list of 28 families based on several sources, but particularly Sharpe, and explained away his choices on the grounds that the fine points of the recognition of families in the oscines were poorly understood and biased towards European birds. This eclectic element found its way into Wetmore's conservative choices, and his classification, with its slight changes in the later versions, became the standard in museum collections and books, particularly in North America.

James Lee Peters (1889-1952), Curator of Birds at the Museum of Comparative Zoology, Harvard University, for 20 years, began making a card catalogue of the birds of the world in 1923 (Bock 1990). This increasingly complex task led him to decide in the late 1920s that Sharpe's *Hand-list,* the only currently available world list, was in need of updating. In the introduction to the first volume of his world checklist he noted that the rapid increase in ornithological knowledge supported the need for such a new work. A major contribution to this increase was obviously the great proliferation of new subspecies, now that trinomial nomenclature was widely accepted in spite of lingering opposition in some quarters (Robin 2001). A few authors were particularly active in this regard, such as Gregory Macalister Mathews (1876-1949), mostly writing on Australian birds (Serventy 1950), and Austin Roberts (1883-1948) in South Africa, who also worked on mammals (Brain 1998). However, like others active in various parts of the world at the time, they also produced important reference works, adding to Peters's concern about updating Sharpe. The other problem with Sharpe's list was that he remained a strict adherent of binomial nomenclature, although he is said to have remarked jokingly that "three names were too many to put on a specimen label". As a result, Sharpe listed as species birds that had been named as subspecies, even if he agreed the taxa were not species as he understood them. Peters followed Wetmore's 1930 classification for all non-passerines and the first part of the suboscine passerines in the seven volumes he completed of his *Check-List of Birds of the World* (1931-1951) before his death.

Erwin Stresemann (1889-1972), based in Berlin, was the most influential ornithologist in Europe in his day, both through his many publications and his editorship of major journals (Haffer 2000). He was invited to prepare the *Aves* volume of Kükenthal and Krumbach's *Handbuch der Zoologie*, which was published in eight instalments (1927-1934). This work was highly praised in its day, but not as widely used as it deserved to be (Haffer 1994). He based his classification on Fürbringer and Gadow but took a more conservative approach to deciding the rankings. Of the 20 orders of living birds recognised by Gadow, Stresemann recognised 48 (extended to 51 in 1959). Similarities and differences with Wetmore (1930) in the oscine passerines, for example, reveal Stresemann's classification to be as eclectic as Wetmore's. Thus, the higher classification of birds had merely become one of practicality with no real progress since the 1890s, and in the view of some workers, studies of higher categories of birds

had run their course. The emphasis of systematic ornithology in the early twentieth century was not only focussed on species but on the rise of trinomial nomenclature, with a need to reclassify genera and species. The 1930s and 1940s saw the beginnings of genetic studies and the "new systematics", with an emphasis on speciation and the species concept (Haffer 1992; see also Eck 1998; Johnson *et al*. 1999). As a result, much was done to bring order to taxonomy at and below the level of genus. Also, through the 1930s and 1940s various anatomical studies were undertaken and, as was seen earlier in the century, some higher classification details were clarified.

The third wave: phylogeny and biochemistry (since 1951)

Ernst Mayr, the most famous ornithologist at the beginning of the twenty-first century, and Dean Amadon, proposed a new classification of birds in 1951. This grew from the various reports on attempts to work towards a natural arrangement of the higher categories of birds developed progressively through various family and group revisions. The inspiration for these studies was the recent arrival from England in the early 1930s of the world-famous Rothschild Collection, and its incorporation into the general collection of the American Museum of Natural History, New York. However, although presenting a revised classification, they also sought to avoid unnecessary changes to the earlier classifications of Wetmore and Stresemann. In the passerines the most notable changes were the recognition of the enlarged Muscicapidae, as proposed by Hartert, and the rearrangement of the sequence of oscine families by putting the crows and crow-like birds last. Both Wetmore and Stresemann had placed the New World nine-primaried groups of finches and their allies last. Later in 1951, Wetmore revised his classification in view of the increasing number of anatomical and other studies. He retained the "finches last" sequence of oscines (see also Friedmann 1955). Mayr (1955) reviewed recent examinations of anatomical characters used to work out the relationships of some of the oscine families. He disagreed with some of the conclusions in this "newly awakened interest in bird anatomy and bird phylogeny" but, while demonstrating that oscine passerines were not as anatomically uniform as once believed, he also cautioned against how these findings could be interpreted.

Mayr's focus on the classification of the passerines had increased in importance when his move from New York to Harvard University in 1953 meant that he became responsible for the continuation of the world checklist begun by Peters. As with the old British Museum *Catalogue*, the amount of work required was too much for one person, so a number of ornithologists contributed to the remaining volumes, the last published in 1987. At the Eleventh International Ornithological Congress in Basel, Switzerland, in 1954, a committee was formed with the purpose of achieving some sort of consensus on the contentious issue of the sequence of oscine families. A stated aim was for the benefit of editorial standardization. In developing a classification, the phylogeny of the families needed to be considered, even if it was compromised for uniformity. Mayr & Greenway (1956) published the results, with the sequence putting the crows last, as preferred by European ornithologists (Mayr 1975).

Proving that the classification and sequence of the oscine families remained a controversial issue at the time, support for the "finches last" sequence soon followed (Wetmore 1957; Amadon 1957; Delacour & Vaurie 1957). Mayr (1958) defended the "crows last" sequence and restated the argument that, while these alternative systems were stimulating, the issue remained that in journals and non-taxonomic works one would be searching for a particular family at the beginning, middle or end of the sequence of oscines. As a result the "crows last" arrangement was subsequently adopted for the Peters checklist volumes (Mayr & Greenway 1960; see Bock 1990). In his last world classification, Wetmore (1960) discussed such issues but kept the finches last.

Stresemann (1959) reviewed what he considered to be the unsolved problems of avian systematics. He commented on recent work both favourably and critically, particularly the recent attempts by René Verheyen to find a whole new classification of birds based on a numerical analysis of skeletal characters; like some earlier classifications, this method threw up anomalies and inconsistencies and offered little of lasting use. On the relationships of the higher categories of birds it seemed reasonable then for Stresemann to think that these were largely unknown, if not unknowable, as he assumed that all sources of information had been exhausted. In a review of bird classification, Robert Storer (1960) discussed such problems, too, and adopted an eclectic classification drawing from recent work and placing the finches last in the oscine sequence. Unlike Stresemann, Storer thought that there were still new fields offering evidence for the relationships of the higher categories, noting comparative behaviour and protein chemistry as two promising fields; he again reported on new developments in 1971.

Charles Sibley began working in 1957 at developing techniques for comparing avian proteins by electrophoresis as a way to understand the genetics of hybrid populations. He also found that the electrophoretic patterns based on comparing egg-white proteins offered promise for understanding the relationships of the higher categories of birds (Sibley 1960). With further developments and improvements in techniques he provided new evidence in two major reviews (Sibley 1970; Sibley & Ahlquist 1972). By 1973 the limitations of these techniques were apparent, and he moved to new developments in DNA hybridization methods (Sibley & Ahlquist 1990; see also Corbin & Brush 1999). Over the next two decades, while new classification details were proposed, as new studies on various groups were undertaken, DNA hybridization emerged as an important research tool for interpreting taxonomic relationships.

Willi Hennig, an entomologist, introduced a new classification system, phylogenetic systematics, in 1950, but only when he revised and published his work in English in 1966 did the potential of his ideas gain wide influence. The system was based on the branching of lineages, thus renamed cladistics (or cladism). Cladistic analysis of characters requires their separation into ancestral (plesiomorphic) and derived (apomorphic) characters. To determine branching points in the phylogeny, it is necessary to trace backwards the uniquely derived characters (synapomorphies). Cladistic classifications could be constructed exclusively on the basis of branching points, and the method proves to be useful for reconstructing phylogenies. Groups sharing the same synapomorphies are sister groups. The results of cladistic analyses can be represented diagrammatically by cladograms. These show series of dichotomies marking the successive splits of the phyletic lines (Wiley 1981). Hennig's system attracted a large number of followers, with many changes and refinements to the system as originally envisaged by him. Cladistic methods have also attracted critics over the years. The two other taxonomic methodologies widely used are traditional or evolutionary methodology, the basis of earlier classifications, and numerical phenetics, which has been most effectively applied to unravelling confusing groups of genera and species (Mayr 1982).

Hans Wolters was the first to apply a phylogenetic approach to a list of the world's birds (Wolters 1975-1980, 1983), and he provided a complex but valuable higher classification to accommodate them. It is also notable for the first extensive application of subgenera, an area that had been of special interest to Wolters and several of his colleagues in Germany over the previous 50 years in particular. Joel Cracraft (1981) also developed a phylogenetic classification of birds, but only as a cladistic analysis of the higher categories. While Cracraft's hierarchies of higher classification offer new interpretations, the overall sequence was still the traditional one of Wetmore, ending with finches last. There were anomalies in how some of the details were worked out (Olson 1982; Sibley & Ahlquist 1990) and some of the problems raised by Cracraft's cladistic analysis have been investigated in later studies (e.g. Raikow 1987). Cracraft has continued to develop his ideas towards a revised classification of birds (e.g. Cracraft & Feinstein 2000).

Walter Bock (1982) worked out a traditional, evolutionary classification, but specialized morphologies compromised the attempt at a phylogeny (Sibley & Ahlquist 1990). For the passerines, the crows and crow-like birds were placed last in the oscine sequence. Storrs Olson (1985) offered a different classification based on a review of fossil birds, dividing bird groups into "basal" and "higher" (including passerines) landbird assemblages and a waterbird assemblage. In devising this arrangement, the assumption was that birds originated on land, and the assemblages are sequenced by degrees of specialization. Karel Voous (1985) updated the classification used in the 1964 *Dictionary of Birds*, which was based on Peters (1931-1951) and Mayr & Greenway (1956), for the revised version of *A Dictionary of Birds*. While Voous maintained a conservative approach to the classification, his modifications meant that it was another eclectic classification.

After publishing numerous papers on the findings based on DNA-DNA hybridization techniques (e.g. Sibley & Ahlquist 1985), Sibley and his colleagues, particularly Jon Ahlquist, exhibited a large wall chart of their conclusions for a world classification of birds at the Nineteenth International Ornithological Congress in Ottawa, Canada, in 1986. This chart attracted much attention and was dubbed "The Tapestry". It was subsequently published (Sibley *et al*. 1988; see also Mayr 1989, Sibley 1989). Sibley's important role in developing new understandings of the higher classification of birds reached its climax in 1990. At the Twentieth International Ornithological Congress in Christchurch, New Zealand, in December 1990, he launched two hefty volumes totalling some 2000 pages, making a *fait accompli* of his work on DNA. In these pages, there were a review of classifications, the interpretation of his DNA data (Sibley & Ahlquist 1990), and a world list of birds based on it (Sibley & Monroe 1990, see also 1993). In a second printing of Sibley & Ahlquist (1990), Sibley (1995) reviewed the

immediate aftermath of the book. He noted: "I have estimated that at least 75 percent of our conclusions agree with traditional ideas…The studies cited above show that independent research has confirmed additional pieces of The Tapestry, in spite of criticisms about the technique and our methods of analysis." Whether one agrees with all or some of the findings or not (e.g. Harshman 1994), Sibley's works, mostly with Ahlquist, have been most significant stimuli to further investigations on the higher classification of birds. Genetic studies have proved to be the most fruitful, particularly when used in conjunction with other data, such as morphology, biogeography and the fossil record (e.g. Cracraft 2001; Feduccia 2003). The pace of research has continued to increase (reviewed in Mindell 1997) and the techniques applied have also been refined and diversified (e.g. Helbig & Seibold 1999; Lovette & Bermingham 2000, 2002; Cicero & Johnson 2001). There is now an increasing focus on nuclear DNA, which apparently offers more consistent results (e.g. Ericson *et al*. 2000, 2002b; Shapiro & Dumbacher 2001; Irestedt *et al*. 2001; Barker *et al*. 2002). However, while the development of techniques such as comparing the sequence data of mitochondrial DNA and nuclear DNA have demonstrated congruity in phylogenetic analyses, conflicting data also have been found (e.g. Johnson 2001; Irestedt *et al*. 2002).

One consequence of the arrival of the new classification has been its impact on regional works, such as checklists and field guides. While a traditional classification has been retained by some (e.g. in Europe, Beaman 1994, Svensson & Grant 1999; and in Africa, Dowsett & Forbes-Watson 1993, Stevenson & Fanshawe 2001), the new classification has also been adopted in its entirety (e.g. in Asia, Inskipp *et al*. 1996, Robson 2000). In other cases, new, eclectic classifications are emerging, notably with the passerines (e.g. in North America, AOU 1997, 1998; in South America, Clements & Shany 2001, Ridgely & Greenfield 2001; in Australia, Christidis & Boles 1994, Higgins *et al.* 2001). Mayr & Bock (1994) argued that the standard (i.e. traditional) classification in wide use should be followed. After discussing their views, they concluded: "It may be best to wait until many, widely accepted changes have accumulated and then to undertake a single major alteration of the standard avian classification and sequence at one time." As Sibley (1995) pointed out, his findings were being increasingly supported. In the nine years since Mayr & Bock defended tradition, i.e. stability, evidence of the wide acceptance of changes, either agreeing with or refuting Sibley & Ahlquist (1990), is certainly accumulating.

A sampling of recent findings within the passerines indicates that:
– the southern origins of Oscine passerines is supported, with the New Zealand Wrens (Acanthisittidae) representing an ancient relict forming a sister group to all other passerines (Ericson *et al*. 2002a; Barker *et al*. 2002);
– the monophyly of the two clades of New World suboscines is gaining clarification (Prum *et al*. 2000; Irestedt et al. 2001; Birdsley 2002), but with recent evidence demonstrating that two genera traditionally placed in Rhinocryptidae probably represent a separate family of uncertain relationships, the newly proposed Melanopareiidae (Irestedt *et al*. 2002);
– the lyrebirds (and probably scrub-birds) are the most basal group of the Oscines (Ericson *et al*. 2002b);
– the Corvida of Sibley & Ahlquist (1990) is not monophyletic, but their Passerida is (Ericson *et al*. 2002a; Barker *et al*. 2002);
– Madagascan taxa traditionally assigned to Pycnonotidae, Timaliidae and Sylviidae represent another ancient radiation comparable to the Vangidae, which also includes *Newtonia* (Fjeldså *et al*. 1999; Cibois *et al*. 1999, 2001; Yamagishi *et al*. 2001);
– various New World nine-primaried Oscine taxa traditionally considered as finches prove to be tanagers and *vice versa* (Burns 1997; Seutin & Bermingham 1997; Groth 1998; Klicka *et al*. 2000; Lougheed *et al*. 2000; Garcia-Moreno *et al*. 2001; Sato *et al*. 2001; Yuri & Mindell 2002), while the Old World genus *Emberiza* is not a recent offshoot (Grapputo *et al*. 2001);
– similar outcomes have been found with taxa traditionally considered thrushes or flycatchers, but in some cases their relationships apparently lie elsewhere (Pasquet *et al*. 1999, 2002; see also Sorensen & Payne 2001); and
– taxa traditionally placed in Paridae, Aegithalidae and Sylviidae are closely related (Sturmbauer *et al*. 1998).

It is now 13 years since the Sibley & Ahlquist classification stirred and stimulated a rapidly increasing field of investigations on the phylogeny of birds. The search for a natural system is alive and well.

Summary: all of the above and more to come

This survey has been generally chronological and of necessity brief, and some well-known names have been omitted for this reason. The objective has been to demonstrate the multi-faceted nature of how naturalists, philosophers, anatomists and ornithologists have used their studies of birds to find how they can be grouped and classified in the quest to find a "natural system" or, more correctly, a classificatory system. The quest to broaden our understanding of the evolution and diversification of birds around the world continues. The limitations of space have principally confined this survey to passerines: their general similarity has made their classification seem deceptively simple but there can be some devil in the detail. We started out with a broad canvas, eventually leading to a tapestry, now being rewoven. Just when we think we know what the relationships of various families or groups appear to be, something new comes to light. However, while various problems appear clearly to have been resolved, others continue to reveal surprises.

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