NATURALISED BIRDS OF THE WORLD

CHRISTOPHER LEVER

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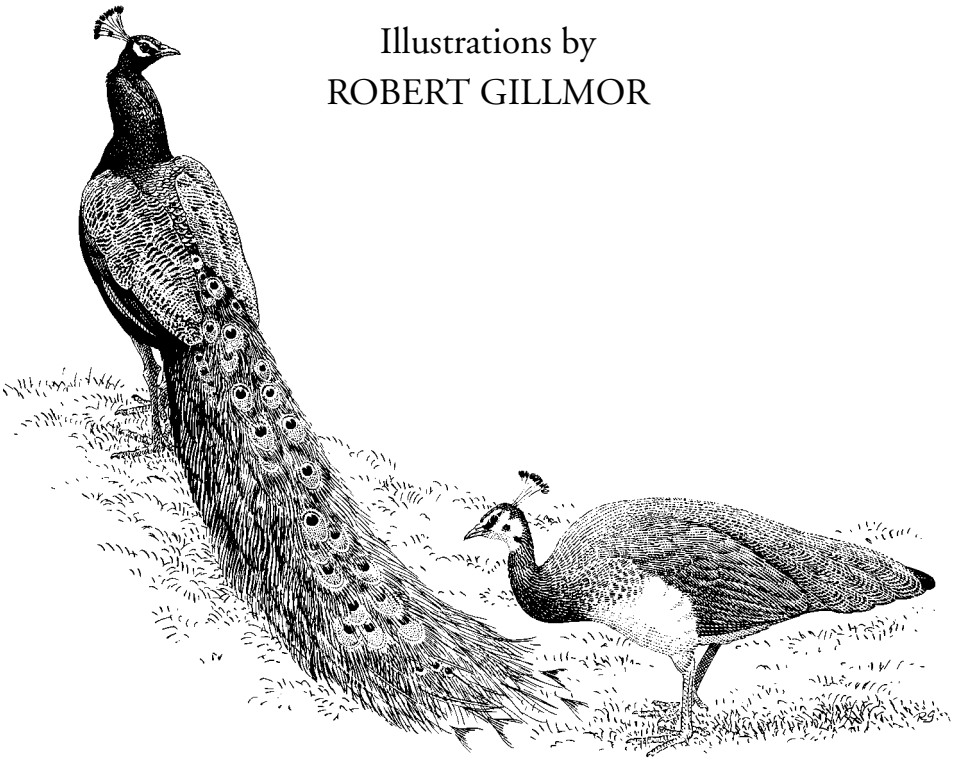
Illustrations by
ROBERT GILLMOR



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As with my previous books, the material resulting from my research for this work has been deposited in the library of the Natural History Museum in London.

Christopher Lever
Winkfield, Berkshire, 2005

Preface

This book, which updates Lever (1987), describes when, where, why, how and by whom the various alien birds now established throughout the world were introduced, how they subsequently became naturalised, and what, if any, ecological and economic impact they have had. The criteria for the inclusion of a species are that it should have been imported to a new country either deliberately or accidentally by human agency, and that it should currently be established in the wild in self-maintaining and self-perpetuating populations independent of man. These criteria provide a good definition of the term 'naturalised'. The term 'feral' properly describes a species that has reverted to the wild from domestication, such as the Feral Pigeon *Columba livia*. Thus 'feral' is not, as it is all too commonly used, a synonym for 'naturalised'.

Each species account is a monograph on an individual bird. (More detailed accounts and further references will be found in Lever 1987). Natural immigrants have only been included when an established exotic has self-colonised a new country, as in the case of the House Sparrow *Passer domesticus* in Africa and Central and South America. The translocation of a species from one part of a country where it occurs to another part of the same country where it does not occur, such as the House Finch *Carpodacus mexicanus* which has been transplanted from the western to the eastern United States, and the natural colonisation by an alien of offlying islands, have in general been ignored: exceptions to the former include birds imported to the Hawaiian Islands from the United States mainland, and to the latter birds that have self-colonised some of New Zealand's subantarctic islands.

In 1974–75 the names and boundaries of several counties in England, Wales, and Scotland were altered. As most of the events described here antedate these changes, the old names and boundaries have been adhered to. Outside Britain, however, the new names of countries and oceanic islands have generally been used.

Since Lever (1987), many new species (e.g. the Purple Swamphen *Porphyrio porphyrio* in the United States) have become naturalised, and these are all included in the text. The status of one species, the Azure-winged Magpie *Cyanopica cyanus*, in Spain and Portugal has recently been reassessed from naturalised exotic to endemic native (see Fok *et al.* 2002, Anon 2002). Some species (e.g. the Yellow-crowned Night Heron *Nyctanassa violacea* in Bermuda, the Eurasian Griffon *Gyps fulvus* in France, and the Northern Goshawk *Accipter gentilis*, White-tailed Eagle *Haliaetus albicilla* and Western Capercaillie *Tetrao urogallus* in England and Scotland) included in Lever (1987) have been excluded here as they are erstwhile native reintroductions rather than alien introductions.

Classification, taxonomy, sequence, scientific and vernacular names, and details of natural range all follow Dickinson (2003).

Introduction

Birds have always held a peculiar fascination for humans. They have been admired for the beauty of their plumage, marvelled at for the variety and delicacy of their songs and, perhaps most of all, envied for their power of flight. What, then, more natural that, in his colonisation of the world, man should have endeavoured to enrich the birdlife of those regions in which he has settled?

Ecosystems exist in a constant state of flux: some species die out, adventives and invasives arrive, and new species slowly evolve through natural selection. These alternatives occur especially when environmental conditions are themselves changing, in particular as a result of human activities. New and artificial habitats, created by urbanisation, land reclamation for agricultural purposes or commercial forestry, or disturbed successional biotic associations, are formed, thus providing opportunities for colonisation by a host of new species. Introductions by man are not inherently different from natural invasions, such as that of the Collared Dove *Streptopelia decaocto* in Europe; the process of establishment and the ecological and/or economic impact that follows may be the same for species arriving by both means. No two species, even if they are close congeners, will necessarily have the same colonising ability; thus the Mandarin Duck *Aix galericulata* has become widely established in Britain, while the Wood Duck *A. sponsa* – the only other member of the genus – has been a relative failure, although given the same opportunities (Lever 1990, 1993).

Motives

Birds (and other animals) have been deliberately introduced by man outside their natural range, possibly since their early domestication some 5,000 years ago (Lever 1996b), for a variety of motives; for sporting purposes; for sentimental or nostalgic reasons; as an aesthetic amenity; as a potential source of food; as a form of biological control of a pest species; as scavengers; and, in pre-Columbian Central America, for their plumage, which was used for ritualistic and decorative purposes; and for conservation reasons. Some birds have been introduced outside their natural range simply out of curiosity as to the outcome. Many have escaped from captivity or domesticity, and several have used man as an unwitting means of transportation as ship-borne stowaways.

Birds (as well as mammals and fish – see Lever 1985, 1996a) have been released for sporting purposes to augment the already existing local game species; such releases have been made principally in North America and the Antipodes, and have been primarily of species from the Odontophoridae, Phasianidae and Anatidae.

Introductions for sentimental or nostalgic reasons have largely involved song birds imported to North America and the Antipodes by homesick settlers (mainly Turdidae, Fringillidae and Emberizidae), and were made under the auspices of local acclimatisation societies (see Lever 1992).

Birds introduced as an aesthetic amenity have mostly been wildfowl (Anatidae) and the so-called 'ornamental' pheasants (Phasianidae).

Introductions of birds as a potential source of food have usually been domesticated species such as the Red Jungle Fowl *Gallus gallus* (the ancestor of the domestic chicken) and the Rock Dove/Feral Pigeon *Columba livia*. In the nineteenth century, Wekas *Gallirallus australis* were imported from Stewart Island, New Zealand, to subantarctic Macquarie Island as a source of food for visiting whalers and sealers. The provision of

an additional food resource is, of course, a concomitant feature of the introduction of new gamebird species.

Many birds have been introduced as a form of biological control of (usually insect) pest species. The House Sparrow *Passer domesticus*, was introduced to the United States in an attempt to control the larvae of the Snow-white Linden moth *Eunomos subsignarius* that were defoliating trees; to Argentina to destroy a psychid moth *Oiketicus kirbyi*; and to Brazil to kill mosquitoes that were causing a human health hazard and caterpillars that were damaging ornamental shrubs. Many of these 'biological controls' eventually themselves became pests, and although exotic species are still sometimes used as controlling agents, this has become generally accepted as a potentially dangerous practice.

Two birds, the Chimango Caracara *Milvago chimango* on Easter Island and the Turkey Vulture *Cathartes aura* on Puerto Rico and Hispaniola, were released to act as scavengers. The former also preys on colonially nesting seabirds and causes injuries to cattle when probing their backs for ticks.

If Haemig (1978, 1979) is correct, several birds, notably the Tufted Jay *Cyanocorax dickeyi*, were imported to pre-Columbian Central America to satisfy the demands of the flourishing trade in ornamental feathers.

At least one species, the Greater Bird of Paradise *Paradisaea apoda*, has been introduced (from the Aru Islands) to Little Tobago Island in the West Indies as a means of conservation to protect it from plumage-collectors for the millinery trade (Ingram 1911), though it has not been seen there since 1981 (ffrench 1991).

Numerous species have become established outside their natural range as a result of escaping (or being released) from captivity or domesticity. Among the families most commonly represented in the former category are the Psittacidae, Estrildidae and Ploceidae, while species in the latter include the Red Jungle Fowl, Rock Dove/Feral Pigeon and Muscovy Duck *Cairina moschata*, ancestor of the domestic farmyard variety.

Several birds have used humans as an unknowing means of transportation by stowing away on ships; most prominent of these marine hitch-hikers is, perhaps, the House Crow *Corvus splendens*, which has been carried in this way to the Arabian Gulf, South Africa, Australia and elsewhere.

Consequences

A number of far-reaching and often unpredictable consequences may attend the naturalisation of an exotic species in a new environment: these include the transmission of parasites, pathogens and diseases; damage to human food resources and buildings; disturbance of the native ecosystems; interspecific competition with indigenous species; predation of (and by) autochthons; and morphological, physiological and/or genetic changes in native populations through hybridisation with exotics, and in exotics themselves through their adaptation to a new environment. Temple (1992) estimated that in the United States 56% of introduced birds are primarily injurious, 5% are mainly beneficial, and 39% may be both injurious and beneficial. In Britain, Williamson & Fitter (1996) cite the so-called 'Tens Rule', which holds that approximately one in ten of imported species gain access to the wild, one in ten of those succeed in becoming established, and one in ten of those become pests.

Most diseases are likely to have more serious effects on hosts that have not been previously exposed to them than on their original pre-adapted hosts. Although in time natural selection tends to result in an accommodation between a pathogen and its host, a new host may become endangered or even exterminated before that occurs. When an alien and a native compete for the same ecological niche, the introductory host may partly or entirely displace the indigenous species.

Epizootic diseases most seriously affecting humans and transmitted by birds include psittacosis (or ornithosis), cryptococcal meningitis, histoplasmosis, toxoplasmosis, encephalitis and encephalomyelitis. Among disorders that primarily affect other birds are Newcastle disease, blackhead, bird pox, avian

influenza and avian malaria. Pathogens carried by introduced birds may have contributed to the decline or extinction of endemic Hawaiian honeycreepers of the genus *Hemignathus*; another honeycreeper the Akepa *Loxops coccineus*; the Hawaiian Goose *Branta sandvicensis* (Berger 1981); the endemic New Zealand Quail *Coturnix pectoralis novaezelandiae* (Oliver 1930, 1955); and the Auckland Island Teal *Anas aucklandica*, Weka, and Red-fronted Parakeet *Cyanoramphus novaezelandiae* (Falla *et al.* 1979). Ectoparasites carried by birds include ticks (which can transmit typhus and relapsing fever to humans), chicken mites and stickfast fleas: among avian endoparasites are cestodes, nematodes and leucocytozoans.

Examples of naturalised birds affecting human food resources are legion, and are fully discussed in the species accounts that follow. Birds that cause damage to buildings (by the deposition of excrement, by pecking at mortar and by blocking gutters and downpipes with nesting material) include House Sparrows, European Starling *Sturnus vulgaris*, and Rock Doves/Feral Pigeons.

Introduced birds frequently compete – mainly for food and nesting sites – with (usually closely related) native species. Here we are confronted with the concept of the 'vacant ecological niche'. In nature, every species occupies a position (or niche) to which it is better adapted than any other species. Thus in any given ecosystem, provided the diffusion of species has been complete, every available niche will already be occupied. An alien animal introduced into such an environment will survive only if it can out-compete autochthonous ones, or if, as in the case of the Little Owl *Athene noctua* in Britain (see Fitter 1959), it can find a previously unoccupied or empty niche. Of these two options the former is the most common.

Where an alien species has food, habitat and breeding requirements that are very similar to those of native species, the Principle of Competitive Exclusion applies: this states that two species with identical ecological requirements cannot co-exist together unless there is a superabundance of their various needs. One will always prove more effective in utilising the available resources and will displace the other.

Introduced species can be responsible for genetic and/or morphological changes in indigenous populations. Although natural selection normally favours native genotypes, continuous infiltration or introgression of an alien's genes into a native population can eventually have an effect which may be beneficial or detrimental. A topical case at the time of writing is that of the Ruddy Duck *Oxyura jamaicensis* which escaped into the wild in England in the 1950s, from where it has spread to parts of southern Europe and North Africa, where it is hybridising with the native White-headed Duck *O. leucocephala*, which is classified as Vulnerable by the World Conservation Union. Strenuous efforts are currently being made to eradicate Ruddy Ducks in Britain (and on the continent) to preserve the genetic integrity of *O. leucocephala*. Smout (2003: 11), with whom the author agrees, argues persuasively against such extermination campaigns, and suggests that 'A more defensible approach might be to revive the notion of some species as pests, but to hesitate before involving conservation in anything analogous to ethnic cleansing for other species'.

Naturalised raptors have been implicated in the decline or extinction of native species. On Easter Island, where they were introduced as scavengers, Chimango Caracaras are a threat to the survival of both native Red-tailed Tropicbirds *Phaethon rubricauda* and Kermadec Petrels *Pterodroma neglecta*, and also introduced Chilean Tinamous *Nothoprocta perdicaria*.

Extensions of a species' distribution sometimes result in considerable genetic variation, such as has occurred in the House Sparrow in North and South America and in the Hawaiian Islands.

Aliens all too often cause damage that is of only minor importance or unknown in their native range; thus the Yellow-fronted Canary *Serinus mozambicus* introduced to the Mascarene Islands and the Village Weaver *Ploceus cucullatus* on Hispaniola are far more

serious pests there than in their African homelands.

The benefits derived from naturalised birds include the provision of new game species; an additional source of food; an added aesthetic amenity; more opportunities for human employment; an economically valuable extension of a country's natural resources; and, as for example in the case of the Golden Pheasant *Chrysolophus pictus* and Mandarin Duck in Britain, the provision of populations of conservation importance.

Habitat Variables

Alien species often succeed in becoming established because man has created an artificial 'disturbed' niche to which they, but not natives, are pre-adapted. Especially in North and South America and the Hawaiian Islands, relatively few alien birds have become naturalised in native unmodified habitats already occupied by indigenes, and the successful establishment of most exotics has been due in part to their close association with human-modified habitats. In Australia and New Zealand, the proportion of exotic to indigenous birds is much higher in suburban than in rural habitats. The presence of exclusively native vegetation is the most important factor governing the abundance of both native and exotic birds, showing a positive and negative correlation respectively. Native species feed proportionately more than aliens on indigenous rather than introduced plants. When not foraging, native birds are observed proportionately more often than aliens on native rather than introduced vegetation, and exotics are noticed proportionately more often than natives on man-made structures. Relatively few alien birds occur regularly inside native forests and few natives are to be found in exotic woodland.

Controlling Factors

Introduced animals can be limited by a single factor or by a combination of several, such as a shortage of (usually winter) food or the effects of predators, parasites and diseases. In the case of predators, a reduction in their number allows that of the prey to recover, which in turn stimulates the population of the predator to increase; this rise in the number of predators depresses that of the prey, eventually resulting in a reduction in the population of predators. As J. R. Krebs wrote (pers. comm. 1992), 'People used to say that predators do not over-exploit their prey; now one thinks of them doing their best to if possible – the evolutionary process of natural selection does not act to favour harmonious properties of communities and ecosystems, but rather acts to favour efficient performance (transfer of resources such as food into reproductive output) at the level of the individual'. Conversely, an absence of regulatory factors and an abundance of natural food resources may allow a species to increase rapidly; such abundant food resources enable birds like the Northern Cardinal *Cardinalis cardinalis*, introduced to the Hawaiian Islands, to breed throughout the year rather than seasonally and to raise far more young than it does in its native North and Central America.

Introduction and Speciation

The colonisation of a new region by an introduced species may be a major event in the evolution of that species and can result in the creation of a new species. This can happen if the colonising event causes isolation between different populations which then genetically diverge as a result of micro-evolutionary processes (as in the case of the White-tailed Jay *Cyanocorax mystacalis* and Tufted Jay in South America and Mexico respectively), or if the colonising event, in cases where the propagule size is low, causes a radical genetic alteration in the founder population. The House Sparrow in Australia and North and South America may be in the course of such speciation.

It is not always easy to get an introduced species established in a new region, even when the conditions appear to be favourable. Factors that increase (but by no means guarantee) the likelihood of success are a congenial climate; a suitable habitat; a vacant

ecological niche; a plentiful supply of acceptable food; generalised rather than specific food requirements; an absence of potential predators; a lack of competition from native species; low mortality and high fecundity rates; a large enough founder stock; a degree of adaptability and behavioural flexibility; and the ability to disperse. To these may be added, in the case of birds, nest site selection; large clutches of eggs; small body mass; and the absence or abandonment of the instinct for full migration, as for example in the case of the Canada Goose *Branta canadensis* in Britain.

Where enough of the factors occur a species' naturalisation typically follows a classic sigmoid growth curve; the initial stock may be severely depleted as a result of predation or natural causes; next, following adaptive changes in the behaviour and ecology of survivors, there may be a population explosion to the maximum numbers that the colonised area will support, followed by a contraction in numbers (and possibly range) to a point where both become stabilised.

In the past decade much research has been done (some of which reaches contradictory conclusions) on the reasons for the success or failure of an introduced bird to become established in a new environment.

Forsyth & Duncan (2001) and Cassey *et al.* (2004) stress the importance of propagule size (introduction effort) as a key determinant of the successful establishment of exotics, and claim that propagule size is both the strongest correlate of introduction success and correlates with many variables previously believed to influence such success. The latter authors believe that apart from the size of the founder stock, only habitat generalism relates to successful establishment in birds (but see Moulton *et al.* 2001a, b below). Although Moulton (1993) argues convincingly that interspecific competition (and other biotic features of the community) play an important role in influencing the success of invasives, Blackburn & Duncan (2001a) suggest that success depends more on the suitability of the abiotic environment for the invasive species rather than the degree of biotic resistance.

Sol & Lefebvre (2000) and Sol *et al.* (2002) show that adaptability and behavioural flexibility are important criteria for invasion success. These criteria are known to be linked to relative brain size, and species with relatively larger brains tend to be more successful invaders.

It has been hypothesised that there is a relationship between the body size of introduced animals and their success rate, and predictions suggest that the success of introductions should be negatively correlated with body size across taxa but positively correlated within closely related taxa. Cassey (2001) found that introduced terrestrial birds have, on average, larger bodies than extant land birds, but that across species, families, and higher family nodes, introduction success is significantly related to smaller body size. Within taxa, however, there is a noticeable positive relationship between successful introduction and body mass. Cassey (2001) concluded that there is an indirect but genuine relationship between the introduction success of terrestrial birds and their body size.

Duncan *et al.* (1999) found that the geographic range of alien birds in New Zealand is unrelated to the period of their establishment. Large geographical ranges are dependent more on an abundance of preferred habitat, fecundity, rapid development, small body size, many and large-scale introductions and a partial migratory instinct (Duncan *et al.* 2003). Several authors (e.g. Moulton *et al.* 2001a, b) have found that successfully introduced species tend to have larger natural geographical ranges than unsuccessful ones, which supports the hypothesis that range size is correlated with adaptability and behavioural flexibility. There is a strong correlation between range size in the British Isles (the source of many New Zealand aliens) and New Zealand: Duncan *et al.* (2001) found much the same in Australia.

Case (1996) suggested that the most important correlate of successful introductions is the number of indigenous species that have died out during the past 3,000 years, which is linked to the amount of human activity and habitat destruction through the effects of

exotic predators, herbivores, and parasites. Thus the number of successful invaders is close to the number of native species lost. In the case of islands, their area correlates positively with the number of introduced species. Successful introductions are not directly linked to the richness of the indigenous avifauna nor the variety of potential mammalian predators. The relative proportion of extinct native species is positively correlated with the numbers of aliens and endemics. There is a strong correlation between the numbers of successes and failures among invasives, and the relative success to failure rate increases with the number of extinct natives. Case (1996) believed that the correlation between introductions and native extinctions exists because native species are usually more common in pristine habitats whereas exotics prefer disturbed habitats. As more of an island's area becomes disturbed, most indigenes lose their habitat, while exotics gain.

Although Case (1996) found little evidence that a rich native avifauna will inhibit the establishment of an alien species, interactions between naturalised and indigenous species may influence habitat distribution of species within islands. In both pristine and man-made habitats, the numbers of exotics and their relative abundance is negatively related to the number of native species.

McLain *et al.* (1995, 1999) and Sorci *et al.* (1998) found that on a number of widely dispersed oceanic islands and in New Zealand the introduction success rate is lower for birds with sexually dichromatic plumage than for those with sexually monochromatic plumage. The diets of the two groups do not differ, but a broader-based diet is associated with a higher rate of introduction success. It was also found that species nesting principally in bushes are more successful than those nesting in trees or on the ground, but that plumage type does not affect nest-site selection. Sexual selection governs the evolution of sexual dichromatism, and thus sexual selection indirectly causes the extinction of small colonising populations – in particular of passerines – meeting new environmental requirements by constraining ecological plasticity and evolutionary response to pressures of natural selection.

Interspecific competition, associated with morphological over-dispersion (where individuals are more dissimilar in size than would be expected by chance), is a limiting factor for the successful introduction of Passeriformes to oceanic islands. Moulton *et al.* (2001b) found that in the Hawaiian Islands and New Zealand, introduced Galliformes were similarly consistently morphologically over-dispersed. They also re-examined the role of propagule size in introduction success, and found that the evidence supporting this proposition is poor, and that community-based factors, including environmental ones and interspecific competition, are important determinants of the success of gamebird introductions. Duncan & Blackburn (2002), however, conclude that competition among morphologically similar species could not have been responsible for the failure of gamebird introductions in New Zealand because the majority of species were liberated at widely separated locations or at different times, did not spread and soon died out if they failed to become established, and could never have encountered other morphologically similar exotics. Even when morphologically similar species were released in the same area and at the same time, historical records suggest that it is unlikely that two species were ever released at the same site, and even if they were, interspecific competition is an improbable cause of failure because most species occurred in extremely low numbers. Duncan & Blackburn (2002) infer that factors other than competition can produce patterns of significant morphological over-dispersion among alien avifauna, and that greater introduction effort expended on more morphologically distinct species may account for the over-dispersion of exotic gamebirds in New Zealand.

Introduced populations may have genetic characteristics, frequently caused by small propagule size, that differ from those in their natural range. This leads to founder effects and subsequent genetic drift, often resulting in greater differences in allozyme patterns

between naturalised populations than between natural ones. In many instances, a large proportion of alleles are lost within a few generations of the introduction event, and the mean level of heterozygosity can also be significantly depleted. Sjoberg (1996) could find no evidence of lowered potential to track environmental changes following a reduction of the number of alleles in an introduced population, nor for inbreeding depression.

The degree of genetic variability occurring in a population is important for its survival and evolution, and populations with a small introduction effort have reduced genetic variation. Many introductions, however, have been made successfully with a small propagule size – Sjoberg (1996) quotes Fabricius (1983a, b) regarding the Canada Goose in Sweden.

Lockwood (1999) concluded that taxonomy is a strong predictor of successful avian introduction; she pointed out that six families (Anatidae, Phasianidae, Passeridae, Psittacidae, Columbidae and Odontophoridae) contain more successfully established exotics than would be expected by chance, and that human influence on probability of transport appears to govern this taxonomic pattern. Three families (Anatidae, Odontophoridae and Phasianidae) hold many more species than expected that were introduced for sporting purposes. Similarly, Passeridae and Sturnidae have far more cage-bird species than expected by chance. Thus, traits that enhance the likelihood of deliberate transport show a definite taxonomic pattern. Brooks (2001) concluded that human preferences may govern the selection of particular families for introduction, with the success of individual species being simply due to increased propagule pressure.

Global information on avian introductions is a valuable tool for studying the factors governing the success or failure of such introductions. The value of this resource, however, may be compromised by two features associated with the non-random nature of introductions (see Lockwood 1999). Blackburn & Duncan (2001b) assess the probable importance of these two features.

Firstly, the characteristics of the species and regions selected for introduction are not representative of species and locations generally, which may bias the perception of the factors affecting the outcome of introductions. Secondly, the spatial and taxonomic clumping of introductions causes difficulties of confounding and lack of independence in statistical analyses of introduction rates of success. Introductions can, however, be analysed validly as independent observations providing this lack of independence can be expressly incorporated in the model, and this technique should be standard practice in any analysis of introduction results.

Every introduction of an alien species is a unique event, because the precise circumstances of each case can never be exactly replicated. Nor are they invariably entirely predictable, since exotic animals react with the native biota in a variety of ways which can often be impossible to forecast (Lever 2005).

The establishment and spread of introduced species is recognised as a major ecological and economic threat throughout the world, and this threat is likely to grow as greater volumes of transport and trade increase the rate of species' introductions. Measuring, assessing, and understanding the impact of invasives is a major, and so far unresolved, problem in invasion biology. Defining and assessing exactly what is meant by 'impact' is not easy, but is crucial in establishing priorities for the management of invasive species. If impacts can be quantified, it should be possible to apply comparative methods to identify why some invasives have a more serious impact than others, and to make use of these data in explanatory models. It is important to study how attributes and characteristics of invasives and of the biotope interact. The biota of islands, for example, are believed to be more susceptible to the impact of exotics because insular species have not been exposed to mainland selective pressures; data on introduced birds may provide opportunities to test these and associated hypotheses. The 'enemy release' hypothesis, for example, suggests that some invaders are

more successful in their naturalised than in their native range due to an absence of such natural enemies as predators, competitors, and pathogens. Species with a rapid rate of population increase may have larger distributions because they are less vulnerable to local extinction when attempting to become established (Duncan *et al.* 2003).

Naturalised Species

TINAMIDAE (TINAMOUS)

Chilean Tinamou
Nothoprocta perdicaria

Natural Range: NC and S Chile.
Naturalised Range: Easter I.

Easter Island
In 1885 Chilean Tinamous of the nominate form (NC Chile) were introduced to Easter Island (Hellmayr 1932). Although they remain established over a century later (Araya *et al.* 1993, Jaramillo *et al.* 2003) they have not spread far, perhaps due to predation by the Chimango Caracara *Milvago chimango*, which was introduced in 1928 (Johnson *et al.* 1970).

Impact: By providing them with an additional source of food, Tinamous may be helping to sustain the population of Caracaras on Easter Island.

STRUTHIONIDAE (OSTRICHES)

Ostrich
Struthio camelus

Natural Range: From S Morocco and Mauritania to Sudan, Ethiopia, N Uganda, Somalia, Kenya, C Tanzania and southern Africa. (Formerly also Syrian and Arabian deserts).
Naturalised Range: Australia.

Australia
In 1869 four Ostriches were despatched from Paris to Melbourne, Victoria, as the intended founder stock of a breeding facility for the production of aigrettes (plumes) used in the millinery trade. From Melbourne the birds were transferred by their owner, Mr (later Sir) Samuel Wilson to his estate at Longerenong in the Wimmera district. Although the Ostriches bred successfully at Longerenong, the wet climate and predation by marsupial cats (*Dasyurus* spp.) forced Wilson in 1874 to send his surviving stock to a station owned by C. M. and S. H. Officer at Murray Downs on the Murray River in New South Wales. After an initially unsatisfactory start the birds started to flourish, and their plumes, marketed in London, were said to be superior to those produced in South Africa.

By 1882 the population at Murray Downs had increased to over 100. In the following year Murray Downs was sold, part of the stock being transferred to a property near Kerang, Victoria, and part to the Kallara

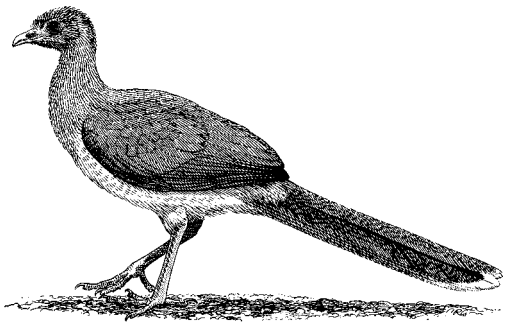
Ostrich

Station on the Darling River in New South Wales. The birds at Kerang eventually increased to 120, but the chicks of those at Kallara all succumbed to the mineral salts in the station's artesian wells.

In the early 1880s Ostriches were also introduced successfully to some of the drier parts of South Australia, where at Port Augusta by 1888 the South Australia Ostrich Company owned a population of 510. Some of these may have been released prior to the First World War, and before 1933 others were freed at Point Sturt on Lake Alexandrina and on Mundoo Island at the mouth of the Murray River, where they multiplied so rapidly that they eventually became a pest.

After the First World War the trade in aigrettes declined dramatically, partly as a result of a change in fashion, partly due to the difficulties in catching the birds for plucking and partly when it became apparent that sheep were more profitable than ostrich plumes. When Ostrich farms closed down most of the surviving stock escaped or were released, and feral populations became established at Murgah, New South Wales, at Redcliffe Station northwest of Morgan, and in the sandhills of the Coorong, Narrung and Port Augusta districts of South Australia (Frith 1979).

Despite predation and shooting, small feral populations of Ostriches survive north of Port Augusta and at Redcliffe, and hundreds or even thousands around the Flinders Range northeast of Port Augusta (Blakers, Davies & Reilly 1984). The Ostriches in South Australia are believed to be mainly *S. c. australis* (southern Africa), possibly intermixed with some of the nominate form from northern and parts of eastern Africa.



Plain Chachalaca

CRACIDAE (CHACHALACAS, CURASSOWS AND GUANS)

Plain Chachalaca
Ortalis vetula

Natural Range: From N Mexico (and a small area of extreme southern Texas) south to Costa Rica. Also on Utilia I., Honduras.
Naturalised Range: USA.

United States
In 1923 Howard E. Coffin obtained 42 Plain Chachalacas of the form *O. v. mccallii* from eastern Mexico which he released on Sapelo Island off the coast of Georgia. In the spring of 1924 some of the birds nested successfully, and within two years they had colonised most of Sapelo and had also flown to the neighbouring Blackbeard Island (Phillips 1928). Plain Chachalacas still occur on Sapelo and Blackbeard Islands, and according to the AOU (1998) also on Little St Simons Island.

NUMIDIDAE (GUINEAFOWL)

Helmeted Guineafowl
Numida meleagris

Natural Range: Much of sub-Saharan Africa. Also in NW Morocco until recently but now believed extinct (Thévenot *et al.* 2003).
Naturalised Range: Asia: ?Japan; ?Yemen. North America: West Indies. South America: Brazil. Australasia: Australia; New Zealand. Atlantic Ocean: ?Annobón I.; Ascension I.; Canary Is., Cape Verde Is. Indian Ocean: ?Chagos Is.; ?Comoro Is.; Mascarene Is. Pacific Ocean: Hawaiian Is.

When Helmeted Guineafowl (ancestors of the domestic variety) were first imported to Europe is uncertain, but they are known to have been domesticated by both the ancient Greeks and the Romans. There is, however, no evidence of their continuous domestication, and they were probably reintroduced by Portuguese traders from west Africa in the late fifteenth/early sixteenth centuries, when in England they were called the 'Tudor Turkey'. The birds were not well known in Europe until the middle of the 16th century.

Japan

Matsuo (1990) says that Guineafowl were imported to Japan from Europe by the Dutch in the mid-nineteenth century; whether any occur there in the wild today is unknown.

Yemen

Meinertzhagen (1954) says that Helmeted Guineafowl were probably introduced to the Arabian Peninsula, where today they occur only in parts of Yemen. The race in Yemen is the nominate *meleagris*, which is found on the other side of the Red Sea in Africa, but natural immigration seems improbable.

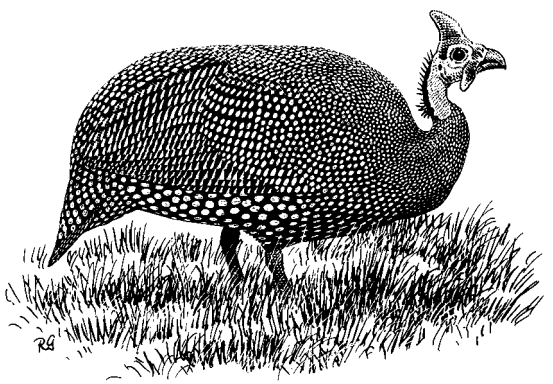
West Indies

Wetmore (1927) repeated the unsubstantiated claim by Karl Ritter who, writing in 1836, stated that Guineafowl were first introduced to the Antilles around 1500. The species is now widely kept in domestication in the Caribbean, and would doubtless also have become widely feral were it not for predation by the also introduced Small Indian Mongoose *Herpestes javanicus* (see Lever 1985). Guineafowl occur in the wild in most lowland parts of Hispaniola, on Cuba, on the Isle of Pines, on Puerto Rico, Barbuda, the Virgin Islands (St Croix), and St Martin (Isle Pinel) (Raffaele *et al.* 1998).

On Hispaniola, Guineafowl were well-established and widely distributed by at least 1733, and remained so for the next 200 years. Wetmore & Swales (1931) found them in numerous localities, though mainly in Haiti. Although the birds are well-established in the foothills of the Sierra de Baoruco in the Dominican Republic they are declining due to overshooting, and predation by Mongooses.

Bond (1979) says that Guineafowl are established on Cuba eastward from Las Villas Province, on the neighbouring Isle of Pines, and on Barbuda in the Leeward Islands, where the Moroccan form *N. m. sabyi* has occurred in the wild since before 1889.

In Puerto Rico, Helmeted Guineafowl occurred in montane areas as early as 1836, but Wetmore (1927) believed that they had by then died out. The AOU (1998), however, lists the species as still established on Puerto Rico.



Helmeted Guineafowl

Brazil

Helmeted Guineafowl have been successfully introduced to the island of Trinidade off the coast of Brazil (AOU 1998, R. C. Banks pers. comm. 2004).

Australia

Simpson & Day (1994) refer to populations of Helmeted Guineafowl on Heron and other Great Barrier Reef islands, and E. F. J. Garcia (pers. comm. 2005) saw a small flock of 20 near Mareeba in the Atherton tablelands, Queensland, in 1999. These Guineafowl populations are not mentioned by Barrett *et al.* (2003).

New Zealand
Several attempts were made in the nineteenth century to establish Guineafowl on South Island but none succeeded, probably due to the severe winters. In North Island, birds were released in various localities, but by the 1920s were established only at Aberfeldy, 65km east of Wanganui. Today they also occur on rough farmland in parts of Northland, Waikato, and Rotorua (Heather & Robertson 1997).

Annobón Island
Guineafowl on Annobón Island off Gabon may be descended from deliberate releases, but could also be natural immigrants from West Africa (Fry 1961).

Ascension Island
According to the AOU (1998) Guineafowl are established on Ascension Island. See also McCulloch 2004.

Canary Islands
According to Langley (2004), a small (< 20) and declining population occurs on Tenerife.

Cape Verde Islands
In 1461 Prince Ferdinand of Portugal imported slaves, and probably Helmeted Guineafowl of the race *N. m. galeatus* from west Africa, to the Cape Verde Islands. They were observed on Sal by the English buccaneer, William Dampier, in 1683, were said to be abundant on Maio in 1709, and were noted on São Thiago by Charles Darwin in 1832. According to Bannerman & Bannerman (1968), they occurred during the nineteenth century on São Nicolau, São Vicente, Fogo, Maio, São Thiago, Brava, Santo Antão and Boa Vista. Guineafowl now occur on most of these islands apart from São Vicente and Brava (Hazevoet 1995).

Chagos Islands
In 1907, Gadow & Gardiner (1907) found a few feral Guineafowl on Takamaka, Fouquet and Anglaise Islands; Bourne (1971) heard reports of them on Salomon Island, and it is possible that a few may survive on some of the less frequented islands.

Comoro Islands
According to Benson (1960), Guineafowl of the form *N. m. mitrata* were probably introduced to Grande Comore, Anjouan and Mayotte, where they were first reported in 1843. They could, however, be natural immigrants from east Africa.

Mascarene Islands
Introduced between 1803 and 1832 (Cheke 1976), Helmeted Guineafowl of the form *mitrata* (eastern and southern Africa) were by 1857 considered to be abundant in northern, central and western Rodrigues (Staub 1973b), but by around the time of the First World War had become rare, apparently due to nest predation by feral Pigs *Sus scrofa* (see Lever 1985), and died out before 1964 (Diamond 1987). However, Showler (2002) states that in 1999 a pair of free-ranging Guineafowl with young was observed on Mont Malartic, and another pair was noted at La Source, so the possibility of the re-establishment of a feral population cannot be discounted.

Jones (1996) lists Helmeted Guineafowl as introduced in the eighteenth century to Mauritius, where they occur in lowland exotic savanna.

Impact: Staub (1973, 1976) and Cheke (1987) say that Helmeted Guineafowl on Rodrigues have been seen as a threat to sown maize, and between 1955 and 1968 were systematically destroyed (North-Coombes 1971).

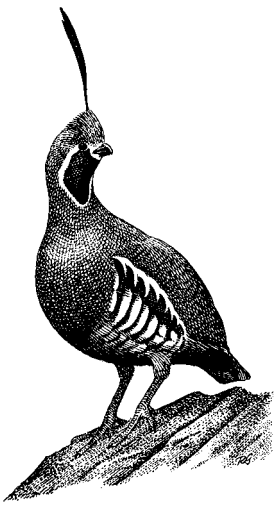
Hawaiian Islands
Since 1874 Guineafowl have occasionally occurred in the wild on several Hawaiian islands, but in most have failed to establish. Schwartz & Schwartz (1949) located a small population of about 500 birds whose numbers were declining, on Lanai, Molokai, Maui, Kauai and Hawaii, and believed the species would soon disappear. A few, however, may survive on Hawaii, Maui, Molokai and Lanai (Pratt *et al.* 1987), though they are 'perhaps not well-established' (AOU 1998: 123).

ODONTOPHORIDAE (NEW WORLD QUAILS)

Mountain Quail
Oreortyx pictus

Natural Range: From SW Washington, Oregon, Nevada and California (including the Little San Bernardino Mts) to N Baja California.
Naturalised Range: North America: Canada.

Canada
Mountain Quail were first introduced to Canada in 1860 or 1861 when Charles Wylde released some at his home near Victoria on Vancouver Island, British Columbia (Wylde 1923, Alford 1928). Others were probably liberated at around the same time on the Gulf islands and on the mainland in the Lower Fraser Valley (Phillips 1928). Although both these introductions ultimately failed, from subsequent releases said to have taken place in the 1870s and 1880s a sizeable population built up at the southern end of Vancouver Island, where Phillips (1928) recorded their presence along the mountain ridges from Victoria to Cowichan Valley at Duncan. Fifty years later, between 300 and 500 were established on southern Vancouver Island as far north as Duncan, where the species still occurs (Johnston & Garrett 1994, AOU 1998).



Mountain Quail

California Quail
Callipepla californica

Natural Range: From W and C Oregon south through California (including Santa Catalina I.) to Baja California and NE Mexico.
Naturalised Range: Europe: France; ?Spain; ?Italy. North America: Canada. South America: Argentina; ?Brazil; Chile. Australasia: Australia; New Zealand. Pacific Ocean: Hawaiian Is.

France
Unsuccessful attempts to establish California Quail on the French mainland have been made since the 1840s (Phillips 1928). Today, the species occurs in the wild only on the island of Corsica, where it became established during the 1960s (Yeatman 1976). Most of the population is found where arable land is associated with patches of maquis (scrub) formed of Cork Oak *Quercus suber*. The species also occurs in much smaller numbers in non-arable localities where human activities (e.g. grazing, woodcutting and burning) have created open grassy and scrubby clearings in the Cork Oak forests. The birds are uncommon and extremely shy (Dubray & Roux 1989, Pietri 1993, Baccetti *et al.* 1997, Aebischer & Pietri 1997).

Summing up the potential habitats of California Quail on Corsica, Pietri (1995) said that between 2,900 and 4,900 birds had been liberated in various localities, more than 70% of which were released during the 1960s. By 1992 the birds occupied nearly 620 sq km in the mid-eastern part of the island (the Aleria plain). Habitat factors and climate are likely to be the principal factors that affect the success or failure of the species to become established. The Aleria plain, where sound agricultural practices since the 1960s and the extension of vineyards provide the birds with a favourable anthropic habitat, is the species' stronghold on Corsica, where Langley (2004) said the population is increasing.

Italy

California Quail have occurred in the wild in parts of northwestern and central Italy and in northwestern Sicily, but may be established only on the island of Maretimmo off Trapani, Sicily, in the Isole Egadi archipelago (Bonelli & Moltoni 1929, Baccetti *et al.* 1997).

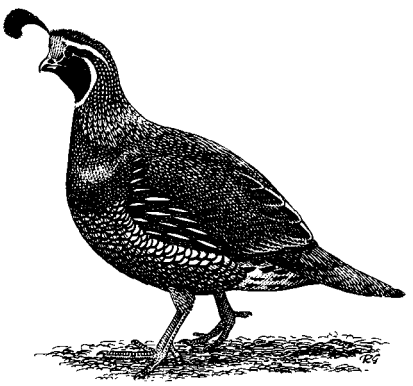
Spain

According to Langley (2004), the California Quail is in the process of becoming established in Spain but Clavell (in Martí & del Moral 2003) notes only that it has bred in Madrid, Catalonia and Mallorca.

Canada

In 1860 or 1861 Charles Wylde released some California Quail near Victoria on Vancouver Island, British Columbia (Wylde 1923); at around the same time H. M. Peers introduced others to Colquitz Farm, while more were planted further west at Metchosin. In the 1870s others were liberated in the same areas, and from 1886 until the 1890s more were released on southern Vancouver Island and on the lower mainland. Between 1907 and 1910 several further introductions were made on Vancouver Island and on the mainland, as well as on South Pender and Denman Islands and on the Queen Charlotte Islands.

By the mid-1950s, California Quail were well-established on Vancouver Island – mainly on the Saanich peninsula, near Victoria, and in the southwest around Sooke; a few remained on South Pender Island (but not on the Queen Charlottes); although the lower mainland introductions had been largely unsuccessful, a few isolated populations survived.



California Quail

Up to a quarter of a million birds are established locally in southern British Columbia (AOU 1998) especially on southern Vancouver Island and in the Okanagan Valley, where their principal limiting factor seems to be exceptionally heavy winter snowfalls.

Power (1994) suggests that the form *catalinensis* on Santa Catalina Island in the Channel Islands off the coast of California may have been introduced by Native Americans, perhaps thousands of years ago. California Quail from Santa Catalina were successfully transferred to Santa Rosa between 1935 and 1940 and to Santa Cruz in 1946 (Power 1994), and unsuccessfully to San Clemente around 1890.

Argentina

California Quail were first introduced to Argentina by Carlos S. Reed, who in 1920 released 25 pairs in the suburbs of Mendoza in southwestern Argentina, followed at a later date by a further 4,000 individuals. Although Reed claimed that the birds became established, they seem subsequently to have died out.

In 1943, ten pairs imported from Chile were liberated on the Primavera *estancia* (ranch) on the Traful River in Neuquén Province south of Mendoza. These birds became well established, and their descendants colonised an extensive area centred on the Traful and Limay Rivers, stretching to the Nahuel Huapi Lake and thence westward over the El Condor *estancia* on the Nahuel Huapi *pampa* (treeless plain) and eastward to the River La Fragua on the San Ramón estancia. North of the Traful, California Quail have spread through the valleys of the Rivers Córdoba and Catedral as far as the outskirts of San Martin de los Andes.

In northern Neuquén Province *C. californica* occurs in considerable numbers in the region between the Chos Malal, Andacollo and El Huecú. This population originates from releases that are believed to have been made between 1968 and 1971 on the Norquin,

Parque El Morado pampa near El Huecú. Navas (1987), from whom this account is derived, saw the species in large numbers in the valley of the River Curi Leuvu and along the road between Chos Malal and Andacollo. See also Mazar Barnett & Pearman 2001.

Impact: Navas (1987) says that in Argentina, where the species has found a vacant ecological niche with no competitors, California Quail provide a new source of food for native predators.

Brazil

Inskipp (1975) says that California Quail have been exported annually from Chile to Argentina and Brazil; their status in the latter is unknown.

Chile

In around 1870 an unsuccessful attempt was made to introduce *C. californica* from California to the Southern Lakes region of Chile, but from other introductions made elsewhere at about the same time California Quail were subsequently successfully translocated to other localities such as the Nilahue Valley in Curico Province in 1914 (Barros 1919). In 1881 or 1882 C. J. Lambert imported large numbers of birds from San Francisco, which he released at La Compañia in Coquimbo Province, where they multiplied and spread (Hellmayr 1932). Phillips (1928) said that California Quail were already important game-birds in Chile, where Hellmayr (1932) recorded the species as common in the central provinces.

Johnson (1965) reported *C. californica* to be well established from Atacama south to Concepción, while Sick (1968) said that from Coquimbo they had spread south to Puerto Montt and inland to Los Angeles. Johnson (1965) indicated that the species' northern limit was the desert and the southern one the area of high precipitation. According to Jaramillo *et al.* (2003: 28), California Quail are currently 'more abundant in Chile than within [their] North American range'.

Pietri (2001: 265) indicates the species' occurrence on Isla Más á Tierra in the Juan Fernandez group 'according to the bibliographic data available …' but gives no further details.

Impact: Vuilleumier (1991: 336; 339) says that the California Quail 'is an ecologically important member of the mediterranean avifauna of Chile', and that its ecological impact is 'significant', but provides no examples. The only native species with which it might compete is the Chilean Tinamou *Nothoprocta perdicaria*; although the range and habitats (farmland, grassland edges near thickets, and native vegetation) of both species overlap, there is no apparent evidence of significant competition. The form established in Chile is *C. c. brunnescens*.

Australia

Between 1862 and about 1930 numerous introductions of California Quail were made from New Zealand to Australia (Victoria, Phillip Island, Tasmania, Huon Island, Rottnest Island, South Australia, New South Wales, Queensland, King Island (Bass Strait) and Norfolk Island). Although in several places the birds bred successfully and became established locally (Ryan 1906, Chisholm 1919, Tarr 1950), the species is said to survive only on Norfolk Island; near Wonthaggi, Victoria; perhaps near Newcastle, New South Wales (Pietri 2001); on King Island in the Bass Strait (Pietri 2001); and perhaps in Tasmania (Barrett *et al.* 2003).

New Zealand

As in Australia, there were many introductions – mostly between 1862 and 1875 – of California Quail to New Zealand (Auckland, Nelson, Kawau Island, Canterbury, Otago, Southland, Wellington, Hawke's Bay, Chatham Island). The birds became widely established, and seem to have reached their maximum numbers and distribution within about 25 years of their introduction (i.e. between *c.* 1890 and 1900) (Oliver 1930). Thereafter they declined, due more to habitat loss rather than to predation by man and introduced mustelids (see Lever 1985).

Thomson (1922) believed that the failure of most game birds to become better established

throughout New Zealand was largely due to competition for food with native species and introduced passerines. Nevertheless, California Quail are now widely distributed in New Zealand, occurring throughout most of North Island and South Island; north and east of the Southern Alps, on some offshore islands, and on the Chatham Islands (Pietri 2001), where they were introduced prior to 1900. They are rare or absent in regions with high rainfall. California Quail in New Zealand are both the nominate form and *C. c. brunnescens* (Heather & Robertson 1997)

Impact: As early as 1913, California Quail had become an agricultural pest in some parts of New Zealand, where they ate young clover plants and seeds, and newly sown and germinating turnip seeds (Thomson 1922); forty years later they were reported (Oliver 1955) to be damaging grape and strawberry crops. They were also accused of spreading the seeds of Blackberry *Rubus fruticosa*, which was probably introduced by the early settlers (Lever 1987). On the other hand, California Quail also eat injurious insects and the seeds of noxious weeds.

Hawaiian Islands

California Quail (both *C. c. californica* and *C. c. brunnescens*) were first introduced from California to Oahu before 1855; at a later date more were released on all the other main islands, where within a decade Walker (1967) said they were well established and a valuable game bird. Munro (1944) indicates that by 1890 they were common and abundant on Hawaii and Molokai, and that by the turn of the century they were also established on Niihau and Kauai.

Between 1895 and 1928 the populations on Hawaii and Kauai considerably declined, due mainly to overgrazing by domestic stock, and land reclamation on the latter for sugar and pineapple plantations. Nevertheless, Caum (1933) found California Quail to be fairly common on Hawaii and Molokai, though less so on Oahu, Maui and Kauai, and absent from Lanai. In 1936–37 a dozen pairs were released on Lanai, and sporadic importations to the islands continued until 1940. Between 1959 and 1961 412 California Quail were liberated on the Puu Waawa Ranch on Hawaii, where by the early 1970s the birds were well established and abundant.

Schwartz and Schwartz (1949) found the species on all the larger islands apart from Oahu, and also on Niihau, and estimated the total population to be about 78,000, of which over 62,000 were on Hawaii and nearly 12,000 on Molokai. Today, California Quail are established on Maui, Molokai and Kaui and on the leeward (drier) side of Hawaii. There they are common in North Kona, Mauna Kea and the Hawaii Volcanoes National Park (Pratt *et al.* 1987), where their principal limiting factors seem to be the intensity of grazing by domestic stock and the availability of water.

Impact: California Quail in the Hawaiian Islands have been implicated in the spread of various exotic grasses, herbs and shrubs (Lever 1994). The species diversity of alien flora is generally highest in broken woodland, and is much influenced by the presence of naturalised game birds (Cuddihy & Stone 1990).

Gambel's Quail
Callipepla gambelii

Natural Range: SW USA and Mexico (including Tiburon I.) south to S Sonora.
Naturalised Range: Pacific Ocean: Hawaiian Is.

Hawaiian Islands

Gambel's Quail has been established on the island of Kahoolawe since the species was imported by H. A. Baldwin in 1928 (Caum 1933). Between 1958 and 1963 a total of 607 were imported to Hawaii, where 294 were released at Puako on the northwest coast and 114 on Lanai and an unknown number on Maui (Walker 1967). Today, Gambel's Quails are established on Lanai, Kahoolawe and perhaps Hawaii (Pratt 1994, AOU 1998).

Northern Bobwhite
Colinus virginianus

Natural Range: From C and E USA south to Florida, and in Central America to NW Guatemala; also on Cuba.

Naturalised Range: Europe: ?Croatia; ?France; Italy; Portugal; ?Spain. North America: ?Canada; West Indies. Australasia: ?New Zealand.

Croatia
Northern Bobwhites have been introduced to Croatia since the 1960s, and are presently established only near Istra where although the population may be self-sustaining it also recruits from periodic stocking (Gariboldi 1997).

France
Although Northern Bobwhites have been introduced to France for sporting purposes on numerous occasions since 1816, only around Sologne and Puisaye in the centre of the country and Les Landes in the southwest are breeding populations established, though whether these would be self-sustaining without regular stocking is uncertain (Voisin 1994, Gariboldi 1997).

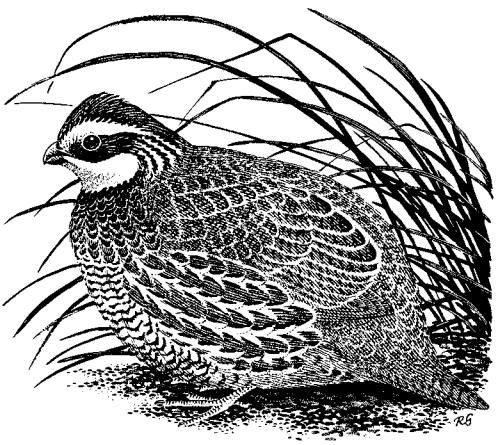
Italy
Italy is the only country in Europe in which Northern Bobwhites are definitely naturalised, having been admitted to the official *Checklist of Italian Birds* in the early 1980s. The species has been introduced to various parts of the country since 1927, its present distribution being confined to some 960 sq km of the plains and hills in Piemonte and Lombardy in the northwest (Canavese, Astigiano, Allesandrino), especially in the Ticino Valley, where the population has declined to between 5,000 and 8,000 breeding pairs which nest in the region between the Sesia and Ticino Rivers. Northern Bobwhites are also said to be established on the island of Mozia off Trapani, Sicily (Fasola & Gariboldi 1985, Iapichino & Massa 1989, Brichetti *et al.* 1992, Meschini & Frugis 1993, Baccetti *et al.* 1997, Gariboldi 1997, Bertolino 1999). The form established in Italy is the nominate *C. v. virginianus* (central and eastern United States).

Portugal; Spain
Langley (2004) lists *C. virginianus* as established in Portugal and apparently becoming so in Spain. Clavell (in Martí & del Moral 2003) only cites breeding in Mallorca in 1996 and males heard calling in Catalonia in 1989 and 1994.

Canada
Several attempts have been made to establish Northern Bobwhites in Canada – in Nova Scotia, Ontario and Manitoba (Phillips 1928) – but only a few descendants of those released in the Okanagan Valley in southwestern British Columbia may survive today (AOU 1998).

West Indies
Northern Bobwhites have been successfully introduced in the Bahamas (Andros, New Providence and Eleuthera); the Greater Antilles (Hispaniola, Puerto Rico); and formerly the Virgin Islands (St Croix), where the species has since died out (AOU 1998).

Cory (1880: 143) was told that the species had been imported to New Providence



Northern Bobwhite

'many years ago' and was then abundant around Nassau. Today, birds of the subspecies *floridanus* are established in pine barrens, thick wooded undergrowth, wasteland, rough pasture and arable land on New Providence, Andros and Eleuthera, and according to the AOU (1998) (which omits Eleuthera) also on Abaco Island.

Cory (1880) believed that the species was introduced to Haiti (Hispaniola) during the period of French rule (1697–1803) where it became established on the southern peninsula.

Northern Bobwhites were imported to Santo Domingo in the Dominican Republic (Hispaniola) around 1890 (Cherrie 1896), where they are still established (AOU 1998).

According to Gundlach (1878a) Northern Bobwhites were introduced to Puerto Rico from Cuba in 1860 by Don Ramón Soler on his *hacienda* Santa Inés near Vega Baja; they still survive on the island today (AOU 1998).

Newton & Newton (1859) record that Northern Bobwhites were introduced to St Croix in about 1810, where the birds have since died out.

Phillips (1928) says that Northern Bobwhites (probably from Florida and perhaps Texas) were introduced to Cuba before 1923, where Dickinson (2003) implies that the form *cubanensis* is indigenous, although the AOU (1998) says the species is introduced. See also Raffaele *et al.* 1998.

The principal limiting factors for Northern Bobwhites in the West Indies are the marginal habitat, overshooting, and predation by the Small Indian Mongoose *Herpestes javanicus* (see Lever 1985).

New Zealand

In 1898–99 the Wellington Acclimatisation Society (see Lever 1992) unsuccessfully imported a total of 1,156 Northern Bobwhites (probably *C. v. taylori*) from the United States, which were widely distributed in North and South Islands: in 1947 the Otago Society imported 200 eggs from California, but the resulting chicks all died. None have been reported since the 1970s (Heather & Robertson 1997).

PHASIANIDAE (TURKEYS, GROUSE, PHEASANTS AND PARTRIDGES)

Wild Turkey
Meleagris gallopavo

Natural Range: SE USA to WC Mexico
Naturalised Range: Europe: Germany; ?Austria; ?Former USSR. Asia: ?Japan. North America: Canada. Australasia: ?Australia; New Zealand. Pacific Ocean: Hawaiian Is.

Germany; Austria; Former USSR

Turkeys were probably originally imported to Europe in the early sixteenth century; they were first noted in Germany around 1530 and were being reared in captivity by at least 1571. Turkeys have a long history in German sporting lore, and small populations survived in the wild in the valley of the River Danube until the outbreak of the Second World War (Niethammer 1963). By the mid-1960s small populations existed only in Kottenforst, Buschoven and Boenning Hardt in the Rhineland (Aliev & Khanmamedov 1966). These authors also refer to the species as feral in parts of Austria and the Latviya SSR of the former USSR. Gebhardt (1996: 206) mentions that 'locally small populations' occur in Germany, although these may not be viable without regular stocking (Spittler 1993).

Japan

According to Matsuo (1990), Wild Turkeys from Europe were imported to Japan by the Dutch in the mid-seventeenth century; whether any occur in the wild is unknown. These are not mentioned by Brazil (1991).

Canada and California

Between 1910 and 1962 a number of unsuccessful attempts were made to establish Wild Turkeys in British Columbia. In the latter year, some wild-caught birds from South Dakota (presumably *M. g. merriami*) were released in the Alberta portion of the Cypress Hills Provincial Park on the

Alberta–Saskatchewan border, where within a year the population had increased to around 50. According to the AOU (1998: 122) Wild Turkeys are currently 'established locally [in] southern British Columbia, southern Alberta, southern Saskatchewan, southern Manitoba, and southern Ontario'.

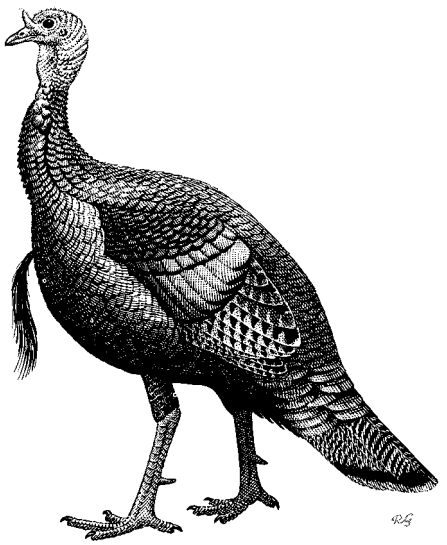
Power (1994) records the successful establishment and breeding of Wild Turkeys introduced to the Channel Islands off the coast of California.

Australia

Barrett *et al.* (2003) record the presence of Wild Turkeys at a single site in South Australia, and at seven on Tasmania where breeding has occurred.

New Zealand

Thomson (1922) recorded the establishment of feral Wild Turkeys, which were first introduced around 1890, in several localities in New Zealand, where he believed their recent decline was due, as in the case of other exotic game birds, to competition for food (especially insects) with introduced songbirds. Today, Turkeys occur on rough farmland in many North Island and a few South Island localities, and also on Moturoa Island in the Bay of Plenty (Heather & Robertson 1997).



Wild Turkey

Hawaiian Islands

According to Locey (1937), Wild Turkeys were first introduced to the Hawaiian Islands as game birds from China in 1788. More were imported, from Chile, in 1815, and by the outbreak of the Second World War they were said to be abundant in the wild, and according to Schwartz & Schwartz (1949), remained so on Niihau (where thousands are said to have been released) after the Second World War; less than 200, however, were found elsewhere, most of which were on Hawaii. Between 1958 and 1962 large numbers of Wild Turkeys of several forms (*silvestris*, *merriami*, *intermedia*, *gallopavo*) were liberated on Hawaii, Kauai, Molokai, Lanai and Maui, where by the latter year they were said to be breeding on Hawaii and Molokai, surviving on Lanai, but declining on Maui and Kauai (Scott *et al.* 1986). The AOU (1998) lists the species as occurring on Hawaii, Maui, Lanai, Kauai and Niihau.

Impact: According to Lewin (1971), Wild Turkeys in the Hawaiian Islands are implicated in the spread of the alien Banana Poka *Passiflora mollissima*, an aggressive species of vine, though Van Riper (1980) suggests they may also help in the expansion of range of native Naio *Myoporum sandvicensis* trees on the slopes of Mauna Kea on Hawaii.

Himalayan Snowcock
Tetraogallus himalayensis

Natural Range: From W Turkistan through the Himalayas to China.
Naturalised Range: North America: USA.

United States

In 1948 the US Fish and Wildlife Service inaugurated a Foreign Game Investigations Program with the ultimate objective of the provision of additional game species. As part of this project, between 1960 and 1970 Himalayan Snowcocks were released in five regions

of Nevada, and also on the slopes of Mauna Kea on Hawaii. (Bland & Temple (1993: 151) give the initial date of introduction of the Himalayan Snowcock in North America as 1933, but with no further details. Johnston & Garrett (1994: 222) give 1962 as the earliest date of introduction. Stiver (1984; quoted by AOU 1998) gives the earliest date as 1963.)

In 1963, the Nevada Game Commission imported 35 Snowcocks from Gilgit, Pakistan, the 19 birds which survived the journey being liberated in April in the Ruby Mountains in northeast Nevada, where they soon disappeared. Subsequently, the Nevada Department of Wildlife established a captive flock whose offspring were released in succeeding years (Christensen 1963, Bump & Bohl 1964). A total of 107 birds were imported from Pakistan, and between 1963 and 1979 2,025 of their offspring were introduced to the wild, of which 1,717 were planted in the Ruby Mountains. Breeding was confirmed in 1977, and three years later the first shooting season was declared. In 1985 the Department of Wildlife estimated the population in the Ruby–East Humboldt Range of the Humboldt National Forest at between 250 and 500 birds.

The breeding range of Himalayan Snowcocks in the Ruby–East Humboldt Range seems confined to elevations above 3,000m (Bland & Temple 1990). Since under 50 sq km of the Range meets this criterion, and the species' breeding densities in China range from 1.3 to 2.0 per square kilometre, the number of birds in the Range is unlikely ever to be large. In the Ruby Mountains, Snowcocks appear to favour deep glacial cirques (steep-sided hollows at the head of a valley or on a mountainside) rimmed by extensive moist meadows and precipitous cliffs (Bland & Temple 1990), and the discontinuous distribution of such cirques and alpine meadows limits the number of localities in which large flocks can establish home ranges (Bland & Temple 1993). The majority of Nevada's Snowcock population occurs in the Thomas Peak–Ruby Dome region of the Ruby Mountains, although coveys are regularly reported to the north and south (Bland & Temple 1993, AOU 1998, Sibley 2000). Because Nevada's Snowcocks are marooned on an alpine island at the centre of the Great Basin, their natural dispersal into other alpine habitats seems unlikely (Bland & Temple 1993).

Impact: The small and isolated alpine meadows of the Ruby Mountains are, like most other alpine meadows, extremely fragile, and possess the richest and most diverse alpine plant community in the Great Basin. Since the introduction of Himalayan Snowcocks was virtually unmonitored, with no prior assessment of these large (60cm high) birds' potential ecological impact, the state of the area's biotic community before, during and after the introduction is largely unknown (Bland & Temple 1993).

Chukar Partridge
Alectoris chukar

Natural Range: From NE Greece through Asia Minor and Arabia to NW India, W Mongolia, S Manchuria and N China.

Naturalised Range: Europe: British Isles; France; Italy. Asia: Oman; UAE. Africa: South Africa. North America: Canada; Mexico; USA. Australasia: New Zealand. Atlantic Ocean: St Helena I. Pacific Ocean: Hawaiian Is.

Europe
Chukar Partridges have been widely introduced as game birds to countries in Europe other than those mentioned above, including Portugal (Dias 1992) and Spain, but are apparently unable to survive in the wild without regular stocking.

British Isles
Since between the two World Wars Chukar Partridges have been released as game birds in parts of England and Scotland, but have seldom been self-maintaining for any length of time. Nevertheless, Aebischer (1997) recorded small established populations, mainly in southwestern and northern England and northern Scotland.

France
According to Aebischer (1997), small populations of 10–100 pairs of Chukars occur south of Paris in central France.

Italy
Attempts have been made since about 1930 to establish Chukars in Italy (mainly in the north), but the species is apparently only naturalised on the islands of Giglio and Montecristo northwest of Rome (Baccetti 1989, Baccetti *et al.* 1997).

Impact: Wherever the ranges of the two species in Europe overlap, the Chukar has tended to hybridise with the native Red-legged Partridge *A. rufa* (Allard 1999).

Oman; United Arab Emirates
The Chukar Partridge 'inhabits rocky and cultivated areas of the Musandam mountains [Oman] and perhaps the UAE mountains … this isolated eastern Arabian population is probably derived from escaped birds which have been imported for food' (Jennings 1981b: 58). Chukars are currently in 'Musandam: breeding resident in mountains' (Anon 2004: 9). Richardson (1992) also records the introduction and escape of Chukars of the Iranian race *werae* in the United Arab Emirates, where he records them as breeding on the high plateau above Wadi Bih, on Sir Bani Yas Island (since 1989), and in the al Ain area where large numbers were released in 1982.

South Africa
In 1964 six Chukar Partridges were seized by customs officers in Cape Town and despatched to Robben Island in Table Bay, where Siegfried (1971) estimated the population to number around 500. P. A. Clancey (pers. comm. 1985) wrote that this 'flourishing population' is 'racially composite' (derived from more than one race), 'so derives from game-farm bred stock'.

Canada
The first Chukar Partridges in Canada were released unsuccessfully in Nova Scotia prior to 1934 – possibly as early as the turn of the century. In 1940 A. D. Hitch of Whonock, British Columbia, unsuccessfully freed some birds at Alkali Lake and Dog Creek, and between 1950 and 1955 a total of 2,463 Chukars were liberated in British Columbia, where by the final year the birds were sufficiently well-established for shooting to be allowed (Carl & Guiguet 1972). Chukar Partridges are presently established in suitable habitats in the Thompson, Fraser, Okanagan and Similakmeen Valleys, and around Shuswap Lake between Kamloops and Revelstoke, in southcentral British Columbia (Johnston & Garrett 1994, AOU 1998).

Mexico
According to Peterson & Chalif (1973), Chukar Partridges have been successfully introduced to the mountains of northern Baja California.

United States
According to Bump (1941), Chukar Partridges have probably been introduced to every state in the USA, but have only become well established in, and to the west of, the Rocky Mountains. W. O. Blaisdell is believed to have imported the first Chukars to the United States, to Illinois, in 1893, the offspring of which he unsuccessfully released at McComb in the following spring. Chukars were first released successfully in Washington in 1938; shooting was first permitted in 1949, and in

Chukar Partridge