Long-term changes in the numbers and abundance of regularly breeding land bird species on Cyprus: a review

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For most of the 20th century the total number of regularly breeding land bird species on Cyprus remained apparently constant, as predicted by the theory of island biogeography. However, since *c*1992 there has been an unexpected increase in that total, which has coincided with extensive environmental changes but also with increased ornithological activity on the island. Examination of the colonising species, and of those pre-existing residents which have undergone large increases, suggests that the main reasons for these colonisations and increases are anthropogenic, particularly increased habitat diversity and rapid climate change; reduced persecution and disturbance may also be important. These environmental changes may have altered the island's equilibrium total. The species which have colonised and increased are mainly resident, including all those with minimum populations ≥100 pairs, suggesting that the environmental changes are favouring residents rather than migrant breeders. A small number of extinctions also occurred during and since the 20th century; these also appear to be anthropogenic or mainly so. The rapid climate change on the island is predicted to continue, suggesting there will be further avian population changes.

INTRODUCTION

The theory of island biogeography (MacArthur & Wilson 1967 and *eg* Schoener 2010, McCollin 2017, Valente *et al* 2017) predicts for an island like Cyprus (Figures 1, 2), large, continental and not recently formed (Blondel & Aronson 1999), that its total number of regularly breeding land bird species (*ie* excluding seabirds) will be in equilibrium. That is, the total number will remain approximately constant over time as non-anthropogenic colonisation and extinction rates maintain a long term dynamic balance, which will vary

Figure 1. Cyprus, showing the main topographical features and locations mentioned in the text.

Figure 2. Cyprus and the eastern Mediterranean region showing neighbouring countries and islands.

Table 1. Regularly breeding land bird species which became extinct on Cyprus during and since the 20th century.

	Former status	Extinct since	Suspected main causes of extinction
Cinereous Vulture *Aegypius monachus*	resident	*c*1982	loss of carrion; poisoning, persecution and disturbance; vulnerable small population
Eastern Imperial Eagle *Aquila heliaca*	resident	*c*1995	loss of carrion; poisoning, persecution and disturbance; vulnerable small population
Lesser Kestrel *Falco naumanni*	migrant breeder	after 1929, up to 1950	pesticide use, loss of nest sites, agricultural intensification, persecution and disturbance
Black-bellied Sandgrouse *Pterocles orientalis*	resident	1980s?	hunting, agricultural intensification, increased frequency of severe drought years
White-throated Dipper *Cinclus cinclus*	resident	1945 or soon after that	prolonged drought, hunting/collecting, vulnerable small population
Dead Sea Sparrow *Passer moabiticus*	mainly dispersive or migrant breeder	colonised c1976. extinct 1990 or soon after	prolonged drought causing drying of habitat, disturbance, vulnerable small population

stochastically around a mean that is largely dependent on island area. The theory also predicts that the species' turnover rate and the variance around the mean will be low. For most of the 20th century Cyprus's regularly breeding land bird total did remain remarkably constant, especially so when anthropogenic changes are discounted (Bucknill 1911, 1913, Jourdain 1930, Bannerman & Bannerman 1958, 1971, Bourne *et al* 1964, Stewart & Christensen 1971, Flint & Stewart 1983, 1992). The changes during that period being the extinctions of Cinereous Vulture *Aegypius monachus,* Lesser Kestrel *Falco naumanni,* Black-bellied Sandgrouse *Pterocles orientalis* and White-throated Dipper *Cinclus cinclus* (the former two anthropogenic, the latter two probably at least partly so) and the colonisation by European Greenfinch *Chloris chloris.* Also, small breeding populations of Long-eared Owls *Asio otus* and Northern Goshawks *Accipiter gentilis* were discovered and another of Dead Sea Sparrows *Passer moabiticus* existed briefly (Flint & Stewart 1983, 1992). However, since the 1990s apparently new colonists have caused an unexpected increase in the total

Table 2. Apparently new colonising land bird species on Cyprus during and since the 20th century.

	Breeding status	Regular breeder since	Suspected main causes of colonisation
Little Grebe *Tachybaptus ruficollis*	resident/ opportunist	1988: irregular previously	presence of many new artificial permanent water bodies/wetlands, reduced persecution
Western Cattle Egret *Bubulcus ibis*	resident	2004 or earlier	increased immigration resulting from range expansion of the species
Mallard *Anas platyrhynchos*	resident/ opportunist	1993: irregular previously	presence of many new artificial permanent water bodies/wetlands, reduced persecution
Northern Goshawk *Accipiter gentilis*	resident	1980s or earlier	reafforestation, reduced disturbance and persecution
Long-legged Buzzard *Buteo rufinus*	resident	1992 or earlier	increased immigration, reduced disturbance and persecution
Common Moorhen *Gallinula chloropus*	resident/ opportunist	1992: irregular previously	presence of many new artificial permanent water bodies/wetlands, reduced persecution
Eurasian Coot *Fulica atra*	resident/ opportunist	1998: irregular previously	presence of many new artificial permanent water bodies/wetlands, reduced persecution
Black-winged Stilt *Himantopus himantopus*	migrant breeder	1999: irregular previously	presence of many new artificial permanent water bodies/wetlands, reduced persecution
Spur-winged Lapwing *Vanellus spinosus*	resident/ migrant breeder	1998 or earlier	presence of many new artificial permanent water bodies/wetlands, reduced persecution
Common Blackbird *Turdus merula*	resident	1980s or earlier	less cold and less wet winters in the higher mountains, increases in neighbouring countries
Sardinian Warbler *Sylvia melanocephala*	resident	1980s? or earlier	increased immigration, climate change, out-competes endemic congener
European Greenfinch *Chloris chloris*	resident	1963 or earlier	creation of habitats with large trees, especially on low ground, regional factors?

number of regularly breeding land bird species, from 72 in 1991 (counted from Flint & Stewart 1992) to 82 in 2016 (counted from BirdLife Cyprus 2018a). Apparently new colonists are here defined as species not listed by Flint & Stewart (1992) as regularly breeding, which have bred, or probably bred, during each year of the most recent decade covered by published BirdLife Cyprus bird reports, *ie* 2007–2016 (see also Methods). Also included in the discussion (and Table 2) for this category is the European Greenfinch; although an earlier colonist its colonisation appears similar in several respects to the colonisations which followed and it was apparently the first of this wave of colonisations.

Here I list and discuss the six regularly breeding species which have been lost (Table 1) as well as Greater Short-toed Lark *Calandrella brachydactyla* which is near extinction and Marbled Duck *Marmaronetta angustirostris*, a former frequent breeder. Then I list and discuss the 15 species which apparently colonised during and since the 20th century (Tables 2, 3) as well as eight species which do not meet the above criteria for regular breeding but which may be in the process of colonising. I also discuss four pre-existing breeding species which have undergone long-term and very large increases in numbers and distribution. These species show similarities to some of the new colonists and may be earlier colonists themselves. The European Serin *Serinus serinus*, apparently such an earlier colonist, is also discussed in this section.

In addition to area, factors determining the number of breeding species on an island include its distance from the mainland, climate, habitat diversity and the level of predation/ persecution. Area and distance from the mainland are constants but changes in climate

Table 3. Apparently colonising land bird species during the 20th century on Cyprus which are probably formerly overlooked scarce long-term breeders.

	Breeding status	First confirmed breeding
Eurasian Hobby *Falco subbuteo*	migrant breeder	1999 but has probably always bred
Long-eared Owl *Asio otus*	resident	1968 but has probably always bred
Woodchat Shrike *Lanius senator*	migrant breeder	1990s but has probably always bred

and predation/persecution can alter island equilibrium totals. Habitat diversity is largely a function of island area but changes in it also seem liable to alter equilibrium totals (*eg* Watson 1964, MacArthur & Wilson 1967, Whittaker & Fernández-Palacios 2007, Hortal *et al* 2009, Schoener 2010). The recent large increase in the number of breeding species on Cyprus has in fact coincided with extensive environmental changes on the island. I describe the latter before listing and discussing the changes in the bird populations, then look for patterns and common factors. This review has had a long gestation; it evolved from and is the published version of the Flint (in prep) discussed in Flint (2011).

METHODS

In preparing this review I have re-examined all the published material on Cyprus birds since Sibthorp (1787), *eg* annual reports, expedition reports, bulletins, articles, checklists, books, as well as unpublished material, *eg* diaries, questionnaires, reports, lists of museum specimens gathered in preparation for Flint & Stewart (1983, 1992), which see for a detailed list. This material often contains information relevant to this review and not published by those authors. For material post Flint & Stewart (1992) I have examined the publications of the Cyprus bird societies (see below) and all other relevant material, published and unpublished, that I am aware of.

The data on which the species' texts are based is both qualitative and quantitative. The primary sources are Flint & Stewart (1983, 1992), the subsequent annual reports of the four Cyprus bird societies (the Cyprus Ornithological Society (hereafter COS), the Cyprus Ornithological Society (founded 1970), Kuşkor and BirdLife Cyprus) and Whaley & Dawes (2003). I have also used the draft Kuşkor report for the years 2002–2004 (unpublished). To avoid frequent and lengthy repetition these sources are usually not cited in the text. Sources other than these are cited. For the same reason, general citations for environmental changes are given only in that section and are not repeated in the species' accounts.

I was resident on Cyprus 1969–1972 and 1998–2004 so witnessed and was impressed by the remarkable changes in its bird populations between those two periods. My observations were mostly published in the reports of the Cyprus bird societies; in the few cases where they augment the literature this is mentioned. In addition to the literature, particularly the latest reports and monthly newsletters/checklists of BirdLife Cyprus, current information on the island and its birds was provided by Alison McArthur and Colin Richardson.

For information on species' population changes elsewhere in the east Mediterranean region (Figure 2) I have used avifaunas/checklists for Greece (Handrinos & Akriotis 1997), Turkey (Kirwan *et al* 2008), Syria (Baumgart *et al* 2003, Murdoch & Betton 2008), Lebanon (Ramadan-Jaradi *et al* 2008), Jordan (Andrews 1995), Israel (Shirihai 1996), the Gaza Strip (Al-Safadi 2006) and Egypt (Goodman & Meininger 1989) plus for their wider status Cramp (and various co-authors/editors, 1977–1994), Hagemeijer & Blair (1997) and del Hoyo *et al* (2018). Population estimates are from BirdLife International (2015) unless otherwise stated. Nomenclature and sequence follow OSME (2017) except for Cetti's Warbler *Cettia cetti*, the

nomenclature of which follows Kirwan *et al* (2008), Gill & Donsker (2018) and Shirihai & Svensson (2018).

In the species' texts annual temperature sum above 5°C in degree days (GDD5) is used to represent temperature, and annual ratio of actual to potential evapotranspiration (AET/PET) to represent aridity, the lower the ratio the drier the climate (Huntley *et al* 2007). Cyprus GDD5s are from Flint (2011); that source includes Cyprus AET/PET ratios calculated using the island's mean AET of 80% of precipitation (Water Development Department 2011); I have here recalculated, using more precise AET values, for the southeastern Mesaoria plain (Voudouris *et al* 2010) and for the higher Troodos mountains (Mederer 2009). As in Flint (2011), PET values are from Water Development Department (2010).

Monitoring and recording of breeding birds

The history of bird recording on the island was detailed by Flint & Stewart (1983, 1992): essentially there were few historical breeding records from the start of the Great War in 1914 until the formation of the Cyprus Ornithological Society in 1957. Regular annual reports have been published since then but with few active observers on the island coverage of breeding birds remained poor for several further decades. For example the two reports for 1970 contain records from only six of the 66 reservoirs then in use and do not mention the Akamas peninsula at all; the two 1980 reports mention only four reservoirs and the two 1990 reports mention 20 of the 98 reservoirs then in use and have better coverage of the west of the island (COS 1971, 1981 & 1991, COS (founded 1970) 1971, 1985 & 1994, Water Development Department 2009). Also, for the north of the island coverage was extremely limited for *c*25 years after 1974, and is still poorer than in the south. Since Flint & Stewart (1992) was compiled coverage in the south of the island has greatly improved. The systematic monitoring of wetlands and water bodies in the south of the island was introduced by Whaley & Dawes (2003) and census/atlas counts in other habitats in the southwest 1997–2010 by Pomeroy & Walsh (*eg* 2006 & 2015). This monitoring and counting, still largely in the south of the island, is now continued and expanded by BirdLife Cyprus (*eg* Hellicar 2016a, Ieronymidou 2018). Thus breeding which may have been unnoticed in the past is now more likely to be detected.

The above pattern of often poor and uneven recording, especially in the earlier years—probably inevitable in such a long-term review—means that some of the colonising species listed below probably bred regularly earlier than the dates given. It also means that, for a few species, it is not certain whether they were new colonists or were overlooked long-term scarce breeders. In these instances I have presented the evidence and explained the reasons for my decisions.

The definition of colonisation can vary from one individual landing on an island, to the relatively lengthy persistence of an immigrant species, especially when breeding and population increase are accomplished (MacArthur & Wilson 1967). Those authors chose to use the latter definition and it is the one I have chosen to use here (with a length of population persistence ≥ 10 years). Thus the many occasional breeders (Flint & Stewart 1983, 1992, Stylianou 2017) are not considered here. Biologists can rarely if ever be certain of recording all colonisation and extinction events in real world systems (MacArthur & Wilson 1967) and that is clearly the case on Cyprus; by choosing a ten year population persistence I hope to have reduced such possibilities.

ENVIRONMENTAL CHANGES

Climate

Cyprus has an intense Mediterranean climate with a strongly-marked seasonal rhythm: long, hot, dry summers and cool, rainy, changeable winters are separated by short autumn and spring seasons of rapid change (Department of Meteorology 2018a). Following recent climate change this strong seasonality has become more marked. The mean annual temperature increased by *c*1°C during the last century, with a more rapid increase of 0.015°C per annum since the 1970s (Department of Meteorology 2018a). Mean temperatures were higher in all seasons 1991–2016, compared with 1901–1930; differences were —spring (Mar–May) +1.3°C, summer (Jun–Aug) +1.5°C, autumn (Sep–Nov) +0.7°C and winter (Dec–Feb) +1.0°C (CCKP 2018). There was a generally larger increase in average minimum temperatures, by (depending on location) 0.7–1.6°C in winter and 2.2–4.5°C in summer, resulting in reduced diurnal temperature ranges (Price *et al* 1999). Although winters now average milder, occasional unusually cold periods still occur, with snow and frost at low altitudes (Department of Meteorology 2018b).

In Europe the warming climate has resulted in earlier springs, with the pollen season starting *c*10 days earlier than in the 1960s and insects (*eg* bees, butterflies, Odonata) emerging earlier (European Environment Agency 2017b). Similar changes might be expected on Cyprus; I am not aware of any long-term flowering plant or insect phenological data from the island but there are recent observations of unusually early flowering (Alan Outen, Özge Özden Fuller both pers comm) and of the unusually early emergence of butterflies (Eddie John, Alan Outen and Özge Özden Fuller, all pers comm) and Odonata (De Knijf & Demolder 2013, Alan Outen pers comm, pers obs). Higher temperatures also increase the activity of snakes and large lizards and their predation risk to nesting birds (DeGregorio *et al* 2014). Such reptiles are extremely common on Cyprus where they are

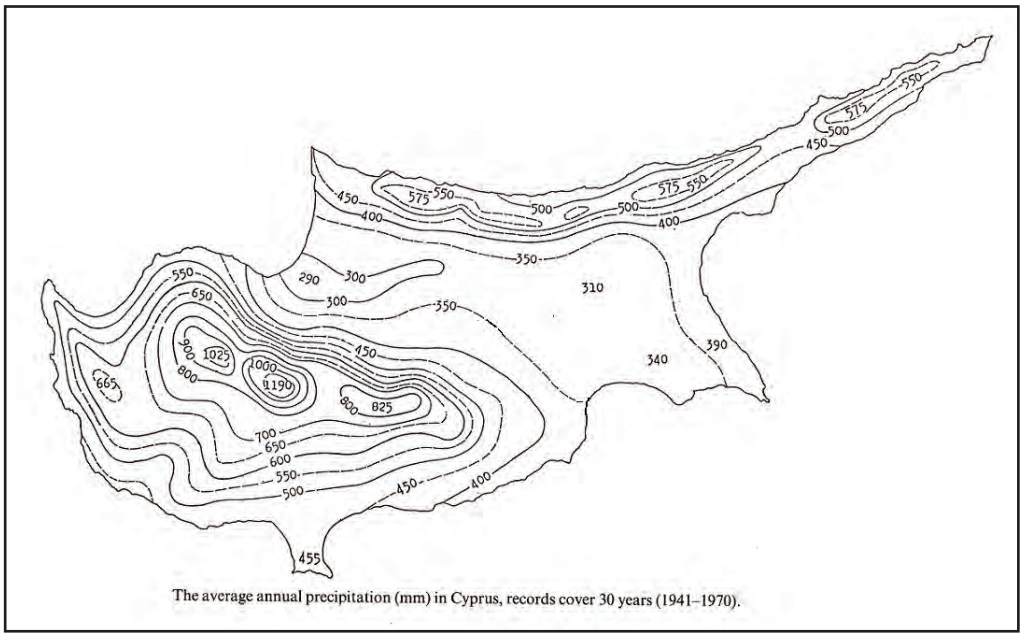

Figure 3. Average annual rainfall (mm) 1941–1970, the most recent period covering the whole island of Cyprus (there is no data from the north of the island after 1973). Rainfall has declined since 1970 but the pattern of distribution has remained the same, *ie* highest in the two mountain ranges and lowest on the Mesaoria plain (map redrawn from Department of Meteorology 1972).

significant nest predators (*eg* Took 1972, COS 1977, Flint & Stewart 1992, Baier *et al* 2013); higher temperatures would be expected to make them active earlier in the spring.

Rainfall on Cyprus (Figure 3) often varies greatly from year to year, with both extremely wet and severe drought years occurring. At times in earlier centuries prolonged droughts have caused the death of forest trees, the drying of springs and wells, crop failure, famine and emigration (Christodoulou 1959, Thirgood 1987). An analysis from tree rings shows that sustained droughts, 2–6 years in length, have occurred in small clusters of years three times in the last 250 years: 1806–1824, 1915–1934 and 1986–2000 (Griggs *et al* 2013). During the 20th century average annual precipitation was 559 mm in the first 30 years and 462 mm in the last 30 years, a decrease of 17%. In the first 17 years of this century (2001–2017) the annual average has been 473 mm (calculated from Department of Meteorology 2018a & b), *ie* no further decrease during this period. The decrease in the 20th century occurred in a step change *c*1970 and during the winter months December–February, when most rainfall occurs, with little change in other months. The decrease has been greatest (15–25%) in the Troodos mountain range above 500 m asl and least (6–15%) on low ground (Rossel 2001). The reduction in the annual rainfall total has been accompanied by reductions in the number of days with rain, in the number of periods of consecutive wet days and in the number of days with high or very high precipitation (Katsanos *et al* 2017).

Since 1970, drought and severe drought years have become more frequent, *ie* during 1901–1970 they occurred on average once every seven years but during 1971–2017 they have occurred on average once every four years. Also since 1970, very high and extremely high rainfall years have become much less frequent, *ie* during 1901–1970 they occurred on average once every 3.5 years but during 1971–2017 they have occurred on average once every 12 years. The most striking change has been the complete absence of extremely high rainfall years since 1970, whereas there were ten previously (severe drought, drought, very high and extremely high rainfall years are defined as having ≤70%, 71–80%, 121–130% and >130% respectively of normal precipitation, *ie* the 503 mm 1961–1990 average, Department of Meteorology 2018a).

Heavy rain can cause soaking, chilling and increased mortality in birds; species with smaller body mass are especially vulnerable (Kennedy 1970, Hume 1986). Heavy winter rain may also wash insects from vegetation (Kennedy 1970), and on Cyprus, unusually high winter rainfall may cause high mortality of over-wintering stages of arthropods, reducing their availability in the following breeding season (Jones 2006). The now less wet winters may thus have improved the overwinter survival of resident breeders, and improved their arthropod food supply, both during the winter and in the following breeding season. Such changes might be expected to have most effect on smaller species, where winters are coldest and wettest and where the reduction in rainfall has been greatest, *ie* within the Troodos massif. The hotter and drier summers, and the increased frequency of droughts, may have been detrimental to breeding success, particularly for migrant species which tend to breed later in the spring (see below), and for those breeding in the hottest and driest part of the island, the Mesaoria plain (*eg* JME Took in COS 1974).

High temperatures and aridity often influence the southern breeding distribution limits of European bird species (Huntley *et al* 2007); this may be particularly so on Cyprus as it is the most arid of all the large Mediterranean islands and the only one with a semi-arid climate (Koundouri 2007).

Wetlands and water bodies

The aridity of the Cyprus climate means that there are no permanent natural wetlands or water bodies apart from a few perennial streams on Troodos. There are seasonal salt

lakes near Larnaca and on the Akrotiri peninsula; the latter occasionally holds water all year. There are also a few mainly small seasonal freshwater lakes and marshes, the most important of which is Famagusta freshwater lake; a larger semi-natural wetland complex which was historically important for breeding water birds and in years of adequate rainfall is still so (*eg* Whaley & Dawes 2005, Charalambidou & Gucel 2013, Birdlife Cyprus 2014). The absence of permanent natural wetlands and water bodies combined with periodic droughts means that until the construction of large numbers of modern dams/reservoirs it was unlikely that waterbirds bred regularly.

Three shallow reservoirs were built on the eastern Mesaoria *c*1900; of these the most important, Kouklia, has many historical and recent breeding waterbird records though in the past the reservoir has also at times been disused. The Mesaoria reservoirs were not a success and no more dams were built until the 1940s, when limited construction of small modern dams began (Christodoulou 1959). Dam construction has greatly increased in more recent decades: total reservoir water capacity (million m^3) increased from 6 in 1960, to 65 in 1981 to 327 in 2008, with the largest increase in the 1980s. Currently there are 51 small dams and 56 large dams (not including recent small dams in the north of the island); half of the small dams have been constructed since 1966 and half of the large dams since 1980. Cyprus now has the most large dams/unit area of any country in Europe (Water Development Department 2017). The construction of modern sewage farms/water treatment works, particularly at Nicosia, has provided year-round relatively disturbance-free habitat for water and wading birds.

These increases in artificial water bodies/wetlands were concurrent with and apparently largely responsible for the increasingly frequent and subsequently regular breeding of several waterbird species. With their changing water levels dam reservoirs can be unsuitable for breeding waterbirds, but this is often not so, *eg* of 15 modern dams (two large, 13 small) visited 1998–2002 in the north of the island, Little Grebe *Tachybaptus ruficollis* bred at 11 and probably bred at another three, Common Moorhen *Gallinula chloropus* and Eurasian Coot *Fulica atra* bred at ten each and Mallard *Anas platyrhynchos*, Black-winged Stilt *Himantopus himantopus* and Spur-winged Lapwing *Vanellus spinosus* at three each. The two large reservoirs, Kanli and Geunyeli, both had all six species breeding (Kuşkor 1999–2003).

Forest and scrub

The forests of Cyprus have a long history of serious degradation, clearance and decline, reaching their lowest point during the early–mid 20th century (Thirgood 1987). In 1949 forest covered 13.7% of the island (of which 0.8% was dense and 12.9% open forest); tall scrub covered a further 2.2% In 1959 designated forest covered 19.1% of the island's area but of this only *c*20% was fully stocked with trees, the remainder being sparsely wooded or was scrub (Christodoulou 1959). Since then the extent and quality of forest and scrub have greatly increased: in 2006 forest and tall scrub covered 32.2% of the island, of this 18.6% was forest (tree height >5 m, crown cover >10%) and 13.6% maquis (shrubs up to 5 m). A further 9.5% was garrigue (subshrubs: 0.5–0.8 m) (Hadjikyriakou 2005, Department of Forests 2006). In 2012 the total area of forest and scrub was the same (European Environment Agency 2017a).

There are two main reasons for these increases. Firstly, a long-term policy of reafforestation, mainly through replanting and the better protection of existing forests. The exclusion of free-range goats has been of particular importance in allowing natural regeneration to widely occur. This reafforestation has been mainly in the hills and mountains but to a lesser extent also on low ground. Prior to the British administration of

the island in 1878, the plains, their adjacent coastal areas and the towns and villages there, including Nicosia, had been largely treeless. But from then onwards, and especially during the last century, plantations/small forests were established at many places on low ground, *eg* at Athalassa and Government house (Nicosia), Salamis (near Famagusta) and Phassouri (near Akrotiri salt lake). The species involved were mainly *Eucalyptus*, *Pinus*, *Cupressus*, *Acacia* and *Tamarix*. During the latter half of the century, as a result of the Goat Exclusion Law and the Village Tree Planting Areas Law there was further extensive tree planting on low ground, in the form of small plantations, wind-breaks and groups of trees (Chapman 1952, Christodoulou 1959).

Secondly, the percentage of Cyprus's area utilised for agriculture has decreased, *eg* >63% in 1949 (based on aerial photos—Christodoulou 1959) but 48% in 2012 (based on satellite photos—European Environment Agency 2017a). This decrease continues, *eg* in the south and west of the island there was a 24% decrease in utilised agricultural area 2003–2010 (Eurostat 2012). Vineyards, which are almost entirely within the Troodos massif, declined from 414 km^2 in 1929 (Christodoulou 1959), to 288 km^2 in 1960, to 190 km^2 in 1999 (Panayides 2005) and to 66 km^2 in 2015 (Statistical Service 2017). This continuing agricultural abandonment and its associated rural depopulation have resulted in extensive regrowth of forest, woodland and scrub on the abandoned land (Thirgood 1987, Hadjikyriakou 2005). The increase in tree planting and in forest and scrub area and quality has probably benefited species like Northern Goshawk, Long-legged Buzzard *Buteo rufinus* and Long-eared Owl, and enabled the spread of the last to low ground. Such changes would also increase the habitat for species like Common Blackbird *Turdus merula*, Cetti's Warbler, Sardinian Warbler *Sylvia melanocephala*, Spanish Sparrow *Passer hispaniolensis* and European Greenfinch.

At the end of the 19th century the mountain forests were subject to extensive human disturbance (from unrestricted timber and fuel extraction, resin tapping, charcoal burning and goat grazing) but such disturbance greatly reduced as these activities were banned or strictly controlled (Christodoulou 1959, Thirgood 1987). This and the continuing rural depopulation are likely to have reduced disturbance and persecution of forest birds, especially the larger species.

Other environmental changes

Irrigable land increased from 8.8% to 26.6% of utilized agricultural land 1960–1999 (Panayides 2005) partly as a result of the Southern Conveyer Project, Phase 1 of which was completed in 1994 and which pipes water from the Troodos mountains to agricultural areas in the southeast. This and other recent schemes now irrigate *c*230 km^2 (Water Development Department 2017).

Agricultural intensification has resulted in many changes: pesticide use increased from 3.2 kg/ha in 1970 to 15.2 kg/ha in 1994 and fertilizer use increased from 335 kg/ha in 1960–1970 to 494 kg/ha in 1990–1999; fallows reduced from 33% of total agricultural land in 1960 to 3.2% in 1999. Other changes include enlarged field sizes, a cessation of terracing and the clearance of stone walls, trees and scrub from field margins (Panayides 2005, Hellicar 2006).

Large reductions in the numbers of domestic animals, notably donkeys and free-range goats, combined with legislation for the hygienic disposal of carcasses (Iezekiel *et al* 2004), both in the wild and at abattoirs, have severely reduced the carrion available for vultures and eagles.

Land used for urbanisation increased from 0.26% of Cyprus's area in 1949 (Christodoulou 1959) to 6.4% in 2012 and including industrial and commercial sites, mines, airports *etc* to

9% (European Environment Agency 2017a), resulting in the loss of some natural habitats, especially in coastal areas and the lower hills.

Hunting (shooting)

In the past this had a significant adverse impact on breeding birds (*eg* Waterer 1954, COS 1959, 1960, Magnin 1987) and especially on water/wading birds, in some cases resulting in breeding failure (*eg* Bourne *et al* 1964, COS 1972, Rayner 1982). Wilson (1954) mentions the increasing numbers of guns from the 1920s onwards, and their adverse impact. That many water/wading bird species now breed regularly suggests a now more benign hunting environment. The end of spring hunting, initially in 1991, but now continued by the EU Birds Directive and Republic of Cyprus legislation (BirdLife Cyprus 2017a) will be important in this—hunting is now not permitted during March–early August.

EXTINCTIONS

Cinereous Vulture *Aegypius monachus*

Non-breeding status: accidental visitor. *Breeding*: former resident; apparently at least 15 times less numerous than the also resident Eurasian Griffon Vulture *Gyps fulvus*. It was not common; one or two pairs nested in both mountain ranges prior to 1950 (Bucknill 1909/1910, Jourdain 1929a, Waterer 1954). Numbers had declined by the mid 1960s, from when there were only 12 records, all of single birds, until the last in 1982. It is possible that some of these later records refer to vagrants from Turkey rather than residents. One record since: a vagrant/accidental visitor remained 2002–2007. The very large reduction in the availability of carrion was probably the main cause of its extinction. Poisoning, persecution and disturbance, which have contributed to the decline in the local Eurasian Griffon Vulture population (Iezekiel *et al* 2004) were probably also factors.

Eastern Imperial Eagle *Aquila heliaca*

Non-breeding status: occasional visitor. *Breeding*: a former resident, with perhaps 12 pairs in 1958 but only one or two pairs by 1992 with the last presumed residents seen 1995. Four records since (2002, 2005, 2006) of presumed immigrants. The reasons for its extinction probably include some or all of those listed above for Cinereous Vulture. Elsewhere this species feeds mainly on medium sized mammals (Cramp & Simmons 1980), but hares *Lepus* are the only such mammals on Cyprus (Kryštufek & Vohralík 2001) so the Cyprus population may have relied to a greater extent on carrion and thus been vulnerable to the near loss of that food source and to poisoning.

Lesser Kestrel *Falco naumanni*

Non-breeding status: passage migrant in variable numbers, now less numerous than in the 1950s and 1960s. *Breeding*: a former summer visitor but with a poorly known history on the island. Lilford (1889) found it an 'exceedingly abundant' breeder and Bucknill (1909/10) described it as a 'very common' summer visitor, though much less numerous than the Common Kestrel *Falco tinnunculus*. Jourdain (1929a, b) saw a mating pair in Nicosia and found a large colony (including a few Common Kestrels) breeding in holes in Famagusta city walls; he described the species as breeding commonly in rocks and old buildings, in colonies and singly, in the plains and in the hills. The next, and final, mention of breeding is Waterer's (1954) general comment that the species is a 'common breeding summer visitor'; though it is not clear which years within his 1928–1950 residence he was referring to.

This species has undergone serious long-term declines in Europe, believed to be due to massive pesticide use, loss of nest sites, agricultural intensification, and persecution and disturbance at its urban colonies (*eg* Hagemeijer & Blair 1997, Orta & Kirwan 2018); most of these factors are present on Cyprus. Bannerman & Bannerman (1971) stated that on Cyprus 'Kestrels of any species have been relentlessly shot' and believed this may have been the reason for this species' extinction. The Common Kestrel *Falco tinnunculus* though remains common and widespread so perhaps other factors were more important. Declines in Syria have been linked to persecution (Baumgart *et al* 2003) and in Israel to excessive pesticide and rodenticide use (Shirihai 1996, Orta & Kirwan 2018). It formerly bred in Lebanon, and did so again in 2001, the first breeding for over 40 years (Ramadan-Jaradi *et al* 2008). On Cyprus 1–3 were present in summer 2015–2017 and of the former breeding species this seems the most likely to re-establish.

Black-bellied Sandgrouse *Pterocles orientalis*

Non-breeding status: a scarce/occasional winter visitor and possible passage migrant. *Breeding*: its history on the island is poorly known—formerly a common resident on the Mesaoria plain but by the 1970s–1980s it was scarce. Subsequently recorded in ten years 1992–2015: apart from one bird drinking at Akhna dam on six dates July-early October 2007, all records have been mid October–early May and usually January–April, singly or in flocks up to 50 and probably of winter visitors. It is possible that a few undetected breeders remain; if so they might be expected to visit reservoirs during the breeding season but the 2007 records above are the only such records so on balance the resident population is probably now extinct (see also Stylianou 2013). It remains possible that a few immigrants might attempt to breed in favourable years.

Within Europe the main threat to this species is intensification of agriculture, including loss of fallows and increased use of agrochemicals; agricultural abandonment and hunting are additional factors (Hagemeijer & Blair 1997, BirdLife International 2017); all these factors are present on Cyprus. Waterer (1954) gave the reason for its reducing numbers as shooting, which continues (*eg* BirdLife Cyprus 2017a, p94). Also, it feeds mostly on seeds and is associated with a wide variety of grasses and flowering plants, especially after rains (Cramp 1985), so the increased frequency of drought and severe drought years after 1970 may have been an additional factor in its decline; in severe drought years winter rainfall in its former breeding areas can be as low as *c*100 mm (Michaelides & Pashiardis 2008), below the 200–500 mm annual precipitation range for the species (Hagemeijer & Blair 1997).

White-throated Dipper *Cinclus cinclus*

Non-breeding status: there are no records of immigrants. *Breeding*: former resident along the few perennial streams in the higher Troodos mountains. First recorded 1887, there were a fair number of records 1907–1909, when it was described as 'tolerably common' by Horsbrugh who shot 'a nice series of adults and juveniles' (in Bucknill 1909/10); perhaps as a result of this it was subsequently listed as 'not common' (Bucknill 1910). Jourdain (1929a, 1930) described it as rare, with a few pairs only. The only definite later records are 1939 (DF Davidson *per* WRP Bourne pers comm) and 1945 (Flint & Stewart 1983, 1992). Waterer (1954) commented that it was present only in small numbers and not easy to see (sometime 1928–1950).

Possible reasons for the decline and extinction of the species include a period of adverse climatic conditions and shooting, or perhaps a combination of the two. In addition to the collection of museum specimens by Horsbrugh and Glaszner, Bucknill (1909/10) mentions that despite protection birds continued to be shot for food. Also, the 1907–1909 records

occurred at the end of a six year period during which rainfall averaged 115% of normal (Department of Meteorology 2018a) and thus they may have represented a peak in the population. The breeding records were from *c*1200–1300 m asl; the area of land above 1200 m asl is small with limited suitable habitat so this isolated population must always have been small and as such vulnerable to extinction from random variation or catastrophe (Shaffer 1981, Hagemeijer & Blair 1997). The Cyprus population was near the southern limit of the species' breeding range in Europe (Cramp 1988) where its density reduces and its distribution becomes patchy (Hagemeijer & Blair 1997) and high temperatures and aridity might be expected to limit its distribution (Huntley *et al* 2007).

Temperature and aridity increased on Cyprus during the 20th century and although these increases were most marked in the later decades there was an earlier and unprecedented arid period. On Troodos rainfall had shown a generally downward trend after 1920 (Rossel 2001) and during 1931/1932–1933/1934 there occurred three consecutive years of drought (two of them severe) during which rainfall there averaged only 62% of normal (Rossel 2001). This was the driest three year period during the 1901–2017 historical precipitation record (Department of Meteorology 2018a & b). The base flow of the Troodos streams is from springs fed by ground water (Water Development Department 2002); Mederer (2009) showed that on Troodos a 10% reduction in precipitation can reduce groundwater recharge by 30%; thus the 1931–1934 drought is likely to have caused a disproportionately severe reduction in stream flow. This may have reduced the already small population of White-throated Dipper to a level from which it was unable to recover. That Davidson considered a 1939 record of significance (above) suggests that the species was by then scarce. It is noteworthy that the years in which this species declined coincided with the 1915–1934 drought cluster period, one of only three such periods in the last 250 years (Griggs *et al* 2013). The lower aridity limit of the White-throated Dipper's breeding range is AET/PET ≥ 0.5 though it mainly breeds in moister areas where AET/PET = 1.0 (Huntley *et al* 2007). Average annual rainfall on Troodos has reduced 15–25% since *c*1970 (Rossel 2001) and AET/PET there (at Prodromos, 1380 m asl) is now at the species' lower limit of 0.5. Drought/severe drought years also now occur on average once every four years. In such years Troodos will be more arid, making the island now probably climatically unsuitable for the species. Its environment is also now further degraded by water extraction from the streams for irrigation and domestic use.

The taxonomic position of the now extinct Cyprus population of White-throated Dipper '*olympicus*' is uncertain but it had apparently not evolved distinct insular characters (*eg* Vaurie 1959, Roselaar in Cramp 1988, Roselaar 1995, Shirihai & Svensson 2018). Also, given the island's long history of periodic, severe and sometimes prolonged droughts, it is questionable how long this species had been breeding on the island and thus whether '*olympicus*' had any validity as an endemic taxon. In this respect it may be significant that the species was not encountered by Sibthorp (1787) during his visit to Troodos, nor was it mentioned to him by the islanders. A DNA analysis of specimens from Cyprus and southern Turkey might show whether or not there is any molecular phylogenetic difference between the two.

Dead Sea Sparrow *Passer moabiticus*

It colonised and then became extinct during the period covered by this review. Its population persisted probably 1976–1990, so more than ten years and thus eligible for inclusion here. *Non-breeding status*: vagrant. *Breeding*: the species, and a breeding colony, were discovered on the island (at Akrotiri salt lake reed beds) in 1980; with hindsight the colony had probably existed since 1976. Breeding was not proven in all years but is assumed

to have been continuous throughout the colony's existence. Maximum population was 20–30 pairs in 1985, spread over three sub-colonies along the northern shore of the lake. The population apparently declined quickly after that; the last record of probable breeding was of four singing males there late April, late May and early June 1990. Subsequently four birds were there late March 1991 and two there mid February 1994, which are the last records from the colony site. A pair also bred at Zakaki (nearby) in 1983. Breeders were apparently mainly dispersive or migratory. During the period of the colony's existence there were occasional records from elsewhere of presumed wanderers/vagrants; only two such records since, 2005 and 2006. These are the last confirmed records of this species from the island in the literature and in the knowledge of Colin Richardson (pers comm – Birdlife Cyprus Recorder at the time) and of Jane Stylianou (pers comm – current BirdLife Cyprus Recorder). Thus the unsourced statement 'small numbers considered still to breed on the island' (Summers-Smith 2018) appears to be unsupported. *NB*: A 1973 record attributed by Cramp & Perrins (1994) to Summers-Smith (1988) is not mentioned by the latter author. There is no 1973 record in the Cyprus literature nor in the BirdLife Cyprus database (Jane Stylianou pers comm); it appears to be erroneous, perhaps a transcription error.

During the main period of the Dead Sea Sparrow colony's existence, there were no drought or severe drought years and annual rainfall (1975/1976–1988/1989) averaged 100% of normal. The colony's extinction coincided with the onset of a cluster of drought years, only the third such in 250 years (Griggs *et al* 2013) with a drought in 1989/1990 (72% of normal rainfall) and a severe drought in 1990/1991 (56%). Given the species' pronounced attachment to open water (Cramp & Perrins 1994), the resulting drying of the area may have made the habitat unsuitable for breeding. Its population decline had apparently started before this though, so other factors may also have been involved, including disturbance from birdwatchers following the publicising of the colony's presence and location.

Additional species

The Greater Short-toed Lark greatly reduced in numbers during the last century and may be near extinction as a regularly breeding bird. The Marbled Duck apparently bred frequently in the past, though probably not regularly; it no longer breeds on the island. The history of these two species is described below.

Marbled Duck *Marmaronetta angustirostris*

Non-breeding status: occasional visitor. *Former breeding status*: poorly known; there are breeding records (of one to a few pairs) only from 1875, 1888, 1910 and 1914. Waterer (1954) described it as a sometimes fairly plentiful summer visitor and suspected it bred at Limassol (sometime 1928–1950); his 'sometimes' would accord with the dispersive and nomadic nature of the species (BirdLife International 2004). Also, the impermanent nature of the island's wetlands means it was unlikely to have bred regularly. Only five records of migrants/visitors since, the last in 2008. The species suffered marked declines and local extinctions in Europe and the east Mediterranean region during the 20th century; its extinction on Cyprus fits this pattern. The reason for its decline elsewhere was apparently mainly habitat loss/degradation and possibly hunting (BirdLife International 2004).

Greater Short-toed Lark *Calandrella brachydactyla*

Non-breeding status: a common passage migrant, most numerous in spring. *Breeding*: formerly a common migrant breeder on the Mesaoria, mainly in the east. Many were still breeding there in 1971, and fair numbers in 1972 but in the 1973 breeding season after a winter drought, although pairs were present in the same area, there was no sign

of breeding (JME Took in COS 1974). After the division of the island in 1974 coverage of the breeding areas was lacking or poor for many years. The species was not recorded in its former breeding areas 1998–2001 (Kuşkor 1999–2003). Possible breeding in the east/southeast by a few birds (max seven) was noted in eight years 1992–2013. There were no summer records 2014–2016 and breeding surveys on the eastern Mesaoria in 2015 did not locate it (BirdLife Cyprus 2017a). Since 2008 it has been listed as an Occasional rather than Regular breeder by BirdLife Cyprus. The plain is a large area and it is possible that a few pairs still breed undetected.

As implied above, reduced rainfall may have been a factor in its decline. In Europe it breeds where GDD5 > 2000 degree days and where there is moderate to severe seasonal moisture deficit with AET/PET < 0.8 (Huntley *et al* 2007), and in Israel it breeds where rainfall is as low as 100 mm (Shirihai 1996). On Cyprus in the southeast in normal years AET/PET is 0.19–0.20 and GDD5 is *c*5500 degree days. Average annual rainfall there is 300–350 mm (Department of Meteorology 2018b). These figures lie within the species' breeding parameters. However, the 1972–1973 drought was the most severe on record, with whole island average rainfall of 213 mm, only 42% of normal (Department of Meteorology 2018a). The plain in spring 1973 was 'like a desert, instead of its usual lush green, and without a blade of corn or grass' (JME Took in COS 1974); this may have caused the apparent breeding failure in that year. Droughts have increased in frequency since then. Agricultural intensification and high pesticide use caused a large reduction in numbers of breeders in Israel (Shirihai 1996); these factors are present on Cyprus also.

APPARENT COLONISATIONS

Of the 15 apparently colonising species, 12 appear to be genuine new colonists (Table 2), and three to be previously overlooked long-term breeders (Table 3).

Little Grebe *Tachybaptus ruficollis*

Non-breeding status: passage migrant and winter visitor in variable numbers. *Breeding*: bred in large numbers at Kouklia reservoir 1910. In the 1960s it was usually absent May–July but was present all year 1967 and bred at Kouklia 1969. After that it became an increasingly frequent breeder when water levels were favourable, and with the exception of 1986–1987, breeding has been confirmed every year since 1980. The numbers breeding and the number of sites used (maximum *c*30) vary greatly depending on water levels; breeding is usually at the reservoirs though some natural sites are also used. A presumed resident population has established though opportunist breeding by winter visitors/migrants almost certainly still occurs. *Population*: 50–150 pairs in 2008–2012. The now regular breeding appears to be due to the construction of large numbers of artificial permanent water bodies and perhaps to reduced persecution. With the possible exception of the next species, these reasons are probably responsible for the now regular breeding by the other waterbird species listed in this section.

Western Cattle Egret *Bubulcus ibis*

Non-breeding status: formerly a scarce migrant, mainly in spring, with 1–2 records/year in the 1970s, increasing to 2–6 records/year in the 1980s and becoming more frequent still in the 1990s and early 2000s, with birds occurring all year. *Breeding*: first confirmed 2004 (a colony of *c*12 pairs at Famagusta freshwater lake, Whaley & Dawes 2005). By 2014 this colony had increased in size to 320 nests and the species is now resident, with non-breeding season roosts of 400–600. Has also bred at Oroklini marsh since 2014 (*c*30 pairs). This species is much less dependent on wetlands and water bodies than the other waterbirds

listed here (Cramp & Simmons 1977). Its colonisation is probably mainly driven by its association with man and his grazing animals and by increased immigration resulting from its spread in Europe (Hagemeijer & Blair 1997, BirdLife International 2004) and the east Mediterranean region (Kirwan *et al* 2008, Shirihai 1996, Goodman & Meininger 1989, Isenmann *et al* 2016).

Mallard *Anas platyrhynchos*
Non-breeding status: common winter visitor and autumn passage migrant. *Breeding*: first confirmed 1970; during the 1970s and 1980s 1–3 pairs probably bred in all years when water levels were suitable. Breeding has been confirmed every year since 1993; at 1–5 sites/year until 2008, increasing to 19 sites in 2012 but at only 6 sites in 2014 and at only three in 2016, both years of low water levels. Usually 1–3 pairs breed at each site, exceptionally up to 6. Believed to be resident; the wide variation in the number of sites used per year suggests that opportunist breeding also occurs. *Population*: 30–100 pairs in 2005–2012. The numbers of winter visitors increased 200–1000% during 1980–2012 (BirdLife International 2015), perhaps attracted by the more numerous water bodies; this may have resulted in increased opportunist breeding at the winters' end. The species has colonised Israel since the 1950s (Shirihai 1996) and first bred in Lebanon in 2005 though attempted earlier (Ramadan-Jaradi *et al* 2008).

Northern Goshawk *Accipiter gentilis*
Non-breeding status: apparently a scarce passage migrant and very scarce winter visitor though the increasing numbers of residents tends to now obscure any immigration. *Breeding*: its history on the island is poorly known; possibly breeding in the Paphos forest 1979, when individuals were found on three occasions late May and early June (Flint 1981). One there April 1980, then no records until 1984 when three or four nests were found January–May, with 15 records of 12 birds May–early October (Rudolph 1990). After which no definite summer or breeding season records until 1992, then none again until 1998 since when birds have usually been recorded all year, sometimes with juveniles in summer and breeding confirmed 2004, 2005 (6+ nests), 2006 and 2013. Given the elusive and inconspicuous nature of this species (Cramp & Simmons 1980), the large size of the Paphos forest and the former difficulty of access, combined with the very small number of active observers in earlier decades, the species was probably breeding unrecorded throughout the 1980s and 1990s and possibly since 1979 or earlier. *Population*: 80–120 pairs in 2008–2012.

This species shows a strong preference for nesting in large, mature forests with a low degree of disturbance by humans, especially where bird killing is significant (Rutz *et al* 2006), as on Cyprus. Thus the recovery and increase in area of the Cyprus forests during the last century, accompanied by a reduction in disturbance and persecution there, may have created suitable breeding habitat which immigrants were able to exploit. Nevertheless, it remains possible that this is a long-overlooked scarce breeder, rather than a new colonist; on balance the latter seems more likely. The only record of a shot bird from Troodos is from August 1910; at that date possibly an immigrant. It was not reported from the Troodos/Paphos forests by DF Davidson (in Bannerman & Bannerman 1958) nor by Waterer (1954), both of whom were forest officers and thus likely to encounter it. In the burst of activity 1957–1958 after the founding of the COS there were 14 records, mainly from the hills and mountains, but all October–mid April. In 1975 Mason (1980) recorded it on Troodos only in late September. It is perhaps more likely that it was a former occasional breeder, or that it bred before the forests were degraded and disturbed and hunting became widespread.

Long-legged Buzzard *Buteo rufinus*
Non-breeding status: scarce winter visitor and passage migrant. *Breeding*: in winter 1991/92 a pair was found nest building in the southern Troodos mountain range and it was thought likely that the site had been used previously. Since 1992 the species has bred annually in the southwest; the population is increasing, spreading eastwards into Nicosia, Larnaca and Famagusta administrative districts and north into the Kyrenia mountain range, and is resident (Whaley & Dawes 2003, Kassinis 2009, BirdLife Cyprus 2003–2018a, Colin Richardson pers comm). *Population*: 80 pairs in 2017 (Nicos Kassinis *per* Colin Richardson pers comm).

Given the recent extinction of large raptors on Cyprus, it is unexpected that this medium-sized raptor should have now successfully colonised. A warming climate has been suggested as a possible reason for the species' northwestward range expansion in Europe (Mrlik & Landsfeld 2002) but it is not immediately obvious how such warming would cause this species to spread southward into Cyprus. On Cyprus the species requires mainly open habitats in its territories (Kassinis 2009, Iezekiel *et al* 2016) but agricultural area has decreased while forest and scrub area has increased so habitat change may not be an important factor in its colonisation. However rural depopulation and agricultural abandonment may have reduced disturbance and persecution and so aided colonisation (shooting has declined though it remains a problem, Kassinis 2009). The species was formerly a very scarce visitor to Cyprus (Stewart & Christensen 1971) but is apparently now less scarce, perhaps because its population in countries to the north and northwest of Cyprus has greatly increased since the 1980s–1990s (Lawicki *et al* 2013, Birdlife International 2015); such an increase in potential colonists may be one of the reasons for the rapid and successful colonisation. On Cyprus the species' high diet diversity and limited dependence on carrion (Kassinis 2009, Bakaloudis *et al* 2012) may make it less vulnerable to poisoning and better able to cope with fluctuations in dietary resources, compared with larger raptors.

Common Moorhen *Gallinula chloropus*
Non-breeding status: passage migrant and winter visitor in variable numbers. *Breeding*: formerly bred in years when water levels were suitable but scarce or absent in summer in non-breeding years; it now breeds regularly. Breeding first recorded 1910, confirmed in four years of the 1960s, four years of the 1970s, eight years of the 1980s, and every year since 1992. Probably 40–50 sites are used in favourable years, as few as ten in dry years; usually 1–3 pairs/site. Believed to be now resident; some opportunist breeding probably still occurs. *Population*: 50–150 pairs in 2006–2012.

Eurasian Coot *Fulica atra*
Non-breeding status: usually a common winter visitor and passage migrant. *Breeding*: first confirmed 1910 ('very large numbers', Bucknill 1911). Wilson (1954) who was on Cyprus 1903–1946, stated that it breeds in 'suitable seasons'. Not recorded as currently breeding by Bourne *et al* (1964). Subsequently bred 1967 and 1969, in three years in the 1970s, in eight years in both the 1980s and the 1990s and every year since 1998. The number of sites used/year varies greatly depending on water levels, with probably *c*25 in favourable years. Usually less than ten pairs/site, sometimes tens, up to 50. Believed to be resident though opportunist breeding by winter visitors probably also occurs. *Population*: 100–250 pairs in 2005–2012. The wintering population increased 300–800% during 1980–2012 (BirdLife International 2015) and this may have led to more opportunist breeding. Winter visitors probably originate mainly in the Ukraine and Russia (BTO 2018) where breeding

populations show a long-term decline (BirdLife International 2015), so the wintering increase on Cyprus is apparently related to the now numerous water bodies rather than to an increase in the source population.

Black-winged Stilt *Himantopus himantopus*
Non-breeding status: common spring passage migrant, scarce on autumn migration. Since 2009 regular overwintering has occurred, with 1–10 individuals at up to six sites, perhaps a reflection of the now milder winters. *Breeding*: in the past apparently an opportunist migrant breeder probably in all years with sufficient water levels, it now breeds regularly. There are historical breeding records from 1905, 1911–1914 and 1950. Baxendale (1915) stated that 'it now breeds regularly at Kouklia reservoir and the fresh water lake'. In recent times it was recorded breeding in most years 1969–1999 and in every year since. In the last century only one or two recorded breeding sites/year, but more recently 12–14 sites in favourable years, as few as four in dry years. Usually 1–20 pairs/site, occasionally up to 50–70. Although an opportunist breeder, the now regular breeding probably means that many individuals return in subsequent years. This species' exotic nature, colonial breeding and persistent noisy mobbing of intruders may explain why it has more historical breeding records than the other less conspicuous waterbirds listed here. *Population*: 50–200 pairs in 2008–2012.

Spur-winged Lapwing *Vanellus spinosus*
Non-breeding status: fairly common spring passage migrant, scarcer on autumn migration. *Breeding*: bred at the reservoirs in some years prior to 1910 when water levels were favourable. The first dated breeding record was at Kouklia reservoir in 1913. Wilson (in Bannerman & Bannerman 1958) stated that it bred at marshes and lakes round Famagusta in favourable years when they were not dried up (sometime 1903–1946). The second dated breeding record was in 1988; then with the exceptions of 1991, 1992 and 1997 (when birds were present in summer, but breeding was not confirmed) it has bred in every year since. The number of sites used/year has increased from one in 1988, to five in 1999, to 15 in 2009 but down to eight in the dry year of 2016. The number of pairs/site is usually 1–5, sometimes up to ten, once 24 (Nicosia sewage farm 2009, Charalambidou *et al* 2012). Breeding sites are sewage farms, marshes and lakes, reservoirs and farm slurry pits. Prior to this recent breeding it was occasional in winter but is now present all year and partly resident, perhaps because of the now milder winters and the safer over-wintering sites. *Population*: 61–68 pairs in 2009 (Charalambidou *et al* 2012).

Bourne *et al* (1964) stated that it 'bred intermittently in the past …. but is now usually shot'. This is clearly not the case now; probably because spring hunting is no longer permitted. Also important in this respect are the sewage farms/water treatment plants, which provide relatively disturbance-free breeding and roosting sites throughout the year. Since *c*2012 other sites such as Oroklini marsh/lake and Achna dam have become increasingly important (BirdLife Cyprus 2014, Alison McArthur pers comm). In Israel this species has greatly expanded its range and numbers since the 1970s due to increases in irrigation and artificial water bodies (Shirihai 1996). Its population has also increased remarkably in the Gaza strip since the 1990s (Al-Safadi 2006) and it has bred in Lebanon 2006 and probably earlier (Ramadan-Jaradi & Bara 2009). These increases may have resulted in more potential colonists reaching Cyprus.

Common Blackbird *Turdus merula*

Non-breeding status: winter visitor in variable numbers to wooded areas on high and low ground, usually common or fairly common though in some winters less so; some passage migrants also occur. *Breeding*: first recorded in the breeding season in 1979 in the forests of the higher Troodos; by the late 1980s song and territorial behaviour were noted there. Breeding (5–20 pairs) at 1400 m asl was confirmed in 1994 (Kourtellarides 1998); the population has since increased and spread and is now well established and resident. In summer, singing birds mainly above 700 m asl, though some down to 400 m asl. *Population*: 200–400 pairs in 2008–2013.

Its colonisation began shortly after the large reduction in winter rainfall on Troodos; this and the now milder winters there may be factors in its colonisation. There has been recent habitat change on Troodos but extensive apparently suitable habitat was present before it colonised (pers obs). It has been a usually common winter visitor for at least a century (*eg* Bucknill 1909/10, Jourdain 1930, Waterer 1954, Stewart & Christensen 1971); such birds are potential colonists, but all normally leave at the end of winter (there were no summer records prior to 1979). During the 1950s–1980s the species greatly increased its population in Israel, believed to be due to habitat change (Shirihai 1996), and since 1975 it has also colonised the Nile delta and northeastern Sinai (Goodman & Meininger 1989, BirdLife International 2018); these increases in nearby countries may have resulted in more east Mediterranean-breeding colonists reaching Cyprus. It may be of significance to its colonisation that this is a highly adaptive species (Hagemeijer & Blair 1997) with an exceptionally diverse habitat range (Cramp 1988).

Sardinian Warbler *Sylvia melanocephala*

Non-breeding status: common winter visitor and passage migrant. *Breeding*: first known to breed in 1992 when a population of at least 13 pairs was discovered on the Akamas peninsula in the west of the island; in 1995 at least 50 pairs were present in a now wider area. Breeding had probably occurred there since 1988 if not earlier (Flint & McArthur 2014). In 2001 a second population of *c*6000 pairs was discovered in the eastern part of the Kyrenia mountain range in the north of the island, this population had clearly existed undetected for many years. These two populations have increased, spread and merged (Flint & McArthur 2014). The species now breeds throughout most of the southwest, west and north of the island and is starting to occur in the southeast. It is believed to be resident or mainly so. The rate of population increase 1997–2011 in Paphos administrative district in the west of the island was 16.4%/year or 356%/decade (Pomeroy *et al* 2016). *Population*: 60 000–110 000 pairs in 2013 (Hellicar 2016a).

Cyprus breeders are nominate *melanocephala* (Flint & McArthur 2014), indicating that colonists are from the north, rather than from the east (the Levant), where race *momus* breeds (Aymí & Gargallo 2018). This species was formerly scarce or uncommon as a winter visitor/passage migrant (Bucknill 1909/10, Jourdain 1930) but by the late 1950s it was fairly common in most winters, perhaps because of its spread in southeastern Europe (Hagemeijer & Blair 1997); this may have increased the number of potential colonists reaching the island. Recent climate change on the island may be an important factor in its colonisation; its larger body mass, better tolerance of aridity and its more sedentary nature, compared with the Cyprus Warbler *Sylvia melanothorax*, may have aided its rapid increase (Flint & McArthur 2014). Like Common Blackbird, this is another generalist species with a wide habitat range (Aymí & Gargallo 2018).

European Greenfinch *Chloris chloris*
Non-breeding status: a common winter visitor and passage migrant. *Breeding*: 'probable' breeding at Paphos with no details (Jourdain 1930); none was found breeding there in 1958. Present all year Akrotiri 1962 and breeding confirmed there and at adjacent Phassouri in 1963. Its increase and spread after that was extremely rapid: by 1971–72 it was breeding in many areas on high and low ground, including Troodos and Nicosia. During 1997–2003 it was one of the most frequently encountered species in censuses, occurring in all surveyed habitats (Pomeroy 2004). Believed to be resident. *Population*: 40 000–120 000 pairs in 2013 (Hellicar 2016a).

This has been a common or abundant winter visitor for at least a century (*eg* Bucknill 1911, Waterer 1954) but prior to 1962 there were no records after early April. The extreme rapidity of its increase and spread makes multiple colonisation sites likely, suggesting island-wide and/or external causal factors. Its breeding distribution on the island is closely linked to habitats with large trees; increases in these habitats during the 20th century may have been partly responsible for its colonisation. The main climate changes on the island occurred after its colonisation began, though there had been some warming previously. It may be of significance that since the mid 20th century it has also greatly increased in Israel following the development of agricultural settlements there (Shirihai 1996), and that since 1985 it has also colonised the Nile delta (Goodman & Meininger 1989, Clement & de Juana 2018). Like Common Blackbird and Sardinian Warbler, this is another species with a wide habitat range (Clement & de Juana 2018).

Eurasian Hobby *Falco subbuteo*
Non-breeding status: common passage migrant. *Breeding*: its history on the island is poorly known. Four unsubstantiated historical records of possible breeding: 1913 (2), undated (2). In 1957 there were 20 summer records from all over the island though no reports of breeding; the species was subsequently described as a common summer visitor (Bourne *et al* 1964). During 1958–1970 there were no reports of breeding and no summer records. During the 1970s and 1990s there were summer records from the Kyrenia mountain range and its northern slopes with probable breeding 1997–1998 and the first confirmed breeding for the island in 1999 with possible breeding at four other sites (Flint 2000). During 2000–2004, pairs, nests, recently fledged young or family parties were present at eight sites there (pers obs). Breeding confirmed there again 2007 and 2013–2018 (Damla Beton, Fred Wake both pers comm). Also, long believed or suspected to breed in the south and west of the island (*eg* Stewart & Christensen 1971, Whaley & Dawes 2003) where now frequently and widely seen in summer and autumn with occasional family parties/juveniles and breeding proven 2014 (Smith *et al* 2016). *Population*: 5–70 pairs and increasing. An earlier estimate of 20–70 pairs (BirdLife International 2004) perhaps more accurately reflects the minimum population.

This is either an overlooked long-term breeder or a new colonist; a review of its historical records and status (Flint 2000) concluded that the former seems the more likely. Its often unobtrusive nature during summer, plus its late breeding season, with family parties mainly mid August–mid October (pers obs), may mean that breeders have sometimes been mistaken for autumn migrants in the past. There appears to have been a recent and perhaps large increase in the number of breeding pairs, perhaps due to continuing reafforestation/agricultural abandonment, and (as flying insects form the main part of its diet, BirdLife International 2015), to the many new water bodies providing an abundance of large dragonflies (Odonata) as food (Flint submitted ms).

Long-eared Owl *Asio otus*

Non-breeding status: scarce passage migrant and probable winter visitor. *Breeding*: probably bred in a plantation at Salamis (near Famagusta) 1963 and one or two pairs bred there 1968–1971 and present there 1973. Reported breeding in a plantation at Athalassa (near Nicosia) 1971 and it had probably bred there earlier. Subsequently recorded in the breeding season with increasing frequency with, from the 1980s, breeding records at *c*45 sites in the Troodos massif (up to *c*1350 m asl) and their adjacent coastal lowlands and on low ground in the centre and southeast of the island, including the suburbs of Nicosia. *Population*: 50–200 pairs in 2001–2013.

Prior to 1963 only six dated records 1878 (Lilford 1889), 1902 and 1903 (von Madarász 1904), 1912 (Cyprus Natural History Society 1913), 1957 and 1960, five of them November–January and one early May on the south coast, perhaps a migrant. The 1912 record involved seven birds on 6 December, this seems a high number for winter visitors and they were perhaps more likely residents. It was not encountered by Sibthorp (1787) but he was told that the 'great horned owl' is found in the mountains. As the Eurasian Eagle Owl *Bubo bubo* has not been recorded from the island, not even as a vagrant it seems likely that it was Long-eared Owl that was being referred to. The breeding of Long-eared Owl is easily overlooked (Cramp 1985) and may have been largely overlooked in Israel prior to the 1970s (Shirihai 1996). On Cyprus also it is probably a previously overlooked resident that has greatly increased in numbers and distribution, rather than a new colonist. During the 20th century reforestation in the hills and mountains and the establishment of plantations at many locations on low ground will have provided additional nesting and roosting habitat. The long term growth of the population in Turkey (Kirwan *et a*l 2008, BirdLife International 2015) may have resulted in more potential breeders visiting Cyprus.

Woodchat Shrike *Lanius senator*

Non-breeding status: a spring passage migrant in variable numbers, occasionally scarce but more usually fairly common; scarce on autumn migration. *Breeding*: believed to have bred *c*1901–1903 (von Madarász 1904). In 1965 there was an early July record from where it was later found breeding, in 1980. Present in summer at ten sites in the southwest and west 1979–1990 and breeding proven at two in 1980 and at another in 1988. Recorded breeding with increasing regularity in the 1990s. In 1995 the first expedition to the Akamas peninsula found up to five pairs breeding (Stagg 1996) and in 2000, 20 breeding pairs were there, with two other pairs elsewhere (Dawes & Whaley 2001). There has been an apparent decline since, with no summer records in 2006 and 2010, and in other years usually present at only one to four sites, though at six sites in 2015. Now listed as an opportunist, occasional breeder (BirdLife Cyprus 2018a). A few pairs would be easy to miss in the west of the island; it is probably just about hanging on as a regularly breeding summer visitor. *Population*: 25–50 pairs during 2001–2012.

Its discovery on the Akamas and adjacent areas coincided with the commencement of regular observations there. Suitable breeding habitat (Yosef & International Shrike Working Group 2018) on the island is decreasing. In Europe it has suffered range contractions towards the southwest and southeast and decreases in numbers in most countries, mainly due to habitat loss/degradation (Yosef & International Shrike Working Group 2018); a range reduction has occurred in Lebanon also (Ramadan-Jaradi & Ramadan-Jaradi 1999). So on balance it seems more likely to be an overlooked long-term scarce breeder on Cyprus rather than a new colonist though this is a fine judgement. Reduced rainfall may be a factor in its apparent decline; Huntley *et al* (2007) give no minimum aridity (AET/PET) limit for the species' breeding in Europe but in Israel it mostly breeds where annual rainfall is >400

mm (Shirihai 1996). At Polis, adjacent to the Akamas, average annual rainfall has declined from 474 mm to 394 mm (Department of Meteorology 2018b) but is below that in the now frequent drought years, *eg* only 258 mm in 2004/2005 (Department of Meteorology *per* Derek Pomeroy).

Additional species

The following eight species bred with increasing frequency during 2007–2016 and may be colonising. The Little Tern *Sternula albifrons* also appears to be colonising but as a seabird is not included in this review.

Black-crowned Night Heron *Nycticorax nycticorax*

Passage migrant, a few non-breeders over-summer. Occasional breeder since 1982. During 2007–2016 it bred in 2010–2011 and 2014–2016. Breeding since 2010 (by 2–4 pairs) has been mainly within the Cattle Egret colony at Famagusta freshwater lake.

Squacco Heron *Ardeola ralloides*

Passage migrant; non-breeders over-summer. Bred (2–4 pairs/year) 2004, 2006–2012 and 2014–2016 within the Cattle Egret colony at Famagusta freshwater lake (*eg* Whaley & Dawes 2005, Miltiadou 2011, Charalambidou & Gucel 2013). When breeding the species typically forms small nuclei in mixed-species colonies of other herons (Martínez-Vilalta *et al* 2018), so it is likely that the presence of the recently established Cattle Egret colony has encouraged it to breed.

Little Egret *Egretta garzetta*

Passage migrant; present in all months. Occasional breeder since 1981. During 2007–2016 it bred in nine years: 2007–2008 and 2010–2016 (possibly in 2006 and 2009 also). Breeding has been mainly within the Cattle Egret colony at the freshwater lake but also at four other sites, one to eight pairs breed/year. Some birds are now possibly resident.

Glossy Ibis *Plegadis falcinellus*

Passage migrant. First bred 2010 then every year since to 2016. Breeding (by 3–20 pairs/year) has been within the Cattle Egret colony at the freshwater lake (*eg* Miltiadou 2011). Glossy Ibis breeds colonially, almost always alongside other waterbirds such as herons and storks (Matheu *et al* 2018) so it is likely that the presence of the recently established Cattle Egret colony has encouraged it to breed.

Red-crested Pochard *Netta rufina*

Winter visitor. Bred 2009–2013 and 2015. Breeding, by 1–3 pairs/year, has been at Oroklini marsh and Kouklia reservoir.

Ferruginous Duck *Aythya nyroca*

Passage migrant and winter visitor, now regular in summer. Bred 2005–2007, 2009–2012 and 2015–2016. Breeding, by 2–6 pairs/year, has been mainly at Phassouri reed beds and Zakaki marsh, but also at three, probably four, reservoirs up to 70 km distant from those sites.

Laughing Dove *Spilopelia senegalensis*

At least five records of apparent immigrants: 1968, 2008 and 2011–2013, four of them late September–mid October. In 2011 up to six birds were in the southeast, in the Ayia Napa

area, April–August; since then it has spread rapidly and in 2017 was recorded at 21 sites, mainly in the south of the island. Usually 1–4 birds/site, though occasional flocks of 10–30. Breeding has been confirmed (*eg* Stylianou & Pentecost 2013); birds are present all year and believed to be resident. Some breeders may originate from releases/escapes (Hellicar 2016b), others from immigration: the initial breeding records were concomitant with records of immigration, though the presence of the local population now obscures any continuing immigration. The Laughing Dove's population in Turkey is large and increased 2000–2012 (BirdLife International 2015); it is the probable source of immigrants to Cyprus. The species was found breeding in Lebanon *c*55–60 years ago; it is now abundant in Beirut and is increasing in other coastal cities and towns (Ramadan-Jaradi *et al* 2008).

Grey Wagtail *Motacilla cinerea*
Winter visitor and passage migrant. Present all year 1968 in the higher Troodos, probably bred there 1969, 1987, 1999, 2010–2012 and 2016 and breeding confirmed 2013–2015. It is possible that breeding may have been overlooked in some apparently non-breeding recent years prior to 2010. This species is not mentioned by earlier authors who collected in summer along the Troodos streams in the late 18th and early 19th centuries and was not found breeding during extensive searches for Dippers along those streams in 1957–1958 and 1970 (Flint & Stewart 1983, 1992, pers obs) so its breeding does appear to be recent. Even so, it remains possible that it was a long-term scarce, perhaps occasional or opportunist breeder. Probably resident. Population: *c*12 pairs in 2018 and apparently increasing (Colin Richardson pers comm). Given the restricted habitat and the species' seasonal moisture deficit limitations (Huntley *et al* 2007) the maximum possible population size is likely to be very small.

PRE-EXISTING BREEDING SPECIES WHICH HAVE UNDERGONE LARGE AND LONG-TERM INCREASES

Eurasian Collared Dove *Streptopelia decaocto*
Non-breeding status: six records of presumed migrants at eastern capes 1972–1992. *Breeding*: the first reliable record of presumed residents is that of Lilford (1889) who saw one or two in Larnaca. Bucknill (1909/10, 1913) found it not uncommon in the Turkish quarter of Nicosia and stated that it also occurred in other towns. Belcher (1929) who was present 1928–1930, stated that small numbers bred in the towns. Ferrier (1936) saw it in Nicosia in 1933 and Waterer (1954) described it a fairly common breeder there (sometime 1928–1950). By the 1950s it had become scarce: in 1954 Bannerman & Bannerman (1958) found it only on the outskirts of Nicosia, and in 1956 could not find it anywhere and feared that it had been exterminated by shooting. A few birds were still present though, with five records of 1–4 birds 1956–1963 from Nicosia, Limassol and Akrotiri. In 1970 five or six pairs were found on the southwest outskirts of Nicosia, with four other birds by the Turkish quarter; the observers, SJ Christensen and JME Took (in COS 1971), were then living and working in the city so may have located birds missed by visitors. These records from 1970 suggest that a remnant of the former population had survived, though they may represent the beginning of a new colonisation. During the remainder of the 1970s and in the 1980s, numbers and distribution slowly increased so that by 1992 it was fairly common in Nicosia, Athalassa (near Nicosia) and parts of Limassol, and was recorded from many other towns and villages. Since then it has continued to increase and spread, mainly in urban areas but some now also in rural areas and at higher altitudes (*eg* Walsh & Pomeroy 2012). *Population*: 8000–15 000 pairs in 2013 (Hellicar 2016a); probably many more by 2018 (Colin Richardson pers comm).

The earlier population was described by Bucknill (1909/10) as almost semi-feral and by Belcher (1929) as semi-domesticated, suggesting that they were escaped/released cage birds. This would be expected for such an isolated population of this species in this region (Kasparek 1998). While a few birds apparently survived from this earlier population the increase and spread since the 1970s seems likely to have been the result of immigration, probably of dispersing young birds (Baptista *et al* 2018) from Turkey. Until 1950 the species' distribution there was mainly in the Aegean/Marmara region, but during 1966–1980 substantial numbers began breeding in the region of southern Turkey directly north of Cyprus, with more there in subsequent years (Kasparek 1998), coinciding with the initial increases and spread on Cyprus. If immigration was the origin of the present population, then the species might be considered a new colonist. Walsh & Pomeroy (2012) imply that the earlier records (prior to 1956) may have been of Barbary Doves *S. 'risoria'*, rather than Eurasian Collared Doves. Those responsible for the earlier records mostly appear to have been experienced and careful observers; it seems unlikely that they all made the same misidentification. The pattern of records from Nicosia (above) also suggests that the earlier and later populations there were of the same species. It is interesting to note that in Lebanon the species was considered extinct but has re-colonised and is expanding rapidly (Ramadan-Jaradi *et al* 2008); a pattern remarkably similar to that on Cyprus.

Zitting Cisticola (Fan-tailed Warbler) *Cisticola juncidis*

Non-breeding status: apart from apparent returning local breeders (below) there are no records of immigration. *Breeding*: in the 1870s–1880s it was common only in cereals or herbage bordering marshes (Guillemard 1888, Lilford 1889), though by 1909 it was fairly common in Paphos district with a few near Nicosia (Bucknill 1909/10) and was described as 'not rare' (Bucknill 1910). Jourdain (1930) described it as "resident on the plains but local, breeds regularly at Famagusta and Morphou". It was not mentioned by Riddell (1927); only one was recorded by Ferrier (1936) and only a few in herbage near wetlands by McNeile (1948–1955). Wilson (1954) mentions it only in reeds and rushes bordering marshes and in 1954 Bannerman & Bannerman (1958) saw in only near wetlands. These marshes and wetlands were adjacent to coasts but by 1958–1959 the species was common inland on the plains wherever long/lush vegetation or standing corn were present (COS 1959, 1960, Ashton-Johnson 1961). Since then it has increased and spread and is now common in cereals or herbage on low ground and the lower hills (usually up to *c*400 m asl) throughout the island, even occurring in patches of weedy waste ground in towns. It disperses widely after breeding; 'apparent immigration' (Horner & Hubbard 1982) probably refers to returning local breeders, suggesting that some very limited partial migration occurs in this otherwise resident species. *Population*: 40 000–120 000 pairs in 2006–2012 and increasing.

In Greece this species shows strong annual fluctuations in numbers and range depending on winter severity (Handrianos & Akriotis 1997); this is apparently also the case in Turkey (Kirwan *et al* 2008). For Cyprus the population data is not sufficiently detailed to make such a link for annual fluctuations, but the species' long-term increase in numbers and distribution has coincided with increasing winter mean temperatures, especially higher minimum temperatures, and after 1970 with many fewer winters of high precipitation. The species' grass/herbage habitat, with little shelter, and its small body mass seem likely to make it especially vulnerable to a combination of cold and prolonged heavy rainfall. In this respect it may be significant that the earlier records were almost entirely from coastal areas, where winters are milder. The species rapidly colonised Crete since 1967 (Handrinos & Akriotis 1997) and Malta since 1973 (Sultana *et al* 2011) and has recently increased in Lebanon (Ramadan-Jaradi *et al* 2008); it may be an earlier colonist on Cyprus.

Cetti's Warbler *Cettia cetti*

Non-breeding status: there are no records of immigration (but see below). *Breeding*: common and widespread resident, formerly scarce and local. Six earlier records, 1875–1911 (Lilford 1889, Natural History Museum, Tring, Bucknill 1911). Lilford (*op cit*) heard it only once during his visit and it was not encountered by Bucknill (1909) or Jourdain (1929b). Neither was it mentioned by Riddell (1927), Ferrier (1936) and McNeile (1948–1955) and it was only recorded once by Bannerman & Bannerman (1958). In 1957–1958 it was present on the north side of Akrotiri salt lake (Phassouri) and at cape Andreas, and was also found in many of the deep river valleys of the southern Troodos foothills, moving to lower ground in winter (COS 1958, Ashton-Johnson 1961, Bourne *et al* 1964). In May–June 1979, 62 singing males were counted in the southwest mainly below 600 m asl (Flint 1981); by contrast, none was detected there during 120 point counts in May 1986 (Massa & Catalisano 1987). By 1992 it had extended its distribution to *eg* Kyrenia and Nicosia, was more numerous within its existing range in the southwest and also occurred in drier and atypical habitats. During 1997–2003 it was found at 34 out of 40 census sites in the southwest and its population was increasing at 12% a year (Pomeroy 2004). It now occurs throughout most of the island, including the two mountain ranges (to 1400 m asl on Troodos), the Karpas peninsula, the east and the southeast, some also in urban areas and it has continued to spread to drier habitats. None was detected in spring 1968 in the southeast in a major study of immigration (Horner & Hubbard 1982) nor in 1969–1972 during extensive ringing of spring/autumn migrants at Akrotiri on the south coast (pers obs), suggesting that the breeding population is resident with no detectable partial migration. *Population*: 25 000–90 000 pairs in 2013 and increasing. There are no population estimates from before the species began to increase, but I would estimate the population in 1970 to have been 100–300 pairs with the majority at cape Andreas (pers obs).

The Cetti's Warbler population is vulnerable to severe winter weather (Hagemeijer & Blair 1997) so in the past its numbers and distribution on Cyprus may have been limited by the formerly colder and wetter winters which may also have been responsible for the apparent fluctuations in its numbers and distribution. In this respect it may be significant that during 1970–1972, although some were in the hills, it was most numerous year round on or near peninsulas at Akamas, Akrotiri and cape Andreas which because of maritime influences have warmer winters than inland (Department of Meteorology 2018a). In southern Turkey breeding Cetti's Warblers in the central Taurus mountains move in autumn/winter to coastal areas of the west and south and across the southern Aegean (Clement 2018a); this population breeds directly north of and close to Cyprus so immigration into the island seems likely. Given the current knowledge of the earlier climate, it seems improbable that the formerly isolated population at cape Andreas was a remnant of a once island-wide population but instead that it represented a recent and separate colonisation event, probably of immigrants from Turkey. This population was also unusual in occupying an atypically dry habitat of tall, dense juniper scrub.

Spanish Sparrow *Passer hispaniolensis*

Non-breeding status: common passage migrant and winter visitor. *Breeding*: locally common resident, formerly scarce. In April–May 1875, Lilford (1889) "did not meet with it in any of the likely looking places that I visited"; these included areas northeast of Famagusta, where it was later found breeding. Bucknill (1910, 1913) considered it 'probably resident'. Jourdain (1929b, 1930) listed it as a not uncommon resident northeast of Famagusta and on the Karpas. McNeile (1948–1955), during extensive studies of the breeding birds did not encounter it anywhere, including northeast of Famagusta and both mountain ranges. In

1957–1959 many colonies were found on the Karpas, with others at Salamis/Famagusta, but it was only found further west in winter (COS 1958–60, Ashton-Johnson 1961). By 1967 a large colony was on the plain at Kouklia and by 1970 it was breeding at Kormakiti in the northwest, in the higher Troodos and the Paphos forest. It continued to increase and spread in the following decades and during 1997–2003 was increasing at 31%/year in the southwest (Pomeroy 2004). *Population*: 150 000–400 000 pairs in 2013 (Hellicar 2016a).

There are not sufficient earlier records to determine whether this species was a new colonist, after 1875, or whether it was formerly present but very scarce; in either case it has undergone a remarkable increase. Possibly reasons for this are; firstly, the extensive tree planting on low ground and reafforestation have provided many new sites for colonies, which typically occupy large mature trees. Secondly, the numbers of immigrants appear to have greatly increased. Migrant flocks were not encountered by Lilford (1889) and migration was not mentioned by other early authors (*eg* Guillemard 1888, 1889, Bucknill 1910, 1911, Jourdain 1929b, 1930, Ferrier 1936); but in the late 1950s and early 1960s migrant flocks numbered tens or hundreds of birds and by the late 1960s flocks of 1000s occurred. This increase, which may have been due to the spread of the species in Bulgaria, Romania and Moldavia in the 1950s–1960s (Cramp & Perrins 1994), may have accelerated the species' spread on Cyprus by providing more potential colonists.

European Serin *Serinus serinus*

This species has been described as a colonist to Cyprus (Hagemeijer & Blair 1997) by 1875 (Mayr 1926 modified by Newton 1978) or by 1800 (Olsson 1969 modified by Burton 1995). In either case, long before the period covered by this review, though the historical literature for the island does not mention or imply any colonisation. The species has been present in the breeding season in its formerly main breeding area, Troodos, since at least 1888 (*eg* Lilford 1889, von Madarász 1904). It was 'in some abundance' there in late May–early June 1909 (Bucknill 1909/10) so has apparently been a common breeding species for a long time, at least on Troodos. Burton (1995) believed that its eastward spread to the east Mediterranean region was due to an earlier amelioration of the climate. Since the 1980s it has also spread southwards to Lebanon, Syria, Jordan, Israel and perhaps the Nile delta (*eg* Murdoch & Betton 2008, Clement 2018b); in Israel its colonisation is believed to be due to habitat change (Shirihai 1996). It also greatly expanded its European range northwards during the last century; contemporaneously with which it expanded its habitat range (*eg* Burton 1995). A similar pattern is shown on Cyprus: since the 1960s it has had a limited and patchy spread from its open pine forest/woodland habitats within the Troodos massif, mainly to adjacent low ground and initially to cypress windbreaks bordering citrus groves but later also to plantations, parks, villages and gardens. Currently (spring 2018) numbers of singing males within the western Troodos massif are greatly reduced, with those present exclusively near water; this reduction may be due to the greatly reduced rainfall there, with some usually flowing seasonal water courses dry (Alison McArthur pers comm). Two recent severe drought years 2013/2014 and 2015/2016 followed by two years of near drought (Department of Meteorology 2018b) may be significant in this.

DISCUSSION

Mediterranean islands have had at least 10 000 years of human occupation (Blondel & Aronson 1999) and habitat modification (Naveh & Vernet 1991); nevertheless, they conform quite closely to the species/area rule (MacArthur & Wilson 1967): an increase in island area of *c*13 times equating to a doubling of the regularly breeding land bird species total (Flint & Stewart 1983, 1992, Iapichino & Massa 1989). Species/area graphs show theoretical

equilibrium totals for Cyprus of *c*71 species (measured from Iapichino & Massa 1989) and *c*81 species (measured from Flint & Stewart 1992); the actual total in 1992 of 74 species (including Hobby and Woodchat Shrike) fell within this range. The increase in the total since then is probably due to an increase in the equilibrium total following the recent environmental changes, rather than to variance around the previous mean. Flint & Stewart (1983, 1992) and Iapichino & Massa (1989) mentioned that for its area Cyprus then had an impoverished avifauna in comparison with west/central Mediterranean islands; they suggested that this may have been due to its eastern location and consequent semi-arid climate and poor habitat diversity (if this was so then the recent colonisations following the construction of reservoirs have gone some way to redress this). The high level of avian endemism on Cyprus (Stattersfield *et al* 1998) with now three endemic species (Gill & Donsker 2018) and a potential fourth (Pentzold *et al* 2013, 2016, Tritsch *et al* 2018, OSME 2018), plus two endemic subspecies, suggests that any anthropogenic changes in previous millennia may not have resulted in major changes to the species composition of natural habitats, at least regarding smaller species.

Of the six extinctions, those of the three birds of prey and the sandgrouse appear to be anthropogenic. Those of the dipper and sparrow perhaps mainly to prolonged drought, though anthropogenic factors may also be important.

Of the 15 apparent colonists (Tables 2, 3) seven are water/wading birds of which six species often bred in the past when water levels were suitable. Their now regular breeding appears to be mainly due to the creation of many new artificial water bodies, though the cessation of spring hunting is probably also important. The colonisation by the Cattle Egret appears not to be related to the presence of artificial water bodies, though is probably also anthropogenic. Of these seven waterbirds, six are resident or mainly so and one a migrant.

The remaining eight species include three, Eurasian Hobby, Long-eared Owl and Woodchat Shrike, which appear to be previously overlooked long-term breeders. The hobby and shrike are trans-Saharan migrants, the owl is resident. The other five species (Northern Goshawk, Long-legged Buzzard, Common Blackbird, Sardinian Warbler and European Greenfinch) appear to be genuine new colonists. All are believed to be resident or mainly so and before colonising were migrants/winter visitors from further north. The reasons for their colonisations are less obvious than with the water/wading birds, but the long-term increases in the quality and area of forest and scrub and in the number of mature trees, and the now more benign winters, are probably the main reasons. For the two raptors, reduced disturbance and persecution are probably also important.

The eight species which may be colonising include six mainly migratory water/wading birds. The reasons for their breeding are probably generally similar to those for the water/wading bird colonists; though for the wading birds the presence of the Cattle Egret colony also appears to be important. The breeding by the resident Laughing Dove appears to be due to escapes/releases and to immigration from the expanding Turkish population; the reasons for the breeding by the also resident Grey Wagtail are less obvious. Of these eight species, probably only Laughing Dove would seem to have the potential to establish a large, secure and permanently viable population on the island.

The four pre-existing breeding species which have undergone large, long-term increases in numbers and distribution, Eurasian Collared Dove, Zitting Cisticola, Cetti's Warbler and Spanish Sparrow, are all resident or apparently so. The increase by the dove appears to be due to immigration from the expanding Turkish population, that by the cisticola and warbler probably mainly to climate change, and that by the sparrow probably to immigration and habitat change.

Two things stand out from this: firstly that a high proportion (10 of 12) of the genuine new colonists and all four of the species which have undergone very large increases, are

resident or mainly so (including all nine of those species with minimum populations ≥100 pairs); and secondly that the colonisations and increases appear to be largely anthropogenic. The latter will be especially so if the warming and drying of the island's climate since the mid 20th century is anthropogenic, as it is extremely likely to be (Lelieveld *et al* 2012, IPCC 2014). Elsewhere in Europe recent population changes also appear to be favouring resident bird species rather than migrants (*eg* Sanderson *et al* 2006, Heldbjerg & Fox 2008).

If the rapid increases shown by Zitting Cisticola, Cetti's and Sardinian Warblers, Spanish Sparrow and European Greenfinch are typical for the island, it would imply a regular and rapid turnover of species (if the total is to remain in approximate equilibrium). However, in the earlier systematic lists and avifaunas (Lilford 1889, Bucknill 1909/10, 1913, Jourdain 1929a, 1930, Bannerman & Bannerman 1958, Bourne *et al* 1964) there is no recorded similar rapid increase and spread by any songbird prior to these recent increases, which have coincided with the recent environmental changes.

Prior to the colonisations in Table 2 there were 45 resident and 28 migratory breeding species (calculated from Stewart & Christensen 1971, Flint & Stewart 1983, 1992 and Table 3); if this ratio were maintained then the 12 new colonists might be expected to contain seven or eight resident species, rather than ten. The changing climate and the high rate of residency among the colonists/increasing species are probably interconnected. The residents are already known to breed earlier than migrants *eg* the first recorded clutches for the resident Crested Lark *Galerida cristata* and Calandra Lark *Melanocorypha calandra* are mid March and early April respectively, compared with the migratory Greater Short-toed Lark's mid April; for the mainly resident Spectacled Warbler *Sylvia conspicillata* early March (but nestlings also then) compared with mid April and early May respectively for the migratory Reed Warbler *Acrocephalus scirpaceus* and Eastern Olivaceous Warbler *Iduna pallida*, and for the resident Corn Bunting *Emberiza calandra* late March compared with mid April and early May respectively for the migratory Cretzschmar's Bunting *Emberiza caesia* and Black-headed Bunting *Emberiza melanocephala* (Flint & Stewart 1992).

In addition to breeding earlier than migrants and benefiting from the more benign winters, residents (being already present on the island) might also be expected to more easily advance their breeding seasons to keep in synchrony with the warmer springs and their presumed earlier arthropod food supply, compared with migrants. The latter by contrast, unless they advanced their spring migration timing, would find their breeding season increasingly out of synchrony with the earlier springs on the island—the phenology mismatch hypothesis (Jones & Cresswell 2010). Birds breeding in highly seasonal habitats are expected to be exceptionally vulnerable to phenology mismatch (Pearce-Higgins & Green 2014). On Cyprus during the spring breeding season, habitats are highly seasonal in the rapidity with which temperature and aridity increase, in the rapidity with which the green herbage of winter and early spring vanishes in the rapidly increasing heat of May, and in the marked increase and decline of arthropod abundance and biomass (Jones 2006). Peak biomass varies in magnitude and date (Jones 2006), apparently dependent on climatic conditions (Flint & McArthur 2014).

Breeding phenology is best monitored by mean first egg laying date (*eg* Weidinger & Král 2007) but no such long-term data exists for Cyprus breeders. Mean first arrival dates for migrant breeders can be calculated; as far as I am aware, the phenology of only one species, the Cyprus Wheatear *Oenanthe cypriaca* (conspicuous and easily detected), has been examined for such an advance in its arrival in spring. During 1970–2009 the first migrants occurred late February–mid March (excluding a few January–mid February possible overwintering birds), with a constant mean first arrival date/decade of 5 March despite increasing observer coverage (Flint 2011). Its similar mean first arrival date 2010–2018 is 6 March. There has been no obvious change in the longer term either: Bucknill

(1909/10) giving 23 February as his earliest record and Bourne *et al* (1964) giving first arrivals as early March. Encounter rates for this species during the breeding season in five areas of natural habitat in the west of the island declined by >50% 2011-2018 with a perceived decline in villages also (Alison McArthur pers comm) and there has been a non-significant *c*38% decline in farmland and forest 2006–2015 (Hellicar 2016a) although there is no evidence of a causal link.

In addition to the natural hazards of migration (Newton 2008), birds migrating from Cyprus into northeast and east Africa face extensive trapping and hunting along the route (*eg* Olivier 2000, BirdLife International 2006, Contesso 2009, Weiz 2013, Elhalawani 2016, MBCC 2017). On their breeding grounds migrant species might also be faced with increased competition from the greatly increased numbers of resident individuals, and with increased predation from reptiles, which can be expected to be more active later in the breeding season as temperatures rise. An example of apparently increased competition is shown by the apparent negative impact of the colonist and resident Sardinian Warbler on the abundance and distribution of the partly migratory Cyprus Warbler (Flint & McArthur 2014, Pomeroy *et al* 2016); the former also starts breeding 1–3 weeks earlier, has more second broods and higher productivity (Jones 2006).

Recent short-term changes in abundance are outside the scope of this review, but it is noteworthy that they also show residents increasing more than migrants. Of 40 common breeding species monitored 2006–2015, the seven showing strong increases (>5%/year) were all resident as were six of the eight showing moderate increases (≤5%/year); the three species showing declines were all migrants (Hellicar 2016a). In that survey the 13 resident species which have increased include ten small passerines (Eurasian Wren *Troglodytes troglodytes*–House Sparrow *Passer domesticus* in size) which might be expected to benefit most from the less cold and less wet winters. Also, the four species in the survey which are confined to the Troodos massif, or mainly so—Eurasian Wren, Cyprus Coal Tit *Periparus cypriotes*, Eurasian Jay *Garrulus glandarius* and European Serin—all show increases; in addition to milder winters, this higher ground has experienced the greatest reduction in winter rainfall.

Climate change may be the main factor in changing the wider distribution of species (*eg* Burton 1995, Huntley *et al* 2007). The link may be difficult to prove in any particular case, since other factors may also be involved (Pearce-Higgins & Green 2014) as they clearly are on Cyprus. Even so, this review suggests that climate change appears to be a causal factor in at least eight of the extinctions, colonisations and increases described here.

Species may be absent as regular breeders from an island because they never reach it, which was clearly not the case in the past with the species discussed here (except for Laughing Dove), or because conditions on the island (*eg* competition from species already present, unsuitable habitat/climate) prevent them from establishing viable populations, even though they may repeatedly attempt to colonise (MacArthur & Wilson 1967). The latter was clearly so with the waterbirds which have now colonised, and may have been so with the European Greenfinch, Sardinian Warbler and Common Blackbird, which were common winter visitors and passage migrants for many decades before they colonised; the first two at least may have occasionally bred or attempted to breed before they colonised. It may be significant that all three are generalists with wide habitat ranges; this may have enabled them to more easily establish within the insular environment, compared with species with more specialised habitat requirements. European Greenfinch and Sardinian Warbler also appear to have colonised at several locations on the island, suggesting that their colonisations were not random, chance events but were responses to some island-wide or regional factor/s. Also, six of the colonists (Cattle Egret, Mallard, Long-legged Buzzard, Spur-winged Lapwing, Common Blackbird and European Greenfinch) and four of the

other species mentioned here (Laughing Dove, Eurasian Collared Dove, Zitting Cisticola, and European Serin) have increased in nearby countries. This is a character of successful island colonists (Newton 2003), suggesting that some of the causal factors on Cyprus for these colonisations and increases may be affecting the wider east Mediterranean region.

It is notable that three of the resident species which have greatly increased their numbers and distribution on the island, Eurasian Collared Dove, Zitting Cisticola and Cetti's Warbler, have also widened their habitat ranges. This appears to have also happened with the also resident European Serin. The most plausible explanation is sequential habitat occupation (Newton 1998), *ie* as populations increase, optimal habitats are occupied first and excess individuals are forced to colonise sub-optimal habitats. In the case of the three species with small body mass—Zitting Cisticola, Cetti's Warbler and European Serin—the probable main cause of their population increases is the ameliorating winters.

The Spectacled Warbler and the Cyprus Warbler are also of small body mass, but unlike Cetti's Warbler and Zitting Cisticola were both widespread and fairly common or common breeding birds before the recent climate changes on the island (*eg* Guillemard 1888, 1889, Lilford 1889, Stewart & Christensen 1971). Both are also partial migrants, the latter more than the former (Stewart & Christensen 1971, Shirihai *et al* 2001, Richardson 2017); this may have enabled them, unlike the two residents, to maintain large populations when winters were colder and wetter. Environmental influences are important in the development of partial migration (Chapman *et al* 2011) and partial migrants can be especially fast in becoming less migratory in response to a warming climate (Lehikoinen *et al* 2006), so both species may have been more migratory in the past, before the climate amelioration.

Looking to the future, the trend of increasing temperature and decreasing rainfall on the island is predicted to continue, with, by 2021–2050 an increase in mean temperature in winter of 1.4°C and in summer of 1.9°C, and a decrease in rainfall of 6–18%, and by 2071–2100, an increase in mean temperature in winter of 3.6°C and in summer of 5°C, and a decrease in rainfall of 20–35%, compared with the 1961–1990 average. In 2021–2050 there are predicted to be 25 more heatwave days per year and in 2071–2100 60 more per year (Giannakopoulos *et al* 2010). Increases in temperature and decreases in rainfall are also predicted in Turkey and the Levant (Lelieveld *et al* 2012). These higher winter temperatures may lead to even further advantage of resident over migrant breeders, and when combined with the hotter breeding seasons and the further reduction in rainfall, it seems inevitable that further rapid and extensive changes in the status of the island's breeding birds will result. To monitor such changes, island-wide censusing/atlasing would be valuable.

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LITERATURE CITED

Al-Safadi, MM. 2006. Observations on the breeding birds of the Gaza Strip, Palestine. *Sandgrouse* 28 (1): 22–33.

Andrews, IJ. 1995. *The Birds of the Hashemite Kingdom of Jordan*. IJ Andrews, Musselburgh, UK.

Ashton-Johnson, JFR. 1961. Notes on the breeding birds of Cyprus. *The Oologists' Record* 35 (3): 33–39.

Aymí, R & G Gargallo. 2018. Sardinian Warbler (*Sylvia melanocephala*). *In*: del Hoyo, J, A Elliott, J Sargatal, DA Christie & E de Juana (eds). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. https://www.hbw.com/node/58968. [Retrieved 5 April 2018]

Baier F, DJ Sparrow & HJ Wiedl. 2013. *The Amphibians and Reptiles of Cyprus*. 2nd edn. Edition Chimaira, Frankfurt um Main, Germany.

Bakaloudis DE, S Iezekiel, CG Vlachos, VA Bontzorlos, M Papakosta & S Birrer. 2012. Assessing bias in diet methods for the Long-legged Buzzard *Buteo rufinus*. *Journal of Arid Environments* 77: 59–65.

Bannerman, DA & WM Bannerman. 1958. *Birds of Cyprus*. Oliver & Boyd, Edinburgh.

Bannerman, DA & WM Bannerman. 1971. *Handbook of the Birds of Cyprus and migrants of the Middle East*. Oliver & Boyd, Edinburgh.

Baptista, LF, PW Trail, HM Horblit, P Boesman, EFJ Garcia & GM Kirwan. 2018. Eurasian Collared-Dove (*Streptopelia decaocto*). *In*: del Hoyo, J, A Elliott, J Sargatal, DA Christie & E de Juana (eds). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. https://www.hbw.com/node/54154. [Retrieved 28 February 2018]

Baumgart,W, M Kasparek & B Stephan. 2003. *Birds of Syria*. OSME, Sandy, UK.

Baxendale, FRS. 1915. Notes on the ornithology of Cyprus. *Ibis* 1915: 217–227.

Belcher, CF. 1929. Something about Cyprus. *The Oologists' Record* 9 (3): 49–52.

BirdLife Cyprus. 2003–2018a. *Cyprus Bird Report*s 2002–2016. BirdLife Cyprus, Nicosia.

BirdLife Cyprus. 2003–2018b. *Monthly Newsletters & Checklists* (from July 2010 Monthly Newsletters were retitled Monthly Checklists). BirdLife Cyprus, Nicosia.

BirdLife Cyprus. 2014. *Important Bird Areas of Cyprus*. Birdlife Cyprus, Nicosia.

BirdLife International. 2004. *Birds in Europe: trends, population estimates and conservation status*. BirdLife International, Cambridge, UK.

BirdLife International. 2006. *Synthesis report 1. Bird hunting practices in Mediterranean Countries of North Africa and the Middle East*. Cambridge, UK.

BirdLife International. 2015. *European Red List of Birds*. Office for Official Publications of the European Communities, Luxembourg.

BirdLife International. 2017. *Pterocles orientalis*. The IUCN Red List of Threatened Species. http://www.iucnredlist.org/details/22693002/0. [Retrieved 6 December 2017]

BirdLife International. 2018. *IUCN Red List for birds*. http://www.birdlife.org. [Retrieved 14 February 2018]

Blondel, J & J Aronson. 1999. *Biology and Wildlife of the Mediterranean Region*. Oxford University Press, UK.

Bourne, WRP, MEJ Gore, J Nicholson, AV Smith, FJ Walker & PCT Wildash. 1964. Check-list of the birds of Cyprus. Cyprus Ornithological Society *Bulletin* 15: 17–38.

BTO. 2018. Common Coot (*Fulica atra*) movements. British Trust for Ornithology. https://www.bto.org/ai/pdfs/145move.pdf. [Retrieved 6 February 2018]

Bucknill, JA. 1909/10. On the ornithology of Cyprus. *Ibis* 1909: 569–613, 1910: 1–45, 385–435.

Bucknill, JA. 1910. A list of the birds of Cyprus. Cyprus Natural History Society *Bulletin 2.*

Bucknill, JA. 1911. A further contribution to the ornithology of Cyprus. *Ibis* 1911: 632–656.

Bucknill, JA. 1913. A third contribution to the ornithology of Cyprus. *Ibis* 1913: 2–14.

Burton, JF. 1995. *Birds and climate change*. Christopher Helm, London.

CCKP. 2018. *Historical climate data – Cyprus.* Climate Change Knowledge Portal, Climate Change Group, The World Bank. http://climateknowledgeportal.worldbank.org. [Retrieved 20 April 2018]

Chapman, BB, C Brönmark, J-Å Nilsson & L-A Hansson. 2011. The ecology and evolution of partial migration. *Oikos* 120: 1764–1775.

Chapman, GW. 1952. Afforestation techniques in Cyprus. *Unasylva* 6 (4).

Charalambidou, I & S Gucel. 2013. First record of mixed-species heron colony: Cattle Egret (*Bubulcus ibis*), Squacco Heron (*Ardeola ralloides*) and Little Egret (*Egretta garzetta*) breeding at Famagusta Freshwater Lake in Cyprus. *Sains Malaysiana*. 42 (10): 1425–1430.

Charalambidou, I, N Kassinis, S Gűcel & W Fuller. 2012. The status and breeding population of the Spur-winged Lapwing *Vanellus spinosus* in Cyprus. *Podoces* 7 (1/2): 1–8.

Christodoulou, D. 1959. *The evolution of the rural land use pattern in Cyprus*. Geographical Publications, Bude, UK.

Clement, P. 2018a. Cetti's Warbler (*Cettia cetti*). *In*: del Hoyo, J, A Elliott, J Sargatal, DA Christie & E de Juana (eds). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. https://www.hbw.com/node/58749. [Retrieved 3 March 2018]

Clement, P. 2018b. European Serin (*Serinus serinus*). *In*: del Hoyo, J, A Elliott, J Sargatal, DA Christie & E de Juana (eds). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. https://www.hbw.com/node/61290. [Retrieved 29 March 2018]

Clement, P & R de Juana. 2018. European Greenfinch (*Chloris chloris*). *In*: del Hoyo, J, A Elliott, J Sargatal, DA Christie & E de Juana (eds). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. https://www.hbw.com/node/61334. [Retrieved 5 April 2018]

Cobham, CD. 1908. *Excerpta Cypria*. Cambridge University Press, UK.

Contesso, C. 2009. *Bushmeat and European Migratory Birds Conservation*. Masters Thesis, Virginia State University, US.

Cramp, S (ed). 1985, 1988. *Birds of the Western Palearctic*. Vols 4, 5. Oxford University Press, UK.

Cramp, S & KEL Simmons (eds). 1977, 1980. *Birds of the Western Palearctic*. Vols 1 & 2. Oxford University Press, UK.

Cramp, S & CM Perrins (eds). 1994. *Birds of the Western Palearctic*. Vol 8. Oxford University Press, UK.

Cyprus Natural History Society. 1913. *Annals* 4. Nicosia.

Cyprus Ornithological Society. 1957–2002. *Bird Reports* 1956–2001.

Cyprus Ornithological Society (founded 1970). 1971–1992. *Bird Reports* 1970–1989.

Dawes, JC. & DJ Whaley. 2001. An apparent increase in breeding Woodchat Shrikes. COS *Annual Report* 47: 115.

DeGregorio, BA, SJ Chiavacci, PJ Weatherhead, JD Willson, TJ Benson & JH Sperry. 2014. Snake predation on North American bird nests: culprits, patterns and future directions. *J Avian Biology* 45: 325–333.

De Knijf, G & H Demolder. 2013. Early spring observations of Odonata from Cyprus. *Libellula* 32: 59–74.

Department of Forests. 2006. *Criteria and indicators for the Sustainable Forest Management in Cyprus*. www.moa.gov.cy/moa/fd/fd.nsf. [Retrieved 18 March 2018]

Department of Meteorology. 1972. *Cyprus: average annual precipitation in mm 1941–70*. Ministry of Agriculture, Natural Resources and Environment, Cyprus.

Department of Meteorology. 2018a. *The climate of Cyprus*. Ministry of Agriculture, Natural Resources and Environment, Cyprus. www.moa.gov. cy/moa/ms. [Retrieved 17 March 2018]

Department of Meteorology. 2018b. *Climatological Information*. Ministry of Agriculture, Cyprus. www.moa.gov. cy/moa/ms. [Retrieved 17 January 2018]

Elhalawani, S. 2016. *Hunting and illegal killing of birds along the Mediterranean coast of Egypt: A socio-economic study.* Report by Nature Conservation Egypt and BirdLife International.

European Environment Agency. 2017a. *Cyprus Land Cover 2012*. https://www.eea.europa.eu/themes/landuse/land-cover-country-fact-sheets/cy-cyprus-landcover-2012.pdf/view. [Retrieved 20 April 2018]

European Environment Agency. 2017b. *Climate change, impacts and vulnerability in Europe 2016*. EEA Report No. 1/2017. https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016. [Retrieved 15 April 2018]

Eurostat. 2012. *Agricultural census for Cyprus*. http://ec.europa.eu/eurostat/statistics-explained/index.php/Agricultural_census_in_Cyprus. [Retrieved 16 January 2018]

Ferrier, JM. 1936. Sixteen days in Cyprus. *The Oologists' Record* 16: 53–59.

Flint, P. 1981. Survey of breeding distribution and habitat 1979. Cyprus Ornithological Society *Annual Report* 27: 95–100.

Flint, P. 2000. The Hobby *Falco subbuteo* as a breeding summer visitor to Cyprus. *North Cyprus Bird Report* 1999: 41–43.

Flint, PR. 2011. Why has only one wheatear *Oenanthe* species colonised Cyprus? *Sandgrouse* 33: 149–162.

Flint, PR. Submitted ms. Observations of Odonata from northern Cyprus.

Flint, P & A McArthur. 2014. Is the Sardinian Warbler *Sylvia melanocephala* displacing the endemic Cyprus Warbler *S. melanothorax* on Cyprus? *Sandgrouse* 36: 63–109.

Flint, PR & PF Stewart. 1983 (1st edn), 1992 (2nd edn). *The Birds of Cyprus*. British Ornithologists' Union, Tring, UK.

Giannakopoulos, C, P Hadjinicolaou, E Kostopoulou, K V Varotsos & C Zerefos. 2010. Precipitation and temperature regime over Cyprus as a result of global climate change. *Advances in Geosciences* 23: 17–24.

Gill, F & D Donsker (eds). 2018. *IOC World Bird List* (*v8.1*). doi: 10.14344/IOC.ML.8.1.

Goodman, SM & PL Meininger. 1989. *The Birds of Egypt*. Oxford University Press, UK.

Griggs, C, C Pearson, SW Manning & B Lorentzen. 2014. A 250-year annual precipitation reconstruction and drought assessment for Cyprus from *Pinus brutia* Ten. tree-rings. *International Journal of Climatology* 34: 2702–2714. [doi:10.1002/joc.3869]

Guillemard, FHH. 1888. Ornithological notes of a tour in Cyprus in 1887. *Ibis* 1888: 94–124.

Guillemard, FHH. 1889. Cyprus and its birds in 1888. *Ibis* 1889: 206–219.

Hadjikyriakou, G. 2005. Forest Fire Management in Cyprus. *International Forest Fire News* 33: 38–43.

Hagemeijer, WJM & MJ Blair. 1997. *The EBCC Atlas of European Breeding Birds*. Poyser, London.

Handrinos, G & T Akriotis. 1997. *The Birds of Greece*. Christopher Helm, London.
Heldbjerg, H & AD Fox. 2008. Long-term population declines in Danish trans-Saharan migrant birds. *Bird Study* 55: 267–279.
Hellicar MA. 2006. Landscape management and agriculture – Benefits for wildlife? Paper presented at *Landscape Management and its Impact on Wildlife—Opportunities for Cyprus*. 29th April 2006, Limassol, Cyprus.
Hellicar, M. 2016a. *Status of common birds in Cyprus, 2015. Ten years of the BirdLife Cyprus Common Birds Monitoring Scheme (CBMS), 2006-2015: Population trends and population size estimates for Cyprus common breeding birds*. https://birdlifecyprus.org/.../STATUSOFCOMMONBIRDSINCYPRUS2015final.pdf. [Retrieved 17 April 2018]
Hellicar, M. 2016b. The Laughing Dove *Streptopelia senegalensis* in Cyprus—the state of play in 2014. *Cyprus Bird Report* 2014: 174–175.
Horner, KO & JP Hubbard. 1982. An analysis of birds limed in spring at Paralimni, Cyprus. Cyprus Ornithological Society (founded 1970) *Bird Report* 7: 54–104.
Hortal, J, KA Triantis, S Meiri, E Thébault & S Sfenthourakis. 2009. Island species richness increases with habitat diversity. *The American Naturalist* 174 (6): E205–E217. DOI: 10.1086/645085.
del Hoyo, J, A Elliott, J Sargatal, DA Christie & E de Juana (eds). 2018. *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona.
Hume, RA. 1986. Reactions of birds to heavy rain. *British Birds* 79: 326–329.
Huntley, B, RE Green, YC Collingham & SG Willis. 2007. *A Climatic Atlas of European Breeding Birds*. RSPB/ Lynx Edicions, Barcelona.
Iapichino, C & B Massa. 1989. *The Birds of Sicily*. British Ornithologists' Union, Tring, UK.
Ieronymidou, C. 2018. BirdLife Cyprus Monitoring Programmes 2016—an overview. *Cyprus Bird Report* 2016: 175–179.
Iezekiel, S, DE Bakaloudis & CG Vlachos, 2004. *The Status and Conservation of Griffon Vulture Gyps fulvus in Cyprus*. www.raptors- international.org/book/raptors_worldwide_2004/Iezekiel_Bakaloudis _2004_67-73.pdf. [Retrieved 24 October 2017]
Iezekiel S, R Yosef, DE Bakaloudis, C Vlachos, M Papakosta, P Tryjanowski. 2016. Breeding ecology of the Long-legged Buzzard (*Buteo rufinus*) in an increasing population on Cyprus. *Journal of Arid Environments*. 135: 12–16.
IPCC. 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, RK Pachauri & LA Meyer (eds)]. IPCC, Geneva, Switzerland.
Isenmann, P, J Hering, S Brehme, M Essghaier, K Etayeb, E Bourass & H Azafzaf. 2016. *Oiseaux de Libye: Birds of Libya*. SEOF, Paris.
Jones T, & Cresswell W. 2010. The phenology mismatch hypothesis: Are declines of migrant birds linked to uneven global climate change? *Journal of Animal Ecology* 79: 98–108.
Jones, VR. 2006. Comparative ecology of the endemic Cyprus Warbler: implications of recent coexistence. PhD thesis, Cambridge University, UK.
Jourdain, FCR. 1929a. The breeding birds of Cyprus. *Journal für Ornithologie* 1929: 33–40.
Jourdain, FCR. 1929b. Diary of a visit to Cyprus in spring 1929. Deposited at Alexander Library, Edward Grey Institute, Oxford, UK.
Jourdain, FCR. 1930. Chapter 'Birds' in *The Handbook of Cyprus.* 9th (Jubilee) Issue: 302–325. Christophers, London.
Kasparek, M. 1998. [Occurrence and spread of the Collared Dove *Streptopelia decaocto* in the Near and Middle East.] *Ornithologische Verhandlungen* 25: 241–279. [In German]
Kassinis, N. 2009. Long-legged Buzzard *Buteo rufinus rufinus* breeding distribution and abundance in Cyprus. *Avocetta* 33: 75–78.
Katsanos, D, A Retalis, F Tymvios & S Michaelides. 2017. Study of Precipitation Extremes in Cyprus. *In*: TS Karacostas *et al* (eds). *Perspectives on Atmospheric Sciences*. Springer, New York.
Kennedy, RJ. 1970. Direct effects of rain on birds: a review. *British Birds* 63 (10): 401–404.
Kirwan, GM, K Boyla, P Castell, B Demirci, M Özen, H Welch & T Marlow. 2008. *The Birds of Turkey*. Christopher Helm, London.
Koundouri, P. 2007. *Coping with Water Deficiency: From Research to Policymaking*. Kluwer Academic Publishers, Dordrecht, Netherlands.
Kourtellarides, L. 1998. *Breeding birds of Cyprus*. Bank of Cyprus Group, Nicosia.
Kryštufek, B & V Vohralík. 2001. *Mammals of Turkey and Cyprus*. Knjižnica Annales Majora, Slovenia.
Kuşkor. 1999–2003 & 2016. *North Cyprus Bird Reports* 1998–2001 and 2012. Kuşkor, Kyrenia, Cyprus.
Lawicki, L, A Corso & L Khil. 2013. Long-legged Buzzards in Europe: Britain next? *Birding World* 26 (8): 332–343.

Lehikoinen, E, TH Sparks & M Zalakevicius. 2006. Arrival and departure dates. *In*: Møller, AP, W Fiedler & P Berthold (eds). *Birds and Climate Change*. Academic Press. London, pp1–31.

Lelieveld, J, P Hadjinicolaou, E Kostopoulou, J Chenoweth, M El Maayar, C Giannakopoulos, C Hannides, MA Lange, M Tanarhte, E Tyrlis & E Xoplaki. 2012. Climate change and impacts in the Eastern Mediterranean and the Middle East. *Climatic Change* 114: 667–687. [DOI 10.1007/s10584-012-0418-4]

Lilford, TP. 1889. A list of the birds of Cyprus. *Ibis* 1889: 305–350.

MacArthur, RH & EO Wilson. 1967. *The Theory of Island Biogeography*. Princeton University Press, NJ.

von Madarász, J. 1904. [About the birds of Cyprus.] *Annales Musei Nationalis Hungarici* 11 1904: 499–561. [In German]

Magnin, G. 1987. *An account of the illegal catching and shooting of birds in Cyprus in 1986*. ICBP, Cambridge, UK.

Martínez-Vilalta, A, A Motis & GM Kirwan. 2018. Squacco Heron (*Ardeola ralloides*). *In*: del Hoyo, J, A Elliott, J Sargatal, DA Christie & E de Juana (eds). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. https://www.hbw.com/node/52698. [Retrieved 23 February 2018]

Mason, RL. 1980. A bird census of the Troodos/Mt Olympus area, Cyprus. Apr 75 to Jan 76. *Royal Air Force Ornithological Society Journal* unnumbered: Contents 1, unpaginated (20 pages).

Massa, B & A Catalisano. 1987. Considerations of the species richness detected along an ecological succession of Cyprus. Cyprus Ornithological Society *Annual Report* 33: 61–64.

Matheu, E, J del Hoyo, GM Kirwan, EFJ Garcia, & P Boesman. 2018. Glossy Ibis (*Plegadis falcinellus*). *In*: del Hoyo, J, A Elliott, J Sargatal, DA Christie & E de Juana (eds). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. https://www.hbw.com/node/52775. (Retrieved 23 February 2018).

Mayr, E. 1926. [The spread of the Serin (*Serinus canaria serinus* L.). A contribution to animal geography.] *Journal für Ornithologie* 74: 571–671. [in German]

MBCC. 2017. *Cyprus Annual Report 2016*. Migratory birds conservation in Cyprus. Gwatt, Switzerland.

McCollin, D. 2017. Turnover Dynamics of Breeding Land Birds on Islands: is Island Biogeographic Theory 'True but Trivial' over Decadal Time-Scales? *Diversity* 9 (1): 3. [https://doi.org/10.3390/d9010003]

McNeile, JH. 1948–1955. Diaries of studies of breeding birds. Typescript, Royal Scottish Museum, Edinburgh.

Mederer, J. 2009. *Water Resources and Dynamics of the Troodos Igneous Aquifer-system, Cyprus— Balanced Groundwater Modelling*. Ph.D Thesis submitted Julius-Maximilians University of Würzburg, Germany.

Michaelides, S & S Pashiardis. 2008. Monitoring Drought in Cyprus during the 2007–2008 Hydrometeorological Year by using the Standardised Precipitation Index (SPI). *European Water* 23/24: 123–131.

Miltiadou, M. 2011. The first breeding record of Glossy Ibises *Plegadis falcinellus* for Cyprus. *Sandgrouse* 33: 102–108.

Mrlik, V, & B Landsfeld. 2002. The occurrence of Long-legged Buzzard (*Buteo rufinus*) in parts of central Europe during 1980–1998 and possible factors for its recent expansion. *Egretta* 45: 104–114.

Murdoch DA & KF Betton. 2008. A checklist of the birds of Syria. *Sandgrouse Supplement* 2.

Naveh, Z & JL Vernet. 1991. The palaeohistory of the Mediterranean biota. *In*: Groves, RH & F Di Castri (eds). *Biogeography of Mediterranean invasions*. Cambridge University Press, UK, pp19–32.

Newton, I. 1978. *Finches*. Collins, London.

Newton, I. 1998. *Population Limitation in Birds*. Academic Press, London.

Newton, I. 2003. *The Speciation and Biogeography of Birds*. Academic Press, London.

Newton, I. 2008. *The Migration Ecology of Birds*. Academic Press, London.

Olivier, C. 2000. Tens of thousands of migrant birds fly into Egyptian death traps. *The Times* 22 October 2000. London.

Orta, J. & GM Kirwan. 2018. Lesser Kestrel (*Falco naumanni*). *In*: del Hoyo, J, A Elliott, J Sargatal, DA Christie & E de Juana (eds). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. https://www.hbw.com/node/53212 [Retrieved 8 April 2018]

Olsson, V. 1969. [The expansion of the Serin (*Serinus serinus*) in northern Europe in recent decades.] *Vogelwarte* 25: 147–156. [In German]

OSME. 2017. The OSME Region List of Bird Taxa, Part F: Simplified OSME Region List (SORL) version 4.1 July 2017. https://www.osme.org/ORL. [Retrieved 7 November 2017]

OSME. 2018. The OSME Region List of Bird Taxa, Part C: Passerines. Version 4.2 April 2018. https://www.osme.org/ORL. [Retrieved 1 July 2018]

Panayides, P. 2005. Six aspects of land use and development activity that result in adverse effects to Cypriot wildlife resources. *Proceedings of the XXV International Congress of the International Union of Game Biologists – IUGB and IXth International Symposium Perdix* 2: 182–196. Ministry of the Interior, Nicosia.

Pearce-Higgins, JW & RE Green. 2014. *Birds and Climate Change: Impacts and Conservation Responses*. Cambridge University Press, UK.

Pentzold, S, C Tritscha, J Marten, DT Tietze, G Giacalone, M Lo Valvo, AA Nazarenko, L Kvist & M Päckert. 2013. Where is the line? Phylogeography and secondary contact of western Palearctic coal tits (*Periparus ater* : Aves, Passeriformes, Paridae). *Zoologischer Anzeiger* 252: 367–382.

Pentzold, S, MI Förschler, DT Tietze, C Randler, J Martens & M Päckert. 2016. Geographic variation in coal tit song across continents and reduced species recognition between Central European and Mediterranean populations. *Vertebrate Zoology* 66 (2): 191–199.
Pomeroy, D. 2004. Cyprus Breeding Birds: Monitoring Results—1997–2003. *Cyprus Bird Report* 2003: 123–133.
Pomeroy, D & F Walsh. 2006. Bird censusing and monitoring on Cyprus. *Sandgrouse* 28: 34–43.
Pomeroy, D & F Walsh. 2015. Monitoring landbird populations in western Cyprus with particular reference to Paphos District. *Sandgrouse* 37 (2): 137–159.
Pomeroy, D, F Walsh, P Flint, M Hellicar & P Shaw. 2016. A sustained decline in Cyprus Warbler *Sylvia melanothorax* numbers in western Cyprus, coinciding with the colonisation of its breeding range by the Sardinian Warbler *S. melanocephala*. *Bird Conservation International* 26 (4): 436–450. [doi:10.1017/S0959270915000337]
Price, C, S Michaelides, S Pashiardis & P Alpert. 1999. Long term changes in diurnal temperature range in Cyprus. *Atmospheric Research* 51: 85–98.
Ramadan-Jaradi, G & T Bara. 2009. First confirmed breeding record of Spur-winged Lapwing *Vanellus spinosus* for Lebanon, 2006. *Sandgrouse* 31(1): 55–56.
Ramadan-Jaradi, G & M Ramadan-Jaradi. 1999. An updated checklist of the birds of Lebanon. *Sandgrouse* 21 (2): 132–170.
Ramadan-Jaradi, G, T Bara & M Ramadan-Jaradi. 2008. Revised checklist of the birds of Lebanon 1999–2007. *Sandgrouse* 30 (1): 22–69.
Rayner, GW. 1982. The breeding of the Night Heron 1982. Cyprus Ornithological Society *Annual Report* 29: 62–63.
Richardson, C. 2017. Review of the status of Spectacled Warbler *Sylvia conspicillata* in Cyprus, and evidence of its dispersal and migration. *Sandgrouse* 39: 72–76.
Riddell, WH. 1927. On some birds of Cyprus in the spring. *Cyprus Agricultural Journal* 22: 94–98, 129–134.
Roselaar, CS. 1995. *Songbirds of Turkey: an atlas of biodiversity of Turkish passerine birds.* Pica Press, Robertsbridge, UK.
Rossel, Fl. 2001. *Hydrometeorological study examining changes in recorded precipitation*. Water Development Department, Cyprus.
Rudolph, T. 1990. Breeding record of the Goshawk (*Accipiter gentilis marginatus*) for Cyprus—1984. Cyprus Ornithological Society (founded 1970) *Bird Report* 19: 77–79.
Rutz, C, RG Bulsma, M Marquiss & RE Kenward. 2006. Population limitation in the Northern Goshawk in Europe: a review with case studies. *Studies in Avian Biology* 31: 158–197.
Sanderson, FJ, PF Donald, DJ Pain, IJ Burfield & FPJ van Bommel. 2006. Long-term population declines in Afro-Palearctic migrant birds. *Biological Conservation* 131: 93–105.
Schoener, TW. 2010. The MacArthur-Wilson Equilibrium Model. *In*: Losos, B & RE Ricklefs (eds). *The Theory of Island Biogeography Revisited*. Princeton University Press, USA, pp52–87.
Shaffer, ML. 1981. Minimum population sizes for species conservation. *BioScience* 31: 131–134.
Shirihai, H. 1996. *The Birds of Israel*. Academic Press, London.
Shirihai, H, G Gargallo & AJ Helbig. 2001. *Sylvia Warblers*. Christopher Helm, London.
Shirihai, H & L Svensson. 2018. *Handbook of Western Palearctic Birds*. Vol 1. Helm, London.
Sibthorp, J. 1787. Manuscript journal of a visit to Cyprus. [Published by Cobham 1908]
Smith, M, D Walker & J Walker. 2016. Two breeding records of Eurasian Hobby in Paphos Area 2014. The first confirmed breeding outside the Pentadaktylos range. *Cyprus Bird Report* 2014: 161–164.
Stagg, AJ. 1996. First breeding record of Woodchat Shrike on the Akamas peninsula and its potential as a regular breeding summer visitor. *In*: Brimmell, A, PE Cozens, V Cozens & R Frost (eds). *A Report of the ornithological survey to the Akamas, Cyprus, in spring 1995*. Royal Air Force Ornithological Society, p70.
Statistical Service. 2017. *Agricultural statistics 2015*. Statistical Service of Cyprus.
Stattersfield, AJ, MJ Crosby, AJ Long & DC Wege. 1998. *Endemic Bird Areas of the World: Priorities for Biodiversity Conservation*. BirdLife International, UK.
Stewart, PF & SJ Christensen. 1971. *A Check List of the Birds of Cyprus 1971*. Peter Stewart, Plymouth.
Stylianou, J. 2013. Black-bellied Sandgrouse in Cyprus. *The Monthly Checklist* October 2013, Issue 9: 16–17. BirdLife Cyprus.
Stylianou, J. 2017. *Birds of Cyprus Checklist* (*2017*) *and table of monthly sightings and yearly occurrences 2011–2016*. BirdLife Cyprus.
Stylianou, J & D Pentecost. 2013. The Laughing Dove in Limassol – and beyond. *The Monthly Checklist* July-August 2013, Issue 7: 15.
Sultana, J, JJ Borg, C Gauci & V Falzon. 2011. *The Breeding Birds of Malta.* BirdLife Malta.
Summers-Smith, JD. 1988. *The Sparrows*. T & AD Poyser, Calton, UK.

Summers-Smith, JD. 2018. Dead Sea Sparrow (*Passer moabiticus*). *In*: del Hoyo, J, A Elliott, J Sargatal, DA Christie & E de Juana (eds). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. https://www.hbw.com/node/60932. [Retrieved 30 June 2018]

Thirgood, JV. 1987. *Cyprus: a chronicle of its forests, land and people*. University of British Columbia Press, Vancouver.

Took, JME. 1972. Breeding records 1971. Cyprus Ornithological Society *Annual Report* 18: 40–49.

Tritsch, C, H Stuckas, J Martens, S Pentzold, L Kvist, M LoValvo, G Giacalone, DT Tietze, A Nazarenko & M Päckert. 2018. Gene flow in the European coal tit, *Periparus ater* (Aves: Passeriformes): low among Mediterranean populations but high in a continental contact zone. *Biological Journal of the Linnean Society* 20: 1–20.

Valente, L, JC Illera, K Havenstein, T Pallien, RS Etienne & R Tiedemann. 2017. Equilibrium bird species diversity in Atlantic islands. *Current Biology* 27: 1660–1666.

Vaurie, C. 1959. *The birds of the Palearctic fauna. Passeriformes.* HF & G Witherby, London.

Voudouris, K, T Kaklis, CA Constantinou, F Evaggelatos, S Papageorgiou, A Mentes, T Irakleous & C Panagiotou. 2010. Pilot study for artificial recharge of the South-eastern Mesaoria aquifer (Cyprus), using tertiary treated wastewater. *Proceedings XIX CBGA Congress*, special volume 99: 173–181. [Scientific Annals. School of Geology, Aristotle University of Thessaloniki, Thessaloniki, Greece]

Walsh, F & D Pomeroy. 2012. Continuing spread of the Eurasian Collared Dove *Streptopelia decaocto* in Western Cyprus. *Cyprus Bird Report* 2011: 147–152.

Water Development Department. 2002. *Assessment of groundwater resources of Cyprus*. Ministry of Agriculture, Natural Resources and Environment, Cyprus. www.cyprus.gov.cy/moa/wdd. [Retrieved 2 December 2017]

Water Development Department. 2009. *Dams of Cyprus*. Ministry of Agriculture, Natural Resources and Environment, Cyprus. www.cyprus.gov.cy/moa/wdd. [Retrieved 2 December 2017]

Water Development Department. 2010. *Final Report on Water Policy, Report 7 – Summary*. Ministry of Agriculture, Natural Resources and Environment, Cyprus. www.cyprus.gov.cy/moa/wdd. [Retrieved 2 December 2017]

Water Development Department. 2011. *Cyprus Profile*. Ministry of Agriculture, Natural Resources and Environment, Cyprus. www.cyprus.gov.cy/moa/wdd. [Retrieved 2 December 2017]

Water Development Department. 2017. *Water Works*. Ministry of Agriculture, Natural Resources and Environment, Cyprus. www.cyprus.gov.cy/moa/wdd. [Retrieved 2 December 2017]

Waterer, RR. 1954. Manuscript questionnaire completed for Bannerman's *Birds of Cyprus*, with additional notes. Original copy retained by P Flint.

Watson, GE. 1964. Ecology and evolution of passerine birds in the islands of the Aegean Sea. PhD Thesis, Yale University, USA.

Weidinger, K & M Král. 2007. Climatic effects on arrival and laying dates in a long-distance migrant, the Collared Flycatcher *Ficedula albicollis*. *Ibis* 149: 836–847.

Weiz, A. 2013. Jonathan Franzen: 'Egypt is the worst place to be a migratory bird'. *The Guardian*, UK Friday 19 July 2013.

Whaley, DJ & JC Dawes. 2003. *Cyprus Breeding Birds Atlas*. David Whaley, Paphos, Cyprus.

Whaley, DJ & JC Dawes 2005. Heron breeding records in Cyprus 2003–4. *Sandgrouse* 27 (2): 160–162.

Whittaker, RJ & JM Fernández-Palacios. 2007. *Island Biogeography*. 2nd edn. Oxford University Press, UK.

Wilson, GF. 1954. Manuscript questionnaire completed for Bannerman's *Birds of Cyprus*. Original copy retained by P Flint.

Yosef, R & International Shrike Working Group. 2018. Woodchat Shrike (*Lanius senator*). *In*: del Hoyo, J, A Elliott, J Sargatal, DA Christie & E de Juana (eds). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. https://www.hbw.com/node/60493. [Retrieved 5 April 2018]

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