

VAGRANCY OR MIGRATION: WHY DO AMERICAN TEALS CROSS THE ATLANTIC?

¿ERRATISMO O MIGRACIÓN: POR QUÉ CRUZAN EL ATLÁNTICO CERCETAS DE NORTEAMÉRICA?

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SUMMARY.—*Vagrancy or migration: why do American teals cross the Atlantic?*

An analysis of published transatlantic records of the blue-winged teal *Anas discors* and the green-winged teal *Anas carolinensis* provides evidence that both species are regular migrants in small numbers to Europe and Africa and that they are not merely vagrants, as hitherto believed. Their occurrence is independent of the prevalence of westerly winds arising from variation in the North Atlantic Oscillation. Unlike transatlantic vagrants, annual record totals of both teals in Europe do not vary greatly between years. There is a high percentage of spring teal records, whereas most transatlantic vagrant species appear mainly in autumn. Each year the Nearctic teal records in Europe show a slow and predictable spread from north to south reflecting their migratory calendar in the Americas, with distinct spring and autumn peaks in northern areas and more winter records further south. As in the Americas, a higher proportion of green-winged teals occur further north and blue-winged teals are relatively more numerous in the south. The apparent lengths of stay of green-winged teals are longer in more southern areas, where the birds apparently winter, than further north, where they mainly occur on passage. This study suggests that the systematic recording and analysis of observations of rarities is worthwhile in order to reveal new migration patterns.

Key words: *Anas carolinensis*, *Anas discors*, blue-winged teal, green-winged teal, transatlantic migration, vagrancy, wintering.

RESUMEN.—*¿Erratismo o migración: por qué cruzan el Atlántico cercetas de Norteamérica?*

Un análisis de los registros transatlánticos publicados sobre la cerceta aliazul *Anas discors* y la cerceta americana *Anas carolinensis* nos lleva a postular que las apariciones de ambas especies en Europa y África se explican mejor por la migración regular de pequeñas cantidades de individuos que por aves arrastradas por fenómenos meteorológicos, tal como hasta ahora se creía. Sus presentaciones son independientes de la prevalencia de vientos del oeste relacionados con la Oscilación del Atlántico Norte. A diferencia de las especies norteamericanas típicamente divagantes, en estas cercetas las cifras anuales en Europa no varían mucho entre años. Hay un alto porcentaje de citas en primavera, mientras que las aves erráticas procedentes de Norteamérica se registran en Europa principalmente en otoño. Cada año, las citas de cerceta aliazul y cerceta americana en Europa muestran una progresión lenta y predecible

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de norte a sur, reflejo de su calendario migratorio en América, con netos picos migratorios en otoño y primavera en las zonas de más al norte y presencia básicamente invernal en las de más al sur. Al igual que en América, las cercetas aliazules tienden a quedarse en invierno en latitudes más meridionales que las cercetas americanas. Las duraciones de las estancias aparentes de las cercetas americanas en una determinada localidad son mayores en las zonas de más al sur, donde parecen pasar el invierno, que en las de más al norte, donde se registran sobre todo durante los pasos. El presente trabajo sugiere que la recogida sistemática y el análisis de los registros de rarezas pueden ser útiles para descubrir nuevos patrones de migración.

Palabras clave: *Anas carolinensis*, *Anas discors*, aves divagantes, cerceta aliazul, cerceta americana, migración transatlántica, invernada.

INTRODUCTION

Avian migration mostly implies latitudinal shifts in populations. North American long-distance migrants typically form part of the so-called Nearctic–Neotropical bird migration system (Newton, 2008) but there are some species in which at least some populations breed in Greenland or other high-latitude areas in North America and winter in Iceland, the British Isles, continental Europe or even Africa. Well-known examples include the great northern diver *Gavia immer*, the greenland white-fronted goose *Anser albifrons flavirostris*, the arctic tern *Sterna paradisaea* and the northern wheatear *Oenanthe oenanthe* (Snow and Perrins, 1998). However, most North American migrants seen in Europe or Africa are regarded as vagrants, i.e. wanderers outside their normal migration range, in so far as that can be judged (Campbell and Lack, 1985), and their presence is normally attributed to wind-drifting over the Atlantic (Nisbet, 1959; Alerstam, 1990; Berthold, 1993; Elkins, 2004; Lees and Gilroy, 2009).

The blue-winged teal *Anas discors* (BWT) and the green-winged teal *Anas carolinensis* (GWT) are Nearctic breeders that are frequently recorded in the Western Palearctic (Alström and Colston, 1991; Mitchell and Young, 1997), where their natural occurrence is confirmed by a relatively high number of recoveries of ringed birds (Dennis, 1994).

Bruun (1971), in his review of movements of North American Anatidae to Europe, identifies seven species that are thought to undertake regular migrations from breeding grounds in Greenland to wintering grounds in Iceland or other areas in NW Europe but he does not include either of the teals among these and instead treats them as vagrants. Similarly, Dejonghe (1981) explains the records of BWTs in Europe and Africa in terms of juvenile dispersal and flight deviations due to particular meteorological conditions. Standard reference sources all consider the occurrences of these teals on the eastern side of the Atlantic to be mostly due to vagrancy (e.g. Ogilvie, 1975; Palmer, 1976; Cramp and Simmons, 1977; Johnson, 1995, and Rohwer *et al.*, 2002). However, the spatial and temporal occurrence patterns of these two species do not match those exhibited by typical American vagrants to Europe (Elkins, 2004; McLaren *et al.*, 2006; Newton, 2008). This is partly because they are widely scattered throughout the year, with a very high proportion of spring records, and also because their average periods of appearance tend to differ at different latitudes across Europe and North Africa (De Juana, 2006). Here we explore an alternative hypothesis to explain the patterns of occurrence of these two species in Europe and Africa, namely that both are regular transatlantic migrants, albeit in very small numbers. They can thus be considered ‘pseu-

do vagrants', as defined by Gilroy and Lees (2003). The same may also apply to several other North American wildfowl species, such as the American wigeon *Anas americana*, the ring-billed duck *Aythya collaris* or the lesser scaup *Aythya affinis*, but we have chosen to concentrate here only on the two teals in view of their taxonomic proximity and general similarities in size, breeding ranges and population levels, and also because they show some differences from each other in migratory behaviour that proved useful when interpreting their occurrence patterns.

METHODS

We have compiled as many records as possible of BWTs and GWTs in the Western Palearctic and sub-Saharan Africa, from all reliable sources. For Europe these are generally the reports published by the different national rarities committees (see homepage of the Association of European Records and Rarities Committees, AERC, at www.aerc.eu and also Handrinos and Akriotis, 1997; Pétursson and Thráinsson, 1999; Thévenot *et al.*, 2003, and De Juana, 2006). In the case of the GWT the data record is partly incomplete, mainly because the species was removed from the national rarity lists of the United Kingdom, Ireland and Sweden in the early 1990s, making the details of subsequent records much less accessible. GWT annual totals for Britain have been published up to 2003 (Fraser and Rogers, 2006; www.scarce-migrants.org.uk). It must also be particularly borne in mind that only drake GWTs in full plumage can be reliably distinguished in the field from Eurasian teals *Anas crecca*: females, immature birds and eclipse males are all but indistinguishable and the eclipse plumage may last until October (Bruun, 1971; Millington, 1998). This means that an unknown proportion of GWTs go unnoticed, especially in early autumn, whereas most BWTs seen are readily identified.

The figures used in the analyses are numbers of records and not numbers of individuals. Hybrids between the GWT and the Eurasian teal are excluded. The ordinal date, where January 1st = 1, February 1st = 32 etc., was used to facilitate the statistical analysis. We estimated the mean date and total length of stay for all records in which the bird or birds were observed for more than one day. Length-of-stay estimates are, of course, minimum ones since individuals may have gone unreported at either end of their occurrences.

Spatial patterns of occurrence have been analysed by grouping all Western Palearctic records (thus excluding those of sub-Saharan Africa) into nine geographical sectors (fig. 1).

We have taken into account the North Atlantic Oscillation (NAO) in order to explore the possible relationship between the annual distribution of records in the Western Palearctic and the prevalence and intensity of westerly winds in different years. A relationship between NAO indexes and the numbers of presumed Nearctic vagrants in the Western Palearctic has been previously shown, at least for waders in France and Britain (Dubois and Luczak, 2004) and landbirds in Britain and Ireland (Elkins, 2008). The NAO may be defined as the year to year variation in the relative position and strength of the two permanent pressure systems that control the direction and strength of westerly winds into Europe (Hurrell *et al.*, 2003), namely the low-pressure system over Iceland and the subtropical high-pressure system over the Azores. During a high NAO index year there is a large difference in atmospheric pressure between the two systems, with a stronger than usual Azores anticyclone and a deeper than normal Icelandic low, which leads to increased westerlies. Conversely, westerlies are diminished or suppressed when the NAO index is low, resulting from a weak subtropical high and a weak Icelandic low. NAO indexes were obtained from the UCAR (University Corporation for Scientific Research) database in

<http://www.cgd.ucar.edu/cas/jhurrell/indices.data.html#naopcann>. We tested for correlation between the annual totals of both species and two different NAO indexes: the Annual Index, that includes every month of the year, and the

SON Index, that only includes the autumn months of September, October and November.

We also explored the possible relationship between occurrence rates in the Western Palearctic and variation in the population sizes

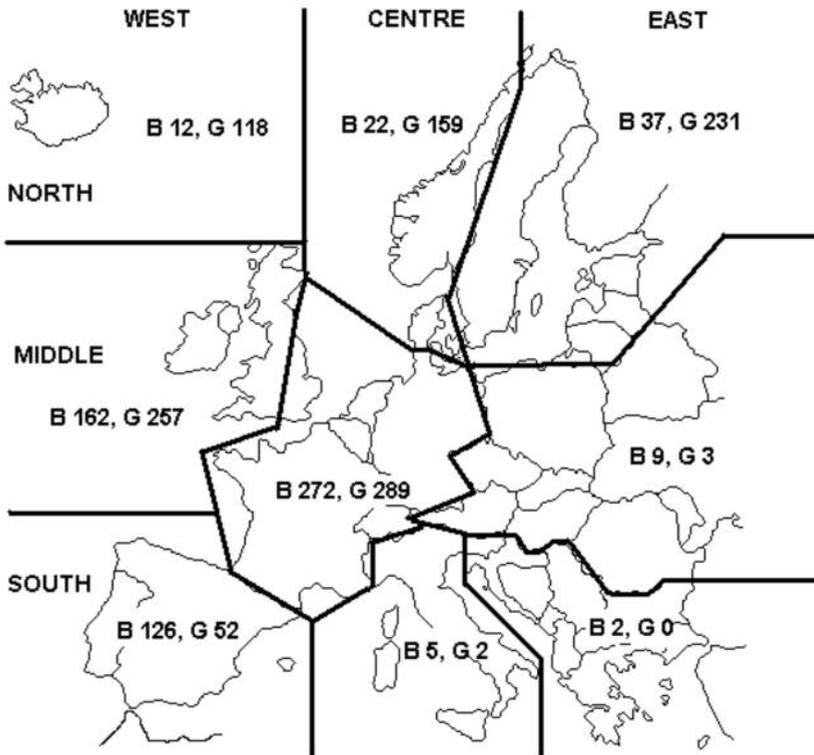


FIG. 1.—The geographical spread of records of blue-winged teals (B) and green-winged teals (G) in the Western Palearctic. Records from different countries are grouped as follows (only countries in which either species has occurred are included): North-West (Iceland, Faeroes), North-Centre (Norway, Denmark), North-East (Sweden, Finland), Middle-West (Ireland, Scotland, Wales, western English counties), Middle-Centre (eastern English counties, France, Netherlands, Belgium, Germany, Switzerland), Middle-East (Poland, Czech Republic, Austria, Hungary), South-West (Portugal and the Azores, Spain and the Canary Islands, Morocco), South-Centre (Italy, Algeria), and South-East (Greece, Egypt).

[*Reparto geográfico de los registros en el Paleártico Occidental de la cerceta aliazul (B) y la cerceta americana (G). Los registros de los diferentes países se agrupan como sigue (únicamente se mencionan aquellos países que cuentan con registros de una u otra especie): “North-West” (Islandia, Islas Feroe), “North-Centre” (Noruega, Dinamarca), “North-East” (Suecia, Finlandia), “Middle-West” (Irlanda, Escocia, Gales, condados occidentales de Inglaterra), “Middle-Centre” (condados orientales de Inglaterra, Francia, Holanda, Bélgica, Alemania, Suiza), “Middle-East” (Polonia, República Checa, Austria, Hungría), “South-West” (Portugal con las islas Azores, España con las islas Canarias, Marruecos), “South-Centre” (Italia, Argelia) y “South-East” (Grecia, Egipto).]*

of the two species in North America, using data supplied by the US Fish and Wildlife Service in its annual reports (Wilkins *et al.*, 2005).

Bivariate regressions, correlation analysis, ANOVA, Kruskal-Wallis and Chi square tests were used for data analysis. Variables were previously examined for normality and log-transformed where necessary.

RESULTS

In total we collated 647 records of BWTs and 1,111 of GWTs. Figure 1 shows the geographical distribution of all the Western Palearctic records available to us, within the previously defined sectors. Observations of both teal species originate primarily from coastal countries of Western Europe, mostly at middle latitudes. In particular, up to 40.5% of BWT records and 30.2% of GWT records have come from the British Isles: for GWT the figure was 77.3% up to 1990, the final year in which the GWT was treated as a rarity in Britain and Ireland. GWT totals in Britain for more recent years include 67 individuals in 2002 and 52 in 2003 (Fraser and Rogers, 2005 and 2006).

Comparing both species, the GWT tends to occur at a higher frequency in the northern areas and the BWT in the southern ones (Chi square test: $\chi^2_2 = 268$, $P < 0.0001$); GWT/BWT record ratios are 7.2 in the North, 1.2 in the Middle, 0.4 in the South. There are also significant differences in longitude, the GWT being comparatively more common in the East (Chi square test: $\chi^2_2 = 116$, $P < 0.0001$); GWT/BWT record ratios are 1.4 in the West, 1.5 in the Centre, 4.9 in the East.

There are just eight records of both species from sub-Saharan Africa: two GWT records and one BWT from Cape Verde (*Bulletin of the African Bird Club*, 12: 180 and 15: 266) and five BWT records from Senegal (Roux *et al.*, 1976; Dejonghe, 1981; *Bulletin of the African Bird Club*, 12: 188 and 13: 228). All

fall within the period December to March. There are also two spring BWT records from North Africa that may relate to birds that had returned across the Sahara: one from Beni-Abbès, Algeria, in April 1974 (Daly and Daly, 1975), and the other from Port Said, Egypt, in March 1990 (Nikolaus and van Westrienen, 1991).

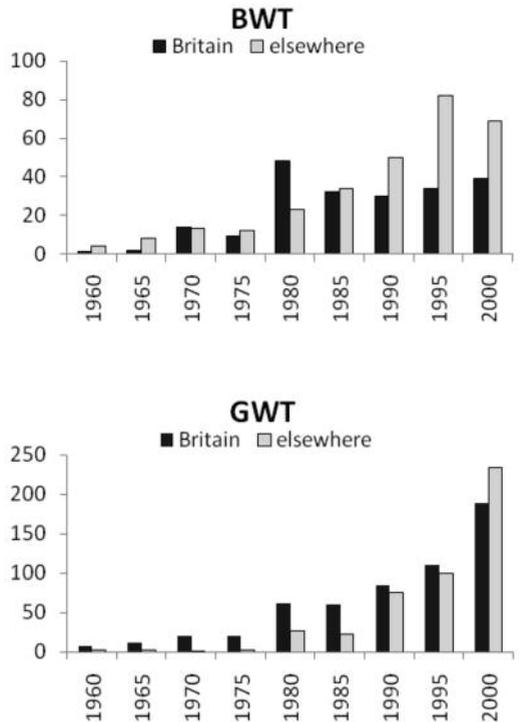


FIG. 2.—Record totals of GWTs and BWTs in the Western Palearctic from 1958-2003, given in five-year periods. GWT records from Ireland are excluded, since we were able to compile them only up to 1990, when the species was removed from the Irish rarity list.

[*Cifras totales de registros de cerceta aliazul (BWT) y cerceta americana (GWT) en el Paleártico Occidental durante 1958-2003, en periodos de cinco años. Para la cerceta americana se excluyen los registros de Irlanda ya que solamente los hemos podido recopilar hasta 1990, año en que se retiró a la especie de la lista irlandesa de rarezas.*]

Trends in annual record totals

Record totals in the Western Palearctic (fig. 2) increased steadily between the mid 1950s and early 2000s for both species (Pearson Correlation: $r = 0.810$ for BWT in Britain and $r = 0.933$ for BWT elsewhere; $r = 0.920$ for GWT in Britain and $r = 0.821$ for GWT elsewhere excluding Ireland; $N = 9$ and $P < 0.01$ in all cases).

There is no significant relationship between the yearly variation in record totals and the changes in the North Atlantic Oscillation. Regression analysis for the period 1971-2002 show that the Annual NAO Index has no effects on the number of records of either the BWT ($y = 5.632 - 0.548 * x$, $r = 0.175$, $N = 32$, $P = 0.340$) or the GWT ($y = 1.306 - 0.034 * x$, $r = -0.077$, $N = 32$, $P = 0.677$). Linear regression using the SON NAO Index gives similar results for the BWT ($y = 5.435 + 1.078 * x$, $r = 0.338$, $N = 32$, $P = 0.059$) and for the GWT ($y = 1.291 - 0.056 * x$, $r = -0.123$, $N = 32$, $P = 0.503$).

In contrast, the occurrence of both species in the Western Palearctic during the same period 1971-2002 closely matches the variation in their respective population sizes in North America (BWT: $y = 0.071 + 0.001 * x$, $r = 0.429$, $N = 32$, $P = 0.014$; GWT: $y = -0.015 + 0.001 * x$, $r = 0.586$, $N = 32$, $P < 0.001$).

Temporal patterns

Western Palearctic BWT and GWT records are widely scattered across the year, being relatively scarce only in summer (fig. 3). Spring records are even more frequent than autumn ones, especially for the GWT, in which the difficulty of detecting eclipse males means that late summer and early autumn individuals are probably overlooked, as noted above. Probably in consequence, whereas BWT records show two main peaks: in spring (March-April) and in autumn (September-

October), GWT records show just a single spring peak and there are almost no GWT records in summer (July-September).

On closer inspection it may be seen that the occurrence patterns differ widely between the different geographical sectors considered (fig. 4). In both species, the monthly distributions of records (mean dates) are bimodal in the north, showing peaks in autumn and in spring, with no winter records of BWT and just a few of GWT. In middle latitudes, in addition to spring and autumn records, there are also some winter BWT records and many

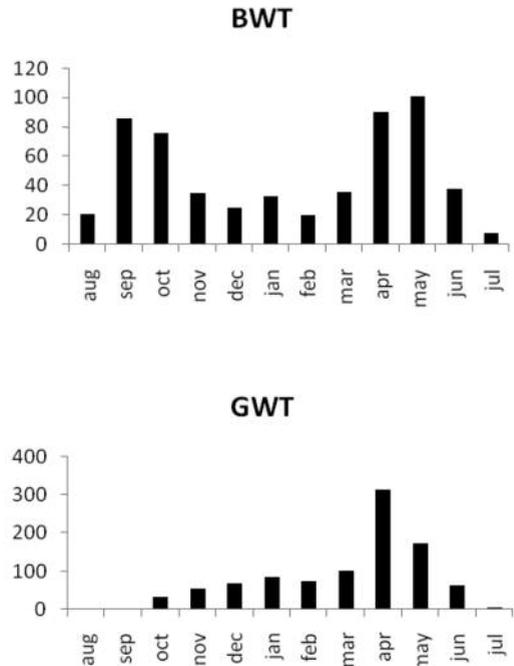


FIG. 3.—Monthly distribution of mean dates of presence for BWT and GWT records in the Western Palearctic (based on a sample of 569 BWT records and 972 GWT records).

[Distribución por meses de las fechas medias de los registros de BWT y GWT en el Paleártico Occidental (basado en una muestra de 569 registros de BWT y 972 de GWT).]

GWT records. In the South-West, where almost all southern records occur, the GWT shows a single and very marked peak in mid-winter but for the BWT there are also many spring and autumn records. Spring record totals tend to increase from west to east in both species. There appear highly significant differences both between the North, Middle and South latitudinal belts (Chi-square test: $\chi^2_{22} = 142$, $P < 0.0001$ for the BWT; $\chi^2_{20} = 400$, $P > 0.0001$ for the GWT) and between the West, Centre and South longitudinal sectors (Chi-square test: $\chi^2_{22} = 114$, $P < 0.0001$ for the BWT; $\chi^2_{20} = 203$, $P < 0.0001$ for the GWT).

In autumn, mean record dates are much earlier in the north than in the south, whereas in spring they are much earlier in the south than in the north (fig. 5). They differ between the northernmost and southernmost zones by 40.9 days in autumn and 63.5 days in spring for BWTs, and 63.4 days in autumn and 73.1 days in spring for GWTs. BWTs tend to occur earlier in autumn and later in spring than GWTs; for example, in the northern zone BWTs appear around three weeks earlier in autumn and two weeks later in spring.

Lengths of stay

The average apparent length of stay is similar in both species, 11.2 days in BWTs and 12.5 days in GWTs. In GWTs it clearly increases from north to south, stays in the southern zone (average 32.4 days) being almost twice as long as those in the middle zone (16.8 days) and almost six times longer than in the northern one (5.5 days). These differences are statistically significant (Kruskal-Wallis test: $H_{2,974} = 56.973$, $P < 0.001$). There is no similar variation in BWTs (Kruskal-Wallis test: $H_{2,568} = 5.786$, $P = 0.055$), the average length of stay being similar in the north (8.2 days) the middle (12.4 days) and the south (8.0 days) zones.

Recoveries of ringed birds

Four recoveries of ringed GWTs and 14 of ringed BWTs provide some indication of the origins of the Nearctic teals that visit the Western Palearctic (Dennis, 1981, 1987 and 1990; Dubois *et al.*, 2000; Grantham, 2004). The ringing localities for both species are located in eastern Canada, except for one BWT record from the adjacent state of Maine, USA. They are thus clearly clumped in easternmost North America: the most westerly site is at Lake Ontario (78° 52' W), and 14 out of 18 birds were ringed in the east coast territories of Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick or Maine. All birds were ringed in summer (July to September) and most were recovered during the following autumn or winter. However, three BWTs were recovered during the following calendar year and one GWT was recovered nine years later. Regarding the geographical pattern of recoveries, it may be worth noting that all GWTs were found in northern or middle-level countries (one in Iceland and three in the British Isles) but most BWT recoveries were in the south (ten in total in Iberia, Mediterranean France, the Azores and Morocco, v. three in the British Isles and one in Denmark).

DISCUSSION

The distribution patterns of these two American teals in the western Palearctic are much better explained as instances of ordinary (regular) migration movements than of vagrancy due to meteorological causes. Nothing in their patterns matches those usually shown by typical Nearctic vagrants to Europe, such as the yellow-billed cuckoo *Coccyzus americanus*, the chimney swift *Chaetura pelagica* or the red-eyed vireo *Vireo olivaceus*, which typically display very large between-year fluctuations in abundance, are concentrated in autumn, occur simultaneously in several

BLUE-WINGED TEAL

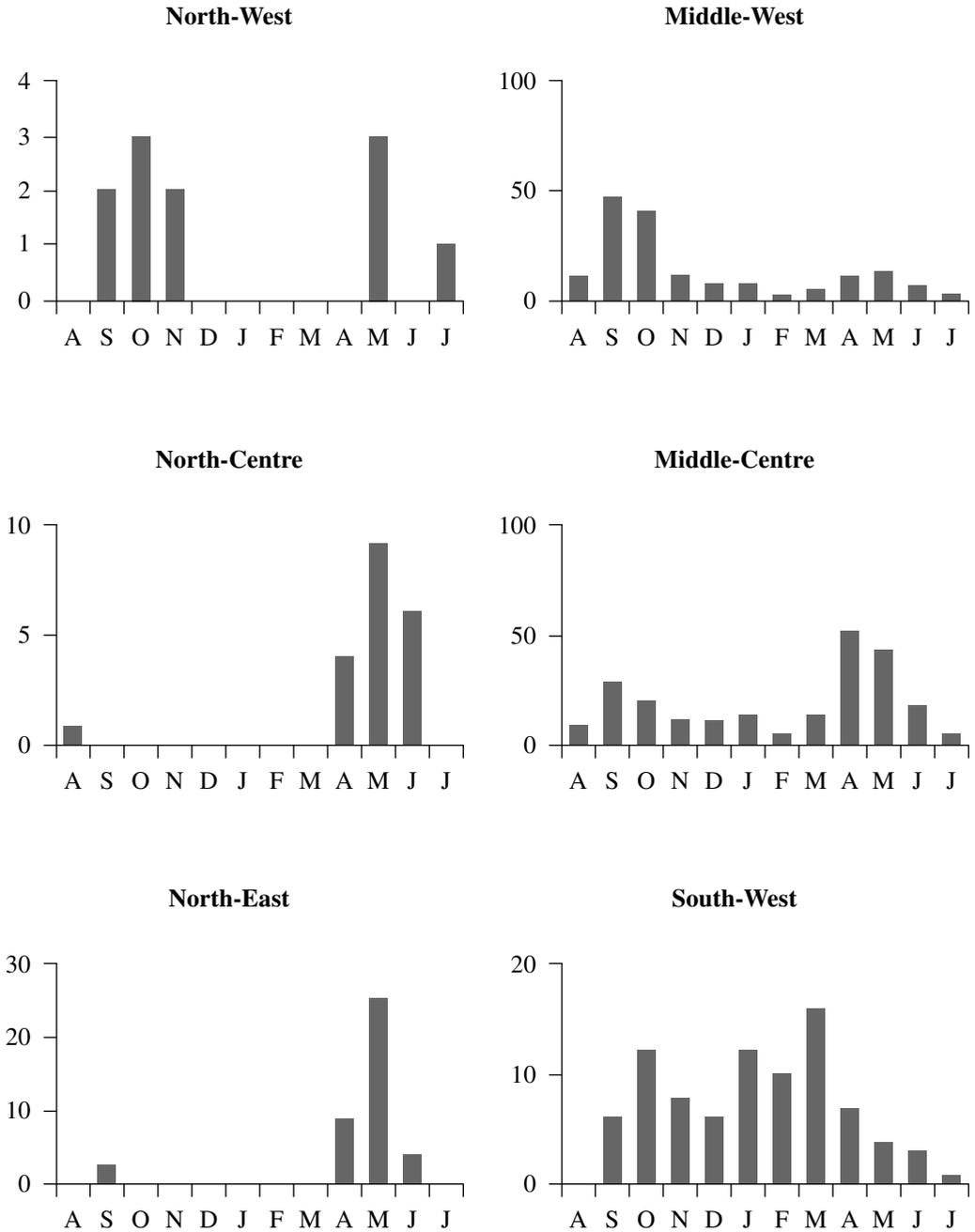


FIG. 4.—The monthly distribution of records (mean dates) in the different geographical sectors considered (see also fig. 1). Sectors with very few records are excluded.

GREEN-WINGED TEAL

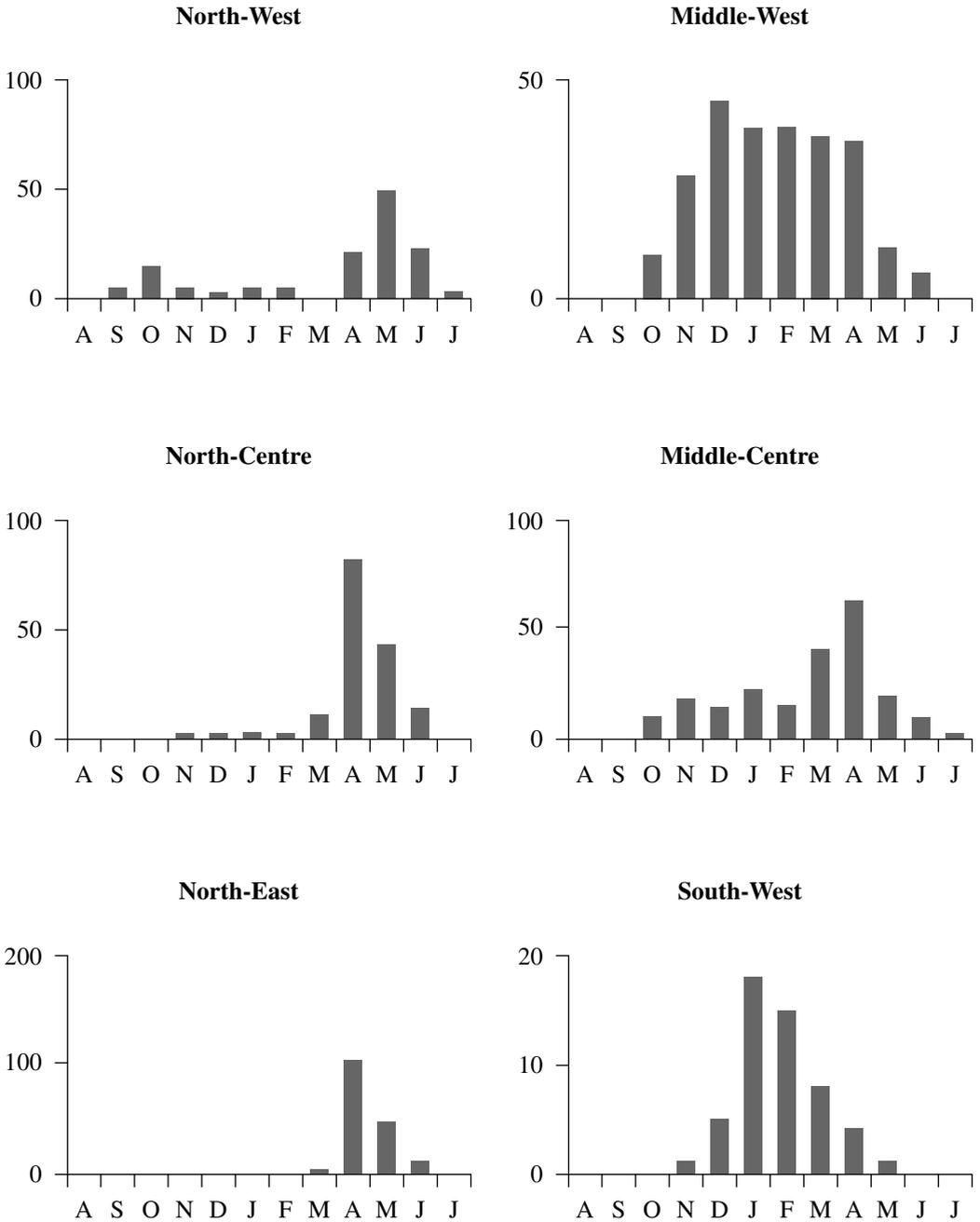


FIG. 4. (cont.)—[Distribución mensual de los registros (fechas medias) en los diferentes sectores geográficos considerados (véase también la fig. 1). Se excluyen los sectores con muy pocos registros.]

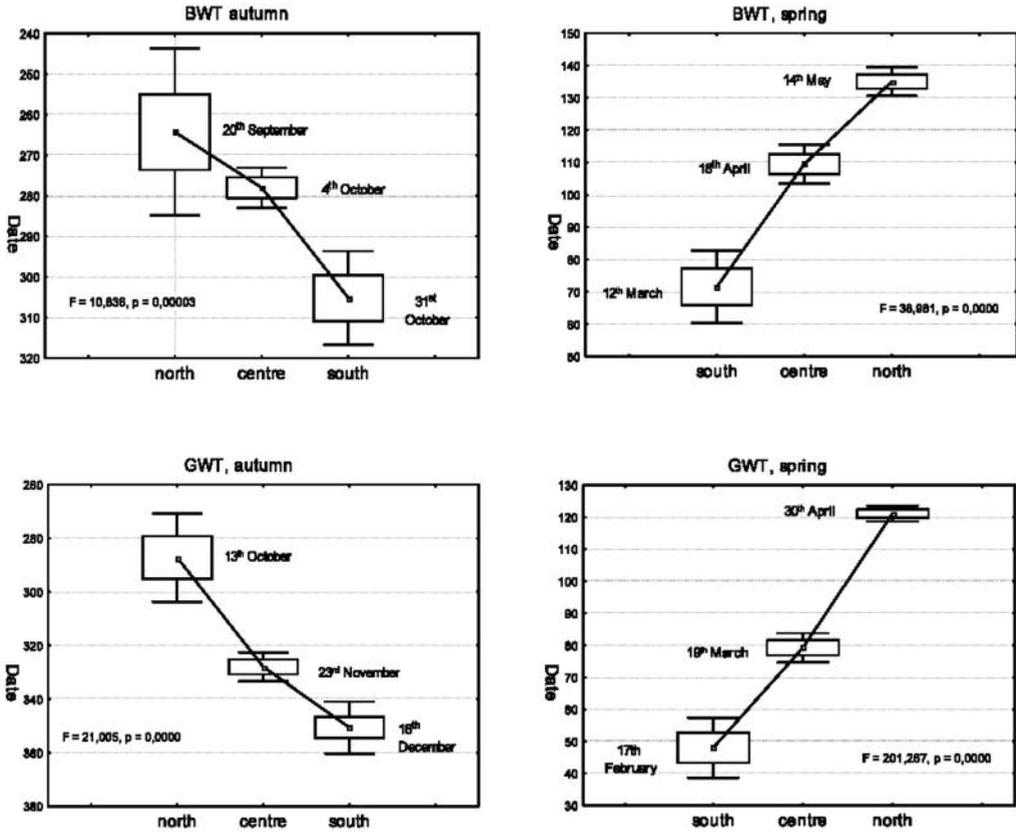


FIG. 5.—Mean record dates of BWTs and GWTs at different latitudes during autumn and spring. The results of ANOVA tests are included.

[Fechas medias de los registros de cerceta aliazul (BWT) y cerceta americana (GWT) en diferentes latitudes, en otoño y primavera. Se incluyen los resultados de los ANOVA llevados a cabo.]

countries across a wide range of latitudes, and in which the birds generally disappear shortly after arrival (Alström and Colston, 1991; Mitchell and Young, 1997; McLaren *et al.*, 2006; Lees and Gilroy, 2009). For example, a recent analysis of the Nearctic landbirds recorded in Britain and Ireland shows that 86% of them arrived in autumn and mostly during the second week of October (Elkins, 2008). This same paper shows a highly significant relationship between the October NAO index and the numbers of vagrants. A similar correlation between a posi-

tive NAO index and the totals of vagrants has been shown for Nearctic waders in France and Britain, the great majority of which also occur in the autumn (Dubois and Luczak, 2004). In our study, we could not find any relationship between teal occurrences and NAO indexes but we demonstrated a correlation with variation in the population sizes in North America for both species. Population growth has been related to increased chances of vagrancy (Bryant, 1997; Veit, 2000; McLaren *et al.*, 2006) but it can similarly explain variation in the numbers of regular migrants.

It may be argued that the observed patterns could apply to vagrants that once in the Old World move south in winter and north in spring, without travelling back to America. We consider this highly unlikely in view of the spatial-temporal patterns shown by these two species (fig. 4). The proportion of summer records (June–August) is very low, even in the northernmost countries, and the distribution of records in autumn –lacking in the east and concentrated predominantly in the British Isles suggests that there are no summering areas further east in the Palearctic.

As would be expected if BWTs and GWTs are regular migrants in the Western Palearctic, their spatial and temporal patterns of occurrence match the progress of their migrations along comparable latitudes on the eastern side of America (see Bellrose, 1980; Palmer, 1976; Johnson, 1995, and Rohwer *et al.*, 2002). In particular, the BWT occurs much earlier in autumn and later in spring, and winters much further south, than the GWT. The main difference between our observations and the American migratory patterns, relates to the winter distribution of BWTs, since most of their mid-winter records on the eastern side of the Atlantic are found at much higher latitudes than in America, roughly between 50° N and 30° N. In contrast, most eastern Canadian BWTs winter in northern South America (Haverschmidt, 1970; Rohwer *et al.*, 2002) i.e. from c.10° N to 5° N. This may be linked to the fact that winter isotherms are located further south in eastern North America than in western Europe, but to some extent it may also be due to the huge differences in observer coverage between Western Europe and the African continent. The issue of the unequal distribution of potential observers is crucial when interpreting the occurrence patterns of rarities (Phillips, 2000; Gilroy and Lees, 2003; De Juana, 2008; Newton, 2008). Taking into account the existing differences in observer coverage, the number of records of BWTs in Morocco

and Senegal (respectively 22 and five up to 2006) may even seem surprisingly high in comparison with those of other Nearctic bird species there (Bergier and Thévenot, 2004). Furthermore, BWT occurrences in Iberia and Morocco show rather short stays: the apparent length of stay of BWTs in the southern zone is on average four times shorter than that of GWTs (8.0 days v. 32.4 days). There are also many spring and autumn records in Iberia, Morocco, the Azores and the Canaries combined. Here the mean record date in autumn is 31st October for BWTs v. 16th December for GWTs, whereas in spring it is 12th March for BWTs compared to 17th February for GWTs. Together this suggests that the BWT records from this area may involve a high proportion of migrant birds as well as winterers. This may be accounted for if a number of BWTs winter in the huge wetlands of the Sahel belt, such as the Senegal Delta or the Niger inundation zone. It would be very difficult to detect them there within the huge flocks of garganeys *Anas querquedula* and other wintering ducks (Alerstam, 1990; Delany and Scott, 2006), since such gatherings are usually monitored from the air.

Another interesting aspect of the occurrence patterns of these teals in Europe seems to be the highly divergent distribution of the spring records between longitudinal sectors. There are comparatively very high numbers of spring records in countries such as Denmark, Sweden, or Finland, where there are almost no records in autumn. This may indicate that on average teals return to North America by more easterly and more northerly routes than those followed during autumn migration. This migration pattern may be another example of loop migration, in which the birds take advantage of more favourable winds (Erni *et al.*, 2005; Gauthreaux *et al.*, 2005; Gill *et al.*, 2005; Liechti, 2006). Global wind patterns make it evident that the prevalent westerlies of the North Atlantic would help the birds to cross from North America to Europe during

the autumn migration, but these same winds would represent an obstacle on their flights back to the breeding grounds. However, if spring migrants first moved north, at 60° N they would reach the belt of polar easterlies, above the Icelandic low, which may help them to return across the Atlantic.

The rather high number of recoveries of these two teals in the Western Palearctic can support our hypothesis that these species perform regular migration to Europe as opposed to vagrancy. The recoveries refer to birds ringed in a relatively small area of south-eastern Canada, from where transatlantic crossings are shortest. For example, following a great circle the distance from Prince Edward Island to Ireland is some 4,000 km, roughly the same as to Venezuela, clearly within the capabilities of both species, particularly if they can take advantage of favourable winds (Pennycuick, 1998). In any case, the transatlantic crossing clearly poses far less of a challenge to ducks than it does to landbirds. BWTs in particular are known to make 'exceedingly long flights' over water when on migration and flocks have been observed resting on the sea (Bellrose, 1980).

The presence of wintering areas in Europe and Africa of species that usually winter in America implies the coexistence of rather different migratory orientations in the same breeding population, which raises interesting questions from an evolutionary perspective. Is the minority east/west orientation in the migration of these Nearctic teals a recent chance development? Changes in winter quarters have been reported in other species (Newton, 2008). For example, some central European blackcaps *Sylvia atricapilla* now migrate to the west-northwest and winter in Britain instead of migrating south to the Mediterranean basin (Berthold and Terrill, 1988). Our result is surprising given that it is generally assumed that birds are less flexible in changing their migration direction than in changing the distance travelled (Sutherland,

1998; Fiedler, 2003), although it is unclear whether this limitation holds for duck species, in which migratory behaviour is socially transmitted, through travelling in mixed-age flocks (Sutherland, 1998; Pulido, 2007). In any case, our study shows that the systematic recording and analysis of 'rarity' records may help discovering new migration routes and novel winter ranges, thereby unravelling a surprising diversity of avian migration patterns.

Finally, certain practical implications arise if green-winged and blue-winged teals are indeed regular migrants to Europe and Africa. Both species should be included in legislative texts relating to conservation, such as the European Union Bird Directive or the Bonn Convention. Also, their movements should be borne in mind when predicting possible pathways for the spread of the highly pathogenic avian influenza H5N1 into the American continent (Kilpatrick *et al.*, 2006; Olsen *et al.*, 2006; Stallknecht and Brown, 2007; Gaidet *et al.*, 2008).

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