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Sexual plumage differences and the outcome of game bird (Aves: Galliformes) introductions on oceanic islands

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ABSTRACT

Galliformes, after Passeriformes, is the group of birds that has been most introduced to oceanic islands. Among Passeriformes, whether the species' plumage is sexually monochromatic or dichromatic, along with other factors such as introduction effort and interspecific competition, has been identified as a factor that limits introduction success. In this study, we tested the hypothesis that sexually dichromatic plumage reduces the probability of success for 51 species from 26 genera of game birds that were introduced onto 12 oceanic islands. Analyses revealed no significant differences in probability of introduction success between monochromatic and dichromatic species at either the generic or specific levels. We also found no significant difference between these two groups in size of native geographic range, wing length or human-introduction effort. Our results do not support the hypothesis that sexually dichromatic plumage (probably a response to sexual selection) predicts introduction outcomes of game birds as has been reported for passerine birds. These findings suggest that passerine and non-passerine birds differ fundamentally in terms of factors that could influence introduction outcome, and should therefore be evaluated separately as opposed to lumping these two groups as 'land birds'.

Keywords: competition, Galliformes, introduction outcomes, oceanic islands, Passeriformes, sexually dichromatic plumage.

INTRODUCTION

Why do some avian introductions to oceanic islands succeed and others fail? Various authors have argued that the outcomes of avian introductions are due to community or

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island-level factors, such as competition with native species (e.g. Moulton and Pimm, 1983, 1987; Lockwood *et al.*, 1993; Lockwood and Moulton, 1994; Brooke *et al.*, 1995), degree of habitat alteration (Case, 1996), human-level factors such as introduction effort (e.g. Veltman *et al.*, 1996; Duncan, 1997; Green, 1997; Duncan and Young, 1999), species-level properties such as variation in competitive level or overall adaptability (Simberlofff and Boecklen, 1991), social behaviour of the species (Sol *et al.*, 2002) and response to sexual selection (McLain *et al.*, 1995, 1999; Sorci *et al.*, 1998), as manifested in the form of plumage differences between the sexes. Accordingly, McLain *et al.* (1999) found that among 132 species of passerine birds introduced onto oceanic islands, species with sexually dichromatic plumage had significantly lower chances for success than species with monochromatic plumage.

Although a large proportion (nearly 50%) of the species that have been introduced to oceanic islands are passerines, other groups, especially the Galliformes (Long, 1981), have also been widely introduced. Accordingly, the aim of this study was to test the hypothesis that species of game birds with dichromatic plumage have reduced chances for success when introduced onto oceanic islands.

Galliformes represent an interesting group for analysis. The game birds represent a phylogenetically less diverse (some authors say a single taxonomic family) and ecologically more homogeneous group than passerines. Moreover, there has been one central reason behind the vast majority of game bird introductions – to establish populations for sport hunting.

McLain *et al.* (1999) also examined the idea that plumage status might be associated with traits such as clutch size or amount of parental care. Tests of mean clutch size might not be as easy to perform for game birds as for Passeriformes. To illustrate, Labisky (1968) found that clutch sizes in *Phasianus colchicus* were highly variable at a specific site as well as at multiple sites throughout the range of the species on mainland North America. Some species also lay eggs in the nests of other individuals. Labisky (1968) found that, in Illinois, about 20% of all incubated clutches of *Phasianus colchicus torquatus* contained eggs laid by two or more females. For these reasons, we did not test for a possible relationship between clutch size and plumage status. However, we did test for relationships between size of native geographic range and plumage status.

METHODS AND MATERIALS

We compiled a list of all galliform species introduced for 12 islands: Hawai'i, Kaua'i, O'ahu, Maui, Moloka'i, Lana'i, New Zealand, Mauritius, La Reunion, Tahiti, Bermuda and Saint Helena. The references we used are listed in the footnote to the Appendix. Based on these sources, we calculated the probability of introduction success for each species for the 12 islands.

Determination of plumage dimorphism

In principle, it seems a simple enough proposition to decide whether a species is plumage dichromatic or monochromatic. This is the case for some game bird species, such as *Phasianus colchicus*, but not for others. At least one species (i.e. *Callipepla squamata*) has both monochromatic and dichromatic subspecies (see below). Other species show

wide variation in plumage differences and the overlap between the sexes can be wide (e.g. *Coturnix ypsilophorus*).

The first observation one makes when examining large numbers of museum specimens is that individuals often vary greatly. In some species, the specimens seem to be exact copies of one another; but, in too many others, the variation is wide.

Individual specimens may vary for genetic reasons. But they also may vary for non-genetic reasons, such as the age of the individual at the time of collection, the amount of time that has passed since the specimens were prepared, or the time of year when the individuals were collected (breeding season versus non-breeding season).

Genetic differences may affect the pattern of coloration in individuals or the extent or intensity of colouring. The obvious case of pattern influence is seen in albino individuals of various species. But there also are highly consistent pattern and colour differences that manifest themselves at the population level. Consider the case of the scaled quail, *Callipepla squamata*. Scaled quail range from southern Colorado and Kansas, south through Texas, New Mexico, southeastern Arizona and into northern Mexico. Among individuals of the subspecies in New Mexico (*C. s. pallida*), males appear identical to females. However, males from the southern Texas subspecies (*C. s. castanogastris*) show a distinct chestnut-coloured belly patch, which is absent in females. Thus, it appears that response to sexual slection may very even among subspecies.

One final problem involves the accuracy of specimen tags. Many monochromatic specimens are unsexed, or marked as sex unknown, or simply marked as 'adult'. Given this uncertainty one must also acknowledge the possibility that in some specimens the sex listed on the tag might be incorrect. In several genera of largely monochromatic game birds, the males are easily identified by the presence of tarsal spurs. However, in some genera there are no spurs (e.g. *Oreortyx*) or the spurs are reduced to mere bumps (e.g. *Alectoris*).

We examined museum specimens of some species at the US National Museum of Natural History (J.D.) and all species at the British Natural History Museum (M.P.M.). We classified species as being either monochromatic or dichromatic. We compared the plumage of male and female specimens from at least six and as many as nine regions of the body for all species. These regions included parts of the head (forehead, cheek, crown), throat, belly, flanks, wings, upper back and lower back. By specifying the body regions in advance, we were forced to examine each species systematically, which aided in revealing subtle differences.

We further noted the presence of differences in feather shape. For example, the feathers on the upper breast and back of some species (e.g. *Gallus* spp.) were elongate in the male and rounded in the female. We also noted any non-plumage differences such as the presence of spurs in some species, and when present we measured the length of a spur on one or two typical specimens.

The plumage colour and pattern were considered for each region and scored in the following way: 0 = male and female had the same colour and pattern; 1 = male and female exhibited differences in colour and/or pattern. From the scores for each body region, each species was classified as monochromatic (no regions > 0) or dichromatic (at least one region = 1). Accordingly, 18 and 33 of the 51 species were classified as monochromatic and dichromatic, respectively (Table 1).

Table 1. Galliform species examined at the US Museum of Natural History and the British Natural History Museum

Species	Score	Spur	Range	PIS	Wing
Ortalis cinericeps	1	–	294	0.000	196.0
Penelope purpurascens	1	–	2612	0.000	402.0
Crax rubra	2	–	1439	0.000	413.5
Ammoperdix griseogularis	2	–	3705	0.000	125.7
Alectoris graeca	1	7.78	941	0.000	161.2
Alectoris chukar	1	6.50	11916	0.778	163.3
Alectoris barbara	1	3.96	1906	0.000	159.0
Alectoris rufa	1	4.52	1102	0.000	154.8
Francolinus pondicerianus	1	12.4	3779	0.833	142.8
Francolinus pintadeanus	1	5.92	2985	0.000	142.1
Francolinus francolinus	2	7.38	4165	1.000	172.9
Francolinus clappertoni	1	17.6	4555	0.000	177.0
Francolinus icterorhynchus	1	16.3	2807	0.000	165.2
Francolinus capensis	1	13.8	472	0.000	204.1
Francolinus adspersus	1	21.1	1621	0.000	173.7
Francolinus erckelii	1	17.4	452	1.000	205.4
Francolinus leucosepus	1	14.9	1956	0.000	204.6
Francolinus afer	1	18.9	6613	0.000	168.3
Perdix perdix	2	–	11316	0.000	151.8
Margaroperdix madagascarensis	2	–	594	0.500	125.1
Coturnix coturnix	2	–	41991	0.250	108.1
Coturnix japonica	2	–	9630	0.833	97.2
Coturnix pectoralis	2	–	1984	0.000	98.0
Coturnix ypsilophora	2	–	3914	1.000	91.8
Coturnix chinensis	2	–	10732	0.143	70.3
Perdicula asiatica	2	–	2825	0.500	82.0
Perdicula argoondah	2	–	1356	0.000	–
Rollulus roulroul	2	–	1421	0.000	133.4
Bambusicola thoracica	1	8.8	1601	0.000	128.4
Gallus gallus	2	29.9	4324	0.364	209.9
Gallus sonneratii	2	33.9	1092	0.000	219.0
Lophura leucomelanos	2	15.3	2304	1.000	220.2
Lophura nycthemera	2	23.5	1581	0.000	250.7
Syrmaticus soemmerringii	2	9.8	298	0.000	213.2
Syrmaticus reevesii	2	14.7	1371	0.000	234.6
Phasianus colchicus	2	9.5	19094	0.727	219.5
Chrysolophus pictus	2	3.8	1447	0.000	183.7
Chrysolophus amherstiae	2	10.9	977	0.000	205.7
Pavo cristatus	2	19.1	3023	0.444	449.5
Tetrao tetrix	2	–	17617	0.000	243.2
Tympanuchus phasianellus	2	–	7575	0.000	202.7
Tympanuchus cupido	2	–	1578	0.000	206.8
Meleagris gallopavo	2	20.8	7499	0.714	413.5
Numida meleagris	1	–	17115	0.200	296.3
Oreortyx pictus	1	–	990	0.000	131.3
Callipepla squamata	2	–	2048	0.000	114.2
Callipepla douglasii	2	–	334	0.000	110.0
Callipepla californica	2	–	1464	0.667	107.7
Callipepla gambelii	2	–	1321	0.400	111.2
Colinus virginianus	2	–	4658	0.125	104.6
Cyrtonyx montezumae	2	–	1276	0.000	122.6

Score is the plumage scores (1 = monochromatic, 2 = dichromatic). Spur is simply the length of the spur (mm) taken from one or two typical specimens. Range size is expressed in 10^3 km^2; wing lengths (mm) are means of 3–14 museum specimens (Moulton *et al.*, 2001b). PIS stands for probability of introduction success. The taxonomic listing follows Sibley and Monroe (1990).

Determination of range size

If, as in passerine birds, size of native geographic range was associated with introduction success (Bock and Ricklefs, 1983; Brown, 1984), it could confound any result we obtained regarding the relationship between plumage differences and probability of introduction success. Thus, we compared the native range sizes of monochromatic and dichromatic species.

Range sizes, estimated from range maps published in the *Handbook of the Birds of the World* (Hoyo *et al.*, 1994), are presented in Table 1. We used the original digital map images and, employing different sets of ground control points for each map region, warped them to a geographic projection in a GIS environment. This method was better than manual digitalization in terms of minimizing digitization errors and retaining maximum accuracy. Subsequently, we overlaid each species distribution with a global 111×111 km grid produced in a cylindrical equal-area projection. If a species was present in a given quadrat, the quadrat area (12364.3 km^2) was multiplied with the proportion of the quadrat that was terrestrial (calculated in 0.006235° resolution) and the value added to the species' range size. We used the full range (breeding and non-breeding) of each species.

Statistical analyses

Statistical tests were performed using Minitab 8.21 (1991). We used Kruskal-Wallis tests to examine differences in range sizes between plumage monochromatic and dichromatic species, and to compare probabilities of success between these two groups.

RESULTS

Our analyses were based on the examination of specimens from all 51 species of game birds at two major museums. These 51 species were introduced a total of 179 times to the 12 islands in this study (see Appendix). The greatest number of introductions occurred on Hawai'i ($n = 34$) and the fewest on Bermuda ($n = 2$). Moloka'i, Lana'i and La Reunion shared the greatest probability of introduction success values. On these three islands, 50% of the game bird species introduced were successful (Moloka'i, 7/14; Lana'i, 7/14; La Reunion, 6/12). The lowest success rates were on Bermuda (0/2), Mauritius (2/9) and Tahiti (1/6).

Nearly half the species (23/51) were released onto a single island. Of these, 21 species failed and two succeeded. More than half the species released onto more than one island succeeded on at least one island (15/28), thereby producing mixed results (see Appendix).

As among the passerines, species that had mixed outcomes were introduced onto significantly more islands (median = 7.50) than species that were either always successful (median = 5.00) or always failed (median = 3.00). These values were significantly different in a Kruskal-Wallis test ($H' = 11.23$, $P = 0.004$). This effect is even more pronounced ($H' = 10.58$, $P = 0.001$) if the always successful and always failed groups are merged, based on the assumption that species introduced to more than one island are either mixed (median = 7.500) or not mixed (median = 3.00). So, on the one hand, in general terms of the outcomes of game bird introductions, there are similarities with the passerine birds. However, when we turn to plumage differences, the similarity ends.

Our first consideration in these analyses involved the possibility of phylogenetic constraints. Previous analyses of the relationship between dichromatic plumage and probability of introduction success have included such a consideration by testing the data using groups based on the genus as well as the species level (McLain *et al.*, 1995, 1999).

Sixteen genera in our data set were represented by a single species. These were *Ammoperdix, Bambusicola, Colinus, Crax, Cyrtonyx, Margaroperdix, Meleagris, Numida, Oreortyx, Ortalis, Pavo, Penelope, Perdix, Phasianus, Rollulus* and *Tetrao*. Six genera had two species each: *Chrysolophus, Gallus, Lophura, Perdicula, Syrmaticus* and *Tympanuchus*. Two genera had four species (*Alectoris* and *Callipepla*), one had five species (*Coturnix*) and one had ten species (*Francolinus*). Of the ten genera represented by more than one species, only one (*Francolinus*) was mixed with respect to plumage status, having both monochromatic and dichromatic species.

Following McLain *et al.* (1999), we conducted our first test at the generic level. For the genera that had both types of species, we used the average probability of success for both the monochromatic and dichromatic species, which resulted in 27 groups.

The seven monochromatic groups had a median probability of introduction success (PIS) of 0.000. The 20 dichromatic groups had a median PIS of 0.153. In a Kruskal-Wallis test, these two groups did not differ ($H' = 1.24$, $P = 0.265$).

Ignoring any phylogenetic constraints, we re-did the analysis at the species level. In this test, there were 18 monochromatic species and 33 dichromatic species. Both groups had median PIS values of 0.000, and still did not differ ($H' = 1.89$, $P = 0.170$).

Possible confounding factors

Although dichromatism has been shown to be a predictor of introduction outcomes among passerine birds (Sorci *et al.*, 1998; McLain *et al.*, 1999), we detected no such effect in our sample of 51 game birds. Why is a similar effect not apparent among game birds? We believe there are three factors that could have confounded our result. The first factor is related to body size, the second to native range size, and the third to the possibility that humans may have preferred dichromatic species, and thus expended greater effort to establish them.

If game birds of a certain size (i.e. either large or small) tended to be more or less often successful when introduced, and if, simultaneously, dichromatism was related to body size, our results might be spurious. Thus, for example, if larger game birds tended to have lower PIS values and at the same time were more likely to be dichromatic, any effect due to dichromatism on probability of introduction success could be masked. To test this possibility, we compared the wing lengths (Moulton *et al.*, 2001b) of monochromatic species with those of dichromatic species. Among the 18 monochromatic species, wing lengths ranged from 128.4 mm (*Bambusicola thoracica*) to 401.0 mm (*Penelope purpurea*), whereas among 32 dichromatic species, wing length varied from 70.3 mm (*Coturnix chinensis*) to 449.5 mm (*Pavo cristatus*). Median wing lengths were 166.8 mm for monochromatic and 162.3 mm for dichromatic species, and did not differ ($H' = 0.44$, $P = 0.505$). Thus, we found no evidence for a confounding body size effect.

The second possibility deals with size of native geographic range. Several authors have documented a positive relationship between species abundance and size of native range (e.g. Bock and Ricklefs, 1983; Brown, 1984). If the dichromatic species in our study had larger geographic ranges than the monochromatic species, and if, because of this, they were

able to achieve higher abundances, they may have been more likely to succeed where they were introduced. A range size effect of this nature could confound our results.

The native geographic range sizes of the 33 dichromatic species ranged from 298×10^3 km^2 (*Syrmaticus soemmerringii*) to $41{,}990 \times 10^3$ km^2 (*Coturnix coturnix*), with a mean of 5332×10^3 km^2. Similarly, among the 18 monochromatic species the values ranged from 294×10^3 km^2 (*Ortalis cinericeps*) to $17{,}115 \times 10^3$ km^2 (*Numida meleagris*), with a mean of 3540×10^3 km^2. The median values of dichromatic species (2048×10^3 km^2) and monochromatic species (1931×10^3 km^2) did not differ (Kruskal-Wallis, $H' = 0.50$, $P = 0.478$).

When we regressed probability of introduction success against size of native range, there was no overall effect ($F = 1.19$, $P = 0.28$). Thus, even if we ignore plumage status, there was no significant relationship between size of native range and chances for introduction success.

A third possible confounding factor is related to human preferences. Because game birds were introduced mostly for sport hunting, it is possible that humans non-randomly selected species for introduction, with respect to plumage state, and/or expended greater effort towards ensuring the success of dichromatic species. We call this the human preference hypothesis.

People introduced more dichromatic species of game birds than monochromatic species on every island except Saint Helena (Appendix), but this alone does not indicate that any additional effort was expended to improve their chances for success. However, if, within islands, there was evidence that humans expended a disproportionate effort towards introductions of dichromatic versus monochromatic species, it would explain why dichromatic species might have higher PIS values. This hypothesis could be tested only if a detailed history existed of the number of introductions and of the numbers of individuals per introduction for each species on each of the 12 islands. Unfortunately, such information is not available. However, we can conduct a partial test of this hypothesis using data for some of the introduced game birds of New Zealand from Veltman *et al.* (1996), as well as those on the Puu Waawaa ranch on the island of Hawai'i (Moulton *et al.*, 2001a).

In New Zealand, Veltman *et al.* (1996) reported that 11 dichromatic game bird species had a median number of individuals introduced of 57, whereas three monochromatic species had a median number of individuals per species of 362. Interestingly, this difference was in the direction opposite to that predicted by the human preference hypothesis, but, nonetheless, was not significant ($H' = 0.05$, $P = 0.815$).

A similar test was possible for the Puu Waawaa ranch on the island of Hawai'i (Moulton *et al.*, 2001a). The median number of individuals for the 14 dichromatic species was 87.5, whereas the median value for monochromatic species was 27. Although this difference was in the predicted direction, it also was not significant ($H' = 0.87$, $P = 0.352$).

A related hypothesis is that dichromatic species may have been introduced onto more islands than monochromatic species. If this were so, it would support the notion that humans have favoured dichromatic species with extra effort. We tested this by comparing the median number of islands of introduction for monochromatic species (median = 1.00; mean = 3.06; minimum = 1; maximum = 10) with that of dichromatic species (median = 3.00; mean = 3.76; minimum = 1; maximum = 11). These median values did not differ any more greatly than expected by chance ($H' = 0.99$, $P = 0.32$). In summary, two predictions of this human preference model failed. People clearly tended to introduce more dichromatic

Table 2. Outcomes of introductions of game birds

Number of islands of introduction	Always failed	Always successful	Mixed	Total
1	21	2	0	23
2	2	0	2	4
3	5	0	0	5
4	2	1	1	4
5	0	0	1	1
6	1	1	2	4
7	1	0	2	3
8	0	0	1	1
9	0	0	3	3
10	0	0	1	1
11	0	0	2	2

species on most of the 12 islands, but there is no evidence to suggest that more individuals of dichromatic species than of monochromatic species were released onto these islands, or that dichromatic species were, on average, released onto more islands than monochromatic species.

There are many other possible confounding factors, but it is not obvious how exactly these should be tested. For example, McLain *et al.* (1999) tested for an effect of variation in amount of parental care and clutch size as well as diet and next location. The need to test these latter factors may be reduced in game birds compared with passerines, as they are phylogenetically less diverse, nest on the ground, exhibit within-species variation in clutch size and consume similar diets.

DISCUSSION

Our results indicate that dichromatism for game birds was not a predictor of introduction outcomes as it was for passerine birds (McLain *et al.*, 1999). We hasten to point out that we tested the idea that plumage difference between the sexes influences introduction success rates of game birds. And it is possible that non-plumage traits are equally important. Such traits as body size, the presence of tarsal spurs and structural feather differences are obvious examples. Body size and feather pattern differences between the sexes would not be unexpected. And males of most (15/19 = 79%) of the monochromatic species in this study had tarsal spurs.

We further looked for an all-or-none pattern as reported by Simberloff and Boecklen (1991) for birds introduced to the Hawaiian Islands. The hallmark of an all-or-none pattern is an absence of species showing mixed introduction outcomes, whereby they succeed on some but not all islands. Of the 51 species included in our analysis, 23 were released onto a single island. Thus, these species cannot show a mixed outcome (Moulton and Sanderson, 1997). Of the remaining 28 species, 15 showed a mixed pattern in introduction outcomes (15/28 = 54%). Moreover, we found that only three of the fourteen species released onto more than five islands did not have a mixed outcome. Thus, there is no evidence for an all-or-none pattern.

On balance, our results indicate that in studying the fates of avian introductions, it might be incorrect to combine passerines and non-passerines, as these groups may differ fundamentally. Faaborg (1977) found that there was an increased ratio of non-passerines to passerines on islands when compared with mainland communities. He attributed this shift to differences in resource levels and differences in metabolic rates. The results of our analyses indicate that game birds differ from passerines in two important ways regarding introduction outcome. First, sexual plumage differences do not appear to predict outcomes of game bird introductions. And, second, probability of success is not a function of native range size in the introduced game birds, whereas it is among passerines. These results lead us to conclude that passerines and non-passerines should be analysed separately and not simply lumped as 'land birds'. However, at this time, the factors that influence the outcome of galliform and passeriform introductions do not appear to coincide.

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APPENDIX

Distribution and fates of game birds released onto 12 islands

Species	HA	KA	OA	MA	MO	LA	TA	RE	SH	BE	NZ	MR
*Ortalis cinericeps**	F											
*Penelope purpurascens**	F											
Crax rubra	F											
Ammoperdix griseogularis	F											
Alectoris graeca											F	
*Alectoris chukar**	S	S	F	S	S	S		F	S		S	
*Alectoris barbara**	F	F		F	F	F					F	
*Alectoris rufa**											F	
*Francolinus pondicerianus**	S	S	S					S	F			S
*Francolinus pintadeanus**	F							F				F
Francolinus francolinus	S	S		S	S							
*Francolinus clappertoni**	F											
*Francolinus icterorhynchus**	F											
*Francolinus capensis**									F			
*Francolinus adsperus**	F											
*Francolinus erckelii**	S	S	S	S	S	S						
*Francolinus leucosepus**	F											
*Francolinus afer**									F			
Perdix perdix	F	F		F							F	
Margaroperdix madagascarensis								S				F
Coturnix coturnix							F	S	F			F
Coturnix japonica	S	S	F	S	S	S						
Coturnix pectoralis				F		F					F	
Coturnix ypsilophora											S	
Coturnix chinensis	F	F	F	F	F			S				F
Perdicula asiatica								S				F
Perdiclua argoondah												F
Rollulus rouloul			F									
*Bambusicola thoracica**	F			F								
Gallus gallus	F	S	S	F	F	F	S	S	F		F	F

APPENDIX—*continued*

Species	HA	KA	OA	MA	MO	LA	TA	RE	SH	BE	NZ	MR
*Gallus sonnerati**	F											
Lophura leucomelanos	S											
Lophura nycthemera		F	F					F			F	
Syrmaticus soemmerringii		F	F	F								
Syrmaticus reevesii	F	F	F	F	F	F					F	
Phasianus colchicus	S	S	S	S	S	S	F	F	S	F	S	
Chrysolophus pictus		F	F				F					
Chrysolophus amherstiae			F									
Pavo cristatus	S	F	S	S	F	F	F		F		S	
Tetrao tetrix											F	
Tympanuchus phasianellus	F										F	
Tympanuchus cupido											F	
Meleagris gallopavo	S	F	F	S	S	S					S	
*Numida meleagris**	F	F	F	F	F	F		F	F		S	S
*Oreortyx pictus**	F	F									F	
Callipepla squamata	F											
Callipepla douglasii	F											
Callipepla californica	S	S	F	S	S	S	F	F			S	
Callipepla gambelii	S	F	F	F		S						
Colinus virginianus	F	F	F	F	F	F				F	S	
Cyrtonyx montezumae	F											
Monochromatic	14	6	4	5	4	4	0	4	5	0	7	3
Dichromatic	20	15	15	14	10	10	6	8	4	2	14	6
Successes	11	8	5	8	7	7	1	6	2	0	8	2
Totals	34	21	19	19	14	14	6	12	9	2	20	9

Note: We used the following references: for the islands of Hawai'i, O'ahu, Maui, Moloka'i, Lana'i, Kaua'i and New Zealand (Moulton *et al.*, 2001a); Bermuda (Wingate, 1973; Long, 1981); Saint Helena (Rowlands *et al.*, 1998); Tahiti (Thibault and Rives, 1975); La Reunion (Diamond, 1987; Barre and Barau, 1996); Mauritius (Diamond, 1987; Rountree *et al.*, 1952). Island codes are as follows: HA = Hawai'i; KA = Kaua'i; OA = O'ahu; MA = Maui; MO = Moloka'i; LA = Lana'i; TA = Tahiti; RE = La Reunion; SH = Saint Helena; BE = Bermuda; NZ = New Zealand; MR = Mauritius. F = failed; S = succeeded.*Monochromatic species. Systematic order follows Sibley and Monroe (1990).