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PHENOTYPIC VARIATION OF THE MEXICAN DUCK (*ANAS PLATYRHYNCHOS DIAZI*) IN MEXICO

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ABSTRACT.—A collection of 98 breeding Mexican Ducks (*Anas platyrhynchos diazi*) was made in Mexico from six areas between the United States border with Chihuahua and Lake Chapala, Jalisco, in order to study geographic variation. Plumage indices showed a relatively smooth clinal change from north to south; northern populations were most influenced by the Northern Mallard (*A. p. platyrhynchos*) phenotype. Most samples were fairly uniform; that from the Río Conchos area in northeastern Chihuahua was noticeably more variable than the others. Soft part coloration is described. Weights varied from 849 to 1,243 g in males and from 647 to 1,264 g in females. Measurements of total, wing, and culmen lengths and bill width were usually significantly larger in males at any one site, but showed no regular geographic trends. Hybridization between *platyrhynchos* and *diazi* phenotypes may or may not be increasing in the middle Rio Grande and Río Conchos valleys; available data are insufficient to decide. Introgression of the Northern Mallard genome into Mexican *diazi* populations may be largely historical owing to recent reductions in the number of migratory Mallards reaching Mexico. A spring 1978 aerial census yielded an estimate of 55,500 *diazi*-like birds in Mexico. Populations of *diazi* appear to be as large as the available habitat allows; management should be directed towards increasing and stabilizing the nesting habitat; and the stability of the zone of intergradation should be investigated.

The Mexican subspecies of the Mallard, *Anas platyrhynchos diazi* (Ridgway), breeds in Arizona, New Mexico, Trans-Pecos Texas, and Mexico. Characteristics of the Mexican Duck phenotype appear in breeding Mallards in northern New Mexico at Lake Burford (Wetmore 1920, Lindsey 1946, Huey and Travis 1961, Ligon 1961) and become more common southward. Breeding *A. platyrhynchos* of southern New Mexico, southeastern Arizona, and Trans-Pecos Texas are phenotypically variable, ranging from pure Northern Mallards (*platyrhynchos* phenotypes) to smaller, dark, sexually monomorphic birds (*diazi* phenotype) similar to those found farther south in Mexico. Hubbard (1977) found a wide array of phenotypic intermediates between Northern Mallards and Mexican Ducks in the general region of the United States-Mexico border with fewer *platyrhynchos* characteristics in populations to the south and more Northern Mallard influence in the phenotypes of samples to the north. He considered most of the birds from the Mexican states of Zacatecas and Jalisco southward and eastward to be phenotypically "pure Mexican ducks."

The Mexican Duck (as *Anas diazi*) was protected under the U.S. Endangered Species Act, being listed as an endangered species in 1967 (USFWS 1977). Recent information concerning populations and their status, especially that contained in Hubbard (1977), led to the birds' removal from the list in 1978 (USFWS 1978).

For the purposes of this report, "Mallard" refers to the entire taxon, *A. platyrhynchos*; "Northern Mallard" refers to *A. p. platyrhynchos*; and "Mexican Duck" refers to *A. p. diazi*.

Hubbard's (1977) analyses were limited by two factors: inadequate samples of breeding birds from large parts of the Mexican range, and a lack of recently collected material. We designed a project to secure material that would clarify patterns of morphological variation sketched by Hubbard and to provide an up-to-date assessment of the phenotypic status of breeding *A. platyrhynchos* in Mexico.

During May, June, and July 1978, teams of biologists from the Albuquerque field office of the Denver Wildlife Research Center collected specimens and data on Mexican Ducks in Mexico. Collecting started in Jalisco and Michoacán and moved northward, ending near the Chihuahua-New Mexico border, and covering about 50% of the Mexican range of *A. p. diazi*.

THE COLLECTING AREAS

Ninety-eight Mexican Ducks were collected in six areas, each representing a region of reasonable habitat uniformity and biogeographic

FIGURE 1. Northern and central Mexico showing 1978 collecting localities and the number of Mexican Duck specimens taken at each site. Dashed lines encircle the areas designated as homogeneous subsamples for population analysis. They are, from south to north, the A—Lago de Chapala, B—Altiplano, C—Durango, D—Southeastern Chihuahua, E—West-Central Chihuahua, and F—Northwestern Chihuahua samples.

integrity (Fig. 1). Duck concentrations had been located during an aerial survey in May by a team from the National Audubon Society led by Eugene Knoder.

The southernmost sample ($n = 21$; A—Lago de Chapala sample) was taken 23–30 May within 15 km of Lago de Chapala in the Cordillera Volcánica of Jalisco and Michoacán at an average elevation of about 1,800 m. The collecting area encompassed the margins of the Lago de Chapala and the cultivated valleys of its associated rivers, the Ríos Santiago and Lerma. One specimen was taken on Lago Atotonilco. We saw several hundred Mexican Ducks while working in this area.

Another collection ($n = 22$; B—Altiplano sample) was made on the high plains (*altiplano*) of northern Jalisco, Aguascalientes, and Zacatecas at an elevation of 2,000 m 16–23 June. The *altiplano* is separated from the Cordillera Volcánica by the escarpment that forms the southern rim of the Mesa Central of Mexico. This boundary region, except for the deep canyon of the Río Santiago, has little duck habitat. Duck flocks were smaller in the *altiplano,* but groups up to about 100 birds were seen on artificial lakes.

The third collection ($n = 14$; C—Durango sample) was made in the state of Durango 24–27 June in the irrigated valley of the Río Mezquital at an elevation of about 2,030 m. This collecting area is isolated from the next area by creosote-bush (*Larrea tridentata*) desert.

Most of the birds in the fourth collection ($n = 12$; D—Southeastern Chihuahua sample) were taken in the upper Río Conchos Valley near Delicias and Ciudad Camargo in southeastern Chihuahua, although two birds from the Chihuahua-Durango border area were also included. The sample was taken on 28 June and 13–15 July. Birds were scattered, but flocks of about 50 were seen. The area lies at about 2,000 m elevation. This region is biogeographically continuous with the valley of the Rio Grande in the area of the Big Bend, and it is separated from the other collecting areas by desert.

The fifth collection ($n = 21$; E—West-Central Chihuahua sample), taken 17–22 July from west-central Chihuahua, centered on the irrigated area around Cuauhtémoc. Birds here were also scattered, but flocks of 25–30 were seen.

The sixth collection ($n = 9$; F—Northwestern Chihuahua sample), taken 26–27 July, came from northwestern Chihuahua at the eastern base of the Sierra Madre Occidental. Most of the specimens were taken within 50 km of the United States border in the vicinity of Ascensión, although one bird from Galeana is included. About 75 birds were seen on one pond.

Our sample units differ somewhat from those used by Hubbard (1977) in his evaluation of Mexican Duck populations. The sample that he called "IX Jalisco" we have split into two, "Lago de Chapala" and "Altiplano," because of habitat discontinuities between them. Our "Durango" sample does not include birds from the Chihuahua-Durango border region as did his "VIII Durango" sample. Instead we have analyzed these birds with the "Southeastern Chihuahua" unit that is associated with the irrigation projects of the Río Conchos. Finally, we divided Chihuahuan specimens (Hubbard's "VIII Chihuahua") into three analytical samples, the "Southeastern Chihuahua" unit mentioned above, the "West-Central Chihuahua" specimens associated with the irrigated lands at the base of the Sierra Madre Occidental, and the "Northwestern Chihuahua" specimens from the desert grassland plains east of the Sierra Madre Occidental. We believe that these sampling subdivisions better reflect

TABLE 1. Medians and ranges for plumage indices and measurements for male *A. p. diazi* from Mexico.

Collection area	*n*	Plumage index	Weight (g)	Total length (mm)	Wing length (mm)	Culmen (mm)	Bill width (mm)
A—Lago de Chapala	10	34.3 (29.0–36.0)	1,073 (849–1,243)	588 (570–615)	275 (265–282)	41.1 (39.3–43.8)	21.5 (19.5–21.6)
B—Altiplano	14	30.3 (27.0–34.5)	1,042 (920–1,154)	570 (530–580)	282 (271–297)	42.5 (39.7–45.1)	21.2 (19.9–22.2)
C—Durango	7	28.5 (23.5–35.5)	1,011 (914–1,056)	570 (545–580)	280 (272–291)	43.2 (36.9–46.1)	20.9 (19.2–22.0)
D—Southeastern Chihuahua	6	24.8 (19.0–31.0)	1,060 (862–1,157)	553 (525–585)	280 (260–289)	40.6 (39.5–42.5)	21.0 (20.3–21.5)
E—West-Central Chihuahua	11	28.5 (20.0–30.5)	997 (861–1,075)	555 (505–580)	274 (264–296)	41.8 (39.5–43.5)	20.9 (20.2–21.9)
F—Northwestern Chihuahua	4	28.3 (25.0–30.0)	1,045 (867–1,064)	545 (535–570)	276 (257–284)	39.5 (35.6–40.6)	21.2 (18.7–21.7)
Total sample	52	29.5 (19.0–36.0)	1,028 (849–1,243)	570 (505–615)	281 (257–297)	42.0 (35.6–46.1)	21.0 (18.7–22.2)

the distribution of relatively separate genetic units.

METHODS

Ducks were generally shot in or near fields where they were feeding or marshes where they were resting. To obtain an unbiased sample, we collected birds as available; none were avoided in the field and none were discarded after they were taken. The ducks were usually processed immediately although some were frozen for a few days. Specimens were weighed, total length was measured, colors of the soft parts were noted, and 50 individuals were photographed. Twelve specimens were prepared as complete skeletons (after the wing length was measured) and the other 86 were skinned, degreased, and prepared as museum study skins.

The prepared skins were then scored for phenotypic characters of the plumage, and wing length (chord), culmen length (from the nostrils), and bill width (at the nostrils) were measured. Hubbard (1977) found that these measurements differed between Mexican Ducks and Northern Mallards. We did not measure tarsus length since Hubbard (1977) found that it did not differ significantly between populations.

The majority of the skins and skeletons are in the University of New Mexico's Museum of Southwestern Biology (MSB), with the remainder deposited at the National Museum of Natural History (USNM) in Washington, D.C. The original data books with photographs, color notes, weights, plumage indices, and measurements are filed at MSB.

We analyzed the plumage of our specimens according to the method developed by Johnsgard (1961) and refined by Hubbard (1977). Hubbard selected 18 characters of feather color, pattern, and shape, and scored 0 points for a character that matched phenotypically pure Northern Mallard, 2 points for characters that matched those of pure Mexican Ducks, and 1 point for intermediate characters. The sum of these 18 scores is the plumage index, which can be as low as 0 (pure Northern Mallard) or as high as 36 (pure Mexican Duck).

Of our total collection, six specimens prepared as skeletons were scored by only one of us (R.P.R.); the remaining 92 were scored independently by each of us. In cases where our scores differed by less than 6, we used the median between the two scores as the score for that specimen. If the difference in the initial scoring was 6 or more, we each rescored the specimen and used the median of all four scores.

The plumage of about half of the birds that we collected was worn and most birds were actively molting. Worn and faded plumage affected the scoring in a few cases, most noticeably in one Chapala bird and several from southeastern Chihuahua. Worn or faded plumage tended to make the bird appear more like a Northern Mallard than it might be genetically and to lower its plumage index. Thus, the bird from Chapala mentioned above scored 29 whereas the 20 others from the same area had median scores between 32.5 and 36.

One of us (N.J.S.) scored 14 previously collected specimens in the USNM that had also been scored by Hubbard. Ten birds were from the *altiplano,* three were from near Lake Chapala, and one was from southeastern Chihua-

TABLE 2. Medians and ranges for plumage indices and measurements of female *A. p. diazi* from Mexico. See Table 1 and Figure 1 for locations of areas A to F.

Collection area	*n*	Plumage index	Weight (g)	Total length (mm)	Wing length (mm)	Culmen (mm)	Bill width (mm)
A	11	34.5 (32.5–36.0)	914 (746–1,267)	550 (535–580)	258 (248–269)	39.4 (36.7–42.0)	19.8 (19.1–20.6)
B	8	30.8 (20.0–33.5)	935 (742–1,076)	500 (490–524)	259 (249–267)	38.0 (35.9–39.6)	19.8 (18.7–21.0)
C	6	29.5 (23.0–32.5)	871 (812–991)	540 (515–555)	269 (264–277)	40.4 (37.7–42.2)	19.9 (19.3–20.2)
D	6	21.5 (14.5–27.5)	969 (801–1,050)	520 (511–540)	265 (260–274)	38.7 (37.6–41.6)	19.8 (19.5–20.3)
E	10	28.8 (22.5–33.5)	868 (647–953)	515 (485–535)	260 (252–268)	38.2 (35.5–38.9)	19.3 (18.0–19.9)
F	5	25.5 (23.0–26.5)	923 (848–1,129)	505 (470–540)	260 (254–264)	36.1 (34.1–40.3)	19.5 (18.9–20.2)
Total	46	29.0 (14.5–36.0)	908 (647–1,267)	525 (470–580)	261 (248–277)	38.8 (34.1–42.2)	19.2 (18.0–21.0)

hua. The values were not included in the present analysis but are discussed in relation to the more recent specimens.

Non-parametric statistics were used except for weights. The plumage index is ranked on an ordinal scale, which is not appropriate for parametric measures (including means), and all non-parametric methods used gave an adequate level of resolution. Medians and quartile deviations (ranges of the central 50% of the observations) were used as appropriate non-parametric measures of central tendency and variation (Siegel 1956, Sokal and Rohlf 1969). Comparisons between samples were usually made with the Mann-Whitney "*U*" statistic. Where other tests were used they are noted in the text. "Significant" means that there is a probability of less than 0.05 that the observed results came from random samplings of the same population.

RESULTS

PLUMAGE INDEX

At no site were the indices for males and females (Tables 1 and 2) significantly different ($P > 0.10$), so all of the scores from each area are lumped in the pair-wise comparisons in Table 3. Birds from all samples were in breeding condition.

Two sites differed from the others in a pair-wise analysis of adjacent samples. The birds from the Lago de Chapala sample scored significantly higher than those of the Altiplano, whereas those from Southeastern Chihuahua scored lower than any other sample. On the other hand, the four samples from the western Mesa Central (Altiplano, Durango, West-Central Chihuahua, Northwestern Chihuahua) formed a chain of gradually declining scores, with no significant differences between them; however, we found a highly significant negative correlation between plumage scores and degrees of latitude ($P < 0.001$, Spearman Rank Correlation).

Chapala and Northwestern Chihuahua birds had the least variable plumage indices, with 2 and 3 points respectively covering the medial 50% of the values. The Altiplano, Durango, and West-Central Chihuahua samples were about equally variable (4 or 4.5 points each), and the Southeastern Chihuahua collection was the most variable with 7 points included in the medial 50% of the plumage indices (Table 3).

The greatest difference between two values for the same bird scored by both of us was 16 points, but 76% of the scores were less than 4 points apart and 86% were within 5 points. The median difference between scores was 1 point. Hubbard (pers. comm.) had given a score of 36 to each of the 14 previously-collected specimens; N.J.S. scored them from 31 to 36 with a median of 35.

Hubbard (1977) ranked the plumage indices into seven categories that verbally express a bird's estimated genetic relationship. None of our specimens ranked closer to Northern Mallard than "*diazi* × *platyrhynchos*." The median for the Lago de Chapala collection fell into the "pure *diazi*" category, those of the Altiplano, Durango, and West-Central Chihuahua samples lay in the "very near *diazi*" category, and the medians of the Southeastern and Northwestern Chihuahua collections were classified as "nearer *diazi*."

TABLE 3. Comparison of plumage indices of *A. p. diazi* of both sexes from different sites in Mexico. NS means differences are not significant ($P \geq 0.05$); *** $P < 0.002$; ** $P < 0.02$. See Table 1 and Figure 1 for locations of areas A to F.

Collection area	*n*	Median plumage index		Quartile deviation
A	21	34.5		33.5–35.5 (2 units)
		***		
B	22	30.3		28.5–33.0 (4.5 units)
		NS		
C	13	29.5		28.0–32.0 (4 units)
		***		
D	12	23.3	NS	19.5–26.5 (7 units)
		**		
E	21	28.5		25.5–29.5 (4 units)
		NS		
F	9	26.0		25.0–28.0 (3 units)

TABLE 4. Statistical comparisons of median measurements of *A. p. diazi* from Mexico. NS means differences are not significant ($P \geq 0.05$); *** $P < 0.002$; ** $P < 0.02$; * $P < 0.05$. See Table 1 and Figure 1 for locations of areas A to F.

	Males							
Collection area	Total length (mm)		Wing length (mm)		Culmen (mm)		Bill width (mm)	
A	588		275		41.1		21.5	
	***		***		NS		NS	
B	570		282		42.5		21.2	
	NS		NS		NS		NS	
C	570		280		43.2		20.9	
	NS		NS		NS		NS	
D	553	NS	280	NS	40.6	NS	21.0	NS
	NS		NS		NS		NS	
E	555		274		41.8		20.9	
	NS		NS		*		NS	
F	545		276		39.5		21.2	

	Females							
Collection area	Total length (mm)		Wing length (mm)		Culmen (mm)		Bill width (mm)	
A	550		258		39.4		19.8	
	***		NS		NS		NS	
B	500		259		38.0		19.8	
	*		***		*		NS	
C	540		269		40.4		19.9	
	NS		NS		NS		NS	
D	520	**	265	**	38.7	*	19.8	*
	NS		NS		NS		NS	
E	515		260		38.2		19.3	
	NS		NS		NS		NS	
F	505		260		36.1		19.5	

SOFT PART COLORATION

The bills of males were usually a clear olive green. A few had bills that were more yellow than green, and three males' bills tended towards a dusky olive drab. Three males had bills with a yellow suffusion above, below, and behind the nostrils; in one this took the form of orange spotting. Three males, all from southeastern Chihuahua, had varying amounts of black speckling between the nostrils which, in one, took the form of a mid-dorsal band extending half the length of the bill. The nail on the tip was dark brown or black. In some birds a narrow (2–3 mm) ring of jet black surrounded the base of the bill. The lower bill tended to be browner than the upper, and sometimes had extensive areas of black mottling basally.

The bills of hens were more variable in color. The ground color was generally a dusky orange, often diluted by olive. The mid-dorsal dark area either took the form of discrete spots and mottling or a general suffusion of brown. In some birds, the bill was almost entirely brown with orange below and behind the nostrils. In one hen, the dark markings formed a black saddle on the bill. Some ducks' bills had a combination of dull orange with an olive cast, a brown suffusion dorsally and anteriorly, and discrete black spots mid-dorsally and laterally. As in the drakes, the nail was dark brown or black. The upper bill tended to be more orange or brown than the lower bill.

Most males had bright orange legs and toes, with dusky orange webbing. Only three drakes had legs classified as being dull or pale orange. A few drakes had legs and feet that were yellower or redder than the average. The legs and feet of the hens were more variable. Two had legs that were as bright orange as many males', but most hens had legs that were clear or pale orange. Seven had dull orange-colored legs.

Sexes differed in iris color, those of males being dark brown, almost black, whereas females' were a paler brown.

WEIGHTS

The only published weights we have found for Mexican Ducks in Mexico are those of Leopold (1959). His figures, based on an unknown number of specimens probably from the Río Lerma marshes in winter, are between 960 and 1,060 g for males and between 815 and 990 g for females. Our measurements generally agreed with these ranges yet extended them in both directions (Tables 1 and 2). Our sample contained 52 males weighing between 849 and 1,243 g ($\bar{x}$ = 1,025, SD = 90) and 46 females between 647 and 1,264 g ($\bar{x}$ = 917, SD = 121).

Males were significantly heavier than females, except in the Lago de Chapala and Southeastern and Northwestern Chihuahua collections.

Weights did not differ significantly between adjacent samples of the same sex. No clear geographic trends appeared, although the Durango and West-Central Chihuahua birds tended to be lighter than the others.

MEASUREMENTS

In general, males in a particular area were significantly larger than females in all measurements; the only non-significant differences between sexes were the culmen measurements in Durango birds, the wing and culmen lengths in the samples from Southeastern and Northwestern Chihuahua, and bill widths in Northwestern Chihuahua (Tables 1, 2, and 4).

The measurements of males showed no regular geographic trends. The only significant differences in total and wing lengths between adjacent samples were between the Chapala and Altiplano birds. The differences were in opposite directions: Chapala drakes were longer but had shorter wings than Altiplano birds. The only other significantly different measurements between drakes in adjacent areas were the culmen measurements in the West-Central and Northwestern Chihuahua samples.

Measurements of females showed a somewhat different pattern. Again the Chapala birds were longer than those of the Altiplano. Durango females were significantly larger than the Altiplano and West-Central Chihuahua birds in all measurements except bill width.

DISCUSSION

REPEATABILITY OF THE PLUMAGE INDEX

Although we sometimes gave quite different scores to the same specimen, the medians of series we each scored did not differ by more than 1 point. In general, our median scores are 1 or 2 points lower than those of Hubbard (1977) for the same geographic area. Some of this difference is probably due to the birds in our sample that have worn and faded plumage, and some is a result of differing interpretations of the subjective characters used to calculate the index.

PHENOTYPIC PATTERNS

Our most important conclusions derive from the plumage indices, which are at present the most sensitive indicators of the genetic state of the population. In general, the plumage patterns we observed confirm Hubbard's conclusions (1977) concerning geographic variation.

The Chapala sample from the Cordillera Volcánica represents the southern terminus of a series of changes in the *platyrhynchos* phenotype that begins in Arizona, New Mexico, and west Texas. These changes are generally rather gradual without sharp discontinuities, especially in the chain of populations from northwestern Chihuahua to northern Jalisco along the western Mesa Central. The Chapala sample is more sharply differentiated, being statistically separable in plumage and in some measurements.

The collection most different from adjacent ones is from southeastern Chihuahua in the Río Conchos drainage. These birds are significantly different from the adjoining samples from Durango and West-Central Chihuahua, and in most characters, especially plumage, show the influence of the northern phenotype. The Río Conchos drainage contains an extensive series of large irrigation projects that have created habitat for a Mexican Duck population that is probably many times larger than that supported under pre-development conditions. The logical original source for the birds inhabiting the area is the region of Trans-Pecos Texas and northern Chihuahua along the Big Bend of the Rio Grande.

No specimens from this border region have been available until recently. Hubbard (pers. comm.) scored nine live ducks trapped at Alpine, Texas, in January 1978. Their mean score was 18.7 and the range was 14–27. In addition, a phenotypically pure Mallard hen was trapped at the same time. He also observed 24 other "Mexican-like" ducks nearby through a spotting scope. He believed that these ducks would have scored about the same as the live-trapped birds.

In an area of active hybridization, variation within the population should be greater than in other areas that are genetically more stable. Using the ranges of plumage indices given in Table 3, the Lago de Chapala sample is least variable; the Altiplano, Durango, and West-Central and Northwestern Chihuahua populations are about equally variable; and the Southeastern Chihuahua population is most heterogeneous.

Plumage characters do not vary concordantly in our sample. Instead, we found that apparent Northern Mallard influences might be expressed in any of Hubbard's plumage characters and no one trait was more reliably present than any other. Perhaps the most useful single character in distinguishing the forms was the presence of a definite greenish sheen in the speculum of Mexican Ducks versus purple in Northern Mallards. All but six of our specimens showed a greenish color. This character has either been ignored or its value de-

nied by most workers (Phillips 1912; Pitelka 1948; Johnsgard 1961, 1968; Aldrich and Baer 1970); however, Huey (1961) and Hubbard (1977) emphasized its importance in distinguishing the taxa. The white band in front of the speculum is missing in the Mexican Duck, contrary to the belief of Bellrose (1976) and many previous authors. The mosaic nature of the patterns of plumage variation can be shown by the fact that the only drakes in our entire collection showing a definite tendency towards a Mallard-like curling of the two central tail feathers were two otherwise high-scoring Mexican Ducks from Lago de Chapala. An almost identical situation has been found in Massachusetts Black Ducks (*A. rubripes*; Phillips 1912).

STABILITY OF THE HYBRID ZONE

An important taxonomic and management issue is the stability of the broad phenotypic cline between Northern Mallards and Mexican Ducks. Concern has been expressed that *diazi*, like *rubripes* of northeastern North America, is being swamped by the *platyrhynchos* phenotype and that it may eventually lose its distinctive characteristics, especially in the United States (Johnsgard 1961, Vincent 1966, Aldrich and Baer 1970, USFWS 1973, Hubbard 1977).

In order to address this problem in the United States, Hubbard (1977) divided 42 museum specimens from Doña Ana Co., New Mexico, into two series, those taken between 1893 and 1920 and those collected "essentially" between 1938 and 1960. From his analysis, he concluded that there was an historic trend from a *diazi*-like population to one that is more *platyrhynchos*-like. This conclusion must be considered tentative for at least three reasons: the samples are small (pre-1920, 25 specimens; post-1937, 17 specimens), they do not show statistically significant differences between the two periods, and the specimens are probably not random samples of the populations presented. Hubbard (1977) also concluded that there were fewer "pure" parental and more "intergrade" phenotypes in the later sample. This statement is statistically significant ($\chi^2 = 4.89$, $P < 0.05$, 1 df), contrary to Hubbard's claim that it is not.

These data indicate an increase in genetic variability (and perhaps increased introgression) in Doña Ana Co. only if the specimens are unbiased samples of the population. Increasing awareness of the intergrade nature of the New Mexico population could easily cause a higher percentage of "hybrids" to be deposited in museums than were actually present in the birds taken by earlier hunters and collectors. The claim of a recent southward spread of the Northern Mallard phenotype (USFWS 1973, Hubbard 1977) has not been documented for the U.S. populations.

An important aspect pertinent to the genetic "purity" of the Mexican Duck in Mexico is the change in the pattern of Northern Mallard migration in Mexico, which Leopold (1959), Saunders (1964), and Saunders and Saunders (1981) have well documented. Formerly (pre-1920), Northern Mallards were a conspicuous component of the wintering waterfowl population as far south as the Valley of México, and some of these northern migrants probably stayed to breed. Today the Northern Mallard is almost unknown in central Mexico and is scarce even in northern Chihuahua. The authors cited above attribute this shift in the migratory habits of the Northern Mallard to the increase in grain production in the midwestern and southern parts of the United States, so most migrating birds are effectively short-stopped before they reach Mexico. Whether or not this explanation is correct, the result of the change is to reduce the opportunity for hybridization and increase the stability of the resident gene pool.

Our data indicate that large, genetically uniform populations of *A. p. diazi* occur in many areas of Mexico. The phenotypic patterns of most of these populations show a zone of clinal variation from the southeasternmost flock to the United States-Mexico border. The only area that may be experiencing an aggressive invasion of Northern Mallard genes, based on the observed phenotypic variation, is the Río Conchos Valley. We found no evidence that the Northern Mallard genetic influence is actively moving beyond this area. On the other hand, it is possible that the Río Conchos region of southeastern Chihuahua has always had a strong infusion of northern phenotypes and the genetic situation there is stable.

CONCLUSIONS AND RECOMMENDATIONS

Before Hubbard's (1977) work clearly showed the subspecific status of *diazi* and the intergrade nature of the populations in the United States, many authors expressed the concern that the continued existence of the Mexican Duck was threatened, especially in the United States, but also in Mexico. Habitat destruction, hunting, and genetic swamping by the *platyrhynchos* genotype were cited as reasons for this fear (Huey 1963, Levy 1964, Vincent 1966, Johnsgard 1968, Aldrich and Baer 1970, USFWS 1973, Hubbard 1977). The change in opinion brought about by Hubbard's (1977) analysis can be perhaps best summed up in a quote of Aldrich (*in* USFWS 1978) ". . . the

statement of the status of the Mexican Duck which I prepared . . . and which was the basis for the original Interior Department listing of the Mexican Duck as 'endangered,' is unjustified."

Anas p. diazi is still common over a wide area of Mexico. An aerial survey of the Mexican highlands by the National Audubon Society in May and June 1978 estimated the minimum population of Mexican and Mexican-like ducks to be at least 55,500 (USFWS 1978). Statements such as those by Johnsgard (1968: 87) that "it is quite possible that the combination of uncontrolled habitat destruction and relatively unregulated hunting that now prevail in Mexico will soon destroy this entire population in a few more years," are not true. Indeed, the workers with the most Mexican experience (Leopold 1959, Saunders 1964, Saunders and Saunders 1981) have consistently emphasized that ducks are hunted much less in Mexico than they are in the United States.

The Mexican Duck seems to have become well adapted to the many large irrigation and grain agricultural systems that have been established throughout the Mexican highlands and these habitats should persist into the foreseeable future. Nymeyer (*in* Hubbard 1977) found in the breeding season that *diazi*-like ducks in New Mexico preferred riparian and pond habitats as compared with *platyrhynchos* phenotypes and that they avoided large reservoirs. In Mexico during our study, we found large numbers of Mexican Ducks, some in breeding condition, using large artificial impoundments for resting and staging areas for forays into surrounding grain fields.

At the present time, *diazi* occurs in central and northern Mexico wherever suitable habitat is available. It has adapted well to the changes wrought by civilization. Hunting pressure appears to be light. The natural wariness of the Mexican Duck that has been noted by many authors will insure its adult survival. We found no evidence for genetic swamping by the Northern Mallard phenotype, and our findings fully support the decision to remove *diazi* from the U.S. List of Endangered and Threatened Species (USFWS 1978).

Populations are as high as could be expected, given the available habitat, and management should concentrate on attempting to increase nesting habitat. We agree with Short's (1978) conclusion that management aimed at trying to reduce hybridization between the *platyrhynchos* and *diazi* phenotypes is ill-founded and potentially wasteful. The strongest statement that can be made from Hubbard's (1977) and our data is that more information is needed before any conclusions regarding temporal trends in phenotype of the Mexican Duck can be drawn. We believe that Hubbard (1977) has correctly identified Doña Ana Co., New Mexico, as a "fulcral" population, i.e., an area where phenotypes are possibly in a state of flux; another such place is the Río Conchos area in Chihuahua, Mexico. Regular unbiased samples, perhaps once every 10 years, would provide the data necessary to test Hubbard's hypothesis that the Northern Mallard phenotype is displacing *diazi*-type birds in these breeding populations.

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