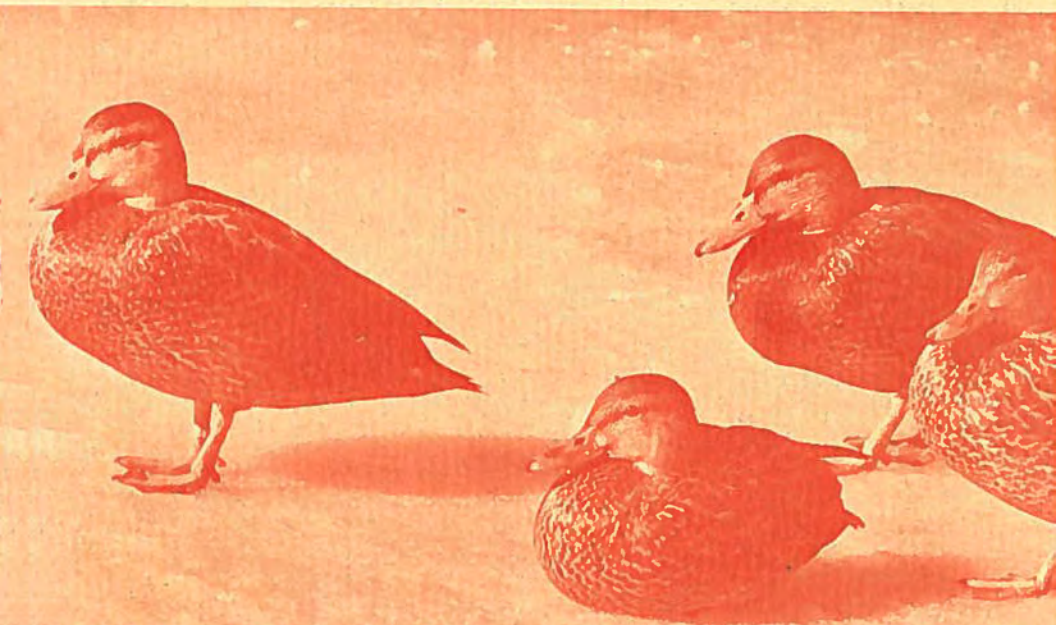
the Biological and taxonomic status of the mexican duck

John P. Hubbard



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The Biological and Taxonomic Status of the Mexican Duck

BY

John P. Hubbard

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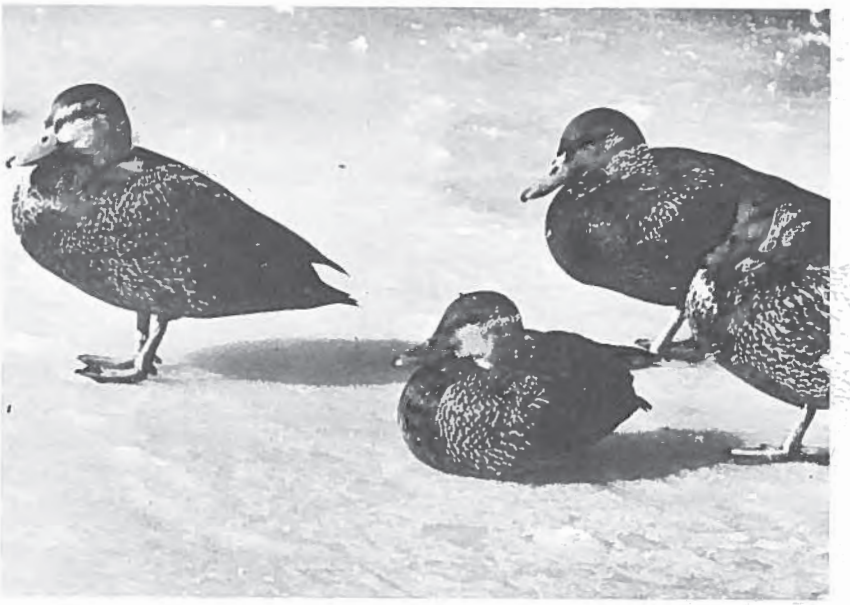

Mexican-like ducks from New Mexico, with two males (plain bills) in the background and two females (mottled bills) in the foreground. The two birds on the left are obviously hybrids with mallards, e.g. by virtue of the more solidly dark breast in the male and the pallor of the ground color in the female.

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ACKNOWLEDGMENTS

First I wish to thank curators and their staffs for allowing me to examine specimens and other data from the following collections: American Museum of Natural History; University of Arizona; California Academy of Science; Carnegie Museum of Natural History; Delaware Museum of Natural History; Denver Museum of Natural History; Field Museum of Natural History; Louisiana State University; University of Michigan Museum of Zoology; Moore Collection, Occidental College; Museum of Comparative Zoology; Museum of Vertebrate Zoology; University of New Mexico; New Mexico State University; Philadelphia Academy of Science; Sul Ross University; United States National Museum of Natural History; Yale Peabody Museum. Several people read and commented on earlier drafts of this paper, including John Aldrich, Charles Davis, Paul Johnsgard, Allan Phillips, and Sartor Williams III. Many other people supplied data and/or helped in other ways with this study, among whom are Norma Ames, William Huey, Roxie Laybourne, Lynn Nymeyer, Patrick O'Brien, Kenneth Parkes, Richard Rigby, James Sands, Gregory Schmitt, Jack Woody, and Gary Zahm. Financial support came both from the New Mexico Department of Game and Fish and the Office of Endangered Species, U.S. Fish and Wildlife Service, Albuquerque, New Mexico. To all of the above and others not specifically mentioned I am most grateful.

the Biological a n taxonomic status of the mexican duck

In several insular regions and on all major continents except South America occur taxa of the mallard duck *(Anas platyrhynchos)* complex, and in some cases the taxonomic status of such forms is still open to question. In North America occur three such taxa besides the mallard, each traditionally recognized as a species: the black duck *(A. rubripes),* mottled duck *(A. fulvigula),* and Mexican duck *(A. diazi).* All of these North American forms are known or suspected to hybridize where their ranges meet or overlap, but the extent and impact of this hybridization seems to be varied (Palmer, 1976).

The taxonomic relationships of the Mexican duck to the mallard have been investigated in some detail, including by Johnsgard (1961) and Aldrich and Baer (1970). Johnsgard (1961) upheld the assertion of such authors as Delacour (1956) and Phillips (1959) that the two are conspecific, and this treatment has been followed in such works as Mayr and Short (1970), Johnsgard (1975), and Bellrose (1976). On the other hand, Aldrich and Baer (1970) retained the two taxa as separate species, and in this treatment they have been followed by Palmer (1976) and to the present by the American Ornithologists' Union.

Previous investigations of the taxonomic status of the Mexican duck vis-a-vis the mallard have mainly dealt with each taxon more as a monolith rather than on a population-by-population basis. My study was designed to follow the latter approach, with the hope that more definite data could be gathered and a better taxonomic assessment made. The eventual aim of the study is to resolve the question of taxonomy, based on a study of specimens and on relevant biological data in the Mexican duck — a North American aridlands endemic and interesting from regardless of its taxonomic position.

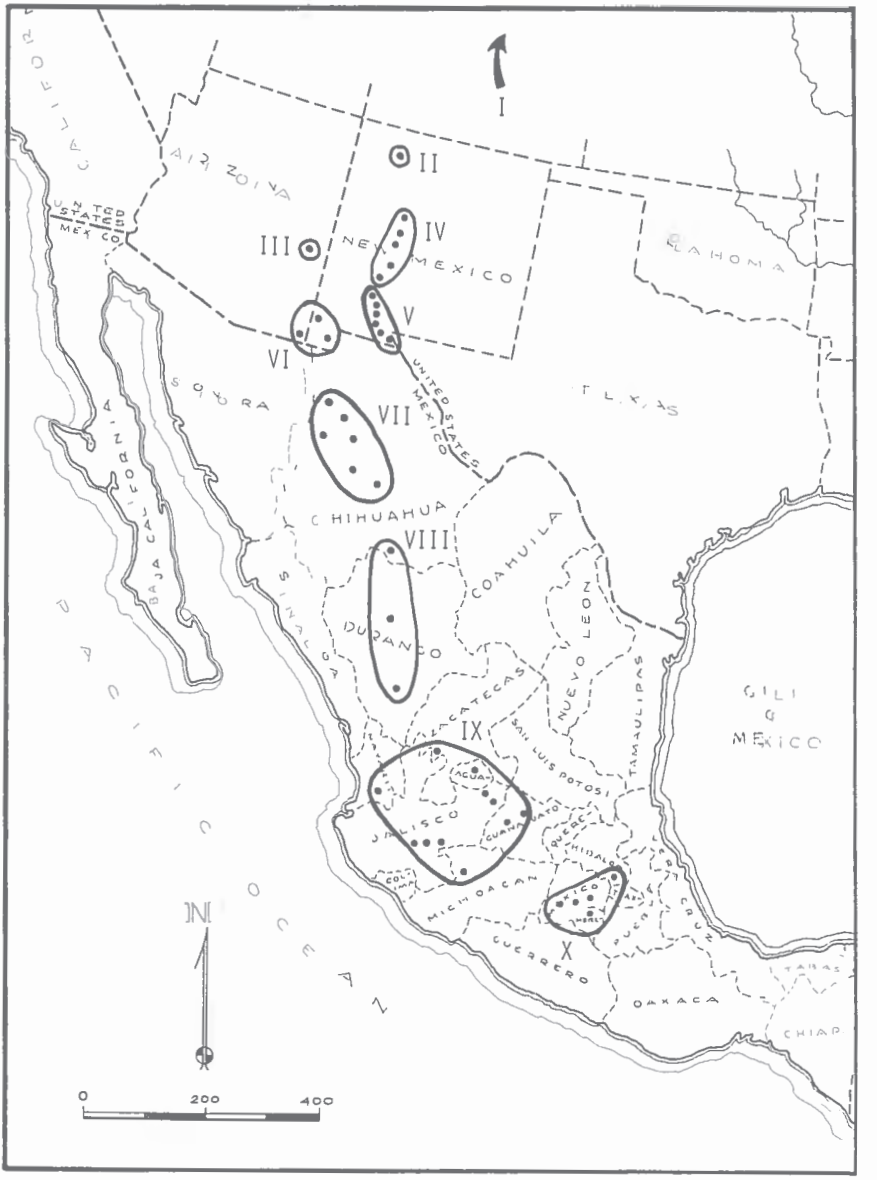

Figure 1. Samples used to study plumage and mensural relationships of mallards and Mexican ducks; I=Prairie Provinces, II=Rio Arriba County, III=Apache County, IV=Valencia County, V=Dona Ana County, VI=Hidalgo County, VII=Chihuahua, VIII=Durango, IX=Jalisco, X=State of Mexico.

METHODS

In order to assess the degree of hybridity in populations of Mexican vis-a-vis mallard ducks, I used a plumage ("hybrid") index system, based on the concepts of Anderson (1949). Johnsgard (1961) also used such a system in analyzing relationships among ducks of this complex in North America. He restricted his analysis to only six characters, as exemplified by individual feathers spanning five character states from the mallard to the black duck. Huey (1961) also set up a system of this type in comparing Mexican ducks to mallards for identification of "pure" individuals of the former, based on *diazi* stock from southwestern New Mexico.

For my comparisons I used eight divisions and 18 subdivisions of the plumages of these ducks, scoring the mallard zero (0) in each, intergrades one (1), and Mexican ducks two (2) (Table 1). Specimens were segregated into ten samples to divide the material into what I regard as logical and appropriate geographic entities, i.e. "Prairie Provinces" (actually the specimens are from a wide area, but Canadian birds dominate); four combinations from New Mexico; Apache County, Arizona; and four combinations from Mexico (Figure 1). The Prairie Province sample was used to provide baseline data on mallard populations, while the remaining samples formed points along a transect from the range of the mallard in northern New Mexico through the range of the Mexican duck in south-central Mexico.

Specimens within samples were segregated by sex for plumage and mensural comparisons. Measurements of immature birds were used in their respective sexual categories if the birds seemed full-grown. Although males and females were scored separately in plumage characters, the scoring system was equivalent, so that sexes could be lumped in computing overall indices for populations. Immatures were also scored separately, as they tend to differ somewhat from adults (e.g. in having narrower and paler ventral streaking); their indices, too, could be lumped at the populational level. Specimens were generally scored on the basis of direct comparisons with typical *platyrhynchos* and *diazi* specimens, especially in larger collections where series were available. Adult males of Mexican-like ducks show hybridity more markedly than females, because characters such as green in the head, black in the rump and crissum, and white in the outer rectrices of breeding-plumaged male mallards are quite different from those

Table 1. Plumage Characters Used in Analysis of Hybridization of Mexican Ducks and Mallards

Character	Mexican duck (Score 2 for each character)		Mallard (Score 0 for each character)		
	Female	Male	Female/immature male	Eclipse adult male	Breeding male
Head/neck					
Ground color	Buff	Buff	Whitish to buffy tan	Similar, but often with some green	Green, with white collar
Streaking	More spotlike, dusky to light brown		Elongated, dark brown to dark gray		None
Chest					
Ground color	Buff, with light brown wash	Similar, but darker wash	Whitish to light tan, some brownish wash	Similar, but more chestnut wash	Chestnut
Streaking	Extensive, broad; generally dark rich brown	Similar, but generally heavier	Light to moderate, generally dark gray-brown		Dark brown if present
Abdomen/flanks					
Ground color	Buff	Buff	Whitish to light tan		Whitish
Streaking	Extensive, broad; dark rich brown	Similar, but generally heavier	Light to moderate, generally dark gray-brown		Grayish vermiculation
Crissum					
Ground color	See Abdomen	See Abdomen	See Abdomen	See Abdomen	Blackish, with white anterior
Streaking	See Abdomen	See Abdomen	See Abdomen	See Abdomen	None
Back					
Ground color	Rich brown	Rich brown	Grayish brown	Grayish brown	Brownish gray
Streaking	Pinkish buff to light cinnamon, (may be barred as well)		Whitish to light buff or tan (may be barred as well)		None
Rump					
Ground color	See Back	See Back	See Back	See Back	Blackish
Streaking	See Back	See Back	See Back	See Back	None
Tail					
Outer feathers	Rich brown with narrow, buff to cinnamon V's; outermost feathers largely dark.		Grayish brown with broader, white to light tan V's; outermost feathers largely pale		Innermost blackish, Outermost whitish
Central pair	Dark brown and straight		Grayish brown, usually straight		Black, curled
Wing					
Speculum	Greenish blue	Greenish blue	More purplish blue	More purplish blue	More purplish blue
Bars	Narrower, anterior one often suffused with dusky		Broader, posterior and anterior both usually clear white		
Scapulars	See Back	See Back	See Back	See Back	White, with gray vermiculation
Lesser coverts	Rich brown	Rich brown	Gray brown	Gray brown to gray	Gray

of male *diazi.* Female Mexican-like ducks generally differ only in degree from mallards, and hence hybridity is more subtle and difficult to discern. Nevertheless, one finds with practice that a typicalness can be discerned in females as well as males, and thus female hybridity does not go undetected.

Measurements and plumage characters within samples were broken down by season where sample sizes permitted, i.e. into breeding samples and overall samples. **Breeding** specimens were considered to be those taken between April and September, whereas **overall** samples included these specimens plus those taken in October through March. The October through March increment from the area outside the Prairie Provinces was limited to birds scoring 4 or more, in order to eliminate migrant mallards. The use of April through September for the breeding season is arbitrary, and a more cautious segregation would have been May through August. However, a comparison of April-September sample indices with those from May-August showed no significant differences (.05 level), and hence the dates were expanded to increase sample sizes.

It should be stated that in many characters, Mexican ducks and mallards (especially females) approach each other or actually overlap. However, mallards from outside the Southwest and Mexican ducks from most of Mexico are virtually always distinguishable in the aggregate of their characters, and I have complete confidence in using the plumage index system outlined here. To be sure, even in "pure" populations there are specimens that score greater than zero among mallards and less than 36 in Mexican ducks. Consequently, rather than emphasize absolute values, it is necessary to follow the trends of scores in assessing populations. This will become more apparent when the results of the analyses are presented.

I have already alluded to the scoring system for plumage characters used in this study, i.e. total score of zero for "pure" mallard and 36 for "pure" Mexican duck. Actually, in order to reflect better what I consider a more accurate association of phenotype with scores, the following categorization was used (also see Table 4):

0-3 "pure" *platyrhynchos*
4-8 very near *platyrhynchos*
9-13 nearer *platyrhynchos*
14-22 *diazi* X *platyrhynchos*
23-27 nearer *diazi*
28-32 very near *diazi*
33-36 "pure" *diazi*

Part of the problem in establishing absolute scores for "pure" *platyrhynchos* or "pure" *diazi* is the probability that natural, intrinsic variation may produce some overlap or approach in characters. After all, these are undeniably closely related forms with a common origin, and their common genetic heritage may well produce similar character states at times. In addition, there are indications that adventitious factors (e.g. bleaching caused by water conditions) may alter character states to produce an overlap or approach in characters, particularly in Mexican *diazi.* Consequently, I again emphasize that one should dwell less on the absolute scores of populations than on the trends and relative scores that they exhibit.

Measurements taken and analyzed were: wing length (chord), tarsus length, culmen from nostril, and bill width at nostril. The accepted level of significance used in this study is at a probability (P) of .05.

At this point, some comment on the samples used in this study is in order. From a biological viewpoint, the problem of accumulating samples of birds to reflect characteristics of given breeding populations is extremely difficult in ducks. The reasons for this are several, including the facts that straggling — or at least non-breeding — ducks may linger in winter or migrational areas, while unsuccessful or post-breeding birds may move away from their breeding grounds to spend part of the summer in other areas. These are among the factors that can lead to non-representative specimens appearing in samples that have been accumulated to reflect given breeding populations. Aside from gonadal data — which are lacking for most specimens — there is almost no way to eliminate such birds from samples that have been put together using seasonal occurence as the major guideline. I fully recognize this fact in the material at hand, but at the same time I do not feel that these drawbacks seriously undermine the validity of my conclusions. Rather, the thing to be kept in mind is that plumage scores and mensural data presented here for various samples are to be viewed as part of an overall perspective — not as absolute profiles of the populations that the samples are supposed to represent. If this view is adhered to, I believe that the findings of this study can be accepted as an accurate reflection of the taxonomic status of the Mexican duck vis-a-vis the mallard in the study area.

DISTRIBUTION AND STATUS

The A.O.U. Check-list (1957) gives the overall range of *Anas diazi* as from the "upper Rio Grande Valley in northern New Mexico to southwestern Texas . . . and the highlands of central Mexico." Regarding the northern population, the so-called New Mexico duck *(A. d. novimexicana),* that source says that *diazi* breeds from Lake Burford and the Gila watershed in New Mexico southward in the Rio Grande Valley to northern Chihuahua (Ramos), "wintering in the breeding range except at higher elevations." Vagrants are attributed to "Nebraska (Dads Lake, Cherry County, October 17, 1921)" and "Colorado (Adams and Sedgewick counties)." Friedmann et al. (1950) state that *diazi* is resident in the states of Nayarit, Jalisco, Michoacan, Chihuahua, Durango, Zacatecas, Aguascalientes, Guanajuato, Mexico, Hidalgo, Tlaxcala, Puebla, and in the Distrito Federal. The mallard is listed by the A.O.U. Check-list (1957) as breeding southward, in part, to "northern Baja California, southern New Mexico, and southern Kansas," and wintering southward to "south-central Mexico" and "rarely to Panama." In Mexico, this species is listed in winter or migration in Baja California, Sonora, Sinaloa, Jalisco, Colima, Michoacan, Chihuahua, Durango, Guanajuato, Mexico, and Veracruz (Friedmann et al., 1950).

In recent years there has been further elucidation of the relative ranges of these two forms, plus establishment of the fact that the related *A. fulvigula maculosa* occurs and/or breeds in Kansas (McHenry, 1968), Colorado (Bailey and Niedrach, 1967), Oklahoma (Sutton, 1971), and perhaps elsewhere in the Southern Plains. *Diazi* is now known to breed in southeastern Arizona (Phillips et al., 1964; Tomlinson et al., 1973) and Trans-Pecos Texas (Aldrich and Bauer, 1970; Tomlinson et al., 1973) as well. In addition, *diazi* has been found in the upper San Francisco drainage on the Mogollon Plateau of New Mexico, while *platyrhynchos* has been reported as breeding southward at least to the Gila Valley (Cliff area) and central Rio Grande Valley (Bosque del Apache National Wildlife Refuge) in the state (e.g. Hubbard, 1970).

Actually, the published range of the Mexican duck needs modification, but rather than take that matter up here, I will discuss it later and in some detail. In particular, however, the reader can anticipate the reassignment of records of *diazi* from Colorado and Nebraska to other species or hybrids, as the case may be.

Table 2. Measurements (in mm) in Populations of Mallards, Mexican Ducks, and Various Hybrids of the Two

Population	Season[1]	Wing length N[2]	Wing length Mean	Wing length S.D.[3]	Tarsus length N	Tarsus length Mean	Tarsus length S.D.	Culmen length N	Culmen length Mean	Culmen length S.D.	Bill width N	Bill width Mean	Bill width S.D.
MALES													
Prairie Provinces	OA	15	280.7	7.2	15	44.2	2.4	15	43.0	1.8	15	22.3	1.1
Rio Arriba County	Br	4	280.7	2.8	4	45.0	2.3	4	42.6	2.2	4	21.9	0.5
Apache County	Br	1	281.0		1	43.0		1	41.5		1	22.0	
Valencia County	OA	9	271.2	10.9	9	45.8	2.4	8	40.6	1.5	9	20.9	1.0
Dona Ana County	Br	11	270.5	6.3	14	44.2	1.6	14	41.3	1.8	14	20.7	1.6
	OA	15	272.0	6.4	18	44.2	1.7	18	41.7	1.9	18	20.9	1.4
Hidalgo County	OA	6	268.0	7.4	6	46.3	1.7	6	43.0	1.6	6	21.2	0.9
Chihuahua	Br	7	276.7	6.6	8	45.2	1.7	8	41.3	1.7	8	21.6	1.0
	OA	10	277.0	6.2	11	44.8	1.8	11	41.5	1.6	11	21.3	1.0
Durango	OA	5	276.1	6.5	5	43.8	1.1	5	42.9	1.1	5	21.6	1.0
Jalisco	Br	10	268.0	7.2	9	45.5	1.3	9	41.7	1.5	8	19.6	1.3
	OA	15	270.6	7.5	14	46.0	1.5	14	41.8	1.7	13	20.6	1.8
State of Mexico	Br	10	267.1	10.3	13	44.5	1.7	13	41.5	2.3	13	20.1	1.5
	OA	11	267.6	9.9	15	44.5	1.8	15	41.6	2.1	15	20.3	1.5
FEMALES													
Prairie Provinces	OA	14	259.7	7.5	14	42.4	1.5	14	39.9	1.5	14	20.2	1.4
Rio Arriba County	Br	7	264.1	7.6	7	42.0	1.1	7	40.1	1.1	7	21.4	0.8
Apache County	Br	9	259.2	9.5	9	41.6	2.3	8	38.7	2.0	9	19.3	1.3
Valencia County	OA	1	245.5		1	45.5		1	36.5		1	17.5	
Dona Ana County	Br	17	254.1	5.5	24	41.7	1.7	24	38.8	2.1	24	19.3	1.3
	OA	27	256.6	6.1	24	42.2	1.8	34	49.1	2.1	34	19.7	1.3
Hidalgo County	Br	2	260.5		2	42.0		2	40.5		2	20.7	
Chihuahua	OA	8	257.0	6.8	9	42.6	0.9	9	38.3	0.9	9	19.9	1.1
Durango	OA	2	265.7		2	42.7		2	39.2		2	20.5	
Jalisco	Br	7	255.9	6.1	7	41.8	1.4	7	38.1	0.7	7	19.9	1.3
	OA	10	253.9	7.5	10	41.8	1.2	10	37.9	1.0	10	19.6	1.6
State of Mexico	Br	11	254.0	5.4	12	43.2	1.7	12	38.3	1.7	12	19.7	1.2
	OA	16	252.1	7.0	15	43.1	1.6	17	38.5	1.5	17	19.4	1.3

[1]OA = overall, Br = breeding
[2]N = number of specimens
[3]S.D. = standard deviation

MENSURAL ANALYSIS

The initial comparisons of measurements were those made between sexes, using samples with at least seven males and seven females (Table 2). In each case females were found to be significantly (.05 level) smaller than males in the four mensural characters, except that in bill width the sexes did not differ significantly in the Jalisco and State of Mexico samples. Clearly, one needs to segregate sexes for mensural comparisons in *platyrhynchos* and *diazi.*

The next set of comparisons was between "typical" *platyrhynchos,* i.e. from the Prairie Provinces, and "typical" *diazi,* i.e. from Zacatecas southward; the latter was represented by the Jalisco and State of Mexico samples. The Jalisco and State of Mexico samples are regarded as "typical" of *diazi* in plumage, and I am assuming that the same is true for measurements; *diazi*-like birds from Durango northward are variously atypical, i.e. show some *platyrhynchos*-like features in plumage. Comparisons revealed that male *platyrhynchos* were significantly longer in wing and culmen and wider in bill than *diazi,* whereas in tarsus length the smaller average size of *diazi* was not significant (.05 level). In comparison of females, the only character in which the somewhat smaller size of *diazi* was significant was culmen length; wing and tarsus length and bill width did not differ significantly.

Based on the above, it is clear that, although typical *diazi* averages smaller than *platyrhynchos* in all of these measurements, most of the differences are significant only in males. The exception is that the culmen is significantly shorter also in female *diazi,* while the tarsus is not significantly shorter in either sex.

In many studies of hybridization, elucidation is attempted of any mensural intergradation that may exist when the interbreeding forms are different in size. In a "classical" case one expects a gradual shift in measurements as one progresses from one form to the other, through a series of intergrading populations. It may also be expected that variability may increase among the intergrade populations, as in theory these are more genetically varied — due to their derivation from two parental types — than those at the extremes of a transect.

It is advisable that the mensural characters being compared be significantly

different in the parental populations. If they are not, even though average differences may exist, one cannot analyze the data with statistical validity. In other words, if one cannot demonstrate that differences are "real" at some level of probability (e.g. .05), then for practical purposes they might better be ignored, or at least not stressed.

In the following comparisons "typical" *platyrhynchos* and "typical" *diazi* are first discussed, and then intervening populations are compared to these.

Wing. With mean values in breeding populations of 267.1 to 268.0 mm, the wing in male *diazi* averages 13.6 to 12.7 mm shorter than the mean in Prairie Province *platyrhynchos* (Table 2). The *platyrhynchos*-like populations of Rio Arriba County, N.M. and Apache County, Arizona, agree closely with the latter, whereas the remaining southwestern U.S. samples are closer to *diazi.* Oddly, the *diazi*-like samples from Chihuahua and Durango average somewhat larger than "typical" *diazi,* and in fact they could be regarded — were it not for their geographic position on the transect — as "intergrades" between *platyrhynchos* and *diazi.* Females show similar intergradation to that of males, but as already indicated average differences in wing length between *diazi* and *platyrhynchos* are not statistically significant.

In essence, the pattern of variation in wing length along the transect between *platyrhynchos* and *diazi* involves an abrupt shift between the *platyrhynchos*-like populations in the Southwest (Rio Arriba County, Apache County) and *diazi*-like ones to the immediate south. Thus, intergradation is not revealed in this character in what might be regarded as the expected area; the apparent "intergradation" seen in Chihuahua and Durango is too far south (and sandwiched between shorter-winged populations) to represent a true step in a cline of intergradation between *platyrhynchos* and *diazi.* The Chihuahua-Durango situation is perhaps best regarded as variation arising independently of any interbreeding between the two forms. On the other hand, the abrupt shift between southwestern U.S. *platyrhynchos*-like and *diazi*-like populations may be due to sampling error, as there is an absence of breeding specimens from the Rio Grande Valley north of Socorro County, New Mexico.

The point should be raised that marked intergradation between the two forms in wing length (or any other character) need not exist, even in the face of gene flow. It is possible for wing length to respond to local selective pressures in such a way as to obscure or even conceal any transition that gene flow might bring about. On the other hand, if gene flow is the chief purveyor of wing length characteristics in these populations, one would expect — at least from plumage characters — that variation would indeed be greater in that area. In the absence of greater variation in wing length, one might theorize that selection is keeping variation within limited bounds in the area. However, wing length in the populations between Rio Arriba County and Durango do not stand apart as being more variable than those to either the north or south. Thus, selection may be operating to shift wing lengths toward an end of the mensural spectrum that does not reflect the gene flow between *platyrhynchos* and *diazi.*

Tarsus. As already indicated, the tarsus does not differ significantly between *platyrhynchos* and *diazi,* regardless of sex. The averages in the two forms are similar both in "typical" and in intervening populations (Table 2).

Culmen. In this character males of *diazi* average 1.3 to 1.5 mm shorter than those of *platyrhynchos* (Table 2), the difference being significant. The trend along the transect between these two forms is rather similar to that in wing length, except that the *diazi*-like populations of Durango and Hidalgo County are the ones that show "intergradation." In the case of Durango this is specious, as the populations from Chihuahua northward are similar to *diazi,* i.e. small. On the other hand, the Hidalgo County sample could reflect true intergradation, as *platyrhynchos* populations breed to the north and would presumably have a long culmen (adjacent sample sizes are too small to ascertain this).

Female *diazi* average 1.6 to 1.8 mm shorter in culmen than those of breeding *platyrhynchos* (Table 2), and the difference is significant. As in males, from the *platyrhynchos*-like population of Rio Arriba County there is a shift southward from longer to shorter culmen length. The pattern of variation shows culmen length as slightly longer in the Southwest than that of "typical" *diazi.* Chihuahua birds average about the same size as *diazi,* but Durango birds are like southwestern samples, i.e. slightly larger. In essence, then, a pattern of intergradation can be discerned between *diazi* and *platyrhynchos,* with southwestern (and Durango) birds generally intermediate to closer to *diazi.*

Bill width. *Diazi* breeding males average 2.1 to 2.7 mm narrower in bill width than those of *platyrhynchos,* and a pattern of intergradation exists between the two through southwestern U.S., Chihuahua, and Durango populations (Table 2). On the other hand, females of the two forms are not significantly different, although *diazi* averages slightly smaller. Females in intervening populations are mosaically variable and no clear pattern of variation emerges.

PLUMAGE ANALYSIS

Variability in "pure" populations

As indicated earlier, the Prairie Province sample can be regarded as representative of "pure" *platyrhynchos,* while the Jalisco and State of Mexico samples represent "pure" *diazi* (Table 3). Judging from the average scores of each of the eighteen characters treated in these samples, some variability occurs even in "pure" populations in most aspects of plumage studied. For example, "pure" *platyrhynchos* should score zero (0) in each character, but in fact in the sample of 17 males and 14 females the values average from 0 to 0.2 per specimen per character. In males the head and neck, chest, abdomen and flanks, back, and rump suites of characters all score zero, whereas the crissum, wings, and tail suites average 0.1 to 0.2. In females all suites of characters show departures from zero, with the mean value per specimen being 0.1. The only aspects within these suites that do not depart from zero are streaking of the head and neck and ground color of the chest, abdomen and flanks, and the crissum.

Among samples of "pure" *diazi,* where the expected mean per character is 2.0, we also find departures similar to the above. In breeding males from Jalisco, values range from 1.9 to 2.0, with only the chest, abdomen and flanks, crissum, and rump suites scoring the anticipated 2.0 in all aspects. Males in the State of Mexico sample more often score 2.0, with only the tail and the wing departing from this value; tail characters average 1.9, while in the wing scores are 1.7 to 2.0 in four characters. Females in the Jalisco sample average 1.7 to 2.0 per character, with only the chest, rump, and wing averaging 2.0. Females from the Mexico sample average 1.6 to 2.0 per character, but no suite is 2.0 throughout. In Jalisco, female scores below 1.9 are those of 1.8 in the streaking of the head and neck, abdomen and flanks, crissum, and back, 1.8 in the ground color of the back, and 1.7 in outer tail feather characteristics. In the State of Mexico females that score below 1.9 are those of 1.6 in the streaking of the chest, abdomen and flanks, and crissum.

The significance of the above is that even "pure" populations are variable, with *platyrhynchos* being somewhat less variable and less prone to depart from anticipated scores than are *diazi.* In *platyrhynchos* the average maximum departure (on the scale from zero to 2) is up to about 9.5%, while

Table 3. Average Score Per Character for Populations of Mallards, Mexican Ducks, and Hybrids

Character	Sample[1]	I	II	III	IV	V	VI	VII	VIII	IX	X
	Season[2]	OA	Br	Br	OA	Br	OA	Br	OA	Br	Br
	Sexes[3]	M F	M F	M F	M F	M F	M F	M F	M F	M F	M F
	Sample size.	15 14	4 7	1 9	10 1	17 25	6 2	8 7	5 2	11 7	13 12
Head/neck											
Ground color		0.0 0.0	0.0 0.3	0.0 0.2	0.8 2.0	1.2 1.2	0.8 2.0	1.5 1.7	1.2 1.0	1.9 2.0	2.0 1.9
Streaking		0.0 0.0	0.0 0.3	0.0 0.2	1.1 1.0	0.8 1.1	1.0 2.0	1.5 1.8	1.2 1.0	1.9 1.8	2.0 2.0
Chest											
Ground color		0.0 0.0	0.0 0.3	0.0 0.2	1.4 2.0	1.3 1.1	0.8 1.5	1.5 1.8	1.8 1.0	2.0 2.0	2.0 1.9
Streaking		0.0 0.1	0.0 0.3	0.0 0.2	1.2 2.0	1.1 0.8	0.8 1.5	1.5 1.4	1.6 2.0	2.0 2.0	2.0 1.6
Abdomen/flanks											
Ground color		0.0 0.0	0.0 0.3	0.0 0.2	1.1 1.0	1.3 1.1	0.8 1.5	1.5 1.8	1.2 1.0	2.0 2.0	2.0 1.9
Streaking		0.0 0.1	0.0 0.3	3.0 0.2	1.0 1.0	0.9 0.8	0.8 1.5	1.6 1.4	1.2 1.0	2.0 1.8	2.0 1.6
Crissum											
Ground color		0.1 0.0	0.0 0.3	0.0 0.2	1.1 1.0	1.2 1.1	0.8 1.5	1.4 1.8	1.4 1.0	2.0 2.0	2.0 1.9
Streaking		0.2 0.1	0.2 0.3	0.0 0.1	1.1 1.0	0.8 0.8	0.8 1.5	1.5 1.4	1.2 1.0	2.0 1.8	2.0 1.6
Back											
Ground color		0.0 0.1	0.0 0.3	1.0 0.2	1.6 2.0	1.3 1.1	0.8 1.5	1.9 1.7	1.6 1.0	2.0 1.8	2.0 1.9
Streaking		0.0 0.1	0.0 0.4	2.0 0.2	1.5 2.0	1.2 1.0	0.8 1.5	1.9 2.0	1.6 2.0	1.9 1.8	2.0 1.9
Rump											
Ground color		0.0 0.1	0.0 0.3	0.0 0.2	1.4 2.0	1.0 1.1	0.8 2.0	1.5 2.0	1.6 1.0	2.0 2.0	2.0 1.9
Streaking		0.0 0.1	0.0 0.4	0.0 0.1	1.4 2.0	1.0 1.1	0.8 2.0	1.5 2.0	1.6 2.0	2.0 2.0	2.0 1.9
Tail											
Outer feathers		0.1 0.1	0.2 0.3	0.0 0.1	1.3 2.0	0.9 1.0	0.8 2.0	1.2 1.7	1.4 2.0	1.9 1.7	1.8 1.9
Inner pair		0.1 0.1	0.2 0.3	0.0 0.2	1.2 2.0	1.0 1.0	1.0 2.0	1.1 1.7	1.4 2.0	1.9 2.0	2.0 2.0
Wing											
Speculum		0.1 0.1	0.0 0.1	0.0 0.2	1.3 2.0	1.0 1.2	0.8 2.0	1.4 2.0	1.4 1.0	1.9 2.0	1.7 2.0
Bars		0.1 0.1	0.0 0.1	0.0 0.2	1.5 2.0	1.2 1.2	0.7 2.0	1.7 2.0	1.4 1.0	2.0 2.0	1.9 1.9
Scapulars		0.1 0.1	0.0 0.3	0.0 0.2	1.4 2.0	1.2 1.1	0.8 2.0	1.7 2.0	1.8 2.0	2.0 2.0	2.0 2.0
Lesser coverts		0.1 0.1	0.0 0.3	0.0 0.2	1.0 2.0	1.2 1.1	0.8 2.0	1.7 2.0	1.8 2.0	2.0 2.0	2.0 2.0

[1]I = Prairie Provinces
II = Rio Arriba County
III = Apache County
IV = Valencia County
V = Dona Ana County
VI = Hidalgo County
VII = Chihuahua
VIII = Durango
IX = Jalisco
X = State of Mexico
[2]OA = overall, Br = breeding
[3]M = male, F = female

that in *diazi* is up to about 24.8%. On the average of all characters (18), the departure is only 2.4% in male *platyrhynchos* and 3.8% in females, while in male *diazi* it is about 6.2% and females 9.1% to 10.5%. Part of the higher values in *diazi,* especially females, could be due to suspected bleaching of the plumage, which causes greater pallor than is typical of this form. However, I do not believe that this factor is serious enough to negate the value of using the index for the affected aspects of plumage.

This degree of variability in what might be thought of as the definitive characters within supposedly "pure" populations might be disconcerting, except that intervening populations are far more variable (Table 3). Furthermore, the latter populations demonstrate trends in variability that are best explained in terms of interbreeding and gene flow (introgression) between *platyrhynchos* and *diazi.* As mentioned earlier, the important consideration in evaluation of the characteristic of populations is less a matter of absolute than of relative values. For example, I have indicated above that on the average *platyrhynchos* departs from the expected score of zero by about 2.4 to 3.8% for 18 characters, whereas *diazi* does so by 6.2 to 10.5%. By comparison, except for the *platyrhynchos*-like populations in Rio Arriba County, which score an average of 1.4% above zero, the intervening populations between *platyrhynchos* and *diazi* differ rather markedly from either zero or 2.0 in the average score for each specimen in the 18 characters. The percent departures (given as: from zero/from 2.0) are as follows: Apache County 8.6/91.8; Valencia County 57.0/42.9; Dona Ana County 50.0 to 52.4/50.0 to 47.5; Hidalgo County 38.1/71.9; Chihuahua 71.4 to 85.7/28.6 to 14.3; and Durango 71.4/28.6.

Variation among characters

In the "pure" populations discussed above, characters differed in the scores from anticipated values (i.e. zero or 2.0) by up to 9.5% in *platyrhynchos* and up to 24.8% in *diazi* (Table 3). This means that within samples, characters also differed among themselves in their scores by similar percentages. What might be expected is that some characters would depart more consistently from expected values than others; however, X^2 testing does not substantiate this. Thus in "pure" populations, the 18 characters can be said to vary from expected scores of zero or 2.0 at about the same rate, or at least at rates that do not differ significantly inter se. The significance of this is that, in general, characters need not be singled out for emphasis in defining "typical" *platyrhynchos* or "typical" *diazi.* Conversely, other characters are not definable as being so variable as to be deleted, or at least weighted in some degree, for purposes of characterizing either of these taxa.

Given that characters seem to have a similar degree of variability in "pure" populations, one does not have to assume that in intergrade populations the same relationship will pertain. After all, in a different genetic milieu, such as hybridization might produce, characters might emerge in a way so as to produce patterns of variability that differ from that of the parental stock. Dominance, for example, could suppress some characters while allowing

others to be expressed. The net result might be that in intergrade populations, certain traits of *diazi* might be expressed while others would be those of *platyrhynchos.* If this were to occur, the degree of departure of the former from a score of 2.0 would be zero and of the latter 100% (or vice versa if zero were the baseline score). With this spectrum of departure values, one would expect a degree of variability that could be demonstrated through X^2 or other statistical testing.

In order to evaluate the above possibility, I subjected the highly intergrade Dona Ana County sample to X^2 testing, with samples segregated into breeding males and breeding females. Values in males of .436 (19 degrees of freedom, df) and females of .300 (24 df) indicated no significant difference (.05 level) in the variability of characters. Hence, based on these samples we can say that the characters are about equally variable in hybrid populations.

The above can be interpreted as meaning that, in hybrid populations, characters of either *diazi* or *platyrhynchos* can be affected equally by gene flow. Thus no clear dominance can be demonstrated in traits of either form, although in practice an influence is more easily detected in some characters than in others. For example, in breeding plumage males that are otherwise rather dark (i.e. *diazi*-like), *platyrhynchos* characteristics can often be seen in the form of some greenish iridescence of the head, blackish on the rump, and/or black and white on the crissum. However, comparisons with typical *diazi* specimens often reveal that such specimens are also generally somewhat paler (including the tail) and otherwise depart from the norm. Although subtle, these departures go hand-in-hand with the more conspicuous signs of introgression. Hence, in practice all characters appear subject to the effects of gene flow in the populations that intervene between "pure" *platyrhynchos* and "pure" *diazi.*

Above I mentioned that no clear dominance was found between the traits of either *platyrhynchos* or *diazi*, but this does not mean that such was entirely absent. For example, I found that most male birds that I regarded as hybrids (including various back-crosses) were "hen-feathered" rather than like breeding male *platyrhynchos.* This could result from the fact that most of the hybrids come from populations where, at least traditionally, *diazi* outnumbered *platyrhynchos.* This could produce swamping in favor of *diazi* and thus the situation above. On the other hand, the few hybrids in plumage approaching that of breeding *platyrhynchos* generally showed only slight departures from the latter in most characters. From this, it may well be that there is, in fact, a dominance of the "hen-feathered" plumage beyond a certain low threshold, even though traits of breeding male *platyrhynchos* express themselves strongly well beyond this threshold.

Plumage index scores

As indicated earlier, with the plumage index used here "pure" populations of *platyrhynchos* should score in the range of 0 to 3 for 18 characters, while "pure" *diazi* should score 33 to 36 (Table 4, Figure 2). Based on this scale the combined samples of males and females from the Prairie Provinces and Apache County are "pure" *platyrhynchos,* while those from Zacatecas southward are "pure" *diazi.* The former scored 1.0 and 2.4 and the latter

Table 4. Plumage Indices of Populations

Sample	Season[1]	Males N	Males Mean	Males S.D.	Females N	Females Mean	Females S.D.	Total N	Total Mean	Total S.D.
Prairie Provinces	OA	15	0.9	1.3	14	1.2	1.4	29	1.0	1.3
Rio Arriba Co.	Br	4	0.7	0.9	7	5.1	9.0	11	3.5	7.3
Apache Co.	Br	1	1.0	—	9	2.6	6.2	10	2.4	5.9
Valencia Co.	OA	10	23.3	10.9	1	31.0		11	20.5	11.9
Dona Ana Co.	Br	17	20.0	11.5	26	24.1	11.1	43	22.6	11.6
	OA	21	20.7	10.5	36	23.2	11.5	57	22.8	10.6
Hidalgo Co.	Br	2	32.0	—	6	14.8	5.4	7	17.9	9.4
Chihuahua	Br	8	27.7	4.5	7	32.4	3.7	15	29.9	4.7
	OA	11	27.8	3.8	8	31.0	5.3	19	29.2	4.6
Durango	OA	5	25.8	5.1	2	30.5		7	27.1	5.7
Jalisco	Br	14	35.3	1.1	10	35.2	1.5	24	35.4	1.1
	OA	18	35.3	1.1	13	33.3	7.1	31	34.5	4.6
State of Mexico	Br	9	35.7	0.5	12	34.8	1.2	21	35.2	1.0
	OA	12	35.7	0.5	17	35.9	1.2	29	35.2	1.0

[1]OA = overall, Br = breeding

35.4 and 35.2, respectively. The Rio Arriba County sample is also close to *platyrhynchos,* scoring 0.7 in males, 9.0 in females, and 3.5 overall. The presence in that breeding population of females scoring 12 and 23 is responsible for raising the index well above the level for *platyrhynchos.* In fact, these two hybrid birds are also primarily responsible for older literature citations of *diazi* occurring at Burford Lake in New Mexico; more recently, Huey and Travis (1961) submitted additional evidence of such occurrences there.

In general, the plumage index shows a pattern of intergradation that extends from northern New Mexico south through Durango, with populations along the lower Rio Grande (El Paso, Texas north to at least Bernalillo County) being near-intermediate (20.5 to 22.6). Admittedly, as one progresses northward the transition from such intermediate scores to that of 3.5 in Rio Arriba is abrupt, but this could be due in part to the lack of adequate material — especially breeding birds — from the central Rio Grande Valley (Socorro to Sandoval County). Southward, the transition from the intermediacy found in the lower Rio Grande is more gradual, i.e. with scores of 27.1 to 29.9 in breeding birds from Durango and Chihuahua. Taken in total, from this evidence, it is apparent that *platyrhynchos* and *diazi* intergrade over the area between northern New Mexico and southern Durango.

At this point, it seems worthwhile to mention some other samples, which were not adequate for inclusion above, but which provide interesting insights nonetheless. Particularly interesting is a sample of five adults from Tularosa Creek, Catron County, New Mexico, taken in October 1967 and 1968. Together these birds score 32.4, a figure that approaches "pure" *diazi* and is the highest for any sample available from the United States. Taken alone, this score suggests that perhaps in Catron County *diazi* and *platyrhynchos* interbreed very little, for indeed the latter appears to breed regularly in the area along with *diazi.* However, I suspect that this is a highly biased sample, for my observations of ducks of this complex in Catron

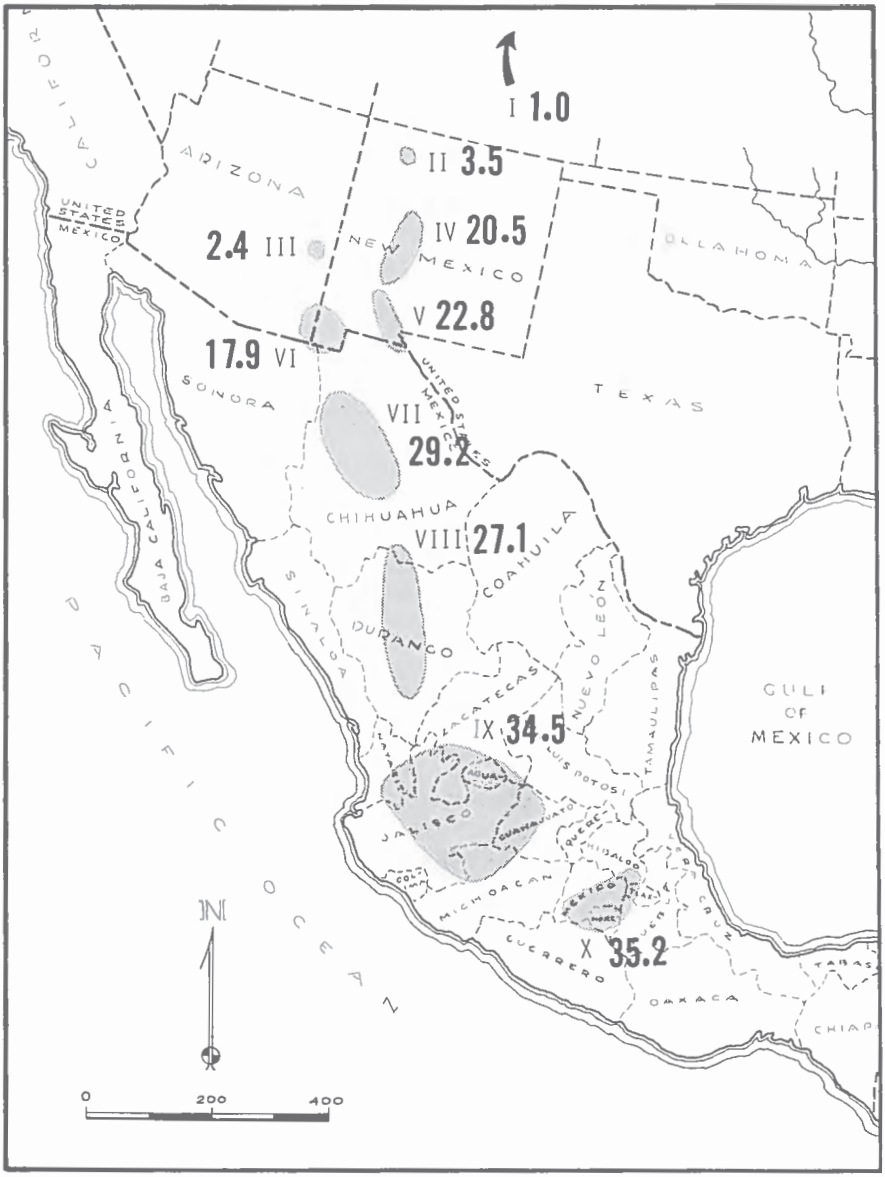

Figure 2. Plumage indices of populations along a transect from mallards to Mexican ducks (see Fig. 1 for names of samples used in this analysis and Table 4 for details on indices used).

County indicate that many hybrids occur there, including on Tularosa Creek and at Centerfire Bog and rarely in the lower San Francisco Valley. This is not to say that the relationships between these two taxa might not be different in Catron County, for different degrees of reproductive isolation are known to exist among various populations of other hybridizing taxa (e.g. Sibley and Sibley, 1964); however, my data do not support this as a valid possibility in Catron County.

Another sample of interest comes from Cochise County, southeastern Arizona, where *diazi* appears to be flourishing in recently created habitat in the Willcox area (e.g. Tomlinson et al., 1973). Actually, few specimens are available from that population, but four breeding-season specimens from there indicate that *platyrhynchos* and hybrids are also present *(platyrhynchos,* Univ. Arizona, 12077 and 12078, each scoring zero; hybrids, Univ. Arizona, 12076 scoring 11 and 12075 scoring 16). In fact, the only Mexican-like duck from the area is one taken in December 1974 (Univ. Arizona, 11906), and it scores only 27. In the aggregate these five birds score 10.8, but the sample size is small and may well not be representative of the population as a whole.

Frequencies of different phenotypes in the populations

It may already be apparent to the reader that reliance on the hybrid index alone could lead to specious conclusions. For example, one could have equal numbers of specimens of two taxa from an area in which no hybridization occurs, yet an average of their scores would show the population to be intermediate! A way around the problem is through presentation of data on phenotypic frequencies in populations (Table 5; also see Methods). For example, among "pure" populations of *platyrhynchos* and *diazi,* one finds that over 90.0% of the combined specimens (males and females) are indeed scored as "pure," i.e. fall in the range 0 to 3 in *platyrhynchos* and 33 to 36 in *diazi* (Table 5). In the State of Mexico sample all breeding (as well as overall) specimens were scored as "pure" *diazi,* whereas 94.1% of the Jalisco sample is so scored (the remaining 5.9% score as "very near *diazi*"). In the overall Jalisco sample, 92.0% of the specimens are "pure," 4.0% "very near *diazi,*" and oddly, 4.0% scores "nearer *platyrhynchos.*" The latter is the result of a score of 10 from a juvenal female collected on 20 October 1940 at San Jacinto, Aguascalientes (Moore Collection, 27920). This bird is definitely pale throughout, and judging from its age it was almost certainly raised locally. Its presence must be regarded as highly unusual among *diazi* populations in southern Mexico, and I would surmise that it is the product of one or more *platyrhynchos*-like parents.

The Prairie Province sample scores 93.3% "pure" *platyrhynchos* and 6.7% "very near *platyrhynchos,*" while the *platyrhynchos*-like breeding populations of Rio Arriba and Apache counties have 81.8 and 80.0%, respectively, of their combined samples scoring "pure." In each the remaining specimens are clearly hybrids, in the categories "nearer *platyrhynchos,*" "intermediate *platyrhynchos* X *diazi,*" and "nearer *diazi.*" Frequency of phenotypes in these populations strongly indicates the beginning of the shift along the transect from *platyrhynchos*-like populations

Table 5. Phenotypic Frequencies in Populations

Population Season[1] & sample size	"pure" *platy.*	very near *platy.*	nearer *platy.*	intermediate *platy.X diazi*	nearer *diazi*	very near *diazi*	"pure" *diazi*
scores:	0-3	4-8	9-13	14-22	23-27	28-32	33-36
I. Prairie Provinces							
OA 15 males	93.3%	6.7%					
OA 14 females	93.3	6.7					
OA 29 total	93.3	6.7					
II. Rio Arriba County							
Br 4 males	100.0%						
Br 7 females	71.4		14.3%		14.3%		
Br 11 total	81.8		9.1		9.1		
III. Apache County							
Br 9 females	77.8%		11.1%	11.1%			
Br 10 total	80.0		10.0	10.0			
IV. Valencia County							
OA 10 males		10.0%	20.0%	10.0%	20.0%	30.0%	10.0%
OA 11 total		9.1	18.2	9.1	18.2	36.3	9.1
V. Dona Ana County							
Br 17 males	11.8%	17.6%		11.8%	23.5%	29.4%	5.9%
Br 25 females	8.0	12.0	4.0%	8.0	8.0	44.0	16.0
Br 42 total	9.5	14.3	2.4	9.5	14.3	38.1	11.9
OA 21 males	9.5%	14.3%		19.0%	23.8%	28.6%	4.8%
OA 34 females	5.9	11.8	2.9%	8.8	58.8	50.0	11.8
OA 55 total	7.3	12.7	1.8	12.7	14.5	41.9	9.1
VI. Hidalgo County							
OA 6 males		16.7%		83.3%			
OA 8 total		12.5		62.5		12.5%	12.5%
VII. Chihuahua							
Br 8 males				12.5%	37.5%	37.5%	12.5%
Br 7 females					14.3	28.6	57.1
Br 15 total				6.7	26.7	33.0	33.0
OA 11 males			9.1%		36.4%	45.4%	9.1%
OA 8 females			12.5		12.5	25.0	25.0
OA 19 total			10.6		26.3	36.8	26.3
VIII. Durango							
OA 5 males			20.0%		40.0%	40.0%	
OA 7 total			14.3		42.8	28.6	14.3%
IX. Jalisco							
Br 10 males							100.0%
Br 7 females						14.3%	85.7
Br 17 total						5.9	94.1
OA 15 males							100.0%
OA 10 females		10.0%				10.0%	80.0
OA 25 total		10.0				4.0	92.0
X. State of Mexico							
Br 13 males							100.0%
Br 16 females							100.0
Br 29 total							100.0
OA 16 males							100.0%
OA 20 females							100.0
OA 36 total							100.0

[1]OA = Overall, Br = breeding

southward through intervening populations to *diazi.* Actually, the shift in certain measurements and in the plumage indices, as already discussed, is rather abrupt.

Other U.S. populations along the transect show an increasing shift toward *diazi,* but "pure" specimens of that form still comprise only 9.1 to 16.0% of the samples in Valencia, Dona Ana, and Hidalgo counties. On the other hand, the level of "very near *diazi*" specimens is higher (28.6 to 50.0%, except that in the notably intergrade population of Hidalgo County the value is 12.5%). Perhaps of all the populations represented, that from Dona Ana County in the lower Rio Grande Valley of New Mexico is the fulcral one as far as reflecting the shift from *platyrhynchos* to *diazi* (the more northern Valencia County sample is smaller and lacks breeding birds). Examination of the Dona Ana County sample reveals that in combined (male and female) breeding specimens, 11.9% are "pure" *diazi* and 38.1% are "very near *diazi,*" versus 9.5% "pure" *platyrhynchos* and 14.3% "very near *platyrhynchos*" (Table 5). The remaining specimens fall in the categories "near *platyrhynchos*" (2.4%),"intermediate" (9.5%), and "nearer *diazi*" (14.3%). In essence, 23.8% of the specimens are essentially *platyrhynchos,* 50.0% essentially *diazi,* and 26.3% are variously intergrade.

In a way the above figures are deceiving, in that they represent the summation of data from specimens collected as early as 1893 and as recently as 1970. If one separates the specimens into earlier and later collected categories, a rather different picture emerges (Table 6). For example, through 1920 we see that 15.7% of the specimens were essentially *platyrhynchos,* 55.4% essentially *diazi,* and 19.3% variously intergrade. Subsequent to 1920 (largely 1938 and later), these categories shift, respectively, to 35.3, 29.4 and 34.2%. Thus, *platyrhynchos*-like and intergrade birds more than doubled and *diazi*-like birds declined by about half after 1920. This indicates a marked shift away from *diazi* and toward both *platyrhynchos* and intergradation in this area in recent years. However, a X^2 (5.66, 6 df) testing shows that the differences in frequency of phenotypes is not significant at the .05 level.

On the other hand, if one compares plumage indices there is a significant difference between the periods. Thus, the combined breeding population scored 25.3 ± 10.6 (N=24) before 1920, but this dropped to 18.5 ± 11.1 (N=16) after that. This indicates, as did the shift in frequencies of phenotypes, that the population has become more intermediate — or less *diazi*-like — since 1920.

South of Dona Ana County, in Chihuahua and Durango, one finds that *platyrhynchos*-like birds are absent as breeders, but on the other hand, "pure" *diazi* comprise only 26.3 and 14.3% of the combined samples, respectively. However, when coupled with "very near *diazi*" specimens, birds that are essentially *diazi* constitute 63.1 and 42.9%, respectively, of the combined samples (the Durango sample is small and not limited to breeding birds, hence its frequency of phenotypes is of only general interest). The remaining specimens are variously intergrade, and overall in both Durango and Chihuahua we see a continuation of the shift from *platyrhynchos* to

the Biological and Taxonomic Status of the Mexican Duck

In several insular regions and on all major continents except South America occur taxa of the mallard duck *(Anas platyrhynchos)* complex, and in some cases the taxonomic status of such forms is still open to question. In North America occur three such taxa besides the mallard, each traditionally recognized as a species: the black duck *(A. rubripes),* mottled duck *(A. fulvigula),* and Mexican duck *(A. diazi).* All of these North American forms are known or suspected to hybridize where their ranges meet or overlap, but the extent and impact of this hybridization seems to be varied (Palmer, 1976).

The taxonomic relationships of the Mexican duck to the mallard have been investigated in some detail, including by Johnsgard (1961) and Aldrich and Baer (1970). Johnsgard (1961) upheld the assertion of such authors as Delacour (1956) and Phillips (1959) that the two are conspecific, and this treatment has been followed in such works as Mayr and Short (1970), Johnsgard (1975), and Bellrose (1976). On the other hand, Aldrich and Baer (1970) retained the two taxa as separate species, and in this treatment they have been followed by Palmer (1976) and to the present by the American Ornithologists' Union.

Previous investigations of the taxonomic status of the Mexican duck vis-a-vis the mallard have mainly dealt with each taxon more as a monolith rather than on a population-by-population basis. My study was designed to follow the latter approach, with the hope that more definite data could be gathered and a better taxonomic assessment made. The eventual aim of the study is to resolve the question of taxonomy, based on a study of specimens and on relevant biological data in the Mexican duck — a North American aridlands endemic and interesting from regardless of its taxonomic position.

diazi. The situation in Chihuahua serves to emphasize that the fulcrum in this shift is probably in Dona Ana County and vicinity, although this could also apply as well to the populations that at least formerly ranged northward in the Rio Grande Valley, perhaps to the Albuquerque area.

Commentary: It should be recognized that the analyses of plumage characters discussed here are based primarily on specimens collected several decades ago. This means that what I have presented may no longer reflect the morphological profiles in some populations of *diazi*-like ducks. This is especially apt to be true in the Southwest, where large-scale releases of pen-reared, essentially pure *diazi* have been carried out in recent years. However, these releases and any shifts they may have caused in morphology are artificial, and in the long run may be reversed by natural events. Whatever the case, the situation as I have outlined it may well be viewed as best reflective of the relationships of *diazi* and *platyrhynchos* in the region. Until we have reason to believe otherwise, I recommend that this assessment be accepted as such.

OTHER POINTS OF COMPARISON BETWEEN *diazi* AND *platyrhynchos*

Geographic variation

To the extent of subspecies being described, both *diazi* and *platyrhynchos* might be regarded as being only slightly variable geographically. *A.p. platyrhynchos* ranges through North America and Eurasia as a breeder, wintering southward to Central America, Borneo, and Africa; the only other race is *A. p. conboschas,* a slightly darker form confined to Greenland (A.O.U., 1957).

In *diazi,* two races have been recognized in the past: *novimexicana* Huber 1920 (type locality: Rio Grande, west of Las Cruces, Dona Ana County, N.M.) and nominate *diazi* Ridgway 1886 (type locality: Laguna del Rosario, Tlaxcaia, Mexico). The former was characterized, rather after the fact, as differing in at least a greater tendency to have the upperparts barred, scalloped, or edged with paler coloration. Aldrich and Baer (1970) and others have discounted this difference, but they gave no quantification of the character. In my analysis, I found the tendency toward having these markings sexually dimorphic in "pure" *diazi* populations, with females much less frequently affected than males. I found the ratio of barred birds to be about 3:1 (75.0%) in males, versus at most one in six (16.7%) in females. Within males, the 3:1 ratio seems to prevail among "pure" specimens (score 33-36) throughout the range of *diazi,* but in specimens scored variously as intergrades (i.e. 15-32), the incidence is higher. For example, among 12 such birds at the U.S. National Museum, all show some degree of dorsal barring. One also sees a higher incidence in females among intergrades, as 3 of 7 in the above collection displayed this. I did not find barring present in any specimen scoring less than 15, which may indicate that barring is masked or displaced by strong *platyrhynchos* influence.

From the above it appears that *diazi-platyrhynchos* intergrades are more likely to be barred than "pure" *diazi,* but the latter shows a high incidence of barring throughout its range. Clearly dorsal barring is not a valid means of distinguishing subspecies among "pure" populations of *diazi,* as already suggested by such authors as Aldrich and Baer (1970). The latter also

discount other characters in the plumage and measurements as allowing the recognition of *novimexicana,* and I believe that this assessment is valid throughout the range of *diazi. "Novimexicana"* has its range entirely within the zone of intergradation between *diazi* and *platyrhynchos;* and specimens from there are so variable that a population cannot be characterized in any simple way. In view of the absence of any consistent and homogeneous set of characteristics, I believe that an adequate basis exists for rejecting *novimexicana* as a valid race of *diazi.*

Sexual dimorphism

That *platyrhynchos* differs markedly from *diazi* — as well as from *rubripes* and *fulvigula* — in having pronounced sexual dimorphism in the breeding plumage is well-known. However, it would be incorrect to say that *diazi* and the others are monomorphic, as differences in colors of the soft parts and size, as well as subtle plumage differences, do exist. There are also vocal and behavioral differences. Furthermore, Johnsgard (1961) has emphasized that the marked plumage dimorphism in *platyrhynchos* has a simple genetic basis, and thus it is probable that this characteristic should receive no undue emphasis in comparing *diazi* to that form. On the other hand, there are intriguing questions that have not been fully explored — nor shall they be here — as regards the degree of dimorphism in this complex of ducks and such aspects as behavior.

Suffice to say, the subject appears to be a complex one, and no simple statement appears to be possible concerning it. For example, one might assume that increased dimorphism would come into play especially where the breeding season is short and rapid establishment of pairs is necessary for successful reproduction. Yet, *A. rubripes* breeds as far north as many *platyrhynchos,* in spite of its reduced dimorphism. Of course, such factors as duration of pair bond and amount of sympatry with similar species could also be among those acting in regards to plumage dimorphism. In regard to sympatry with other ducks, *diazi* certainly displays less in the breeding season than *platyrhynchos,* but so far there seems to be little to indicate that the pair bond is materially different. At any rate, while this is an interesting subject for additional study, sexual dimorphism at this point does not, per se, seem to set *diazi* off markedly from *platyrhynchos.*

Soft part coloration

There have been various statements about the soft part colors of *platyrhynchos* and *diazi* and how the two forms may differ from each other. In general, the differences center on the mandible coloration of living birds, which differs in at least adult males of the two forms and may also in females and in the young. In adult males of *platyrhynchos* the mandible is typically yellow, which contrasts markedly with the pale green color that typifies the mandible of *diazi* (e.g. "pure" specimens from Mexico, Guanajuato, Jalisco). In females the mandible of adult *platyrhynchos* is orange, with brown to blackish spotting that may coalesce to form a "saddle." Females of *diazi* are apparently rather variable, even in supposedly "pure" populations in southern Mexico. Data on specimen tags of Jalisco and Nayarit specimens

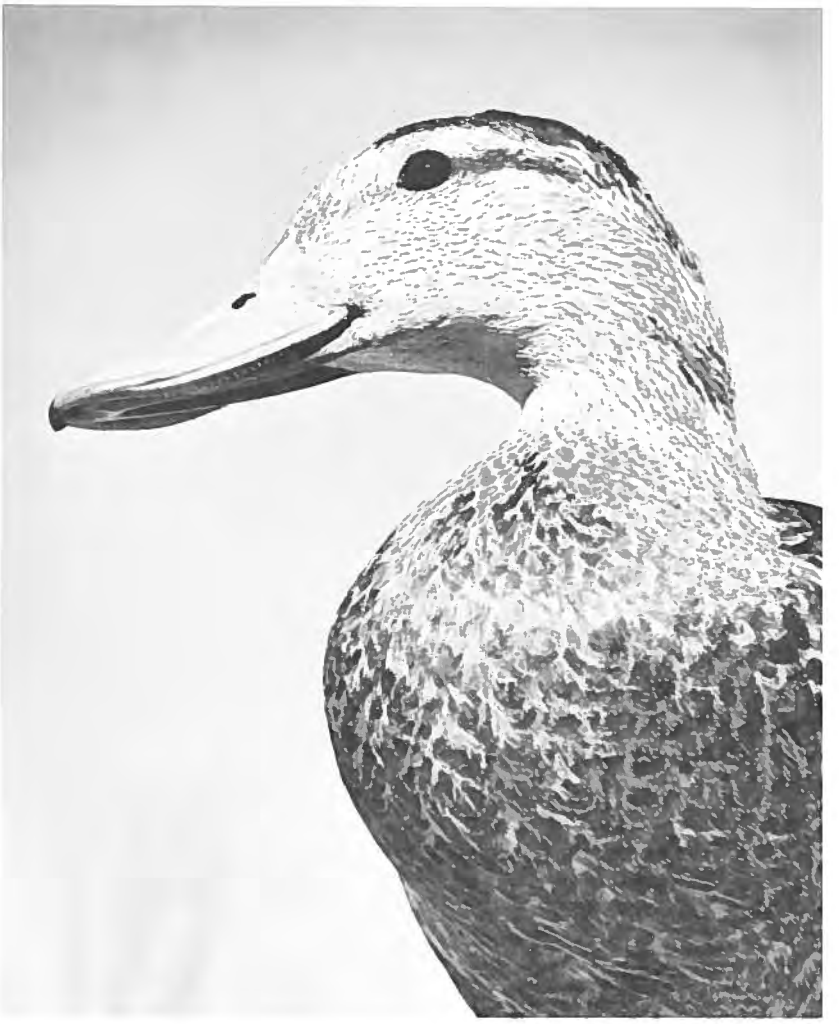

Figure 3. Male Mexican-like duck from New Mexico, showing the plain bill and darker breast that distinguish the male from the female.

indicate that the mandible was "yellowish green," "greenish orange," "olive (with black spots)," and "orangish with black saddle and dusky tip." From this small sample it would appear impossible at this time to state categorically what the typical mandible color is of adult female *diazi,* much less whether it differs materially from that of *platyrhynchos.* It may well be that *diazi* females tend to have the mandible other than the orange of *platyrhynchos* and with little or no dark markings, but I cannot ascertain this from present information.

In male specimens that have intergrade scores in plumage, there is generally a tendency for bill color to be greenish as in *diazi* rather than yellowish as in *platyrhynchos.* In such specimens (scores in the range 18 to 27) only one is annotated as yellowish ("bill clear oil yellow . . . tinge of green"); that bird is an adult from Dona Ana County. Among three more-*diazi* like specimens (scores 28-32) one is annotated as yellowish ("bill pyrite yellow"); that is also an adult from Dona Ana County.

Unfortunately, only 21 males and 10 females of all the specimens examined have notations concerning bill color on their labels, and once the soft parts dry the natural colors are lost. However, the mandibles of males tend to dry to a grayish green, whereas those of females are brownish orange. Thus bill color is generally a useful way of checking sex in dried specimens, even though it is of little use in the hybrid analysis. I did notice a tendency among certain obvious hybrids, also pointed out by Aldrich and Baer (1970), for pale areas to occur on the mandible. This feature is extremely rare in *platyrhynchos* and was not seen at all in "pure" *diazi,* so that its presence could well be a useful signal of hybridity. Unfortunately, it is far from universal in hybrids, and I have specifically noted it only in a few cases. It should be pointed out that the bill of *platyrhynchos* dries to resemble that of *diazi* in coloration.

In regards to possible differences between these two forms in younger birds, Nymeyer (1975) reported that in 11 broods each of *diazi*-like and *platyrhynchos*-like ducks, the former had bright orange mandibles and the latter dull orange. This difference persisted through the age of about six weeks and was observed in birds in New Mexico's lower Rio Grande Valley and vicinity in the summer of 1975. On the other hand, W.S. Huey (pers. comm.), who raised many *diazi* and *platyrhynchos* young in the 1960's, detected no such difference, and he has doubts that it actually exists.

Eye color in adults of both forms appears to be brownish, while the legs and feet are various shades of orange. There appears to be no consistent difference in any of these characters between *diazi* and *platyrhynchos,* at least based on data on labels of specimens.

Migration

Contrasted to *diazi, platyrhynchos* is a highly mobile species, and many populations appear to be exclusively migratory. On the other hand, over most of its range *diazi* appears to be at most nomadic, probably moving about in a general area of residence in search for water, food, and other requirements. Farther north, the *diazi*-like populations of the southwestern U.S. would be expected to be somewhat less sedentary, but data concerning this area are scanty. Part of the problem lies in an accurate determination of winter distribution, as detecting the few hundred *diazi*-like birds among the thousands of migrants of other species is often difficult. However, the available data show that birds are both resident and also given to movement in the region, but at this point it is not possible to say to what extent either status might prevail.

Banding recoveries (U.S. Fish and Wildlife Service data, July 1975) of wild *diazi*-like ducks show three notable cases of dispersal: (1) a bird banded at Radium Springs, Dona Ana County, on 20 August 1959, was recovered 250 miles to the south of Yepómera, Chihuahua, on 27 February 1961; (2) a bird banded at Bitter Lake National Wildlife Refuge, Chaves County, N.M., on 6 February 1966, was recovered 145 miles to the west of Bosque del Apache National Wildlife Refuge on 1 March 1968; and (3) a bird banded at San Simon Cienaga, Hidalgo County, on 23 August 1967, was recovered near Los Lunas, Valencia County, on 8 November 1969. Of three other wild birds recovered, all in Dona Ana County, two were recovered in the same county in the winter after banding; the third was recovered there a month after banding in the autumn. Pen-reared birds are recovered much more frequently, but to date none has been recovered away from the original site of banding (28 recoveries).

Breeding season (timing)

Analysis of the available data indicates that in the Southwest the breeding season of both *diazi*-like and *platyrhynchos*-like ducks generally extends from late spring through late summer (extremes early spring to early autumn). On the average, it appears that *diazi* nests there somewhat later in the season than does *platyrhynchos.* Among the most extensive of the meager data are those of Nymeyer (1975), who studied two forms in Dona Ana and Luna counties, New Mexico in the summer of 1975. He found 21 broods, including in May (1 cf. *platyrhynchos*), June (3 cf. *platyrhynchos*), July (4 cf. *platyrhynchos,* 4 cf. *diazi*), and August (3 cf. *platyrhynchos,* 6 cf. *diazi*). Specimen data, although sparse, indicate that *diazi*-like birds breed earlier in the Southwest than the above would suggest, as the label of an adult female taken in Dona Ana County on 25 April 1933 was annotated as "laying" (collector Allan Brooks) and large downies were taken in Cochise County, Arizona, in late May 1947 (collector Allan R. Phillips) and in Hidalgo County on 16 June 1945 (collector A.A. Lindsey). At Delicias, Chihuahua, the label of an adult female collected on 29 May 1966 (collector Ken Baer) is annotated "with young ducklings," indicating that breeding may occur rather early there as well.

Farther south in Mexico it would appear that most *diazi* nest rather late, probably because there is a shortage of water and of nesting cover until the rains begin in summer (Williams, 1973, 1974, 1975, 1976). This same phenomenon may pertain to certain U.S. *diazi*-like birds, but it would appear that nesting can occur as early as suitable conditions exist there after early spring. This may well also be true in Mexico, but it may be that conditions for pre-rainy season breeding are generally not favorable. In particular, grazing, burning, and other factors may reduce nesting cover by late spring to the point that breeding is delayed in that region; reduction in water areas may also be important. That breeding may occur earlier is illustrated by collection of grown juveniles in the State of Mexico as early as the first week of July 1904 (collector W.W. Brown), but most appear no earlier than August and especially September.

In summary, *diazi* appears to begin breeding somewhat later than

platyrhynchos, especially in southern Mexico. *Diazi* can and does breed early under suitable conditions, and in the southwestern U.S. essentially complete overlap occurs with *platyrhynchos* in this regard — in spite of the tendency outlined above. In view of this overlap, and the probability that *diazi*-like birds are opportunistic when conditions are suitable, it would appear that any central tendency away from complete overlap between *diazi* and *platyrhynchos* is incomplete at best. Under the circumstances, and particularly because the data are meager, differences in the timing of breeding in these two forms — especially in the Southwest and adjacent Mexico — cannot be strongly emphasized and may not be significant.

Eggs and young

Lindsey (1946) and Huey (1962) have provided data on the eggs of *diazi*-like ducks, the former giving the mean of 23 eggs from Hidalgo County as 41.2 x 56.8 mm and of 71 from Mexico as 41.0 x 55.2 mm. Huey's figures are based on eggs from the same Hidalgo County stock, but the eggs average smaller than the above, at 40.2 x 53.9 mm. I cannot account for this difference, although Huey's birds were captive-reared. At any rate, all of the above means fall below those given for *platyrhynchos* by Bent (1923), i.e. 41.6 x 57.8 mm. However, I doubt that these differ significantly from Lindsey's (1946) values; without individual measurements — including preferably *platyrhynchos* from the Southwest, this cannot be tested. Egg coloration seems to be the same in *platyrhynchos* and *diazi,* at least based on the information available to me.

Downy young of *diazi* that I have seen are patterned like those of *platyrhynchos,* but they are somewhat darker throughout (also see Soft part coloration, above). W.S. Huey (pers. comm.) found downies of *diazi*-like ducks from New Mexico to be similar to those of *platyrhynchos,* except that the former averaged slightly warmer brown and deeper buff.

Behavior

Habitat selection. Nymeyer (1975) studied habitat partitioning between *diazi*-like and *platyrhynchos*-like birds in Dona Ana and Luna counties of New Mexico from 19 May through 21 August 1975. In 599 observations of resting birds, he found that *diazi*-like ducks used the river (Rio Grande) 41.6% of the time and *platyrhynchos*-like ones did 37.5%. Other resting sites used, respectively, were 11.3 and 13.0% in marshes, 11.3 and 11.0% in flooded fields, 16.0 and 11.0% in bosque (riparian woodland), 17.8 and 10.0% in ponds, and zero and 17.5% on large reservoirs. There are differences in the utilization of sites by the two, and these are highly significant ($X^2=24.5$, 5 df, $P<.005$). These differences lie mainly in the somewhat greater use of the bosque and ponds by *diazi*-like birds and the exclusive use of large reservoirs by *platyrhynchos*-like birds.

In 135 observations of feeding birds, Nymeyer (1975) found about equal use of the river (21.8 and 22.9%), but *diazi*-like ducks predominated in flooded fields (74.7 to 41.7%) whereas *platyrhynchos*-like birds did so in the bosque

(33.3 to 3.4%). These differences are highly significant ($X^2=15.9$, 2 df, $P<.005$), although the sample sizes are small. No significant difference was found in the habitat distribution of 11 broods of each type of duck ($X^2=4.9$, 5 df. $.5>P>.25$), although *diazi*-like birds showed a preponderance on ponds (63.8 to 18.2%) and *platyrhynchos*-like birds in flooded pastures (36.4 to 9.1%) and on canals and ditches (27.3% to zero).

These observations point to differences in habitat selection by adults of these two types of ducks in the lower Rio Grande Valley of New Mexico, but several cautions apply in using the data. The major consideration is the fact that all birds were field-identified, without recourse to either collecting or to a good series of specimens to aid in field identification. Thus, the data must be thought of in the context of applying to birds that were judged as either more like Mexican ducks (i.e. *diazi*-like birds) or more like mallards (i.e. *platyrhynchos*-like birds). Intergrade birds may have been rather arbitrarily assigned, and both the past specimen record and my own observations from the area indicate that intergrades are frequent in the area. In addition, the sample sizes of observations are both rather small and were limited to one field season. However, even given these cautions, the data gathered by Nymeyer may be viewed as having some validity, and these do suggest trends in differential use of habitats — even in this area of extensive hybridization.

Beyond the above study, there appears to be little in the way of solid data to substantiate, or even meaningfully suggest, the existence of habitat differences in *diazi* and *platyrhynchos.* Various authors (e.g. Lindsey, 1946) have, nonetheless, made such suggestions, and perhaps with additional studies they may be proved correct.

Pairing behavior. Based on a study of *diazi* from largely captive-released stock, Bevill and Davis (1969) found that this form began pairing behavior at San Simon Cienaga, Hidalgo County, as early as December in 1968. This behavior continued into March and overlapped with similar activity in *platyrhynchos* in the same area, but the two forms tended to stay apart and did not form any mixed pairs. Huber (in Bent, 1932) noted a similar segregation in April near Las Cruces, but Lindsey (1946) implied much mixed pairing around Albuquerque, at least in the case of hybrids versus *platyrhynchos*. However, he was speaking of the situation in a zoological park, and considering the artificial conditions this should not be counted as reflecting the situation in the wild.

That mixed pairing must occur cannot be doubted, as there is no other satisfactory explanation for the hybridity that exists in the southwestern U.S. and northern Mexico. Lindsey (1946) may have been the first to report a mixed pair, in the case of an apparent *diazi* X *platyrhynchos* male paired with a female *diazi* at the San Simon Cienaga summer of 1945. Huey (1962) reported a mixture of *diazi, diazi* X *platyrhynchos,* and *platyrhynchos* in Dona Ana County in August 1959, but the manner of pairing — if any — among these birds was not known.

In the summer of 1975 in Dona Ana County, New Mexico, Nymeyer (1975)

obtained what may be the first quantification to any extent of the make-up of pairs in that area. As earlier stated, field identifications are not accurate enough to identify many hybrids, and so what he terms either *diazi* or *platyrhynchos* should be regarded as best-estimate identifications. He found a minimum of 36 *diazi* and 55 *platyrhynchos* in the Rio Grande Valley, plus 21 *diazi* and 19 *platyrhynchos* in the Uvas Valley, just west of there. In the latter area there were 7 pairs of *diazi* and 8 of *platyrhynchos* (plus 7 and 11 unpaired birds, respectively), with no mixed pairs. In the Rio Grande Valley there were 11 pairs of *diazi* (plus 13 unpaired birds) and 10 of *platyrhynchos* (37 unpaired birds). In addition, there were 4 *diazi* paired with *platyrhynchos* and one apparently mated with a pintail *(Anas acuta).* Overall, the incidence of *diazi* that were mis-paired was 8.8% (5 of 57), or 13.9% (5 of 36) if the Uvas Valley is not considered.

Even though this may seem a high level of mis-pairing involving *diazi* and even though the level would probably be higher were all hybrids discernible, it is still hardly a rate that would allow one to discount non-random mating. Far more *diazi*-like birds were paired with similar birds (and vice versa in the case in *platyrhynchos*), and this is a strong indication that pairing is not random in this complex.

Nymeyer (1975) mentions that he found unpaired *diazi* associating with other duck species during summer, contrary to the implications of earlier authors. However, he found that in paired *diazi* the male did not permit approach of other ducks closer than 4 to 5 feet, and usually the pair stayed at least 15 to 20 feet apart from other ducks.

THE STATUS OF *Anas diazi*-LIKE DUCKS IN THE GREAT PLAINS REGION

The earliest extralimital record of *Anas diazi* appears to be that of Conover (1922), who cited as this species a specimen from Dads Lake, Cherry County, Nebraska, taken on 17 October 1921. I have examined the bird (Field Mus. 973, Conover Collection), and although it was identified as *diazi* by H.C. Oberholser, the specimen is clearly not this form. In my opinion it is actually *A. platyrhynchos* X *A. rubripes,* on the basis of such plumage features as the predominance of dusky and grayish tones and the largely concolorous tail. The tail character is particularly important, as in both *diazi* and female *platyrhynchos* the tail has very distinct light and dark areas, whereas in *rubripes* (and *A. fulvigula maculosa*) the tail is largely dark with light areas reduced or absent.

In northeastern Colorado, Bailey and Niedrach (1967) have enumerated three specimens (plus one sight record) as representing *diazi*, and I have examined these. In each case my assessment is that these are probably *A. f. maculosa* X *A. platyrhynchos,* not *A. diazi.* Most clear-cut are an adult (probable) female taken in Sedgwick County on 4 March 1947 (Denver Mus. Nat. Hist. 25374) and an immature female taken on 29 October 1939 in Adams County (D.M.N.H. 20557). In each case there is a general resemblance to *A. diazi*, but both specimens are ventrally pale for that form and have cheeks that are somewhat intermediate toward *A. platyrhynchos*. More importantly, the tails resemble the more concolorous ones of *maculosa*, rather than the distinctly light-and-dark ones of *diazi*.

In size, the adult above is larger than *diazi*-like birds in wing (273++), tarsus (50.0), culmen from nostril (49.0), and in bill width (25.0). Judging from measurements given in Oberholser (1974) for *A. f. maculosa* (e.g. wing 227.1-261.1, tarsus 39.9-45.0 in females; wing 245.1-267.0, tarsus 42.9-48.0 in males), it is also large for that species. However, one would expect that in some cases hybrids between *maculosa* and *platyrhynchos* would be larger than the former and more like the latter. While this bird exceeds most of the values obtained for the few *platyrhynchos* that I measured, Oberholser (1974) shows values of wing (257.0-276.1) but not for tarsus (41.9-46.5), that encompass the specimen. The immature (wing 246, tarsus 45.0, culmen

46.0, bill width 20.0) is smaller than the average *diazi* in wing and larger in tarsus and culmen, hence it might be considered closer to *maculosa* in the former and to *platyrhynchos* in the latter two characters.

The third Colorado specimen that has been called *diazi* is an adult male (wing 277, tarsus 45.0, culmen 46.0, bill width 24.0) taken on 19 November 1944 in Adams County (D.M.N.H. 24393). Resembling it is another adult probable male (wing 284.5, tarsus 50.0, culmen 51.0, bill width 28.0) taken on 15 February 1949 in Sedgwick County (D.M.N.H. 25908). These two resemble eclipse plumage male *platyrhynchos,* but they are darker above and below and have ventral vermiculations and blackish in the crissum. The Sedgwick County specimen has heavier streaking on the head and the tail is more solidly dark than the Adams County bird.

In my assessment, there is no question that the latter two birds are both hybrids, but the problem lies in determining what besides *platyrhynchos* might be involved in their parentage. Because of the richness of the coloration (browns versus dusky to gray tones predominating) and associated features, it would not appear that *rubripes* is the other member of the hybrid pair. That leaves *maculosa* and *diazi,* and I would expect that the products of either of these forms interbreeding with *platyrhynchos* would probably be very similar — especially if back-crossing were involved. However, because of the more solid tail in the Sedgwick County bird, I would call it *platyrhynchos* X *maculosa.* Furthermore, I believe that the Adams County bird is most likely this same pairing, although this assessment is based largely on geographic probability.

In Colorado, the published records of *A. maculosa* are of an adult (probable) male that was taken 6 November 1907 near Loveland, Larimer (D.M.N.H. 353), and an adult male (D.M.N.H. 33794), taken 18 September 1962 near Ft. Collins, Larimer County (Bailey and Niedrach, 1967). Actually, the 1907 specimen is slightly toward *platyrhynchos,* as there is a very faint suffusion of green on the head and the central rectrices are slightly curled. The 1962 specimen appeared to be typical *maculosa,* but oddly the bill is mottled with paler coloration as in some *platyrhynchos* X *diazi* hybrids. Another bird that is near *maculosa* is a two-thirds grown juvenile (questionable) female, taken on 22 October 1933 in Adams County (D.M.N.H. 12302). This bird is of a dark coloration approaching *rubripes,* which from the literature (e.g. Bent, 1923) fits the description of young *maculosa.* However, the speculum is bordered with white, which may well be an indication of *platyrhynchos* influence.

Anas diazi is unreported from Oklahoma, but in the plains of western Texas there are at least two records. Oberholser (1974) indicates that a bird was collected (perhaps not saved?) near Vigo, Swisher County in the autumn of 1951, and a sight record was obtained in nearby Randall County in October 1949. The nearest record of *A. f. maculosa* to the plains region of Texas is of six birds seen near Mertzon, Irion County on 31 July 1921. Farther east in Texas there are specimen records of *maculosa* northward to Dallas and Kaufman County, and there is also a possible breeding record from the former county, i.e. adults and 4 ducklings seen in the summer of 1970 (Oberholser, 1974).

At this point the Swisher and Randall county records of *diazi* cannot be substantiated, and they might well not be correct. In fact, it is more likely that the birds in question were actually *maculosa,* as that species is known to occur to the north as outlined above. *Diazi* has been substantiated in Texas only in the Trans-Pecos region, with specimens known to have been preserved only from El Paso (hybrid), Jeff Davis, and Brewster counties (Oberholser, 1974).

In eastern New Mexico, *diazi*-like ducks have been reported by various authors, including Ligon (1961). The only specimens that I have seen from that area are two adult males from Chaves County, one collected at Dexter 5 November 1945 and the other at Bitter Lake National Wildlife Refuge on 23 January 1973. Both are essentially intermediate between *platyrhynchos* and either *diazi* or *maculosa,* but *platyrhynchos* characters dominate. From this I presume that the birds might be the products of backcrosses with *platyrhynchos,* which makes discrimination between other parents difficult. In addition, there are no substantiated records of ducks close to *diazi* in New Mexico from east of Alamogordo, Otero County (*maculosa* has not been substantiated from anywhere in the state). Hence, geographic grounds are of limited value in assessing the ancestry of these two specimens. Even this could be invalidated if these were migrants from elsewhere, e.g. northeastern Colorado. However, judging from the similarities of these specimens to other *platyrhynchos* X *diazi* hybrids — e.g. in their light-and dark tails, I would assign them to this pairing of parents.

Based on the above information, it would appear that records of *Anas diazi* from the Great Plains are all either in error or questionable. Certainly, the 1921 Nebraska record is erroneous, the Colorado records at best refer to hybrids (most likely *maculosa* X *platyrhynchos* rather than *diazi* X *platyrhynchos)* or to *maculosa,* the eastern New Mexico ones to hybrids (based on present evidence), and the western Texas ones are questionable. On the other hand, what emerges is the fact that *Anas fulvigula maculosa* is established as a breeding bird in the Great Plains, where it appears to be hybridizing to some degree with *A. platyrhynchos,* e.g. in northeastern Colorado. The existence of this inland population is extremely interesting, especially in a species that has long been regarded largely as a coastal duck. Even now, the need toward reappraisal of the status of *maculosa* may not be widely appreciated, and the matter has probably not received as much emphasis as it deserves.

The presence of *A. f. maculosa* in the Great Plains is not a recent event, as the first specimen was taken in Kansas, at Neosho Falls in Woodward County, on 11 March 1876 (Goss 1891). However, it was not until 1963 that the species was recognized again in that state, when it was found nesting at Cheyenne Bottoms in Barton County. Several specimens were obtained there in 1963 and 1964 (McHenry, 1968), and in recent years more data have been gathered on that population. For example, *maculosa* has been banded there in every month except December and January, including one bird on 5 March 1968 that was recovered in southwestern Louisiana on 17 December 1969 (Sutton, 1971).

Summarizing for Colorado, *Anas fulvigula maculosa* is represented from the northeastern part of that state by one apparently "pure" specimen (collected in 1962), two "nearly pure" ones (in 1970 and 1933), and four apparent hybrids with *platyrhynchos* (in 1939, 1944, 1947, and 1949). While one or two of the hybrids could involve *diazi* rather than *maculosa,* plumage and mensural characters and geographic probability argue against this as being the case. Furthermore, the juvenile specimen (1933) suggests that *maculosa*-like ducks breed in Colorado, and the hybrids may result from this.

Besides Kansas and Colorado, *maculosa* is now also known from Oklahoma, where an adult male was collected on 16 December 1970 near Burns Flat, Washita County (Sutton, 1971). There is at least one sight record that might also pertain to this species, that of a bird seen on 22 July 1964 in Bryan County, in the southeastern part of the state. Sutton (1967, 1971) also suggests that the Salt Plains National Wildlife Refuge might be an attractive breeding place for this species.

The situation in Texas and New Mexico as regards *maculosa* has already been discussed, and in the former state there is some indication that true inland populations may exist. Interesting is the prospect that the range of *maculosa* could expand westward to the point of contact with that of *diazi,* and hybridization could occur. The potential for this event may not be high, but it is certainly a possibility to keep in mind.

As far as I am aware, the only published records of extralimital *diazi*-like ducks are from the Great Plains, and as discussed above, these appear erroneous or questionable. The only other extralimital specimen that I have encountered which could conceivably be regarded as *diazi* is an adult (probable) male taken on 27 July 1927 at Alviso, California (Calif. Acad. Nat. Sci. 14153). This bird is very dark and heavily marked and has the rectrices similar to those of *diazi.* If the specimen were from the Southwest, I would call it *platyrhynchos* X *diazi,* but considering its place of origin, I hesitate to so identify it. At any rate, it is at best a hybrid and thus does not represent a "pure" example of *A. diazi.*

THE NUMBERS OF *diazi*-LIKE DUCKS

New Mexico

Prior to the 1930's, the estimates of numbers of *diazi*-like ducks in New Mexico are largely anecdotal, and in general the data are so meagre as to make any firm statement impossible. The earliest accounts of the species there appear to be those of Henry (1854, 1859), who refers to *diazi* under the name *Anas obscura*. Henry spent the periods August-December 1852 and 1854 to 1858 in what is now Dona Ana County (Bailey, 1928). In 1854, he wrote that *"obscura"* was "rare, a few seen on the Rio Grande every spring, on their passage north," while *A. "boschas"* (= *platyrhynchos*) was "extremely common everywhere in winter. Many resident throughout the year. Breeds in greater or lesser number." Later (1859) he observed that *"obscura* was much rarer than the above," the latter in reference to *"boschas."* We have no way of knowing how accurate these assessments were, for Dr. Henry may have experienced difficulty in properly distinguishing the two forms; however, taken at face value they do not imply that *diazi* was very numerous.

Subsequent authors, many of whom faced the problem of proper identification of *diazi,* also made generalizations concerning its abundance, without reference to exact numbers and/or to more than local areas. For example, Leopold (1919) considered *diazi,* which he called "mottled ducks (?)," to comprise five percent of the total duck population in the Rio Grande Valley around Albuquerque. This amounts to about 300 birds, based on Leopold's total of about 6200 total ducks seen there in the year 1918. Huber (1920) regarded *diazi* as being fairly common in the valley throughout the year, being less conspicuous among hoards of migrants in autumn and winter.

More exact figures of *diazi* were forthcoming in 1946, when 250 were counted at Bosque del Apache National Wildlife Refuge (Ligon, 1961). The following year 100 were counted in spring, with an estimated 200 young produced, for a total of 300 birds. Declines occurred in 1948, when only 32 young were counted, and in 1949 (5 broods); by 1956 the species was rare at the refuge.

At San Simon Cienaga, Ligon (1961) estimated 12 pairs in June 1935, along

with three broods of unstated size. By 1966-67, before pen-reared *diazi* releases were made at the cienaga, no more than seven were counted (Bevill and Davis, 1969). At the nearby Gray Ranch, also in Hidalgo County, 37 adults and grown young were seen in July 1968.

From the above, it appears that in the 1930's and 1940's, minimum numbers of *diazi*-like ducks in New Mexico were on the order of several hundred and probably more. Counting populations from Albuquerque southward, in Hidalgo County, and those that presumably existed in Catron County and elsewhere, it may well be that with the young of the year, at least 1000 *diazi*-like ducks existed in New Mexico.

By the early 1960's, Huey (1962) indicated that the population probably did not exceed 150 in peak periods and was limited, as far as productive habitat, to three areas in Hidalgo and Dona Ana counties. At that time, the New Mexico Department of Game and Fish and cooperators embarked on a program of captive-rearing of *diazi,* with releases into the wild beginning in the late 1960's. The stock for this program came from southwestern New Mexico and was selectively bred to obtain the purest strain possible. Through the present time several hundred pen-reared *diazi* have been released, mainly at San Simon Cienaga and in the lower Rio Grande Valley of New Mexico. As of 1975, however, only limited releases were still being made, these by the U.S. Fish and Wildlife Service at Bosque del Apache National Wildlife Refuge.

In recent years there has been little coordinated monitoring of the numbers of *diazi*-like ducks in New Mexico, but nevertheless it would appear that numbers are definitely up over the 1950's and 1960's. The maximum figure for the recent period is of 50 birds in southern Luna County in July 1973 (pers. obs.). In release areas for pen-reared birds the maximum is 41 at San Simon in December 1969 (Davis and Bevill, 1970).

In the autumn of 1975, censuses were undertaken of *diazi*-like ducks in New Mexico as part of the activities of the Mexican Duck Recovery Team, formulated by the U.S. Fish and Wildlife Service. Although the censuses have not yet been fully coordinated and only parts of Dona Ana, Luna, Hidalgo, Grant, Catron, and Valencia counties have been at all well-covered, the figures (Table 7) can be regarded as minimum estimates for the state. McKinley, Bernalillo, Rio Arriba, and other counties have also been the object of partial censuses, without any recent records of *diazi*-like ducks for these areas.

It should be emphasized that the figures of 166 *diazi*-like ducks in August-September 1975 and 177 in October-November include hybrids as well as "pure" birds. The criterion for including birds as *diazi*-like is simply that they be more like *diazi* than *platyrhynchos.* This approach is made necessary by the fact that it is impractical in this region of massive hybridization to have more specific criteria for field application. Still, the figures can be taken as indicative of a population of several hundred *diazi*-like ducks existing in New Mexico at present. Based on a general assessment of the data, I would estimate the statewide figure at between 200 and 300 at peak levels.

Arizona

Phillips et al. (1964) recorded *diazi* as occurring in southeastern Arizona, but they gave no population figures from there. Tomlinson et al. (1973), reporting on what appears to be a recently-established or expanded population near Willcox, Cochise County, indicated that between 100 and 150 *diazi* occupied the general area. More recently, O'Brien (1975) has estimated the minimum adult population at 150 to 200 in the area. It would appear that the bulk of the population is in the Willcox area, with only small numbers elsewhere in southeast Arizona. In August 1975, O'Brien (in litt.) counted 95 *diazi*-like birds in the Willcox area, but lack of time prohibited censuses elsewhere in southeastern Arizona.

Texas

Early reports of *diazi* in Texas give no accurate indication of numbers there, but it appears that the population was not large. Aldrich and Baer (1970), Ohlendorf and Patton (1971), Wauer (1973), Tomlinson et al. (1973), and Oberholser (1974) have updated the picture in Texas, and it appears that *diazi*-like ducks have been reliably recorded in five Trans-Pecos counties (El Paso, Hudspeth, Jeff Davis, Reeves, and Brewster). On 22 October 1976, Jim Voelzer and Roy Tomlinson (pers. comm.) counted 317 Mexican-like ducks on the Rio Grande between Presidio and El Paso, and on the same date we saw about 20 at Marfa, Brewster County. On 19 January 1977, Voelzer (pers. comm.) counted 220 on the same stretch of the Rio Grande. Based on the available data, I would estimate a population of perhaps 300 to 400 *diazi*-like ducks for Texas in peak periods, mainly along the Rio Grande (south to the Presidio area) and locally to the north.

United States

In total, I would estimate 650 to 900 *diazi*-like ducks inhabit the United States. These figures are based on estimates of 200 to 300 for New Mexico, 150 to 200 for Arizona, and 300 to 400 for Texas.

Mexico

Johnsgard (1961) summarized data on *diazi* numbers gathered by the U.S. Fish and Wildlife Service during its aerial surveys of waterfowl in Mexico. In the period beginning 1947, the smallest total observed was 780 in 1951 and the largest 10,322 in 1958. Johnsgard (1961) interpreted the data from this source as indicative of a total population of less than 20,000 *diazi* in all of its range, with the vast majority in Mexico.

Aldrich and Baer (1970) carried out ground surveys over most of the Mexican range of *diazi* in 1966 and found only 120 birds at 43 sites in May. Although these data suggested a serious decline, these authors did indicate that concentrations of at least 1000 *diazi* were recorded in Chihuahua in January 1965 and in Jalisco in January 1968.

In 1973, Williams (1973) found about 800 *diazi* between Chihuahua and Jalisco in the period April-August, mainly in the latter state. In July and August 1976, Williams (1976) found 173 birds in Chihuahua and Durango, and he estimated that the summer population of the area could conceivably be 2000 or more individuals. In 1975, Williams (1975) was a member of an aerial census team that surveyed part of the Mexican Plateau for *diazi.* Over 16,000 ducks of this type were counted in Jalisco and adjacent states, leading him to estimate that possibly up to 40,000 birds inhabit Mexico. If this is indeed the case, then *diazi* is fairly numerous in that country, perhaps even to the point of saturation of the available habitat. At any rate, the minimum figure for the species is at least 16,000 birds, plus some 650 to 900 (mainly hybrid) birds in the United States.

RESTORATION PROGRAMS

Restoration of *diazi*-like ducks has been centered in New Mexico, where initial efforts were begun by the New Mexico Department of Game and Fish in 1959 (Huey, 1962). At that time breeding stock was obtained in the form of five young, these being captured at San Simon Cienaga. In 1960, three more birds were taken from the wild at Radium Springs, Dona Ana County, and in 1961, 25 young were reared by the captive birds. At that time pairs of these captives were distributed among aviculturists for rearing of additional birds, and in 1962 16 birds were made available to the Bosque del Apache National Wildlife Refuge for rearing purposes.

Release of the progeny of captive birds was begun by the New Mexico Game and Fish in 1963, with eight birds placed at La Joya State Game Refuge, Socorro County. Releases there totaled 114 birds through 1965, at which time the effort was directed toward San Simon Cienaga. There releases began in 1967 and continued through 1969, with 115 birds released in all (Davis and Bevill, 1970). At Bosque del Apache National Wildlife Refuge releases began in 1965, and through 1975 these totaled 156 birds (Zahm, ms.).

In total, some 385 captive-bred *diazi*-like birds have been released in New Mexico since 1963, at La Joya State Game Refuge, Bosque del Apache National Wildlife Refuge and San Simon Cienaga.

TAXONOMIC STATUS OF *diazi*

There exists no doubt that *Anas platyrhynchos* and *A. diazi* interbreed in the southwestern United States, and judging from the patterns in variation of measurements and plumage, backcrossing and introgression also occur. Both of these facts are well-known and have led to taxonomic assessments of these two forms as being conspecies (e.g., Phillips, 1959; Delacour, 1956; Johnsgard, 1961, 1975; Bellrose, 1976). On the other hand, such authorities as Aldrich and Baer (1970) and Palmer (1976) have viewed the same evidence and retained the two as separate species. Before probing the matter of taxonomic treatment further, it seems worthwhile to first review the data.

As information summarized in this paper indicates, along a transect from the range of *A. platyrhynchos* through the southwestern United States into the range of *A. diazi,* there is abundant evidence that these two forms interbreed and intergrade. The strongest evidence lies in the pattern of variation in plumage characters, although measurements generally show merging of the larger *platyrhynchos* with the smaller *diazi.* As already indicated, in this study plumage indices of "pure" *platyrhynchos* are around 1.0, while those of "pure" *diazi* are around 34 or 35 (in theory, the former should score near zero and the latter near 36). As one progresses southward from the range of *platyrhynchos* and northward from that of *diazi,* these indices shifts toward intermediacy (18 is the median point) in the southwestern United States.

As already indicated, the fulcral population along this transect is that in the lower Rio Grande Valley of southern New Mexico, the so-called Dona Ana County sample (actually extends from Sierra County in New Mexico to El Paso County in Texas). There, evidence of hybridization exists as early as 1893, when the first U.S. *diazi*-like specimen was preserved from near El Paso. Based on an accumulation of 43 breeding season (April-September) specimens taken between then and 1960, the population shows a plumage index of 22.6 on the scale from zero to 36. These 43 specimens fall into seven arbitrary phenotypic categories, i.e., "pure" *platyrhynchos* (9.5%), "very near *platyrhynchos*" (14.3%), "nearer *platyrhynchos*" (2.4%), "intermediate *platyrhynchos* X *diazi*" (9.5%), "nearer *diazi*" (14.3%), "very near *diazi*" (38.1%), and "pure" *diazi* (11.9%).

Populations from elsewhere in the Southwest and in northern Mexico also

show evidence of interbreeding and introgression, with apparent gene flow extending over a distance of some 900 miles between Rio Arriba County in New Mexico on the north and southern Durango on the south. Of course, the populations on each end of this transect are much closer phenotypically to either *platyrhynchos* (north) or *diazi* (south), but plumage indices show even these to be "impure." For example, the Rio Arriba sample scores 3.5 and is thus very near *platyrhynchos* overall, but single specimens in a series of 11 fall in the categories "nearer *platyrhynchos*" (score range 9-13) and "nearer *diazi*" (score range 23-27). In the Durango sample (seven specimens) the index is 27.1, with phenotypic proportions of 14.3% intermediate, 42.8% "nearer *diazi,*" 28.6% "very near *diazi,*" and only 14.3% "pure" *diazi.* Populations in Chihuahua and from other areas of southwestern U.S. show varying, generally intergrading indices and phenotypic distributions in plumage and need not be discussed here.

As mentioned above, the Dona Ana County sample is regarded as fulcral in this study, although it would also be appropriate to extend the sampling area northward along the Rio Grande into central or even northern New Mexico. However, the available specimens do not permit that approach, as these are few — even to the point of being unrepresented as far as breeding birds. Under the circumstances, the Dona Ana County population must carry the burden in providing the data for a taxonomic assessment of the relationships of *diazi* to *platyrhynchos.* As has been shown above, that population has a plumage index approaching intermediacy and a varied distribution of phenotypes from "pure" *platyrhynchos* to "pure" *diazi.* Before examining these aspects further, let me first sketch in an outline for taxonomically assessing the findings.

Various authors have analyzed hybrid situations involving vertebrates, and from their studies have come certain guidelines for interpreting them. In his comprehensive paper, Short (1969) provides a resume of what might be regarded as consensus thinking concerning hybridization and its implications, and I shall draw on this work as a starting point for interpreting the *diazi-platyrhynchos* situation.

Short (1969) recognizes that in areas where hybridization occurs between two forms, the implications about taxonomic status of the entities are to be found in the overall make-up of the populations within the area where hybridization actually takes place. For example, if parental phenotypes are overwhelmingly predominant and hybrids are rare, the implication is that selection exists against hybridization and that the two are actual species. On the other hand, if hybrids predominate and the parental types are rare, then selection would appear limited and a conspecific treatment would be favored. Short sets 5% as the frequency of parental phenotypes beyond which hybridizing forms may be said to coexist in the area of interbreeding. A frequency of 5% or less, on the other hand, can be regarded as one that might arise from recombination among hybrids. In a hybrid zone connecting two forms that are to be regarded as conspecies, Short feels that parental phenotypes should be actually or virtually lacking.

Not surprisingly, Short (1969) does not establish a numerical level above 5%

(and below 100%) at which the frequency of parental phenotypes indicates whether two forms are conspecies or separate species. However, the implication is that anything above 5% parental phenotypes calls for caution in designating two forms as conspecies, due to the apparent action of selection in the hybrid zone in maintaining this representation. In Dona Ana County, the data show percentages of parental phenotypes in the breeding population that are notably higher than 5%. For example, in 55 males and females collected between 1893 and 1960, 7.3% are "pure" *platyrhynchos* and 9.1% are "pure" *diazi* (another 12.7 and 41.0% are "very near" these respective taxa).

As already discussed, it is illuminating to divide the Dona Ana County breeding sample into earlier and later subsamples, with the former 1893 to 1920 and the other essentially 1938 to 1960. In the earlier period, 26.9% (7.7% *platyrhynchos,* 19.2% *diazi*) were "pure," compared to 11.8% (all *platyrhynchos)* in the later period. While the overall distribution of phenotypes does not show a significant shift (X^2 testing), there is no escaping the fact that a decrease in the percentage of parental phenotypes has occurred, i.e. from 26.2 to 11.8%. The latter is still more than the 5% level established by Short (1969), but it seems to signal the possibility that hybridity is increasing in the population. Perhaps the frequency of parental phenotypes will continue to decrease, but only time will tell.

Based on the 1938 to 1960 sample, the present Dona Ana County breeding population can be said to be 88.1% hybrid to one degree or another (Table 6). Compared to the 1893 to 1920 period, that is an increase of 15% from the past level of 73.1% hybrid birds. Comparisons clearly show that the trend is away from a *diazi*-like population to one that is more *platyrhynchos*-like or more intergraded. In the period through 1920, specimens show that about two-thirds of the population was *diazi*-like, versus one-sixth being intergrade and one-sixth *platyrhynchos*-like. In specimens taken since then, about one-third are assignable to each category, thus representing a decline by about half among *diazi*-like elements and an approximate doubling by intergrades and near-*platyrhynchos* elements.

Given the above characteristics in the Dona Ana County population, what then, is the taxonomic status of *diazi* relative to *platyrhynchos*? My interpretation of the data, particularly that relating to the apparent increase in hybridization, is that *A. diazi* is more accurately regardable as a conspecies with *platyrhynchos* than as a species separate from it. However, I do not believe that the situation is so patently simple that one can gloss over the inconsistencies in a conspecific approach. For the record, I would like to reiterate and briefly discuss some of these inconsistencies and some related aspects of the situation.

The major inconsistency in regarding *diazi* and *platyrhynchos* as conspecific is the fact that the major shifts in mensural and plumage characters occur rather abruptly, a finding which may indicate that counter-selection against gene flow is operative. Short (1969) discounts steep clines of intergradation as reflective of taxonomic status, provided that at the point where gene exchange (i.e., interbreeding) occurs, hybrids far outnumber parental phenotypes. In other words, Short apparently believes that the issue of

conspecificity is decided in the hybrid zone, not away from it. Thus, if hybridization is massive, regardless of the extent of gene flow away from that point, then reproductive isolation is absent and the interbreeding forms can be regarded as conspecific.

It is difficult to argue cogently against Short's (1969) pronouncements regarding gene flow in regard to the situation involving *diazi* and *platyrhynchos*. However, Short's tendency to regard species in what I would term a monolithic way is too simplistic, even for the present situation. The fact is, species are not monoliths, but rather they are series of populations. The integrity of a species thus merits investigation on a population-by-population assessment of gene flow, as suggested by Bigelow (1965).

Short (1969) is aware that within a species, some populations may differ in response to sympatry with a related taxon, such as in the case of *Pipilo erythrophthalmus* and *P. ocai* in Mexico (e.g. Sibley and Sibley, 1964). However, by treating *P. ocai* as a monolithic unit and basing his assessment only on interactions involving those populations (*P. o. alticola, P. o. nigrescens*) that interbreed massively with *P. erythrophthalmus*, Short argues for merger of the two species. Those populations of *P. ocai* that occur sympatrically with *P. erythophthalmus* with little or no interbreeding (*P.* o. *ocai, P. o. brunnescens*) seem to count for little, as their particular evolutionary state becomes submerged in Short's monolithic treatment.

In my view, the differing responses to sympatry by populations — in this case subspecies — deserve a more objective treatment. One that avoids the extreme monolithic approach would be to regard *P. o. ocai* and *P. o. brunnescens* as a species separate from *P. erythrophthalmus*, because these populations do not interbreed with it to any extent. On the other hand, *P. o. alticola* and *P. o. nigrescens* could be treated as conspecific with *P. erythrophthalmus*, as they interbreed with *P. e. griseipygius* and *P. e. macroynx,* respectively. When one considers the fact that each of the races of *P. ocai* is allopatric, Short's (1969) monolithic approach is even less satisfactory, as it leads to lumping all *P. ocai* with all *P. erythrophthalmus* simply by association.

Given that a species should be considered in the light of its populations rather than as a monolith, the question arises as to whether peripheral populations have any greater standing than non-peripheral ones in evaluation of taxonomic status. For example, if two forms contact and interbreed along a transect of populations, should there be more emphasis given to what happens in the peripheral population of each species than to others more removed from the point of interbreeding? According to Short's (1969) position, there would indeed be more — or complete — emphasis on peripheral populations, because they are the ones in which he assesses the degree of reproductive isolation that may exist between two monoliths.

If one views a species as a **series** of populations, unless there is an actual demonstration of gene flow among them, then a question exists as to whether they actually constitute a species. Bigelow (1965) goes to the point of defining species strictly in terms of gene flow, and I believe it is a valid concept, insofar as we are able to detect and measure gene flow. Thus, a

species may be regarded as one or more populations linked by an actual or potential continuum of gene flow. Conversely where gene flow is absent between populations, then these may be regarded as separate species. Of course, not all populations of a species will be able to interbreed inter se, but here the critical word is **linkage.**

From the above discussion, it should be apparent that it is Short's (1969) emphasis on reproductive isolation as a characteristic of the species that leads to his down-playing the significance of gene flow in populations. This means that away from those peripheral populations in which two species contact and interbreed, what happens with regard to apparent gene flow (e.g. the rather abrupt shift between *diazi* and *platyrhynchos*) is held as being of little significance in deciding taxonomic status. However, in following Bigelow (1965) and in equating such abruptness to counter-selection, I would conclude that it **is** significant taxonomically, indicating that even with massive interbreeding, *diazi* and *platyrhynchos* genes are not absolutely freely interchangeable. Taken at face value, this conclusion is certainly not intended as a telling argument in favor of retaining *diazi* as a species separate from *platyrhynchos*; rather, I believe that the situation demands consideration in the overall assessment of this taxonomic problem.

Besides the existence of a rather abrupt shift between *diazi* and *platyrhynchos* in the Southwest, I have earlier mentioned that behavioral and ecological differences may exist where these two forms contact in New Mexico. These aspects have not been fully studied in the field, and to do so will require considerable time and effort. Until this can be done and until various other aspects are better probed, the taxonomic assessment that I wish to offer here must be regarded at best as tentative and subject to revision. In that regard, I wish to propose that *diazi* be treated as conspecific with *platyrhynchos*, based largely on the fact that hybridization seems to be increasing between the two in Dona Ana County and perhaps elsewhere in the Southwest. Factors that argue against this treatment have already been discussed, and there will be those who may regard the question as still too open and opt for retaining *A. diazi* and *A. platyrhynchos* as separate species. At this point there is no correct answer, but it is clear that *diazi* interbreeds and backcrosses massively with *platyrhynchos* and that introgression is widespread.

HISTORY OF *diazi* AND *platyrhynchos*

In a separate paper I discussed (Hubbard, 1973) the possible evolutionary origin of these two forms, with *diazi* postulated to have arisen in a refugium in Mexico and *platyrhynchos* in Eurasia. I opted for two versions as far as the chronology of these events, one involving only the last glaciation and the other the last two glaciations. At present I favor the former, and I believe that these two forms are contemporaries of *A. fulvigula* and *A. rubripes* in time of origin.

As I reconstruct it, following the end of the Wisconsinan (last) glacial period, *platyrhynchos* probably spread into western North America from Alaska. Meanwhile, *diazi* came to occupy the Mexican and Transvolcanic plateaus, with a small population extending northward into New Mexico. Eventually *diazi* and *platyrhynchos* may have come into contact in northern New Mexico, and interbreeding and introgression may have first begun there several thousand years ago. It seems likely the Rio Grande Valley between southern Colorado and northern Chihuahua would have been a corridor along which major interbreeding may have transpired, with similar but limited situations developing in isolated areas throughout the southern Southwest. Conceivably, at some point in prehistoric time *platyrhynchos* and *diazi* may have actually come to intergrade through a cline along the Rio Grande, shifting from the former in the north to the latter in the south. Whether this did happen, we will of course never know, and with the arrival of European (if not Asiatic) man the primeval situation undoubtedly changed.

When the Spanish explorers of what is now New Mexico travelled along the Rio Grande in 1540, they found Pueblo Indians occupying villages and farming the valley. To what extent these original settlers had already altered habitats of these ducks, we can only guess. It is likely that habitat disturbances were mostly limited, although some of the birds were undoubtedly taken as food. The Spanish soon began to change the Rio Grande, and within a century or so their villages spread up and down the valley. Canals were dug, marshes drained, bosques felled, and other alterations of habitat were made; but all-in-all the genetic continuum between *platyrhynchos* and *diazi* may have been affected only in a limited way overall.

Arrival in New Mexico of anglo settlers in the mid-1800's certainly saw a continuation of gradual changes in the valley. These, coupled with changes accumulated over several centuries and the expanding population in this fragile and arid land, more and more disrupted duck populations. In the 20th century reclamation works accelerated the disruptions, and after many decades they have still not abated. The Rio Grande of today is a far cry from that of prehistory, certainly in regards to the miles of thickets of introduced tamarisk (*Tamarix chinensis*), the maze of canals and levees, the stock tanks and reservoirs, and the settlements and agricultural lands. Certainly, by 1940 the Rio Grande Valley of yesteryear was gone, and the ducks of this complex were faced with a new world.

The total effects down through the years of man's settlement and alteration of the Rio Grande Valley are probably untold, but for populations of ducks these can be surmised in a least a general way (e.g. Levy, 1964). First was the gradual disappearance of sloughs, swamps, marshes, and — in places — of even the river itself. In their place came canals, ponds and reservoirs, plus what might be termed "classical" duck habitat in the form of such refuges as Bosque del Apache (founded 1931). What this meant was that the habitats favored by *diazi* (and its presumed intergrades with *platyrhynchos*) gradually were replaced by types to which *platyrhynchos* was better adapted. The latter form, pushing southward to winter in larger numbers as agriculture and suitable waters developed, probably began to summer in increasing numbers all the way to southern New Mexico. In time *platyrhynchos* came to breed in essentially all of the valley, and today it far outnumbers *diazi*-like ducks at such places as Bosque del Apache National Wildlife Refuge.

The net effect of this southward penetrance of *platyrhynchos* would have been to superimpose additional populations of such ducks on previous populations that formed the continuum between *platyrhynchos* in the north and *diazi* in the south. These superimposed populations may well have interbred freely with the available cohorts, whether from the ranks of new arrivals or from the old continuum. Undoubtedly, such actions would have led to widely variable breeding populations and offspring, and we may still be seeing new influxes of *platyrhynchos* that will further interact with the variable status quo populations. In time and with continued alteration of the valley, *diazi*-like ducks may well become scarcer and scarcer, eventually largely disappearing from the area as breeders. This prospect seems quite likely, in view of the fact that continually changing conditions along the river seem destined to promote variability. Certainly there seems to be no prospect of *diazi* reenforcing itself as a species in the valley, if anywhere in the Southwest, and we have seen that apparent introgression with *platyrhynchos* is evident as far southward in the range of *diazi* as Durango, Mexico.

As lamentable as it is that the Rio Grande no longer harbors primeval habitats and the duck populations that were once characteristic of them, at the same time we have no alternative to acceptance of what "nature" has wrought as to the evolutionary course of *diazi* and *platyrhynchos.* To be sure we have probably speeded up the absorption of *diazi* by *platyrhynchos,* but

it was probably under way well before we appeared on the scene. This recognition does not, however, mean that we should absolve ourselves of further responsibility in the matter, as will be seen from the list of recommendations proposed at the end of this paper.

REVISED RANGE OF *platyrhynchos* AND *diazi*

In view of the data already presented, I would amend the range of *platyrhynchos* to indicate that it breeds southward to southern Arizona and southern New Mexico, interbreeding with *diazi* extensively along the lower Rio Grande (Socorro County southward to western Texas), southwestern New Mexico (Hidalgo County), and southeastern Arizona (Cochise County). *Diazi* can be said to breed northward in pure form from Puebla to San Luis Potosi, Zacatecas, and Nayarit; to breed in increasingly hybrid (with *platyrhynchos*) form through Durango and Chihuahua to southeastern Arizona (Cochise County) and southern New Mexico (Hidalgo County; Rio Grande Valley north to Socorro County, and apparently Pecos Valley north to Chaves County); and to have formerly bred in variously hybrid form northward in New Mexico along the Rio Grande (to Bernalillo County) and in Rio Arriba County (Burford Lake).

RECOMMENDATIONS

It is my opinion that a reevaluation of the status of the Mexican duck is needed from a management standpoint, to take into account more current information on taxonomy, populational characteristics, numbers, biology, and other parameters. With this in mind, I wish to offer the following recommendations for what I regard as the three major segments of this taxon and its intergrades with the mallard.

1. Management emphasis should be placed on those populations from Zacatecas southward, as these represent the purest populations. Judging from data gathered by Williams (1973, 1974, 1975), ducks in this southern Mexican population are both numerous and probably near saturation in the available habitat there. Under these circumstances, this taxon should be declassified to threatened status, with at least annual censusing to be done to monitor its status.

2. Populations in Durango and Chihuahua should be classified as *A. p. diazi* approaching *platyrhynchos.* These populations should be monitored and steps taken to encourage them without fostering further invasion or hybridization by *A. p. platyrhynchos.* Steps should include gathering biological data, censusing, and improvement and preservation of *diazi* habitats in these areas.

3. Populations in most of the United States should be regarded as irretrievably hybrid with *platyrhynchos* (i.e. *A. p. diazi* X *A. p. platyrhynchos*), and no further or only limited action should be taken that is ostensibly aimed at specifically benefiting *diazi* in the area. In particular, rearing and release of *diazi*-like ducks at Bosque del Apache National Wildlife Refuge should be discontinued. In addition, further developments that might encourage expansion of breeding *A. p. platyrhynchos* should be discouraged in order to prevent buildup of such a gene pool that could threaten the populations cited in paragraphs 1 and 2. Management work in behalf of *diazi* at such sites as at San Simon Cienaga, Hidalgo County, New Mexico should be reevaluated, and should continue only if gene flow from *A. p. platyrhynchos* can be eliminated or considerably reduced. On the other hand, improvement and preservation of duck habitat should not be abandoned in the area, so long as it does not magnify the presence there of *A. p. platyrhynchos.*

SUMMARY

The biological and taxonomic status of the Mexican duck (*Anas diazi)* was studied vis-a-vis the mallard (*A. platyrhynchos),* with the emphasis on determining whether these two taxa are a conspecies or separate species. Data largely from plumage analyses of specimens reveals that interbreeding and introgression occur in the southwestern United States and adjacent Mexico. Although intergradation between the two forms is rather abrupt and *diazi*-like ducks persist to some degree in the major hybrid zones, the overall data suggest that the Mexican duck should be regarded as a subspecies of the mallard and not as a separate species. Distribution, numbers, evolutionary history, and other considerations of Mexican ducks are discussed, including the questions of endangerment and future management.

SPECIMENS EXAMINED

ADULTS AND IMMATURES

Anas platyrhynchos (Score 0-3)

Mackenzie - 4 males, 1 female; Alberta - 5 males, 5 females; Montana - 1 female; North Dakota - 2 males, 2 females; Idaho - 1 male; Utah - 2 males, 1 female; Wisconsin - 1 female; Iowa - 1 male, 2 females; Arizona: Apache Co. - 1 male, 7 females; Cochise Co. - 2 males; New Mexico: Rio Arriba Co. - 4 males, 5 females; Mora Co. - 1 female; Dona Ana Co. - 2 males, 4 females.

Very near *platyrhynchos* (Score 4-8)

New Mexico: Socorro Co. - 1 male; Sierra Co. - 1 male, 1 female; Dona Ana Co. - 2 males, 3 females; Hidalgo Co. - 1 male.

Nearer *platyrhynchos* (Score 9-13)

Arizona: Apache Co. - 1 female; New Mexico: Rio Arriba Co. - 1 female; Valencia Co. - 2 males; Socorro Co. - 1 female; Dona Ana Co. - 1 female; Aguascalientes - 1 female.

Intermediate *platyrhynchos* X *diazi* (Score 14-22)

Arizona: Apache Co. - 1 female; Cochise Co. - 1 female [= male]; Bernalillo Co. - 1 male; Socorro Co. - 2 males; Sierra Co. - 1 male, 1 female; Chaves Co. - 2 males; Dona Ana Co. - 5 males, 2 females; Hidalgo Co. - 6 males; Texas: Jeff Davis Co. - 1 female [= male]; Chihuahua - 1 male, 1 female; Durango - 1 male.

Near *diazi* (Score 23-27)

Arizona: Cochise Co. - 1 male; New Mexico: Rio Arriba Co. - 1 female; Bernalillo Co. - 1 male; Valencia Co. - 1 male; Sierra Co. - 1 male; Dona Ana Co. - 4 males, 2 females; Texas: El Paso Co. - 1 male; Chihuahua - 4 males, 1 female; Durango - 2 males, 1 female.

Very near *diazi* (Score 28-32)

New Mexico: Bernalillo Co. - 2 males; Valencia Co. - 1 male, 1 female; Dona Ana Co. - 7 males, 17 females; Catron Co. - 2 females; Hidalgo Co. - 1 female; Chihuahua - 6 males, 2 females; Durango - 1 male; Jalisco - 1 female.

Anas diazi (Score 33-36)

New Mexico: Dona Ana Co. - 4 females; Catron Co. - 3 females; Hidalgo Co. - 1 female; Texas: Trans-Pecos area - 1 [female]; Chihuahua - 1 male, 4 females; Durango - 1 female; Zacatecas - 1 male; San Luis Potosi - 3 males; Nayarit - 1 female; Jalisco-12 males, 6 females; Guanajuato - 1 male, 1 female; Michoacan - 1 male; State of Mexico - 6 males, 9 females; Distrito Federal-8 males, 9 females; Morelos - 1 male, 2 females; Hidalgo - 1 female.

JUVENILES

Anas platyrhynchos (±)
New Mexico: Dona Ana Co. - 1 male, 1 female (Las Cruces, 27 July 1920)

Anas diazi (±)
Arizona: Cochise Co. - 1 female (San Bernardino Ranch, late May 1947); Hidalgo Co. - 1 male (San Simon Cienaga, 16 June 1945); State of Mexico - 1 female (Lerma, 2 July 1904).

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