Description and Identification of American Black Duck, Mallard, and Hybrid Wing Plumage

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Cover photo: U.S. Fish and Wildlife Service research staff banding American Black Ducks on the mid-Atlantic coast, Cape May County, New Jersey, January, 1977. Photo by Ronald E. Kirby, USGS.

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Description and Identification of American Black Duck, Mallard, and Hybrid Wing Plumage

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Abstract: We developed a key to identify wings of hybrids between American Black Ducks (*Anas rubripes*) and Mallards (*A. platyrhynchos*). Material for analysis included review of historical descriptions dating from the late 1700's, older museum collections in Europe and North America, wings collected from hunters in North America and Great Britain, birds banded in Canada and the United States, and a flock of propagated hybrids. All first filial generation (F_1) American Black Duck x Mallard hybrids were identified correctly with the key. A lower proportion of other hybrid cohorts (i.e., backcrosses of F_1 to parental forms (P_1), and second and third filial generations (F_2, F_3, etc.) were identified. We successfully identified a larger portion of male than female hybrids for all hybrid progeny cohorts examined except F_1. The new key identified 2.37 times more hybrids in the 1977 U.S. Fish and Wildlife Service Parts Collection Survey (annual determination of the species, age, and sex composition of the waterfowl harvest using detached wings contributed by hunters) than were identified by standard techniques. The proportion of American Black Duck x Mallard hybrids to the American Black Duck parental population (the ratio: hybrids/[hybrids + American Black Ducks]) may therefore be closer to 0.132 than 0.056, the historically reported value. The hybrid key is suggested for use from North Carolina north in the Atlantic Flyway and Arkansas and Tennessee north in the Mississippi Flyway (areas where other members of the Mallard group will not confound assessment). We provide suggestions for further research that would assist identification of wings in parts collection surveys and permit estimation of the proportional representation of Mallard genes in the American Black Duck gene pool.

Key Words: American Black Duck, *Anas platyrhynchos*, *Anas rubripes*, domestic Mallard, hybridization, Mallard, museum, parts collection surveys, plumage, waterfowl, wings.

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Résumé: Une clef pour identifier les ailes d'hybrides entre le Canard noir *(Anas rubripes)* et le Canard colvert *(A. platyrhynchos)* a été développée à partir de documentations diverses. Celles-ci étaient composées de descriptions datant de la fin du XVIII[e] siècle jusqu'à nos jours, d'anciennes collections de spécimens issues des musées européens et nord-américains, d'ailes récoltées auprès de chasseurs d'Amérique du Nord et d'Angleterre, d'oiseaux capturés à des fins de baguage au Canada et aux États-Unis, et d'individus d'un groupe captif dont la généalogie était connue. Cette clef a permis d'identifier correctement tous les hybrides Canard noir x Canard colvert de la première génération (F_1). Une proportion plus faible des générations subséquentes d'hybrides (i.e. croisement F_1 x forme parentale, hybrides F_2, F_3, etc.) a été correctement identifiée avec la clef, et dans ce cas, le taux de succès d'identification était plus élevé chez les mâles hybrides que chez les femelles. L'utilisation de cette même clef pour identifier les ailes de la récolte de 1977 de l'*United States Fish and Wildlife Service* a permis d'identifier 2,37 fois plus d'hybrides que les méthodes traditionnelles utilisées jusque-là. Suite à ces identifications, la proportion d'hybrides Canard noir x Canard colvert par rapport à la population parentale du Canard noir (le ratio : hybrides/[hybrides + Canard noir]) est évaluée à 0,132 plutôt qu'à 0,056, la valeur rapportée historiquement. L'utilisation de cette clef est donc recommandée pour identifier les ailes des canards provenant des régions s'étendant jusqu'au sud de la Caroline du Nord dans le corridor de migration de l'Atlantique, et jusqu'au sud de l'Arkansas et du Tennessee dans le corridor de migration du Mississippi, excluant ainsi les régions plus méridionales où d'autres espèces apparentées au Canard colvert pourraient compromettre l'identification. Des suggestions sont également proposées quant au développement de méthodes destinées à faciliter l'identification des ailes envoyées par les chasseurs et permettant l'estimation de la proportion des gènes de Canard colvert dans le pool génétique du Canard noir.

Introduction

The American Black Duck (*Anas rubripes*) (hereafter Black Duck) is a priority concern of waterfowl managers as described in the North American Waterfowl Management Plan (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1986) because its populations have declined. This decline has been attributed to loss and degradation of habitat, harvest by hunters, and competition and hybridization with Mallards (*A. platyrhynchos*), which are expanding their range eastward (Rogers and Patterson 1984; Ankney et al. 1987, 1988; Kirby 1988; Rusch et al. 1989). Relative numbers of the two species in many portions of the East have changed (Collins 1974; Dennis et al. 1984; Ankney et al. 1987; D'Eon et al. 1995). Continued release of captive-reared Mallards and the establishment of resident, feral Mallard flocks have provided opportunity for increased interspecific matings between Black Ducks and Mallards. Some waterfowl ecologists believe that introgressive hybridization has been and will continue to have an increasingly detrimental influence on Black Ducks (Heusmann 1974, 1988; Spencer 1980, 1986; Ankney et al. 1987; Kirby 1988), but biologists differ on the consequences of hybridization for the Black Duck gene pool (Ankney et al. 1986, 1987, 1989; Ankney and Dennis 1988; Hepp et al. 1988; Conroy et al. 1989). Because of these disagreements, population monitoring schemes need estimates of year-specific incidence of hybridization and the long-term trend in hybridization.

Early attempts to assess the incidence and trend of hybridization between the two species with electrophoretic techniques failed except in identifying first filial generation (F_1) hybrids and the parental generation (P_1) (Morgan et al. 1976, 1978, 1984a, 1984b). Subsequent biochemical investigations (Patton and Avise 1983, 1985; Oates et al. 1984; Ankney et al. 1986; Avise et al. 1990) and phylogenetic (cladistic) analyses (Livezey 1991 and review therein) confirmed that Black Ducks and Mallards are closely related but did not provide information useful in identifying hybrids.

A true estimate of hybridization rate, that is, the proportion of mixed pair bonds formed in the wild or the actual numbers of hybrids hatching from mixed-species matings, has been obtained only in limited, accessible areas (e.g., Longcore et al. 1987; Sanderson 1993; D'Eon et al. 1994). No schemes to obtain such data on a large scale in the wild have been attempted. Instead,

measures of interaction between Black Ducks and Mallards have been confined to documenting shifts in the breeding range (e.g., Collins 1974; Dennis and North 1984a, 1984b; Dennis et al. 1984, 1989; Ross and Fillman 1990), examining changes in the relative abundance of the two species in annual Mid-winter Waterfowl Survey counts (Steiner 1984) or Christmas Bird Counts (Wing 1943; Johnsgard 1961; Johnsgard and DiSilvestro 1976), and calculating the fraction of the wings submitted to the annual U.S. Fish and Wildlife Service and Canadian Wildlife Service Parts Collection Surveys putatively identified as hybrids (Johnsgard 1967; summaries in Carney et al. 1975, 1983). Only this last measure attempts to address frequency of hybridization per se in wild populations.

Despite the limitations of the parts collection surveys (Martin and Carney 1977; Boyd and Finney 1978), they are valuable information tools for management (Boyd et al. 1974). It is the only technique currently capable of detecting changes in Black Duck x Mallard hybridization over the entire range of sympatry. In the early 1970's, the Canadian Wildlife Service (Québec Region, Ste-Foy, Québec) and two U.S. Fish and Wildlife Service (now U.S. Geological Survey) entities (Northern Prairie Wildlife Research Center, Jamestown, North Dakota, and Patuxent Wildlife Research Center, Laurel, Maryland) independently began studies to refine means of detecting Black Duck x Mallard hybrids. These efforts were combined in 1976. Between 1976 and 1983, field, laboratory, and museum studies were conducted. Since 1984, the techniques established were further evaluated in the field; oral presentations on the techniques also resulted in important feedback. In this paper, we present the sum of more than two decades of evaluation of the issue, provide an improved key for identification of Black Duck x Mallard hybrids, and reinterpret previously published data on Black Duck x Mallard hybridization.

Scope of the Problem

Standard keys used in North American parts collection surveys (Carney 1964, 1992) identify age and sex of waterfowl by species but not intergrades or aberrant forms. Consequently, identification of Black Duck x Mallard wings is subjective and inexact (Carney et al. 1983:1). Historically, Mallard-like wings with unusually dark dorsal surfaces, overall dark wings with an anterior white border to the speculum, and wings with an indistinct white line anterior to the speculum all have been considered indicators of hybridization with Black Ducks. However, these traits have not been rigorously assessed as indicators of hybridization (Heusmann 1974). S. M. Carney (U.S. Fish and Wildlife Service, personal communication) described more recent techniques as "relatively standard throughout," even though specific criteria for identifying hybrids and captive-reared (= hand-reared) and domestic-strain birds have not been published. Carney defined the criteria used by the mid-1980's for Black Duck x Mallard hybrids as follows:

> [In comparison with the typical Mallard wing]...good procedures for this type of identification are lacking. Birds intermediate in color between the two species are considered hybrids. These normally have a poorly defined white stripe anterior to the speculum ... . Although we only look on the underwing of birds that are suspect, the presence of a few dark brown feathers usually causes us to consider the bird a hybrid. Birds considered to be "hand-reared" are those with extra white on the tertials, dark underwings, or odd proportions of length to width (a few of the latter are unusually large wings). Unfortunately, the major area for both crosses and "hand-reared" birds appears to be the same, i.e., southern New England to Virginia.

Major difficulties in identifying wild Black Duck x Mallard hybrids arise from (1) the lack of obvious sexual dichromatism in the Black Duck; (2) the existence of a number of plumage characteristics, often referred to as inherent "Mallard" characteristics, in typical Black Duck plumage (Phillips 1912, 1915, 1921); (3) substantial plumage variation among individuals possibly related to nutrition and stress (cf. Kirby and Fredrickson 1990); (4) a rather broad range of "typical" plumage features in both species; (5) considerable geographic variation in plumage of both species; and (6) interbreeding of wild Black Ducks with released or otherwise feral Mallards throughout much of historic Black Duck breeding and wintering range. Further, uncertainty about what constitutes "typical" Black Duck plumage has stymied attempts to determine hybridization incidence (e.g., Heusmann 1974; Johnsgard and DiSilvestro 1976; Morgan et al. 1978, 1984b), even though most investigators agree that plumage coloration per se (Bellrose 1976) or plumage coloration plus the "curly" tail feather character of male Mallards (Livezey 1991) can be used to distinguish the two species even in the absence of other useful morphometric variables (cf. Hanson and Ankney 1994). The range of variation in Black Duck plumage has not been described and only limited descriptions of Black Duck x Mallard hybrid plumage are available (Dutcher 1889; Eaton 1903; Bigelow 1907; Phillips 1915, 1921; Kortright 1942). Palmer (1976:328) summarized what little is known of this variation:

> ...the Black has considerable individual variation in characters of feathering, some geographical

variations in these, some clinal variations in size (larger northward), and the effects of limited crossing with Mallard and perhaps Mottled Duck are somewhat obscured by imprecise knowledge of the full extent of variation in "pure" Black Ducks.

Methods

We reviewed historical (1758 - present) descriptions of Mallard and Black Duck wing plumage to establish standards for comparison. We confirmed species and hybrid characters through inspection of wings from Mallard populations that probably had little or no contact with Black Duck populations, including the collections of 11 museums (Smithsonian Museum of Natural History, Washington, D.C.; American Museum of Natural History, New York, New York; Academy of Natural Sciences, Philadelphia, Pennsylvania; Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; Royal Museum of Natural History, Toronto, Ontario; Museum of Natural History of Canada, Ottawa, Ontario; Wildfowl Trust, Slimbridge, Gloucestershire, England; Harrison Museum, Seven Oaks, Kent, England; British Museum, Tring, Hertfordshire, England; Royal Scottish Museum, Edinburgh, Scotland; and the Allison Collection, Loch Leven, Kinross, Scotland). We further evaluated species and hybrid characters in live-trapped birds from Thurso, Québec (1974-76), New Jersey (1976-78), and Maine (1977-78) and parts collection survey receipts from three countries and a number of years (Canadian Parts Collection Surveys 1975-76, 1976-77, 1977-78, 1978-79; U.S. Atlantic Flyway 1976-77, 1977-78, 1978-79; U.S. Pacific Flyway 1976-77; British Parts Collection Survey 1976-77). We also examined an experimental flock of 248 Black Duck x Mallard hybrids. Finally, we developed a key for identifying hybrid forms and reanalyzed Mallard-like and Black Duck-like wings obtained in the 1977 U. S. Parts Collection Survey.

Plumage Examination

We used a subsample of the live birds and whole-body study skins to compare plumage characters with published descriptions. For each bird, we initially sorted data for 42 individual feathers or feather tracts by size, shape, color, and internal patterns within feathers as part of an ongoing study in Canada (P. Dupuis, unpublished data). We compared areas of white on the wing dorsum to a Mallard standard (e.g., a male and female wing showing the characters illustrated in Carney 1992: Figs. 3 and 4). We examined additional specimens for only wing characters, although other aspects of the plumage, if unusual, were noted qualitatively. We analyzed plumage criteria in the same fashion for the large numbers of wings obtained from the annual parts collection surveys. We also analyzed specimens of Mottled Ducks (*A. fulvigula*) and Mexican Ducks (*A. diaza* = *diazi* group of *A. platyrhynchos* of American Ornithologists' Union 1998) whose ranges partially overlap those of Black Ducks and Mallards. In order to quantify the total range of variation in the collections, we likewise evaluated all specimens in the 11 museum collections that were identified in the catalogues or on the specimen labels as *Anas* spp. hybrids, domestic breeds, or unusual varieties.

Experimental Flock of Hybrids

In the early 1970's, F. B. Lee reared a captive flock of P_1 Mallards from California and North Dakota and P_1 Black Ducks from New Brunswick (some hand-reared in North Dakota) at Northern Prairie Wildlife Research Center near Jamestown, North Dakota. In 1974-76, a breeding program was established to develop various hybrids from these parental forms. Following a series of related studies, the hybrid flock became available for our use in November, 1976, when we examined them and compared them with wild birds shot by hunters and reported to the U.S. Parts Collection Survey. We made study skins of representative individuals and entered them into the collections of the Smithsonian Museum of Natural History.

Results

Historical and Current Descriptions of Mallard and Black Duck Wing Plumages

Mallard

First scientific descriptions of the Mallard (Latham 1785; Pennant 1785) differed little from earlier nonscientific descriptions or subsequent scientific accounts. Palmer (1976:276-280) described Mallard wing plumage as follows:

a. the greater secondary coverts are white subterminally and black at the tips in both sexes in all plumages, with the white of the female often extending proximally beyond the metallic area (speculum) but not onto innermost secondaries;
b. the secondaries forming the speculum are black subterminally with broad white tips in all plumages, forming a trailing white bar in both sexes; and
c. axillars and most of the wing lining are white in both sexes, but the most proximal of the light underwing coverts have dark barring in the female.

Black Duck

Earliest written descriptions of the Black Duck appeared only after initial European exploration of North America's eastern shore. The modern definition is as follows (Palmer 1976:321-326):

a. greater secondary coverts terminal black, with sometimes "more or less of a thin or poorly defined white line forward of this black stripe";
b. secondaries have broad black ends, which vary from bird to bird from white at the very tip to ends solid black; and
c. in the wing lining, many greater coverts are light gray, others white, but some sooty-fuscous coverts with whitish margins generally are present beyond the bend of the wing, and axillars are white.

Palmer emphasized that "typical" Black Duck and Mallard wings also differed in other respects including overall color, amount of light edging on feathers, extent of iridescence (but not necessarily or consistently the color) of the speculum, presence of vermiculation, and presence of internal markings in feathers. Although further variation is introduced by the presence in wing collections of domestic Mallards, which display a range of characters unlike those of the wild Mallard (Delacour 1964:154-166), the modern consensus remains that "typical" wings (as described by Palmer for each species) are strikingly different to even the casual observer.

Older accounts of Black Duck wing plumage (from 1785; references in Appendix) differ from Palmer's (1976) description. In these older accounts, the occasional presence of white subterminally on the greater secondary coverts was never mentioned as a species character except by Phillips (1912), who mentioned that some Black Ducks in New England showed this trait. Palmer's description agrees with commonly accepted criteria used by those who currently handle Black Ducks in banding operations: the Black Duck may or may not have "some" white anterior to the speculum. For example, the description in Carney's (1992:141) key ("[secondaries] blue bordered front or back (not both) with white") for Black Duck and Mottled Duck allows less expression of white than Palmer (1976). Although Palmer's description may accurately describe wings of mid- to late 20th-century birds assumed to be Black Ducks, historical evidence from the references in the Appendix supports our contention that subterminal white on the secondary coverts of Black Ducks is rare, and at its most extreme, it is a pale gray subterminal tinge in some birds as described by Cramp and Simmons (1977).

Accounts did not mention white as occurring on the terminal edge of the secondary feathers of Black Ducks until Nuttall (1834). Thereafter, some authors listed this character while others did not, and some attributed it to males only. Not until the 20th century did most authors list white as possibly being present as a thin terminal line, and the sex specificity was retained for at least 25 more years (e.g., Forbush 1925). Forbush (1925) and Bagg and Eliot (1937) attributed this character to adults only, but age and sex specificities of this trait were omitted by all authors after 1940. It may be that terminal white on the secondaries was always variable and sometimes inconspicuous, giving the impression that "most" Black Ducks were without white, or concomitantly, that the proportion of birds with white-tipped secondaries increased in this century. Regardless, the important determination for plumage analysis is that historical descriptions support the conclusion that Black Ducks from across their range may have a more-or-less complete terminal band of white on the secondaries that form the speculum, and the maximum width may be equivalent to that on Mallards.

Underwing Plumage

Descriptions of underwing plumage in both the Black Duck and the Mallard have historically varied. "White" or "silvery white" are always listed as the most conspicuous features of this plumage in the Black Duck. Certainly, from a distance as a field mark, this trait is distinguishing. However, paintings by several artists showed dark feathers in the underwing of the Black Duck [Audubon 1838, Fuertes (in Forbush 1925 and Oberholser 1974), Hunt (in Heilner 1946), Ruthven and Zimmerman (1965), Weber (in Wetmore 1965), Ogilvie (1975), and Hines (1978)]. Similarly, a photograph in Wright (1954) shows some dark feathers, and Palmer (1976) specifically mentioned "sooty-fuscous" feathers on the underwing.

The Mallard has been described as generally having "creamy white" underwings. We observed that male Mallards trapped in Québec (1975-90) and male specimens in Canadian museums collected before 1935 did not have dark underwing feathers. Mallard females had a variable but always small number (generally less than seven) of dark underwing feathers. In obvious contrast, Black Ducks of both sexes had a variable, but consistently large, number (always more than 10) of these dark feathers. A large group of birds, believed to be hybrids, fell between Mallards and Black Ducks for this character. Ball's (1934:23) comment that a hybrid specimen showed its *A. rubripes* inheritance in the underwing coverts through a broken row of dark spots near the edge of the wing is the only reported prior observation of this phenomenon.

Species Descriptions and the Characters of Study Skins and Wings

Mallard Wings in Museums and Modern Parts Collections

We examined 469 specimens collected from 1867 to 1977 in areas outside North America. These birds were presumed to have had no probability of contact with Black Ducks.

Palearctic and Orient. All but one of 332 Mallard skins (adult male from Sweden, 1908) were typical, as there were no obvious aberrancies in body plumage, white edging on the anterior and posterior borders of the speculum was complete (>80% of all feathers of the speculum), there were no large dark underwing feathers, and there were fewer than 10 small dark underwing feathers. The single aberrant bird appeared to be a cross with a domestic variety.

Great Britain. All but 3 of 137 wings analyzed from the British Parts Collection Surveys showed typical Mallard features as above. One exception had narrow white bars, others had 3 and 9 small dark feathers in the underwing.

North America. We examined 1,705 wings from the U.S. Parts Collection Survey for the Pacific Flyway (1976-77 season), 2,280 wings from the Canadian Parts Collection Survey (British Columbia, 1975-76 and 1976-78 hunting seasons), and 85 older skins (1840-1937) from the collection of the Academy of Natural Sciences, Philadelphia, Pennsylvania, to evaluate the modern description of Mallards. These specimens were selected because of their low probability of contact with Black Ducks, Mexican Ducks, or Mallard x Mexican Duck hybrids (i.e., wings from northern California, Nevada, Oregon, Washington, Idaho, western Montana, western Colorado, and western Wyoming). All wings in the Pacific Flyway sample had white wing bars above and below 80% or more of the speculum and were otherwise typical Mallards. Two females had one brown feather on an underwing; one female had three brown feathers on one underwing. Only one of the wings from British Columbia (male) had characters different from those of a typical Mallard (dark feathers in the underwing). In the Philadelphia collection, 52 male skins were typical Mallards in all respects; one male skin (6 August 1927, Bear River, Utah) was typical on the dorsal wing surface and elsewhere but had two dark brown feathers on the underwing; 32 female skins were typical in all respects except that four skins each had one dark brown feather in the underwing.

Black Duck Wings in Museums and Modern Parts Collections

We examined 312 Black Duck skins at the Academy of Natural Sciences, Philadelphia, Pennsylvania; American Museum of Natural History, New York, New York; and Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, each of which contained substantial collections of comparatively old specimens (1873-1939). Ninety-seven percent of the males and 99 percent of the females resembled in general form and coloration typical Black Ducks per Cramp and Simmons (1977). These specimens had either no white on the dorsal surface of the wing or only a lower bar (white terminal) on the secondaries. Only two of these ducks had fewer than 10 brown feathers on the underwing.

A Revised Description of Mallard Wing Plumage

Based upon our historical literature review and empirical assessment of study skins, wings, and live birds, we contend that typical Mallard wing plumage can be characterized as follows (Figs. 1 and 2):

Dorsal: The speculum is bounded by anterior and posterior white bars, each usually more than 5 mm wide, but not always so. These bars are continuous and delimit without interruption more than 80% of the iridescent secondaries. This white has strictly delimited margins with adjacent colors including black on the posterior bar; fuscous-gray, gray, or shades of brown, depending upon age, sex, and season, and black on the anterior subterminal bar (color terminology of Palmer 1976). The remainder of the wing dorsum for both sexes and all ages is as described by Palmer (1976) and Cramp and Simmons (1977).

Ventral: Underwing coverts (lining of the wing) are white in both sexes. Male Mallards never have dark feathers in the underwing coverts; but female Mallards are more variable and may have a few (usually less than seven but always less than 10) dark brown feathers on the anterior edge of the underwing.

A Revised Description of Black Duck Wing Plumage

Based upon our literature review and assessment of study skins, wings, and live birds, we contend that Black Duck wing plumage is characterized as follows (Fig. 3):

Dorsal: Black Ducks can have white posterior to the speculum, but they never have white anterior to the speculum. White posterior to the speculum may vary from none, to a thin white edge, to that present on typical Mallards. The lack of white anterior to the speculum on the greater secondary coverts strictly separates Black Ducks from Mallards. However, Black Ducks often do have a pale gray subterminal line (terminology of Cramp and Simmons 1977) on these coverts, and on some birds this gray line is suffused with one of several shades of "brown" or

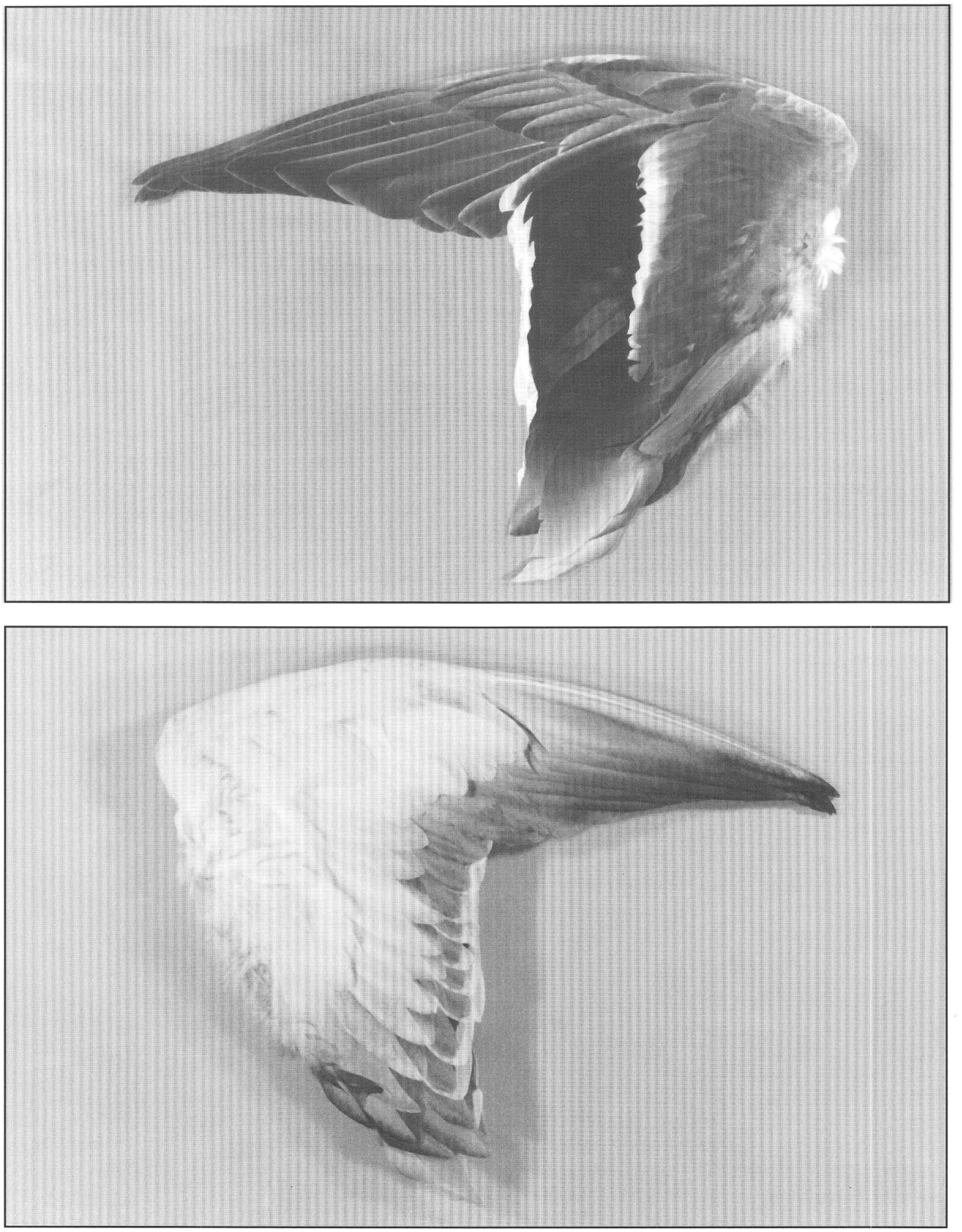

Fig 1. Photograph of a typical wing from an immature male Mallard illustrating the range of dorsal and ventral characters expected in wild forms. Note the sharp borders between white and black bordering the speculum, the large and even width of this white from the proximal to the distal end of the speculum (considered 100% for comparison), and the overall uniform white of the underwings. This wing has slightly more white than average on the proximal edge of the speculum.

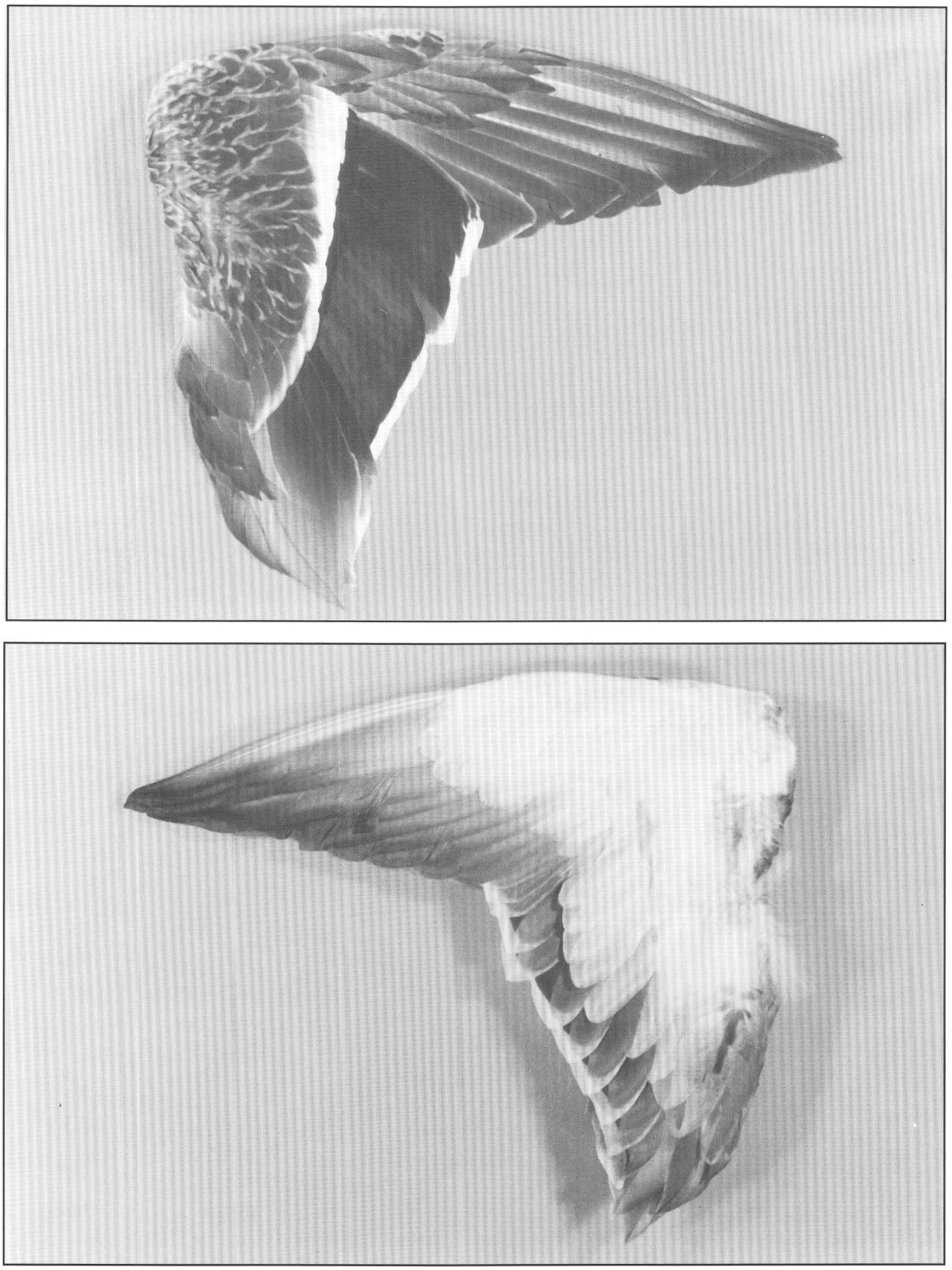

Fig. 2. Dorsal and ventral photographs of a typical wing from an immature female Mallard illustrating the same features as in Figure 1. Note the further extent of white across the tertials in the female than in the male.

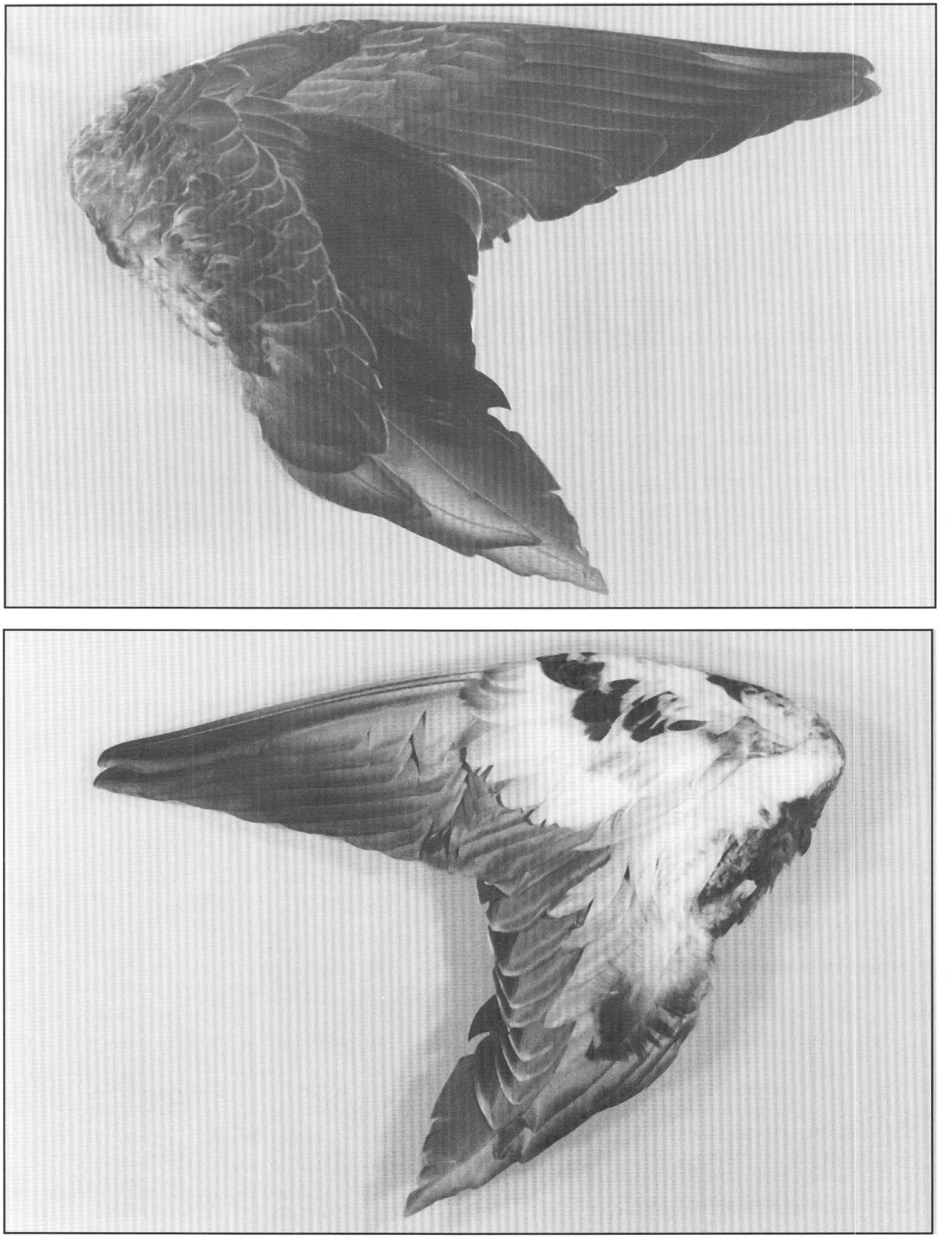

Fig. 3. Dorsal and ventral photographs of a typical wing from a Black Duck (in this case, an adult male) illustrating characters expected in wild forms. Note lack of an anterior white bar bordering the speculum, the trace of white on the posterior bar, and the presence of more than 10 brown feathers on the underwing.

"tan." The overall effect is difficult to describe precisely, since several colors (#23 [Raw Umber], #24 [Buff], #36 [Amber], #37 [Antique Brown], #38 [Tawny], #39 [Cinnamon], #40 [Cinnamon Rufous], and various combinations with one of the Neutral Grays [terminology of Smithe 1974a, 1974b]) may be present. The result is a line of variable width adjacent to the terminal black that is distinctly *not white* in comparison with the white on the dorsal surface of a Mallard wing.

Ventral: All Black Ducks have more than 10 dark brown feathers on or near the leading edge in the lining of the wing (Fig. 3).

Independent Confirmation of the Revised Black Duck Wing Description

We applied our diagnostic criteria to an independent sample of older Black Duck skins collected from 1842 to 1939 that are deposited in the Smithsonian Museum of Natural History. At arm's length, we viewed each available skin in the entire collection labeled as either a "Mallard," "Black Duck," "domestic Mallard," "aberrant form," "Mallard-like," or "hybrid." We used the presence of white and more than 10 dark feathers to classify each skin as (a) Black Duck-like, (b) Mallard-like, or (c) an obvious mixture of the two or a domestic breed. (These initial decisions were made without knowledge of the information on labels attached to the skins.) We then evaluated those specimens in category "a" with the Black Duck wing criteria. Ninety of 94 specimens (96%) met the dorsal and ventral wing criteria. No birds we classified as "b" or "c" were labeled Black Ducks by the original collectors or determined to be Black Ducks by us after closer inspection. We concluded from this sample that in excess of 95% of all Black Ducks meet the proposed criteria.

Black Duck x Mallard Hybrid Wing Plumage

Available descriptions of Black Duck x Mallard hybrids by Dutcher (1889), Eaton (1903), Bigelow (1907), Kortright (1942), and Gillham and Gillham (1996) are of limited value because the authors could not be certain of their specimens' genetic history. Only Phillips (1915, 1921) described ducks he knew were progeny of mixed pairs. He found F_1 hybrids to be darker overall than Mallards, but all had both upper and lower white wing bars bordering the speculum. He found reduced amounts of white in F_2 progeny and young from backcrosses to Black Ducks. Upper wing bars were absent in only one F_2 bird. He did not comment on the appearance of the underwing of his hybrids.

We were able to locate eight of Phillips' Black Duck x Mallard specimens from his hybridization studies in the Museum of Comparative Zoology, Harvard University. Seven of these birds did not fit the criteria for typical Black Ducks or Mallards, and one bird, F_2 male number 172, was indistinguishable from a typical Black Duck as noted by Phillips (1915:78). No other historical specimens of progeny from confirmed hybrid matings were known to us.

Hybrids Propagated at Jamestown

None of the 23 female and 42 male F_1 hybrids propagated at the Jamestown facility matched the above criteria for typical Black Duck or Mallard wing plumage. These birds all had narrower, and usually less distinct, white wing bars than Mallards and too few (to be a Black Duck) or too many (to be a Mallard) dark feathers on the underwing. Twenty-two male F_2, six of 13 female F_2, five male F_3, and two of nine female F_3 did not meet criteria for typical Black Duck or Mallard wing plumage based on presence/absence of white wing bars and underwing dark feathers. In backcrosses of F_1 hybrid ducks to Black Ducks, 47 of 49 males and 35 of 44 females did not fit the standard criteria for the two species. In backcrosses of F_1 hybrids to Mallards, 40 of 49 males and four of 42 females did not fit the species criteria.

In sum, all F_1 hybrids, regardless of sex, could be distinguished from parental species by using the species definitions for white on the dorsal surface of the wing and dark feathers on the underwing. All male F_2 and F_3 generations showed these characters, but only 36% of the female F_2 and F_3 showed them. Our wing characters correctly identified 96% of males and 80% of females resulting from backcrosses between F_1 hybrids and Black Ducks, but we could identify only 82% of males and 10% of females resulting from backcross of F_1 hybrids to Mallards.

Figures 4 through 7 provide examples of hybrids from the propagated flock, wing receipts in Canadian and U.S. Parts Collection Surveys, and birds handled in Québec and New Jersey banding operations during 1976-80. Figure captions note those characters that identify the bird as of hybrid origin.

Sex Determination of Hybrid Wings

Undamaged wings of 131 hand-reared hybrids were measured for comparison with Carney's (1964, 1992) keys for Black Ducks. Three of 52 (6%) adult male wings measured less than 282 mm, Carney's lower limit criterion for absolute identification to sex based on this measurement. All of the smaller wings were in the in-between grouping (279-281 mm), which requires inspection of plumage characters for sex determination in Carney's key. Eight of 59 (14%) wings from adult

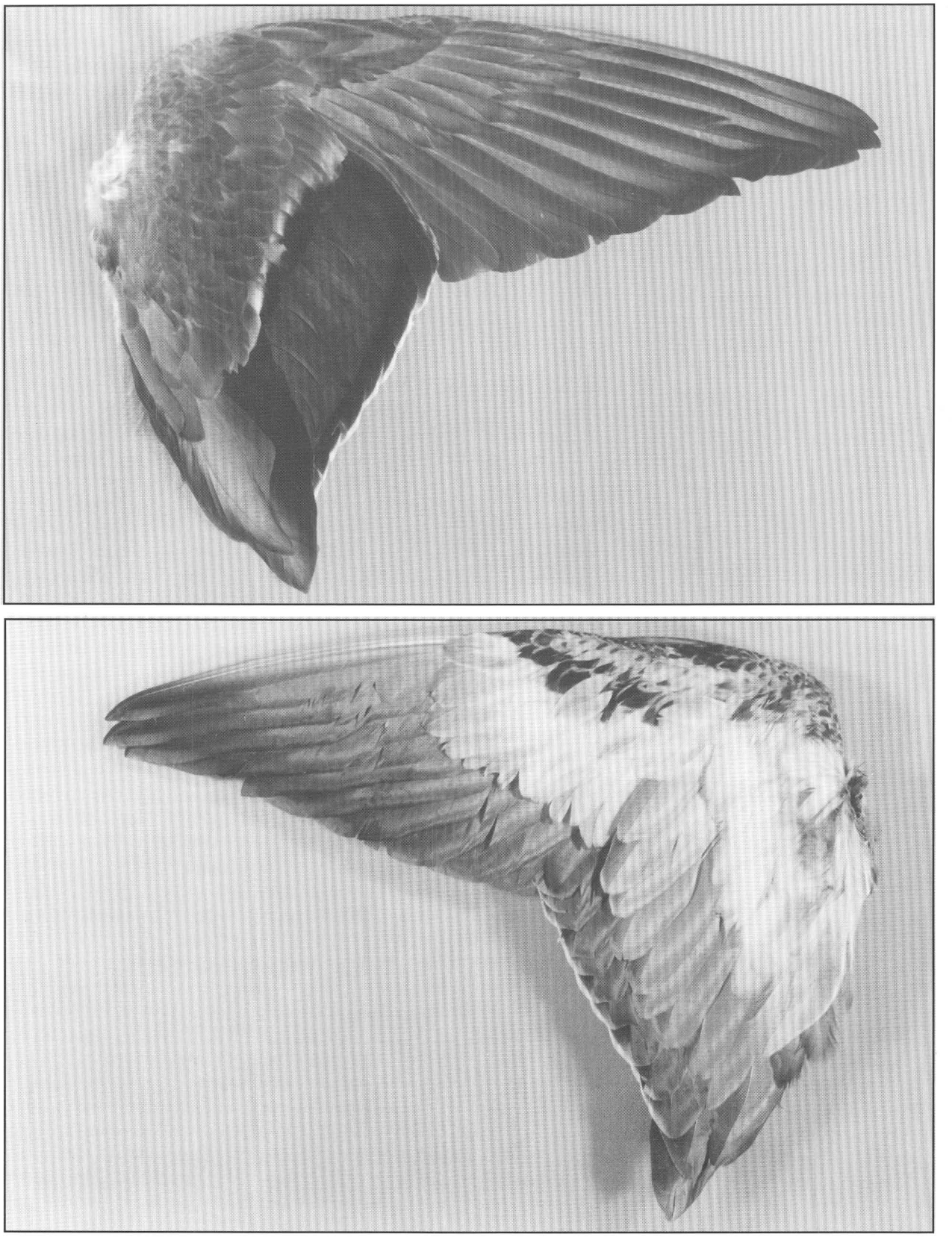

Fig. 4. Dorsal and ventral photographs of a wing from an adult male hybrid resembling for the most part a Black Duck. Note the trace of an anterior bar (hybrid character), restricted posterior bar on the secondaries about 10% the width of a normal male Mallard posterior bar (a Black Duck character), and the presence of more than 10 brown feathers on the underwing (Black Duck character).

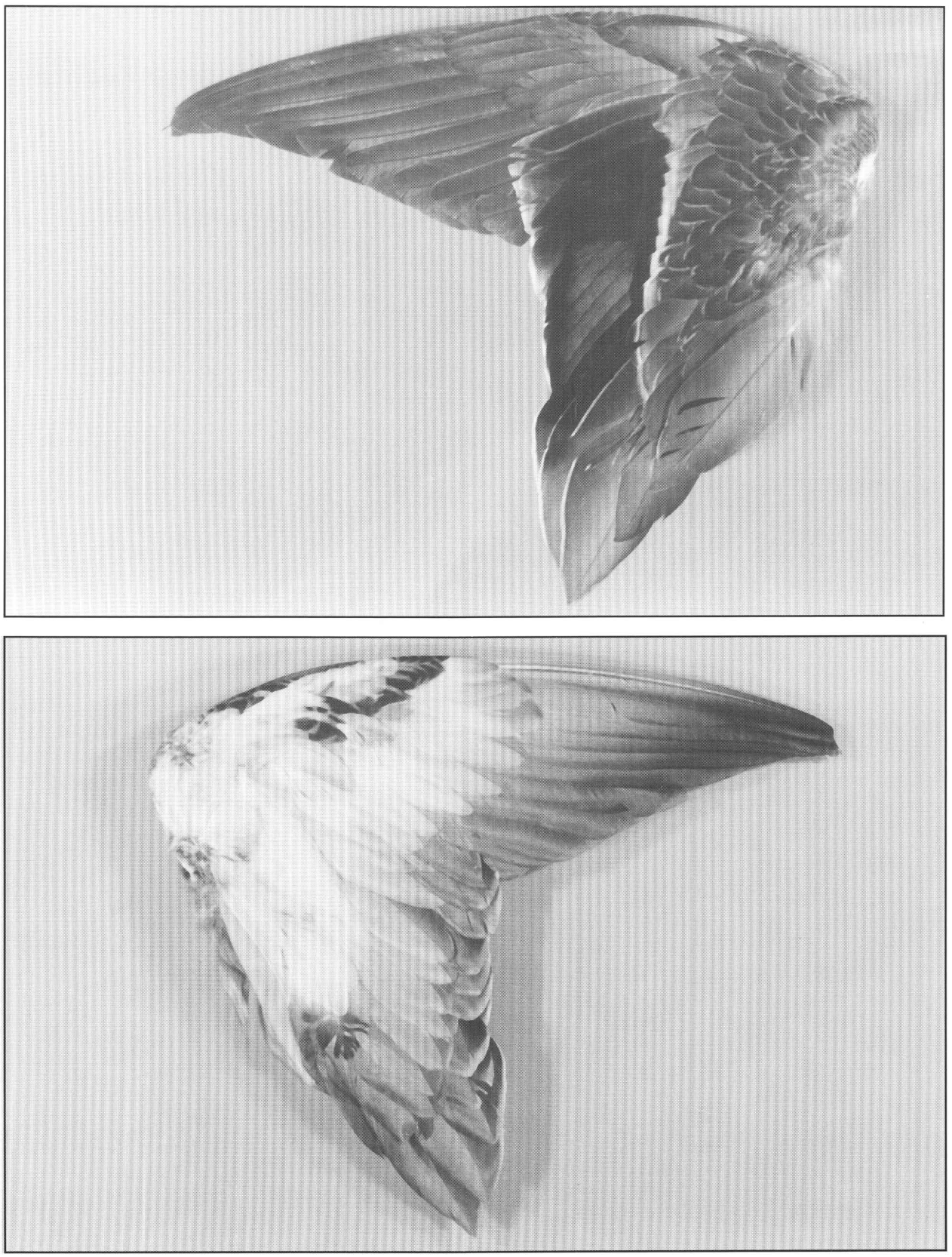

Fig. 5. Dorsal and ventral photographs of a wing from an immature female hybrid resembling for the most part a Black Duck. Note the anterior bar about 50% the width of that of a Mallard (hybrid character), the posterior bar about 10% of that of a Mallard (Black Duck character), and more than 10 brown feathers on the underwing (Black Duck character).

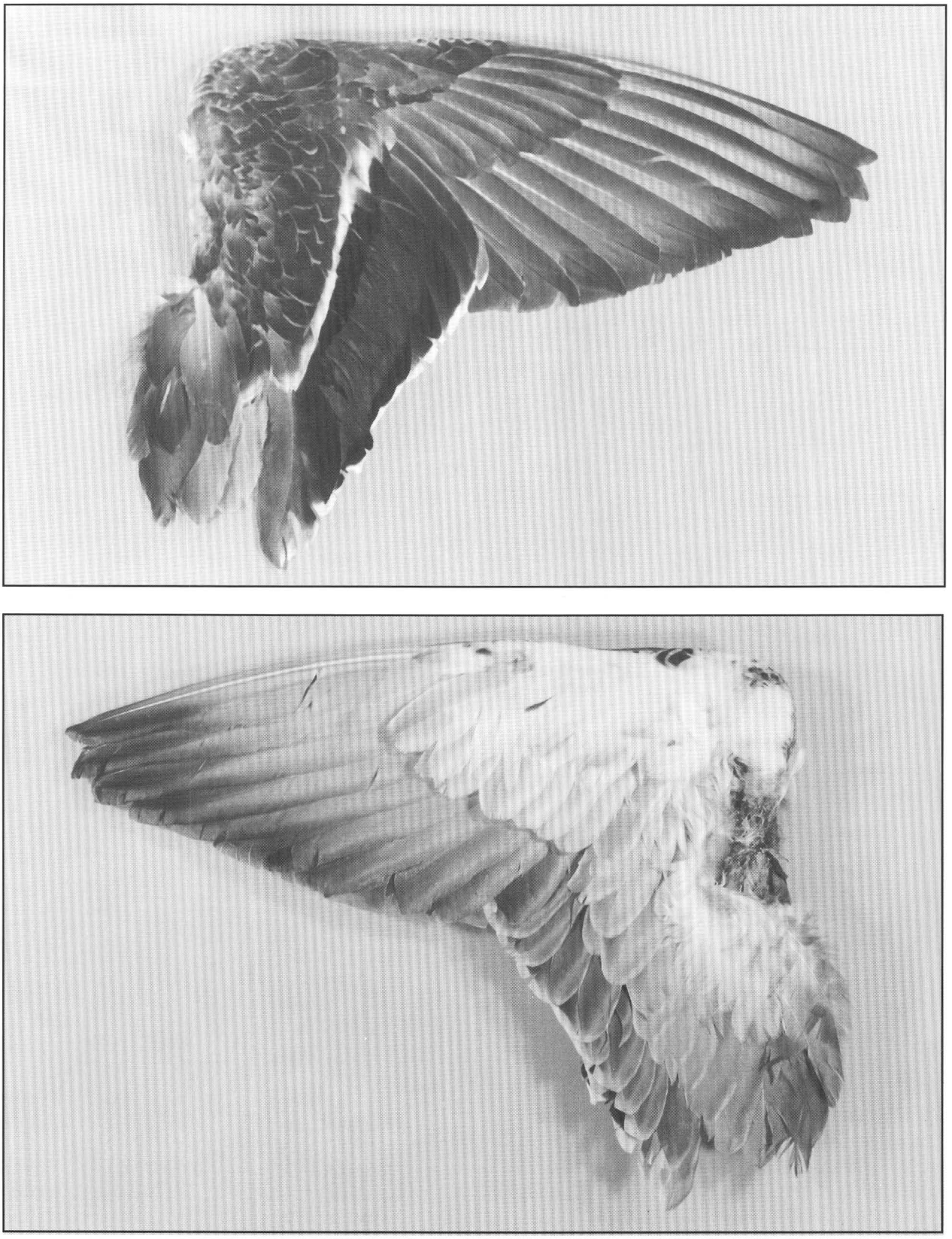

Fig. 6. Dorsal and ventral photographs of a wing from an adult female hybrid resembling for the most part a Mallard. Note the anterior and posterior bars about 50% that of a Mallard (hybrid character), and more than 10 brown feathers on the underwing (Black Duck character). Many of the brown feathers are small and do not show well in the photograph except near the bend of the wing (wrist).

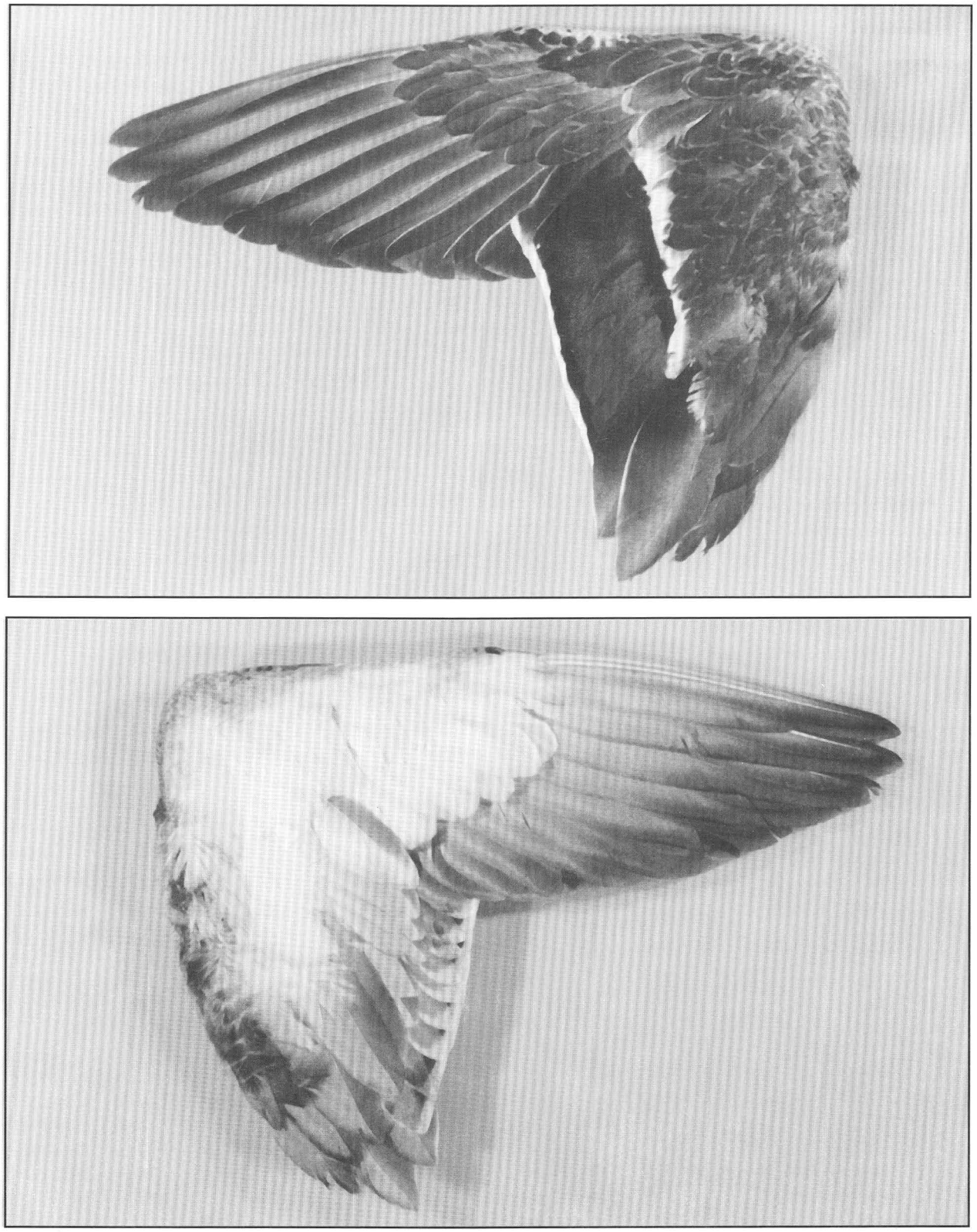

Fig. 7. Dorsal and ventral photographs of a wing from an immature female hybrid resembling for the most part a wing intermediate between Black Duck and Mallard. Note that the anterior bar is almost that normally found on Mallards (Mallard character), but the posterior bar is only about 50% of that found on Mallards. The underwing has six brown feathers. The unlikeness of the two wing bars identifies this wing as a hybrid even though it was only slightly darker than an average mallard wing. Many would identify this wing as a mallard.

females exceeded 278 mm, Carney's upper limit criterion for absolute identification of females on the basis of wing length. Of those eight, four fell within the range 279-281 mm, which would have required further inspection of the plumage. The four remaining wings would have been initially identified as from males, on the basis of length, for an error rate of 7%. Three of the wings in question, however, more closely resembled wings from Mallards than Black Ducks and were correctly identified by presence of plumage characters used to identify sex of Mallards (Carney 1992). The remaining wing would be misidentified with any but most careful inspection in addition to measurement. We conclude that sex of an adult hybrid wing is misclassified 2-7% of the time using wing characters, and that this error is biased against correct identification of females.

The measurements for the immature birds identified all but one of 10 females correctly with current Canadian Wildlife Service criteria for wing length of < 271 mm (Reed and Boyd 1972). Wing chords of 10 immature males exceeded 272 mm, Reed and Boyd's lower limit criterion for identification of young males. Bias, again, is against correct identification of females. The single wing from a female that was misidentified resembled the wing of a Black Duck. Only careful inspection would have revealed its sex after the measurement was made.

Because the error rate for determining sex of hybrid wings seems to be approximately in the range < 5%, we conclude that current techniques for determining the sex of Black Ducks are sufficient to determine the sex of hybrids from wings alone. Measurements usually suffice, but a careful worker will take advantage of both measurements and plumage characters to determine sex, especially if the wing has any white anterior to the speculum. In such instances, criteria for determining sex of Mallard wings easily apply (Carney and Geis 1960, Carney 1992).

Discussion

Key for the Identification of Hybrid Wings

We developed a key from our analyses (Table; also see page 27). We are confident the key facilitates discrimination among wild Black Ducks, Mallards, and their hybrids. In general, most wings will be obvious forms of domestic Mallards, Mallards, or Black Ducks; only a few wings will require closer scrutiny to determine if they are from hybrids.

Identification of Domestic Mallards

Wings from domestic Mallards, even if the birds are feral and free-flying for several generations, confound attempts to estimate hybrid incidence in the wild Black Duck and Mallard population through parts collection surveys. Unfortunately, complete descriptions of domestic forms of the Mallard are not available, even though useful discussions and some illustrations may be found in Jaap (1934), Lancaster (1963), Delacour (1964), Batty (1985), and Kear (1990). For identifying wings of otherwise unavailable birds, it is easier to state what a wild Mallard wing looks like (i.e., Palmer's 1976 definition) than what it is does not. With reference to Palmer's definition, this means that all Mallard-type wings with large amounts of white, unusual colors, or overall dark underwings, etc., must be removed at the first step in a hybrid key. Persons familiar with domestic Mallards with whom we discussed this step concurred with us that common domestic Mallard strains are easily identified as are many uncommon ones, such as the recessive melanistic form known as the "Dusky Mallard." Characteristics listed above for the domestic Mallard can invariably identify domestic forms, particularly if care is taken to examine the underwing for overall dark coloration and dark spotting (F. B. Lee, Emeritus Biologist, Northern Prairie Wildlife Research Center, personal communication.)

Limitations of the Wing Key

Despite many attempts to qualitatively and quantitatively differentiate plumages in the Mallard group, the sexual dichromatism in the Mallard and the similarity of the southern forms to one another and to female Mallards have largely defeated such efforts. For example, Palmer (1976:314) described both sexes of the Mottled Duck as superficially alike and quite similar to Black Ducks, but with general coloring not quite as dark as Black Ducks (though darker than female Mallards). He emphasized the presence of a white bar only at the trailing edge of speculum, and even then often obscure or lacking, especially in Florida birds. Differences from Black Ducks were described as "a matter of degree." Similarly, Palmer (1976:309) described both sexes of the Mexican Duck as resembling female Mallards in general appearance but with "darker, richer browns," especially on the breast. Palmer described white on the dorsal wing surface of both sexes of the Mexican Duck as a bar at the leading and another at the trailing edge of the speculum, or variably, an indistinct "brownish or dusky" bar.

These and similar descriptions are inadequate unless one has a reference collection. Thus, keys for identifying members of the Mallard group (e.g., Bellrose 1976:72) usually suggest that knowledge of the geographic origin

Table. A dichotomous key for identification of wings from American Black Ducks, Mallards, and hybrids between the two. Like-numbered couplets will permit only one choice; numbers in parentheses indicate the next couplet to compare.

1. Wing distinctly unlike those figured for Black Ducks and Mallards by Bellrose (1976: plates 6 and 7) including but not limited to: gray underwing (Smithe 1974a: colors #83-#86); white in areas other than bounds of speculum (colored portion of secondaries) on the dorsum; extremely faded feather areas or colors not usually observed in American Black Ducks and Mallards, especially shades of black mixed with white for a piebald effect. Actual size of the wing is immaterial, although in many domestic breeds the ratio of length to width seems out of proportion compared with wild birds, and the wing may be extremely large in some breeds. In sum, resembling any bird figured by Delacour (1964:154-166) ..... **DOMESTIC MALLARD OR DOMESTIC CROSS**

1. Not as above ..... **(2)**

2. Wing Mallard-like on dorsal surface including two complete white bars bounding the speculum. This white forms a broad white terminal bar on the secondaries and a similar subterminal bar on each greater covert ..... **(3)**

2. Wing not Mallard-like on dorsal surface. One of the two white bars bounding the speculum may be lacking, incomplete, or indistinct; wing usually darker than most Mallard wings ..... **(6)**

3. Wing Mallard-like; white bar anterior to speculum terminates at the proximal edge of the speculum: male ..... **(4)**

3. Wing Mallard-like; white bar anterior to the speculum extends onto the greater tertial coverts: female ..... **(5)**

4. Dark brown coverts absent on the undersurface (lining) of the wing. Gray vermiculated feathers are permissible; the brown in question does not appear on the Mallard wing but is similar to that observed on Black Duck dorsal wing surfaces ..... **MALLARD**

4. At least one dark brown feather on lining, usually on leading edge and often near bend of wing ..... **HYBRID**

5. Dark brown feathers (<10, small) present on the underwing, usually along the leading edge ..... **MALLARD**

5. Dark brown feathers (>10, small or medium-sized) on the underwing, usually along the leading edge and near the alula ..... **HYBRID**

6. Wing Black Duck-like; white subterminal bar present on >1 greater covert anterior to speculum; white terminal bar on secondaries may be present or lacking ..... **HYBRID**

6. Wing Black Duck-like; white subterminal bar on greater coverts lacking. White on posterior edge of speculum (tips of secondaries) may be complete, incomplete, or lacking ..... **(7)**

7. Dark brown feathers (<10, small) present on underwing ..... **HYBRID**

7. Dark brown feathers (>10, small to medium) present on underwing ..... **BLACK DUCK**

of the specimen is necessary to make positive identification. To demonstrate the confusion that might result from applying the hybrid key to other members of the Mallard group, we inspected 237 specimens collected from 1872 to 1929 and originally identified by the collectors as *Anas fulvigula*, *A. f. fulvigula*, *A. f. maculosa*, *Anas diazi*, or *A. d. novimexicana*. Many of the specimens examined met the hybrid criteria if we ignored other characters of the plumage. This hybrid identification was especially true regarding Mottled Ducks, which in this sample had a mean of 17 dark feathers in the underwing, and many Mexican Ducks that did not have the expected two white bars bounding the speculum. We conclude that our key should be used only for specimens obtained from portions of the continent where Mexican and Mottled Ducks are unlikely to be encountered: North Carolina and north in the Atlantic Flyway and Arkansas and Tennessee north in the Mississippi Flyway (unless birds obtained from the Louisiana and Mississippi coastal areas where Mottled Ducks are found can be separated from birds shot elsewhere in these latter states).

What Proportion of the Hybrids in a Sample Can Be Identified?

The rank order of abundance of hybrids in any freely-mixing population of Black Ducks, Mallards, and their hybrids will be $P_1 > F_1 > F_2 > F_3 ... > F_n$. This order is dictated because $F_2, F_3 ... F_n$ hybrids are very rare as a consequence of the F_1 itself being rare compared to the parental populations. In other words, most F_1 matings would be a backcross to one or the other of the parental forms in subsequent years instead of *inter se* (Merrell 1981). As a result, hybrids detectable in a wild population of Black Ducks and Mallards would be F_1 birds and a large but unknown fraction of the F_1 backcrosses to P_1. Both the absolute number and proportional representation of $F_2, F_3 ... F_n$, and other combinations, whether detectable or not, would be quite small.

Our data showed that 82-96% of the male progeny and 10-80% of the female progeny of backcrosses to P_1 will be detectable, depending upon the P_1 in the cross. Because wings from many of the backcrosses of hybrids to either P_1, especially females, defy identification with any plumage key, inability to detect all backcrosses prevents determining the true proportion of hybrids in the wild from even large samples of wings. It seems imprudent to generate a correction factor to account for these undetectable hybrids resulting from $F_1 \times P_1$ matings since we lack information on the proportion of F_1 that mate with Black Ducks versus Mallards. Thus we do not know whether misidentification is as a Black Duck or a Mallard. Regardless, the wing characters employed are capable of identifying a large and constant fraction of the hybrids present in a sample, namely 100% of the F_1, at least 82% of male progeny of backcrosses to either P_1, and 80% of the female progeny of backcrosses to Black Ducks, but perhaps as few as 10% of the female progeny of backcrosses to Mallards. The hybrid key and the North American parts collection surveys certainly can be used to generate an index to error in mate choice of the two parental populations. We recommend it for this use as well as for identifying birds in hand during banding operations.

Reinterpretation of the 1977 U.S. Parts Collection Survey

We reexamined the 4,608 wings obtained in the 1977 U.S. Parts Collection Survey for the Atlantic Flyway originally identified as Black Duck, Mallard, or hybrid between the two. With the new criteria presented in our key (Table), we found that the number of hybrids had been underestimated by at least a factor of 2.37 (237 wings versus 100 wings). This underestimation would change the proportion of hybrids/(hybrids + Black Ducks) from 0.056 to 0.132, the proportion of hybrids/(hybrids + Mallards) from 0.034 to 0.078, and the ratio of hybrids/(hybrids + Black Ducks + Mallards), which is the incidence of overall hybridization, from 0.022 to 0.052. When we applied our new criteria, we identified 34 (34%) of wings classified as hybrids as domestic strains, Mallards, or Black Ducks. We reclassified as hybrids 136 (8%) of the wings originally identified as Black Duck. Similarly, we identified as hybrids 34 (1.2%) of the wings originally classified as Mallards. The most important conclusion for management is that hybridization between the Black Duck and Mallard occurred at about twice the rate heretofore reported for the Atlantic Flyway in 1977.

We could not make a similar comparison in any subsequent year. Our work generated substantial interest among participants in the "wing bees" (cooperative evaluations of parts collection survey receipts) in identifying Black Duck x Mallard hybrids. Managers of the U.S. Parts Collection Survey modified the criteria used to identify hybrids after 1977, and we confirmed that subsequent wing bees have identified larger percentages of hybrids among the available wings. Managers of the Canadian Parts Collection Survey likewise emphasized recording Black Duck-like and Mallard-like hybrids.

Comparison with Another Quantitative Measure of Hybridization

Barnes (1989) presented another key for identifying F_1 hybrids between the Black Duck and Mallard. He

concluded that the area of the color band on the fifth greater secondary covert (whether white or some other color) was a measure that discriminated between the P_1 forms and the F_1 hybrids, and the length of the white band at the tip of the fifth secondary correctly identified 19 of 22 hybrids from a sample of P_1 and F_1 birds.

As is generally the case with F_1 hybrids, Black Duck x Mallard F_1 are uniform in phenotype and intermediate between the parental forms in most characters. Our review has shown that subterminal white on the secondary coverts is not a Black Duck character. Barnes's criterion for area of "color" on the secondary coverts is thus the same as our presence/absence criterion for white in these feathers except that he requires a measurement. We believe that a presence/absence criterion is preferable because dimensions and amount of white in this color band will be distributed approximately normally (as are most other morphological characters) in a sample. This normal distribution can be seen in the intermediate frequency distribution of this character for hybrids between the frequency distributions for Mallards and Black Ducks in Barnes (1989:Fig. 2).

Further, we have shown that the amount of terminal white on the secondaries of Black Ducks is variable and is a poor criterion of genetic origin. It is particularly poor as a criterion when applied to F_2 and subsequent generations that are quite mutable because of Mendellian segregation and recombination, and which may theoretically include the extremes of the P_1 populations. The frequency distributions of white on the wings of birds raised in the experimental flock in Jamestown (Fig. 8) clearly show the intermediate nature of the F_1, the expected broader range of values of the F_2 (because of genetic segregation and recombination), and the shift in F_1 x P_1 crosses in the direction of the P_1 phenotype. Barnes's key may be relied upon for experimental work with F_1 and P_1 known-parentage birds, but our key (Table) should be used for all birds of unknown genetic origin.

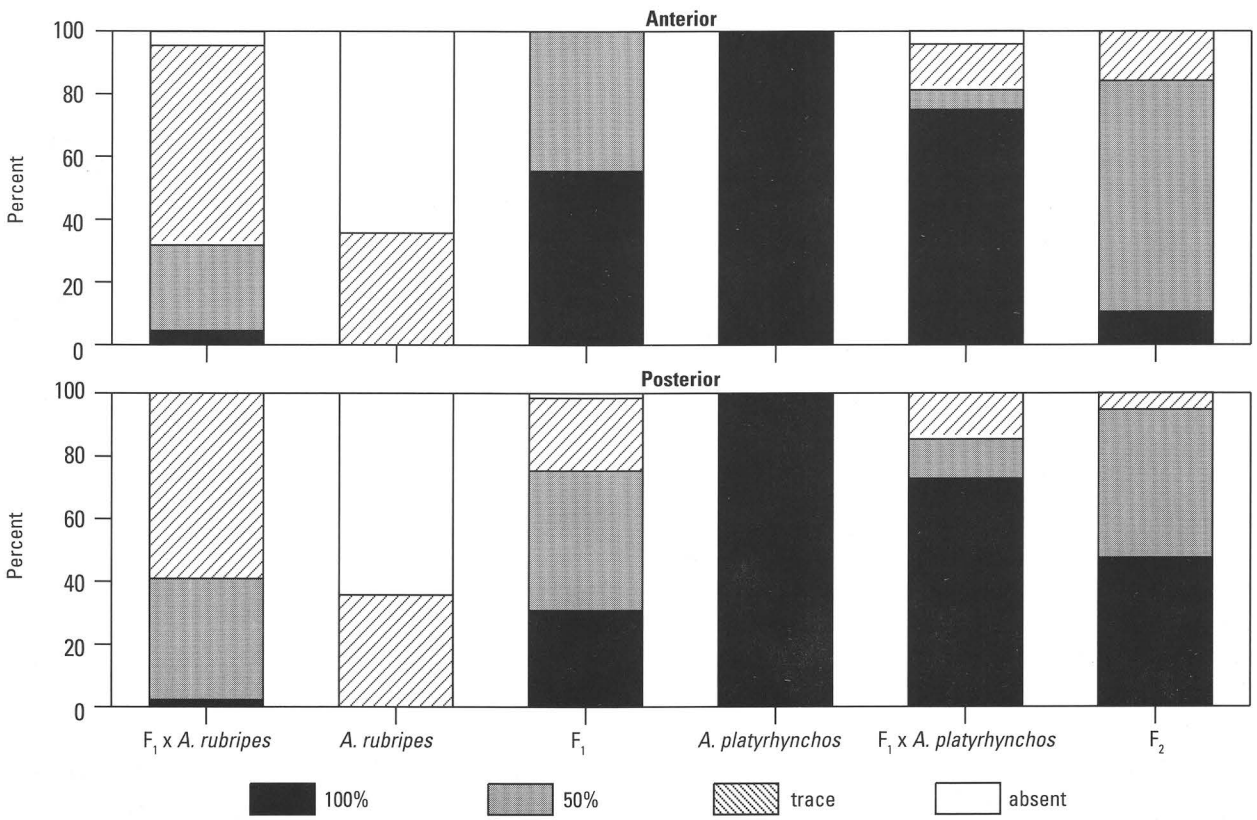

Fig. 8. Frequency distribution of the width of white bars bounding the speculum on the wing dorsum of Black Ducks, Mallards, and hybrids from an experimental flock reared at Northern Prairie Wildlife Research Center. All measurements are compared with Mallard = 100%; actual range in width 0-10 mm.

The Need for Additional Research

Throughout our analyses, we recognized that a key designed for use with the parts collection surveys was limited by the differences among Black Ducks, Mallards, and hybrids that could be consistently recognized by inspection of single wings. Such limitations are not applicable to morphological assessment of whole birds. Nonetheless, Hanson and Ankney (1994) showed that discriminant function analysis of standard morphometric measurements could not separate Mallards and Black Ducks. In contrast, Byers and Carey (1991) were able to correctly classify wild versus urban and game-farm Mallards with a similar analysis. Within-population variation in the Mallard and slight differences between Black Ducks and Mallards thus seem sufficient to confound simple morphometric analysis of hybridization between Black Ducks and Mallards. Regardless, there is a need to develop a key for whole birds. To that end, plumage descriptions such as those in Palmer (1976) for Mallards and Black Ducks need to be developed for F_1 hybrids and backcrosses of F_1 to both parental forms. These plumage descriptions would best be accomplished with a simultaneous attempt to more completely describe the variation in Black Duck plumage from throughout its range. Finally, a guide to the plumage characters of domestic breeds of the Mallard and captive-reared Mallards would be a helpful adjunct to interpreting both wings in the parts collection surveys and birds captured in the wild.

Identification of wings as from hybrid ducks is a post facto assessment of the phenomenon that is of greatest interest: the interaction of Black Ducks and Mallards in the wild and the resulting population consequences for each species. Attempts to separate the effects of natural range expansion of the Mallard, anthropogenic habitat change, release of captive-reared Mallards by individuals and governments, behavioral differences between the species, the effects of sport hunting, and hybridization upon population dynamics of Black Ducks and Mallards have been unsuccessful , but not for want of trying. Failure may be attributed to the fact that experiments to detect true differences are difficult to design and conduct, and as a result, studies to date have resulted in universally weak inferences (Nichols 1991). Consequently, the literature remains replete with insufficiently tested, usually single-factor, hypotheses and controversial conjecture (Nudds et al. 1996). Another attempt at a complete listing of research needs for the Black Duck thus would be redundant, but two questions with bearing on the effects of hybridization on the parental populations do seem amenable to investigation.

The first (also raised by Rusch et al. 1989) is, what are the ratios of Black Duck x Mallard pairs to correctly formed pairs in various habitats? The answer to this question would provide an apparent measure of error in mate choice in the wild that could be compared geographically with parts collection survey data and could be compared with changes in species ratios over time in various habitats. In other words, testable hypotheses about the dynamics of hybridization per se could be formed.

The second question is, what are the genetic consequences of hybridization at the rates observed in the wild? Further biochemical studies of Black Ducks and their hybrids, such as those by Patton and Avise (1983, 1985), Kessler and Avise (1984), Oates et al. (1984), Ankney et al. (1986), and Avise et al. (1990), should be devised to elucidate the genetic and population consequences of hybridization to both Black Ducks and Mallards. This effort would initially require laboratory study, but ultimately sampling of wild birds would be needed to elucidate true levels of admixture of gene pools. From this, modeling exercises could be used to address genetic and population consequences of interaction between the two species.

Suggestions for management of Black Ducks have been collected in a series of papers on the species (Spencer 1980, 1981, 1986; Rogers and Patterson 1984; Kirby 1988; Rusch et al. 1989; Conroy and Krementz 1990; and especially criticism of these and similar studies by Anderson et al. 1987; Nichols 1991; and Nudds et al. 1996). Comparison of the calls for action in these later papers with strikingly similar pleas raised 30 years before (Barske 1968) shows that questions regarding management of eastern waterfowl populations have not diminished. Rigorous testing of hypotheses is yet needed to identify cause-and-effect relationships within Black Duck populations. Further studies of hybridization and other population phenomena of Black Ducks and Mallards in areas of sympatry are warranted.

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C. J. Henny and R. P. Morgan, II, founded the hybrid flock maintained at Northern Prairie Wildlife Research Center. F. B. Lee conducted the mating trials. Study skins

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Appendix

This Appendix is a chronological list of critical literature selected from more than 200 items reviewed to assess historical trends in published descriptions of Black Ducks and Mallards. All sources known to us were searched for descriptions of the presence/absence of white on the wing dorsum and ventral wing coloration. References found redundant because of reprinting, incomplete revision, wholesale paraphrasing by contemporaneous authors, or later publication of field guides and regional ornithologies based upon previous works were deleted from further consideration after initial review. Although many of the remaining works in this Appendix are not entirely independent of one another—contemporaneous authors were no doubt aware of one another's work—unique text in these citations and the overall level of detail in descriptions provide evidence that these authors were describing many birds from specimens in hand or from notes taken from such specimens by others. The citations in this Appendix are thus a source of definitive categorization of the changes in descriptions of Black Ducks from 1785 to date. Illustrators, if known to be different from the authors, are shown in parentheses.

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A dichotomous key for identification of wings from American Black Ducks, Mallards, and hybrids between the two.
Like-numbered couplets will permit only one choice; numbers in parentheses indicate the next couplet to compare.

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1. Wing distinctly unlike those figured for Black Ducks and Mallards by Bellrose (1976: plates 6 and 7) including but not limited to: gray underwing (Smithe 1974a: colors #83-#86); white in areas other than bounds of speculum (colored portion of secondaries) on the dorsum; extremely faded feather areas or colors not usually observed in American Black Ducks and Mallards, especially shades of black mixed with white for a piebald effect. Actual size of the wing is immaterial, although in many domestic breeds the ratio of length to width seems out of proportion compared with wild birds, and the wing may be extremely large in some breeds. In sum, resembling any bird figured by Delacour (1964:154-166) ..... **DOMESTIC MALLARD OR DOMESTIC CROSS**

1. Not as above ..... **(2)**

2. Wing Mallard-like on dorsal surface including two complete white bars bounding the speculum. This white forms a broad white terminal bar on the secondaries and a similar subterminal bar on each greater covert ..... **(3)**

2. Wing not Mallard-like on dorsal surface. One of the two white bars bounding the speculum may be lacking, incomplete, or indistinct; wing usually darker than most Mallard wings ..... **(6)**

3. Wing Mallard-like; white bar anterior to speculum terminates at the proximal edge of the speculum: male ..... **(4)**

3. Wing Mallard-like; white bar anterior to the speculum extends onto the greater tertial coverts: female ..... **(5)**

4. Dark brown coverts absent on the undersurface (lining) of the wing. Gray vermiculated feathers are permissible; the brown in question does not appear on the Mallard wing but is similar to that observed on Black Duck dorsal wing surfaces ..... **MALLARD**

4. At least one dark brown feather on lining, usually on leading edge and often near bend of wing ..... **HYBRID**

5. Dark brown feathers (<10, small) present on the underwing, usually along the leading edge ..... **MALLARD**

5. Dark brown feathers (>10, small or medium-sized) on the underwing, usually along the leading edge and near the alula ..... **HYBRID**

6. Wing Black Duck-like; white subterminal bar present on >1 greater covert anterior to speculum; white terminal bar on secondaries may be present or lacking ..... **HYBRID**

6. Wing Black Duck-like; white subterminal bar on greater coverts lacking. White on posterior edge of speculum (tips of secondaries) may be complete, incomplete, or lacking ..... **(7)**

7. Dark brown feathers (<10, small) present on underwing ..... **HYBRID**

7. Dark brown feathers (>10, small to medium) present on underwing ..... **BLACK DUCK**

A dichotomous key for identification of wings from American Black Ducks, Mallards, and hybrids between the two.
Like-numbered couplets will permit only one choice; numbers in parentheses indicate the next couplet to compare.

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1. Wing distinctly unlike those figured for Black Ducks and Mallards by Bellrose (1976: plates 6 and 7) including but not limited to: gray underwing (Smithe 1974a: colors #83-#86); white in areas other than bounds of speculum (colored portion of secondaries) on the dorsum; extremely faded feather areas or colors not usually observed in American Black Ducks and Mallards, especially shades of black mixed with white for a piebald effect. Actual size of the wing is immaterial, although in many domestic breeds the ratio of length to width seems out of proportion compared with wild birds, and the wing may be extremely large in some breeds. In sum, resembling any bird figured by Delacour (1964:154-166) ..... **DOMESTIC MALLARD OR DOMESTIC CROSS**

1. Not as above ..... **(2)**

2. Wing Mallard-like on dorsal surface including two complete white bars bounding the speculum. This white forms a broad white terminal bar on the secondaries and a similar subterminal bar on each greater covert ..... **(3)**

2. Wing not Mallard-like on dorsal surface. One of the two white bars bounding the speculum may be lacking, incomplete, or indistinct; wing usually darker than most Mallard wings ..... **(6)**

3. Wing Mallard-like; white bar anterior to speculum terminates at the proximal edge of the speculum: male ..... **(4)**

3. Wing Mallard-like; white bar anterior to the speculum extends onto the greater tertial coverts: female ..... **(5)**

4. Dark brown coverts absent on the undersurface (lining) of the wing. Gray vermiculated feathers are permissible; the brown in question does not appear on the Mallard wing but is similar to that observed on Black Duck dorsal wing surfaces ..... **MALLARD**

4. At least one dark brown feather on lining, usually on leading edge and often near bend of wing ..... **HYBRID**

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13. ABSTRACT (Maximum 200 words)

We developed a key to identify wings of hybrids between American Black Ducks (*Anas rubripes*) and Mallards (*A. platyrhynchos*). Material for analysis included review of historical descriptions dating from the late 1700's, older museum collections in Europe and North America, wings collected from hunters in North America and Great Britain, birds banded in Canada and the United States, and a flock of propagated hybrids. All first filial generation (F_1) American Black Duck x Mallard hybrids were identified correctly with the key. A lower proportion of other hybrid cohorts (i.e., backcrosses of F_1 to parental forms (P_1)), and second and third filial generations (F_2, F_3, etc.) were identified. We successfully identified a larger portion of male than female hybrids for all hybrid progeny cohorts examined except F_1. The new key identified 2.37 times more hybrids in the 1977 U.S. Fish and Wildlife Service Parts Collection Survey (annual determination of the species, age, and sex composition of the waterfowl harvest using detached wings contributed by hunters) than were identified by standard techniques. The proportion of American Black Duck x Mallard hybrids to the American Black Duck parental population (the ratio: hybrids/[hybrids + American Black Ducks]) may therefore be closer to 0.132 than 0.056, the historically reported value. The hybrid key is suggested for use from North Carolina north in the Atlantic Flyway and Arkansas and Tennessee north in the Mississippi Flyway (areas where other members of the Mallard group will not confound assessment). We provide suggestions for further research that would assist identification of wings in parts collection surveys and permit estimation of the proportional representation of Mallard genes in the American Black Duck gene pool.

14. SUBJECT TERMS (Keywords)

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