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## AGE AND SEX DIFFERENCES IN THE BLACK-AND-BLUE JAYS OF MIDDLE AMERICA

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### INTRODUCTION

The black-and-blue jays constitute four allopatric species: *Cyanocorax melanocyanea*, the Bushy-crested Jay, *C. sanblasiana*, the San Blas Jay, *C. yucatanica*, the Yucatan Jay, and *C. beecheii*, the Beechey or Purple-backed Jay. Since Ridgway's publication (*U.S. Natl. Mus., Bull.* 50, Pt. 3:313-317, 1904) it has been recognized, but only generally, that plumage and soft part characteristics in these jays are complex, with definitive (i.e. non-molting, at least temporarily stabilized) stages in at least juvenile, first-year, and adult age groups. My studies reveal that ontogeny of plumage and soft part coloration in these species is more elaborate than previously supposed by anyone. One can accurately distinguish juveniles, first-, second-, and third-year subadult classes without reference to weight or mensural characteristics but rather on distinctive plumage and soft part color differences. As a part of my long range studies of comparative biology of these jays, I collected specimens and kept birds in captivity to observe the details of ontogenetic changes of external morphology and their timing. I also gathered information from museum study skins. A knowledge of changes in plumage and soft part color of these birds was necessary to understand the role of age in the complex social structure of these jays. What follows, therefore, is a descriptive analysis of stages and changes in external morphology, based on specimens and captive live birds.

### DESCRIPTIVE ANALYSIS

#### *Cyanocorax melanocyanea*

Juvenile.—(Fig. 1A.) head, nape, and breast dull blackish-gray; mantle and remainder of underparts dull neutral gray, the back with scattered blue feathers. Upper surfaces of wings dull blue, rectrices deeper blue with a violet wash. Under surfaces of wings grayish-white to light neutral gray; under surfaces of rectrices dusky neutral gray. Bill dull yellowish-horn, developing brownish tip just before fledging. Brownish color gradually spreads over one-third of the bill distally. Inside of bill white. Tarsus and toes deep neutral gray to blackish-gray, with some dull horn color on toes. Iris dark brown or blackish-brown.

*First prebasic* (= *postjuvenal*) *molt stage*.—(Fig. 1B.) This involves only the body. Bill particolored, showing horn color mainly

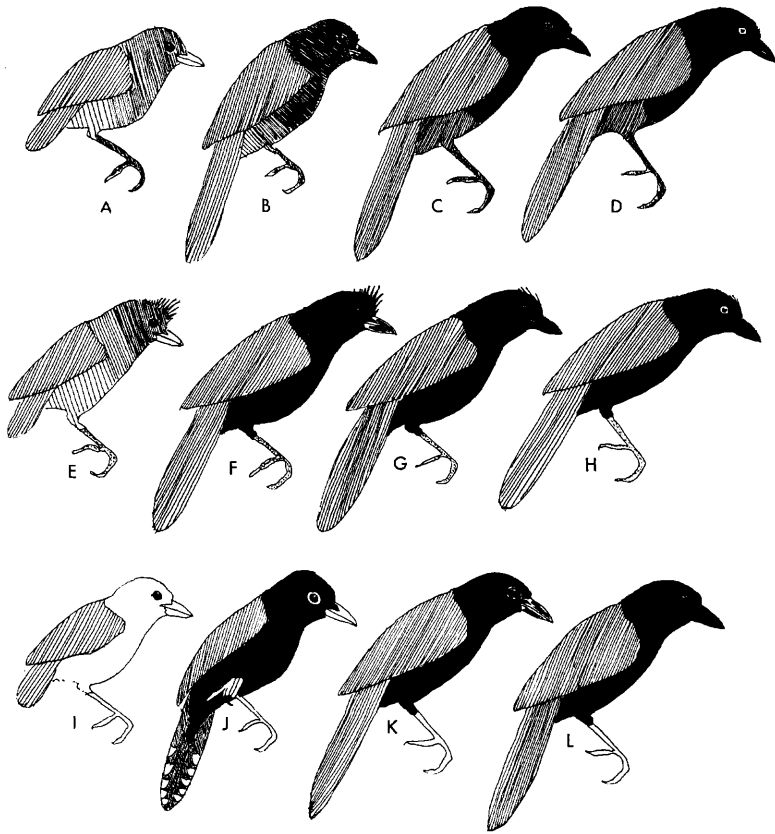


FIGURE 1. Schematic representations of some key stages in the development of plumage and external soft part coloration in three species of jays. See text for full explanation. **Line 1:** *Cyanocorax melanocyanea*. A. Juvenile. B. First prebasic molt stage. C. First-year stage. D. Second-year and adult stages. **Line 2.** *C. sanblasiana nelsoni*. E. Juvenile. F. First-year stage. G. Second-year stage. **Note:** *Third-year stage not illustrated.* H. Adult. **Line 3.** *C. yucatanica*. I. Juvenile. J. First-year stage. K. Second-year stage. L. Third-year and adult stages.

in basal half and along tomium, with the remainder blackish-brown. Body as above with various numbers of dull black feathers replacing the gray ones.

*First-year stage.*—(Fig. 1C.) Birds of the first brood (social flocks raise two successive and overlapping broods) have completed change to first-year plumage by early December. By mid-January, soft part coloration also stabilizes. Plumage essentially like that of adults but less glossy in general. Bill horn colored on basal one-third to one-half of lower mandible and extreme basal circumnasal area; remainder dull black. Iris dark olive-tan. Legs dull black with irregular edgings of horn, and toe pads horn colored. Inside

of bill dull white. An irregular amount of horn color persists on the basal portion of the upper and lower mandibles through the first year, decreasing by March to the point where it is hardly visible in the field. The iris may lighten slightly to pale olive tan or dull yellowish-horn color. By late May iris color is greenish-yellow in some individuals.

*Second prebasic (= first postnuptial) molt stage.*—Plumage indistinguishable from that of adult (see Ridgway, op. cit.). Bill solid black exteriorly, but considerable white inside with black beginning to spread along the edges and median line. Iris greenish-yellow as compared with pure yellow of adult.

*Second-year stage.*—Data incomplete. Probably full adult plumage and soft part color (Fig. 1D.) except for inside color of bill, since one captive at the time of third prebasic molt had pure yellow irides and largely black inside the bill.

*Full adult stage.*—(Fig. 1D.) Plumage as described by Ridgway (op. cit.). Iris bright yellow, bill black inside and out, tarsi and toes black with horn edgings and toe pads.

#### *Cyanocorax sanblasiana nelsoni*<sup>1</sup>

*Juvenile.*—(Fig. 1E.) Similar to juvenile *C. melanocyanea*, but with head and body feathers blacker and a prominent fronto-nasal crest developing in nestlings before feathers are unsheathed. Legs dull brown and bill slightly more yellowish and without a dark tip. Inside of bill white. Iris dark brown.

Two fully grown captive juveniles with well developed crests showed first signs of bill darkening—a distal lateral spot of black on the upper mandible.

*First prebasic molt-stage.*—Molt develops first on body, then on head. The two captive juveniles mentioned above fledged on 25 June and began first prebasic molt about 14 September. Black area on bill spreading over distal part of upper mandible. Molt complete by 1 November.

*First-year stage.*—(Fig. 1F.) There is a gradual change in bill color through the first year, and it is individually variable. In one bird on 26 December, new areas of black appeared in circumnasal area, and the distal one-fourth of the bill was black. In the other bird, on the same date, the black was restricted to the extreme bill tip, the remainder of the bill remaining yellowish-horn color. Through the first year of life the bill remains largely pale. The inside of the bill remains white through the first year of life. Tarsi and toes are now dull greenish-yellow, as they remain throughout life.

<sup>1</sup>While this paper was in press, I became aware of a paper by John Davis (*Condor*, 62: 215-219, 1960) containing an important discussion of iris color and its ontogeny in *C. sanblasiana*. The data of Davis make it necessary for the remarks herein on this species to be restricted to the race *nelsoni*; in the nominate race the iris color apparently becomes yellow early in the first year of life!

The two first-year captive San Blas Jays each passed through a partial prealternate (= prenuptial) molt involving, so far as I determined, only the feathers of the head. Such a molt has not been described previously for any corvid, and I have not detected it in any other jays. I also do not know if it is characteristic of the species. When more data are available the character and possible significance of this molt will be discussed elsewhere. At this time, I would welcome from readers any information on prealternate molts in jays.

*Pre-second-year stage.*—Shortly before the second prebasic molt, in August and September, some individuals have acquired almost completely dull black bills, except for the area of horn color on the sides of the lower mandible, just above the tomium, or irregular small areas or pale color elsewhere. By the onset of molt in mid-September, the two captives had completely dark bills exteriorly. However, two individuals, obtained at one year of age in June, still showed markedly particolored bills while molting in September.

*Second prebasic molt stage.*—This is a complete molt resulting in deeper blue and black feathering, the black becoming glossy and indistinguishable from that of the adults. The crest is greatly reduced in number of feathers, but those that remain are long and still prominent, although directed slightly more posteriorly in normal carriage. If the bill is exteriorly particolored, it remains white inside except for a pronounced tomial margin of black. As the bill becomes black outside, the inside also becomes partly black (Fig. 3A). However, during the second year of life it remains distinctly particolored—never black or black with slight traces of white. The iris remains dark brown.

*Second-year stage.*—(Fig. 1G.) Following the second prebasic molt, from late November and afterward, birds generally have completely black bills exteriorly, particolored interiorly, and long sparse crests. Over this period the iris gradually pales to olive brown in some individuals but remains dark brown in others. Second-year birds are at least sometimes sexually mature, since a female captive of this age laid eggs in my aviary.

*Third prebasic (= second postnuptial) molt stage.*—Generally this molt reduces the crest to its final repeating state. This may be characterized by no crest or one or two wispy feathers, which even adults may possess. The bill becomes solid black inside and out, except that some individuals probably retain for life some extremely small areas of white.

*Third-year stage.*—This is a stage not previously described. In it the iris remains dark brown to olive brown, but otherwise the bird is indistinguishable from the adult (Fig. 1. Intermediate to G and H.). A female, acquired in July 1970 at the end of the second year of life, then went through the third prebasic molt and externally did not change in appearance. By January 1972 when the bird died, the iris was slightly lighter in color (olive).

*Fourth prebasic (= third postnuptial) molt stage.*—I have held no captives that made the transition from third-year stage to full adult stage, which differs only in that the iris becomes yellow. It is possible, but unlikely in my opinion, that birds remain in the dark-eyed stage for longer than three years. I presume that the irides become fully yellow sometime about the fourth prebasic molt. The female mentioned above, whose irides were becoming paler at death in January 1972, supports this presumption.

*Full adult stage.*—(Fig. 1H.) Except for one characteristic this stage has been described adequately by Ridgway (op. cit.). He and all subsequent authors have thought that the sexes are alike. They are, however, distinguishable by iris color: males have greenish or olive yellow irides and females have pure yellow irides. A person not aware of this subtle difference would probably term the iris color of both sexes yellow and thus museum specimens with accompanying data on soft part colors are usually not of much help in substantiating this claim. I base it upon three adult males and eight adult females. The three males were birds taken in the wild. Three of the females were taken in the wild and five were captive birds. Once familiar to the observer, this character can be used to sex adults with a binocular in the wild! Study of these same 11 birds in addition to another male and three female captives over two years of age and two museum skins of males indicates a non-overlapping size difference between the sexes as well. Females weigh from 91.3 to 110.3 g and males from 117.0 to 123.0 g (details in Table 1). From data on weights of two captives taken at fledging and studied for slightly over one year, it is not safe to age birds of this age by weight. These two captive juveniles varied in weight from < 100 g to > 130 g, although on a given date the male always weighed more than the female.

#### *Cyanocorax yucatanica*

Except for the juvenile stage and post-juvenile molt stage, the description below is based primarily on a group of six captives obtained in April 1968 from a bird dealer in Merida, Yucatan. These included two full adults, two birds almost two years old, and two birds almost one year old. These were kept captive until early 1972.

*Juvenile.*—(Fig. 1I.) Head and body white, remainder of dorsal surfaces grayish-blue. Ventral surfaces of wings and tail dull gray; rectrices, except middle pair, white-tipped. Bill, tarsi and toes pale yellowish with pinkish flesh tones. Inside of bill white. Iris dark blackish-brown.

*First prebasic molt stage.*—Molt involves only body and head feathers. Prior to molt or accompanying it there is increased yellow pigmentation of the tarsi and toes, bill, and fleshy eye ring.

*First-year stage.*—(Fig. 1J.) Entire head and body deep black. Bill tarsi, toes, and fleshy eye ring yellow. Inside of bill white. Mantle blue with glaucous overtones (these overtones differ sub-

TABLE 1. Weights in grams of San Blas Jays (*Cyanocorax sanblasiana*) demonstrating sexual size dimorphism.

| Specimen                           | Males | Females       |
|------------------------------------|-------|---------------|
| JWH-768 ad.                        | 120.4 |               |
| JWH-766 ad.                        | 122.1 |               |
| Live-trapped ad.                   | 123.0 |               |
| MVZ-137777                         | 117.0 |               |
| MVZ-115620 2nd yr?                 | 121.0 |               |
| JWH-765 ad.                        |       | 92.2          |
| JWH-767 ad.                        |       | 112.5         |
| (JWH-782 ad.)*                     |       | 102.0         |
| (JWH-779 ad.)                      |       | 102.0         |
| (JWH-814 ad.)                      |       | 110.3         |
| (Discarded ad.)                    |       | 98.9          |
| (Discarded ad.)                    |       | 107.2         |
| MVZ-136220 ad.                     |       | 99.9          |
| Live-trapped ad.                   |       | 108.2         |
| (JWH-780 2 yr. old)                |       | 92.6          |
| (JWH-788 1 yr., died<br>at 2 yrs.) |       | 101.6 (102.2) |
| (1 yr. old, no<br>specimen saved)  |       | 91.3          |

\*Specimens in parentheses were captives.

specifically in the two races, *yucatanica* and *rivularis*). Upper surface of wings dull blue. Tail purplish blue. Ventral surface of wings and tail deep gray, and rectrices, except middle pair, white-tipped. Since rectrices are retained from juvenal plumage, the white tips may wear completely away long before the second prebasic molt.

In June at the earliest, or as late as August, some dark "shadows" may appear on the bill, but the bill remains essentially yellow, and further progress toward the particolored condition does not occur until September. Then blackish pigment begins to appear around nasal openings and on the rami of the lower mandible.

*Second-year stage.*—(Fig. 1K.) Full adult plumage. Bill highly variable but at first still almost completely yellow and by March becoming black and yellow particolored. Tarsi and toes yellow, as they remain through life. At about two years of age, some individuals are wholly black-billed, others retaining markedly particolored bills. Yellow eye ring may show some black interruptions at any time in the second year. At least by the third prebasic molt

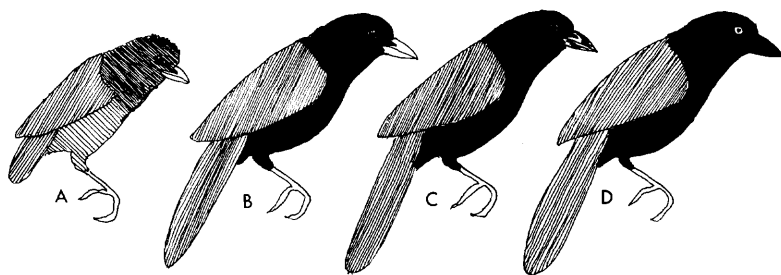


FIGURE 2. Schematic representation of some key stages in the development of plumage and external soft part coloration in a jay, *Cyanocorax beecheii*. See text for full explanation. A. Juvenile. B. First-year stage. C. Second-year stage. D. Third-year and adult stages.

period and usually by the age of two years, the ring is almost completely black with one to several small yellow interruptions. The progress in blackening of bill and eye ring is usually not bilaterally symmetrical.

*Third-year stage.*—A bit of yellow may persist on the eye ring and on the bill well into the third year, at least to November, but by January it is gone. In the early part of the third year the first blackening of the inside of the bill begins to occur. On 27 November one bird showed several isolated centers of black pigment in the upper mandible (Fig. 3B left) and by 8 May these had joined to include over 50 per cent of the inside black (Fig. 3B right).

*Fourth-year stage.*—(Fig. 1L.) By this stage the bills of all birds are black exteriorly. Variable small amounts of white may remain on the inside upper mandible, but in general the inside of the bill is black, and aging individuals at this stage by variable amounts of white is not safe. All six captives were identical in soft part and plumage color in spring 1972.

#### *Cyanocorax beecheii*

No captives of this species have been raised from known first-year age through significant ontogenetic changes. However, several captives have been retained for over two years of life and although they were not of known age at acquisition, the changes of soft part color occurred as predicted from their estimated ages. The Moore Laboratory of Zoology collection has an excellent series of skins depicting the following stages: late juvenile, first prebasic molt, what may almost certainly be considered first-year, second prebasic molt, early and late second-year, and full adult. From these specimens, we may construct the following picture.

*Juvenile.*—(Fig. 2A.) Like juvenile of *C. sanblasiana*, but bird much larger and with prominent erect supraorbital crest. Breast black, rather sharply delimited from the gray abdomen. Bill yellowish horn, tarsi and toes dull horn, inside of bill white, iris probably dark brown (see first-year stage).



FIGURE 3. A. Schematic drawing of the head of a subadult *Cyanocorax sanblasiana nelsoni*, showing outwardly particolored bill and largely white interior marked with isolated patches of black. The bill becomes black inside and out in the adult. B. Inside of bill of third-year stage subadult *C. yucatanica* showing progress in blackening of inside of upper mandible from 27 November (left) to 8 May (right).

*First prebasic molt stage.*—One specimen, dated 12 August (MLZ 30877). Only body feathers involved, mantle becoming purplish-blue, and head, nape and underparts black. Molt of body feathers proceeding from head posteriorly. No changes in color of bill, tarsi, or toes.

*First-year stage.*—(Fig. 2B.) Plumage like full adults (Ridgway, 1904: 316). Bill tarsi, and toes yellow, iris dark brown (from color transparency reference). Inside of bill white. A prominent erectile crest persists through life. This description apparently holds for the entire first year of life, since an 8 June specimen (MLZ 15303) that is undoubtedly a bird of the previous year shows no soft part color changes.

*Second prebasic molt stage.*—One specimen (MLZ 11714) taken 31 August is in heavy molt and is acquiring the particolored bill.



FIGURE 4. Schematic drawing of heads of two specimens of *Cyanocorax beecheii*, showing progress of blackening of bill in second-year stage from October (left) to May (right).



*Second-year stage.*—(Fig. 2C.) The distinctive particolored bill condition persists irregularly through most of the second year. An 11 October specimen (MLZ 9601) has over 80 per cent of the bill black externally and greenish-yellow irides. A specimen taken 5 October (MLZ 11757) has a similar bill, whereas a 10 May specimen (MLZ 28201) still has the bill only 80 per cent black (Fig. 4). The bill remains white inside.

*Third-year stage.*—Except for persistent white inside bill, indistinguishable from adults (Fig. 2D.). Iris yellow. Rarely a bird in the third year shows traces of horn color on the outside of the bill near base. In one captive this seemed to be stabilized and to bear no relationship to age.

*Fourth-year stage.*—(Fig. 2D.) Full adult. Inside of bill black (minute amounts of white may persist and stabilize, having no apparent relationship to age). Iris yellow.

#### A WORD OF CAUTION

An examination of large numbers of specimens of black-and-blue jays will almost always reveal anomalous specimens not conforming exactly to any one of the foregoing descriptions. Rarely, nearly adult birds may show not only some white remaining inside the upper mandible but also anywhere on the outside of the bill. One specimen of *C. sanblasiana* in the British Museum (Natural History) has faintly white-tipped rectrices, a condition characteristic of first year *C. yucatanica*, but so far as I know unique in *C. sanblasiana*. Readers are thus warned that anomalies must be viewed within the context of other features characterizing each stage of ontogeny.

#### SUMMARY

Plumage and soft part color changes from juvenile to full adult are described for the four allopatric black-and-blue jays, *Cyanocorax melanocyanea*, *sanblasiana*, *yucatanica*, and *beecheii*. These descriptions include accounts of the definitive stages as well as transitory phases and their approximate timing. In general, individual specimens in which soft part coloration has been noted or preserved can accurately be aged to within a few months up to the fourth year of life after which the full adult character is established and maintained. In *C. melanocyanea* stages through only the second year of life can be distinguished consistently from the adult.

Over the first three to four years of life iris color changes from dark brown or black to yellow, except in *C. yucatanica* in which a yellow eye ring in the first year gives way to black and the iris is always dark brown. Bill color changes from horn or yellow in the first year to black by the end of first year (*melanocyanea*) or by three years of age. A prominent frontonasal crest disappears gradually from the first year to virtual absence in adulthood (*sanblasiana*) or by the first year plumage (*beecheii*). A prominent erectile crest persists in *C. beecheii*. Crests in the other two species are very short at all times. In *yucatanica* juveniles have pure white

head and body feathers and white-tipped rectrices (which persist through the first year of life). A third-year stage is described for *sanblasiana* (like adult except for dark irides). Birds immediately subadult can be distinguished from adults by the white interior of the upper mandible. In *sanblasiana* there is sexual size dimorphism from about age two years onward and sexual dichromatism in iris color of adults. Males have greenish-yellow irides and females have pure yellow irides.

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