

A TAXONOMIC REVISION OF THE NEW WORLD JAYS

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The generic and sub-generic classification of the New World jays employed by Blake (*in* Mayr and Greenway 1962:206-228) perpetuates a system largely similar to that of the earliest authoritative works on New World birds (e.g., Sharpe 1877). Blake does submerge *Uroleuca* Temminck and *Xanthoura* Nelson, which were still recognized by Hellmayr (1934:29, 30) but does not follow recommendations for mass lumping of genera proposed by Amadon (1944a). Phillips et al. (1964:106) have since also recommended large scale amalgamation of genera in this assemblage. Amadon's recommendations were premature; information on these jays gathered and published during the past two decades has negated some of his conclusions. Phillips et al. and Phillips (1966:110-112) are obviously aware of the accumulated knowledge on general biology, behavior, and vocalizations, especially on the previously almost unknown Neotropical species, but do not provide taxonomic revision of genera taking consistent account of this knowledge.

The remarks of Phillips et al. (1964:106) supporting their proposed merger of genera are differentiated from the earlier statement of Phillips (1950:86) only by an acknowledgment that studies on anatomy and "biology" "may prove the existence of valid genera in these jays." Although in 1961 I had given evidence for differences at the tribal level between *Cyanocorax* and *Cyanocitta* on the one hand and *Aphelocoma* and (tentatively in 1961, confirmed in 1964) *Cyanolyca* on the other, Phillips (1966:110-111) ignored these conclusions. In fact, in acknowledging my contributions to our knowledge of jays by naming a subspecies for me, he placed *Cyanolyca mirabilis* in the genus *Cyanocorax*. On the other hand, *Cyanocitta*, which is closer to *Cyanocorax* than is *Cyanolyca*, was retained by Phillips.

It has until now been my wish first to accumulate biological information, then to suggest phylogenetic and taxonomic relationships based on this information, and thereafter to consider erection of revised formal nomenclature. However, now that arrangements are being made to publish another A. O. U. Check-

list of North American birds (including México and Central America), I feel it necessary to state my views formally on the taxonomy of New World jays, even though the habits of many species in the assemblage are still poorly known.

The following annotated arrangement excludes the genera *Gymnorhinus* and *Perisoreus*, which I do not consider to be a part of the New World assemblage otherwise considered here. The former contains only one species, which is not a jay at all by any standard except that its plumage is blue in color. It is probably derived from Old World corvines such as *Nucifraga* (Hardy 1961:113) which it resembles, except in color. *Perisoreus* consists of two Asiatic species, one (*infaustus*) widespread and polytypic, the other (*internigrans*) monotypic, and one polytypic North American species (*canadensis*), which closely resembles them. The genus is probably of Palearctic origin, based on this zoogeographic evidence, and its species bear little resemblance to the North American assemblage.

In my 1961 paper, I suggested that two evolutionary assemblages of New World jays existed and proposed tribal status for them as follows: Ornate jays, tribe Cyanocoracini, and Inornate jays, tribe Aphelocomini. Conversations with a number of taxonomists, including Dean Amadon, Eugene Eisenmann, and Kenneth Parkes, have shown me that awarding tribal status to these assemblages is inappropriate and poses complications when one considers the Old World jays and their subfamilial and tribal categorization. Division of a cosmopolitan subfamily into tribes should await a study of the group as a whole on a worldwide basis. The assemblages that I called tribes of New World jays, nevertheless, seem to be natural ones, and in the following taxonomic synopsis, I shall refer to them as the ornate and inornate lines.

ORNATE LINE

Most species possess prominent crests or greatly elongate nasal and frontal tufts. Facial plumage pattern is complex, usually including a triangular cheek patch and superciliary spot. At least one species in each genus or subgenus

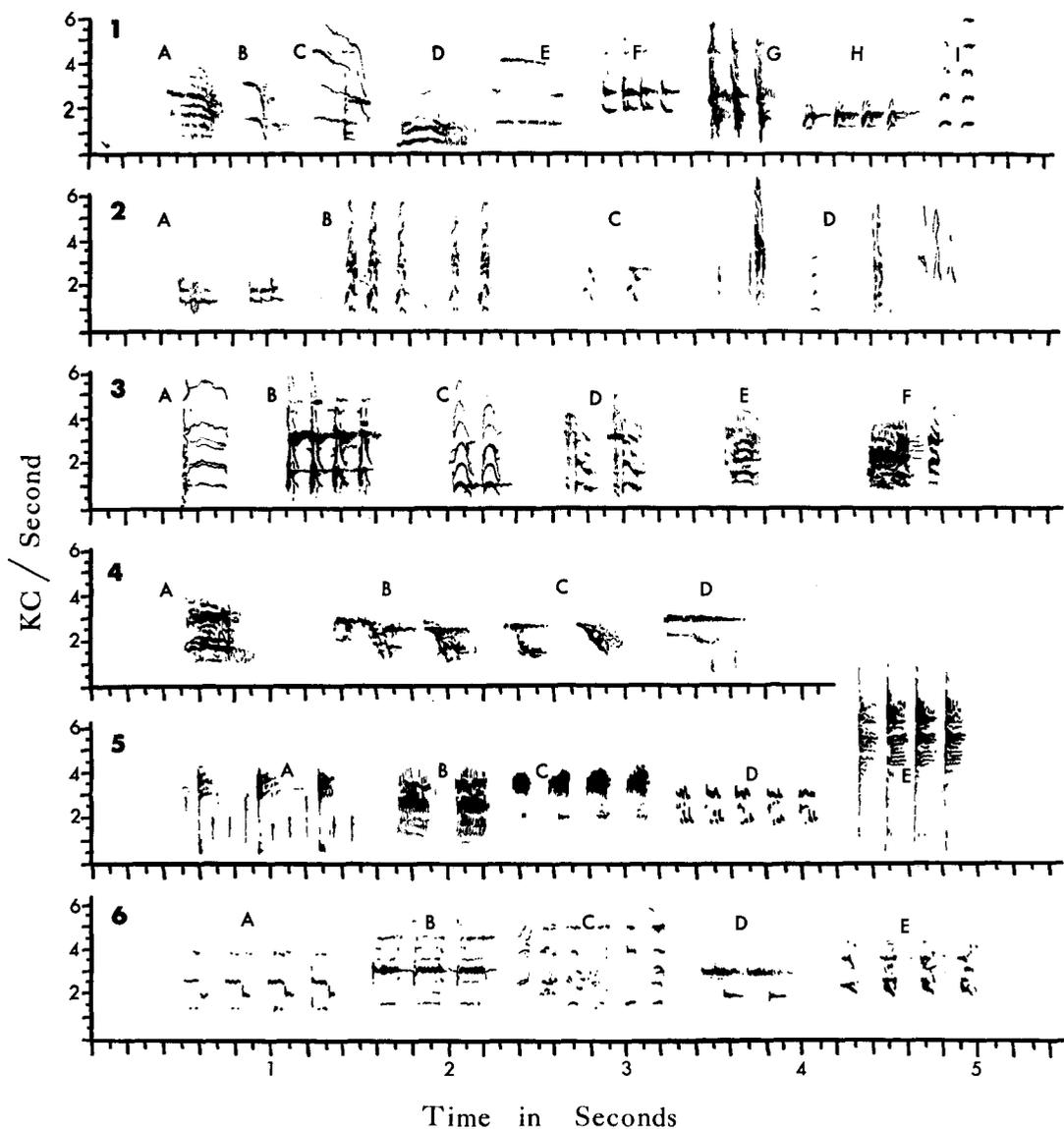


FIGURE 1. Sound spectrographs of some calls of *Cyanocorax*. Line 1. *Cyanocorax chrysops*.—A. Begging, nasal, harsh *jaay* of one adult toward another. B. *Eeitch!* C. *Eeeerrch* (higher pitched than B). D. Full-throated mellow *oooh!* similar to single note call of Laughing Falcon (*Herpetotheres cachinnans*). E. *Cleeo*. F. Rapid-fire, very penetrating *creech-creech-creech-creech*. G. *Chook!-chook!-chook!* H. *Chock-chock-chock-chock!* like staccato call of Laughing Falcon. I. High-pitched *eee! eee!*

Line 2. *C. chrysops* continued.—A. Loud *clackety-clackety*. *Cyanocorax mystacalis*.—B. *Che-che-che!* a flock social call sounding much like a *Dryocopus* woodpecker. C. *Choo choo!* a softer, mellower location call. D. *So*to voce singing.

Line 3. *Cyanocorax dickeyi*.—A. Whining nasal *ch-zheerr!* ("ricochet" call of Crossin 1967). B. *Chock-chock-chock-chock!* flock social call. C. *Poop-poop!* ("mellow hoot" of Crossin, op. cit.). D. *Ped-el* flock contact call. E. Begging *a-r-r-r-r* of female accepting food at nest. F. Nasal *aaagh* recognition call and begging call of female.

Line 4. *Cyanocorax affinis*.—A. Whining, begging *jeer* of full-grown juveniles. B. *Chattery-che-che-cheeh!* C. *Peeoh*, a clearly rendered flock social call—species specific call. D. *Cheoo!* a variant of C.

Line 5. *Cyanocorax yncas*.—A. Syncopated dry rattle. B. Harsh *rassh! rassh!* C. Rapid *rasch-rasch-rasch!* D. Rapid-fire bell call. E. Sharp *tick-tick-tick-tick!*

Line 6. A. *Cleop cleop cleop*, a rolling "bell" call. B. *Eek eek eek!* C. Rapid-rasping call variant (rare). D. "Squeaky gate," *wheedle wheedle*. E. *Jeer-jeer-jeer-jeer*.

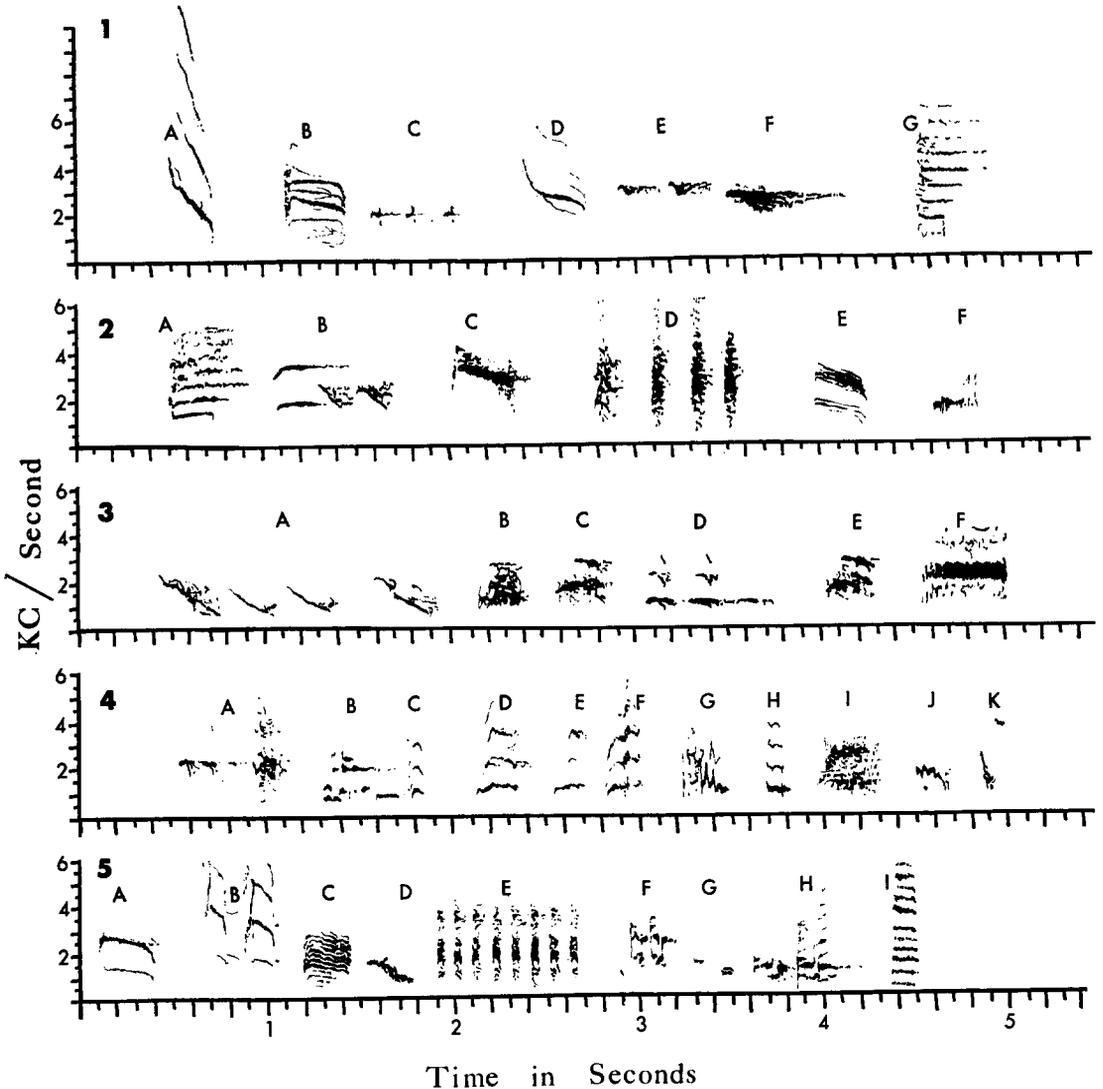


FIGURE 2. Sound spectrographs of some calls of *Cyanocorax*. Line 1. *Cyanocorax cayanus*.—A. Clear downward whistle, much like *Cyanocorax formosa* (line 3A, B) and *C. morio* (5B) to the ear. B. *Jaay!* very similar in structure and aurally to the jay call of *Cyanocitta cristata* (fig. 3, line 2A). C. Robin-like (*Turdus*) *perk! perk! perk!* D. "Burred" downward whistle. E. Staccato nasal *penk! penk!* F. Very harsh downward whistle. G. Resonant piping *penk! penk!*

Line 2. *Cyanocorax cayanus* continued.—A. Squawking cry, possibly a begging juvenile. B. Metallic *ree*, upwardly inflected and here superimposed on voice of another bird, species unknown. *Cyanocorax violaceus*.—C. *Jeer!* call harsh and downwardly inflected. D. "Choppy" juvenal begging and location call. *Cyanocorax cristatellus*.—E. Downwardly inflected *jeer!* call, very piercing and harsh. F. Low, soft conversational flock note.

Line 3. *Cyanocorax formosa*.—A. Clear, downwardly inflected whistle. B. Short "snoring" *clooo*. C. Harsh downward *jeer!* call. D. Insistent *peeph! peeph!* E. Squawking *schrrrr*. F. Froglike snore.

Line 4. *C. formosa* continued.—A, B, C, D, E, F. Six variants of emphatic "tin horn" piping notes. G. Rolling or trilling downward *prrrreeeeeo!* H. *Poop!* I. Harsh rasping call (like *Cyanocitta stelleri*, fig. 3, line 1C). J. Soft *arroh arroh!* K. Abrasive *chiosh*, the terminus of which (*osh*) is the abruptly higher note component.

Line 5. *Cyanocorax morio*.—A. Prolonged *peer*, downwardly inflected. B. Shorter (more excited) *peer* notes prefixed by a mechanical *pop* produced by the furcular pouch. *Cyanocorax beecheii*.—C. Downwardly inflected cawing note. D. *Crooo* (downwardly flexed) food expectancy note. *Cyanocorax yucatanica*.—E. Rapid-fire rasping chatter (*C. sanblasiana* has similar call). F. *Clok! klok!* with resonant quality, much like fig. 1, line 5D of *Cyanocorax yncas*. G. *Crook-crook!* another resonant call. H. "Bell" call, comparable to fig. 3, line 2D of *Cyanocitta cristata*. I. "Tin horn" pipingnote (see similar line 1G above; similar call of *C. beecheii* not shown).

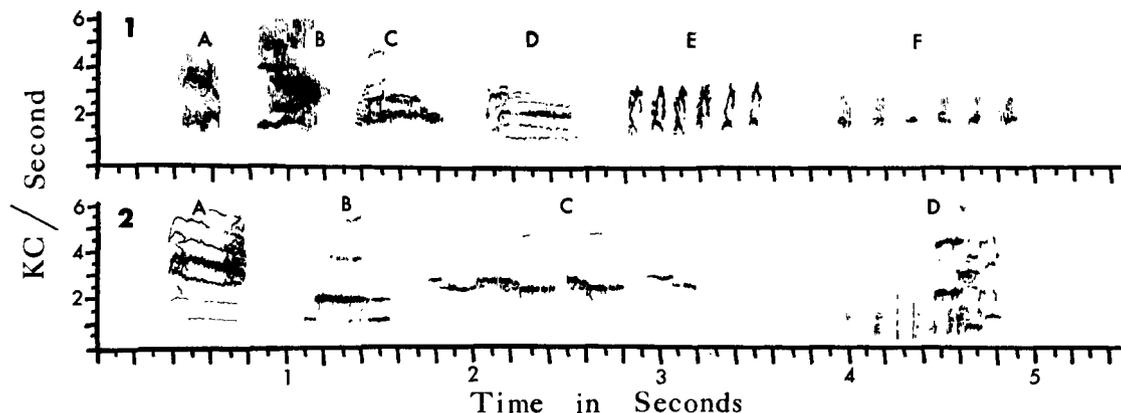


FIGURE 3. Sound spectrographs of some calls of *Cyanocitta*. Line 1. *Cyanocitta stelleri*.—A, B. Versions of the harsh, rasping alarm call. C. Half-speed print of A (frequency scale reduced and time scale increased accordingly). D. Low-pitched “bell”-“squeaky gate” call, a resonant *chrrr chrrr*. E. Rapid-fire alarm flock social call. F. Another type of rapid-fire chatter.

Line 2. *Cyanocitta cristata*.—A. Typical jeer alarm call. B. “Bell” call. C. “Squeaky gate” call. D. Intermediate (to the ear) between B and C.

has a white-tipped tail. The vocal repertoire is usually complex, consisting of from four to more than a dozen separate and distinctive call-categories. Typically (and almost always when the repertoire is smaller) it includes a downwardly flexed *jay* or *jeer!*, and usually (always when the repertoire is rich) note combinations, that may be described as bell-like or resembling the sound of a squeaking gate. Figure 1, line 1 (*Cyanocorax chrysops*) and lines 5 and 6 (*C. yncas*) present examples of species with large repertoires. Examples of downwardly inflected *jay* or *jeer!* calls are shown in figure 2, line 1 A and line 5 A. Examples of structurally variant but aurally “squeaky gate” or “bell” calls may be found in figure 1, line 5 D, 6 A, D (*C. yncas*), and figure 2, line 5 F, H, and figure 3, line 2 B, C, D. Table 1 provides a categorization of sonagrams in figures 1–3 and also summarizes types of vocalizations in the inornate line.

In my opinion, the most frequent evolutionary trend to be seen in New World jays of the ornate line is one of simplification, involving shortening of the crest, infusion of melanin leading to obscurement of pattern of plumage (fig. 6), and reduction of repertoire. Evidence for this trend will be pointed out in the following discussion.

Several species groups are evident within the subgenus *Cyanocorax* of the ornate line, and the list of species below as well as the discussion that follows refers to these groups. Designation of these groups is mainly for convenience in the discussion; they have no taxonomic significance per se.

Genus *Cyanocorax* Boie

Subgenus *Cyanocorax* Boie

Species Group I

- C. dickeyi* (Moore)
- C. mystacalis* (Geoffrey St. Hilaire)
- C. chrysops* (Vieillot)
- C. cyanopogon* (Wied)
- C. affinis* (Pelzeln)

Species Group II

- C. cayanus* (Linnaeus)
- C. heilprini* (Gentry)
- C. violaceus* (Du Bus)

Species Group III

- C. yncas* (Boddaert)

Species Group IV

- C. cyanomelas* Vieillot
- C. caeruleus* Vieillot

Subgenus *Uroleuca* Bonaparte

- C. cristatellus* (Temminck)

Subgenus *Calocitta* Gray

- Cyanocorax formosa* (Swainson)

Subgenus *Psilorhinus* Ruppell

- Cyanocorax morio* (Wagler)

Subgenus *Cissilopha* Bonaparte

- Cyanocorax melanocyanea* (Hartlaub)
- C. yucatanica* (Dubois)
- C. sanblasiana* (Lafresnaye)
- C. beecheii* (Vigors)

Genus *Cyanocitta* Strickland

- Cyanocitta stelleri* (Gmelin)
- C. cristata* (Linnaeus)

SUBGENUS CYANOCORAX

Species Group I. I believe this group (*Cyanocorax dickeyi*, *C. mystacalis*, *C. chrysops*, *C. cyanopogon*, and *C. affinis*) exhibits

TABLE 1. Categories of vocalizations of New World jays of the ornate and inornate lines.^a

| Genus and Species | Downwardly inflected call | Rapid-fire chatter | "Squeaky gate" and "bell" call, etc. (resonant) | Non-jay like | Upwardly inflected call | Kwesh syringeal | Non-Sotto voce | Unclassified jay calls, begging calls, feeding calls |
|----------------------------|---------------------------|--------------------|---|--------------|-------------------------|-----------------|----------------|--|
| Figure 1 <i>Cyanocorax</i> | | | | | | | | |
| <i>chrysops</i> | 1-A-C | 1-F, G, H | 1-E, I | 1-D | | | | |
| <i>mystacalis</i> | | 2-B, C | | | | | 2-D | |
| <i>dickeyi</i> | | 3-B, C | 3-D | | | | X | 3-A, E, F |
| <i>affinis</i> | 4-C, D | 4-A | | | | | | 4-B |
| <i>yncas</i> | 5-B | 5-C, E, G | 5-D, 6-A, B | | | 5-A | | X |
| | | 6-C, E | 6-D | | | | | |
| Figure 2 | | | | | | | | |
| <i>cayanus</i> | 1-A, B, D | 1-C | 1-G | 1-E, F | 2-B | | | 2-A |
| <i>violaceus</i> | 2-C | | | | | | | 2-D |
| <i>crystalinus</i> | 2-E | | | | | | | 2-F |
| <i>formosa</i> | 3-A, B, C, E, F | | 4-A-F | 4-K | | | | 3-D, F |
| | 4-G, I, J | | | | | | | 4-H |
| <i>morio</i> | 5-A, B (part) | | | | | 5-B | | |
| <i>beecheii</i> | 5-C | | | | | | X | 5-D |
| <i>yucatanica</i> | | 5-E | 5-F-I | | | | | |
| <i>caeruleus</i> | X | | | | | | | |
| Figure 3 <i>Cyanocitta</i> | | | | | | | | |
| <i>stelleri</i> | 1-A, B, C, E | | 1-D | | | | | |
| <i>crystata</i> | 2-A | | 2-B, C, D | X | | X | X | X |
| <i>Aphelocoma</i> | | | | | | | | |
| <i>viridicyana</i> | | | | X | X | X | | |
| <i>cucullata</i> | | | | | X | | | |
| <i>pumilo</i> | | | | | X | X | | |
| <i>mirabilis</i> | | | | | X, X ^b | | | |
| <i>nana</i> | | | | | X ^b | | | X |
| <i>unicolor</i> | | | | | X | | | |
| <i>ultramarina</i> | | | | | X | | | X |
| <i>coerulescens</i> | | | | | X | X | X | X |

^a Numerals refer to lines in figures and letters to such designations in those lines; X indicates that such a vocalization is known for the species but not illustrated in this paper.
^b Doubly flexed.

the oldest characteristics of external morphology, color, and color pattern (prominent tufted crests and bold, complex plumage pattern) to be found in the ornate line (fig. 4), while *chrysops*, *dickeyi*, and *affinis* are also rich in vocal repertoire (fig. 1). The similar but simpler repertoire of *C. mystacalis* may be explained by its unusual open habitat preferences (see discussion, p. 371). Vocalizations of *C. cyanopogon* are unknown.

C. dickeyi, a sedentary species not given even to accidental occurrence outside of its small known range (fig. 11), seems to represent a relict rather than a population derived from a single flock of birds lost or blown by storm far from a native home. The latter alternative cannot be lightly dismissed when one considers this almost certainly was the way that a flock of San Blas Jays (*C. sanblasiana*) reached the vicinity of Tuscon, Arizona, in 1937 (see Phillips et al. 1964:105) from the species' nearest normal range in southwestern México. Probably, however, the ancestral population of *C. dickeyi* largely disappeared

with the later colonization of Middle American tropical and subtropical woodlands by the ancestors of *Cyanocorax formosa*, *C. morio*, and the "*Cissilopha*" complex.

Cyanocorax cyanopogon is, in external morphology and plumage pattern, intermediate between *chrysops* and *cayanus* of Species Group II and represents the first step in a line with tendencies toward reduction of the crest, infusion of melanins resulting in masking of other colors and obscuring of facial pattern, and white-tipped tails (fig. 4). The end of this particular line among living forms is *C. violaceus* (fig. 6). *C. cyanopogon* shows a prominent but in part non-tufted or soft crest. The blue of the back is heavily infused with brown. The pattern and richness of head color pattern is less bold than in *chrysops*. Figure 5 shows the geographic range of this form.

Cyanocorax chrysops and *C. cyanopogon* were recently considered conspecific by Blake (1962:223), based upon Pinto (1954) but De Schauensee (1966:100) casts serious doubt

on this. It can be seen from figure 5 that the place of collection of Pinto's (1954:75) specimens of "interpositus," the specimens allegedly linking *chrysops* and *cyanopogon*, makes them difficult to accept as intermediates in any genetic sense. I have examined several specimens of "interpositus" in São Paulo (one of which, through exchange, is now in the Moore Laboratory of Zoology). The birds seem to me to be molting, worn, subadult examples of *cyanopogon*. According to De Schauensee (1966:100), all but one of the four known specimens of the form are subadult.

While I believe it unquestionable that *cyanopogon* and *chrysops* are closely related, there are nevertheless no intermediate specimens from intermediate geographic localities to support the idea that they are conspecific. I predict that they will prove specifically distinct. As a matter of fact, Hélio Camargo (oral comm.) is fairly certain that he has observed both forms in the same areas in the state of Matto Grosso, Brazil, although he has no specimens to substantiate this. There are three geographically far flung, undoubted races of *chrysops*, none of which shows tendencies toward the distinct phenotype of *cyanopogon*. The ranges of the two species are not geo-

graphically far removed. I have no information available on the vocalizations of *cyanopogon*.

Cyanocorax affinis (fig. 4), like *cyanopogon*, represents only a slight phenotypic divergence from the hypothetical primitive form embodied in the *C. chrysops*, *mystacalis*, and *dickeyi* group. Its existence in the Caribbean lowlands north to Costa Rica lends credence to the idea of probable widespread existence in past geological time of an ancestral form in the appropriate habitats between South America and the present latitude of distribution of *dickeyi*. I believe that *affinis* is a somewhat divergent remnant of that ancestor (divergent on the basis of the strong similarity of *chrysops*, *mystacalis*, and *dickeyi* to each other). *C. affinis* is very like *chrysops* in plumage, differing mostly in not having the short plush occipitocoronal crest. The vocal repertoire (fig. 2) is moderately complex and contains components shared by other members of the ornate line.

Species Group II. In my opinion this series of three species (*Cyanocorax cayanus*, *C.*

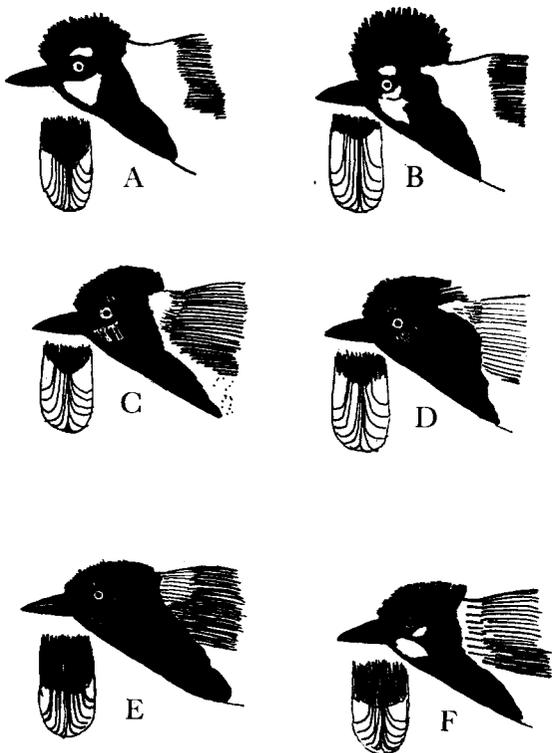


FIGURE 4. Profiles of foreparts and undertail patterns of six jays. A. *Cyanocorax mystacalis*; B. *C. dickeyi*; C. *C. chrysops*; D. *C. cyanopogon*; E. *C. affinis*; F. *C. cayanus*.

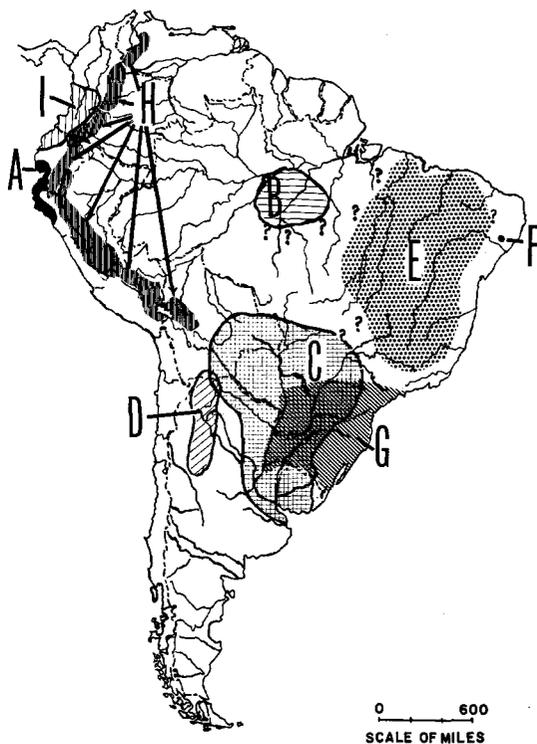


FIGURE 5. Distribution of certain South American jays, genera *Cyanocorax* and *Aphelocoma*. A. *C. mystacalis*; B. *C. chrysops diesingii*; C. *C. c. chrysops*; D. *C. c. tucumanus*; E. *C. cyanopogon*; F. *C. "chrysops interpositus"*; G. *C. caeruleus*; H. *Aphelocoma viridicyana*, six races from the top downward, *meridiana*, *armillata*, *quindiuana*, *turcosa*, *jolyaea*, *cyano-laema*, and *viridicyana*; I. *A. pulchra*.

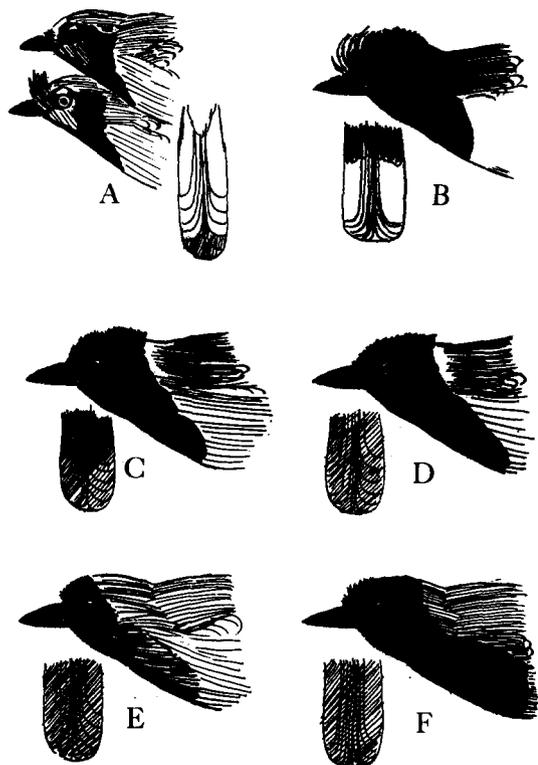


FIGURE 6. Profiles of foreparts and undertail patterns of six jays. A. *C. yncas* (northern and southern types); B. *C. cristatellus*; C. *C. heilprini*; D. *C. violaceus*; E. *C. cyanomelas*; F. *C. caeruleus*.

heilprini, and *C. violaceus*) shows the most frequent evolutionary trend to be seen in New World jays: shortening of the crest, infusion of melanin leading to obscuring of pattern of plumage (figs. 4, 6), and, considering information only on the first and last species, simplification of vocal repertoire. *C. cayanus* has a well-developed although short crest, prominent facial markings, boldly patterned but brownish plumage, and white-tipped tail. *C. heilprini* is darker and the crest is shorter, except fronto-nasally. Its facial pattern is almost completely obscured, evident only in the two dark purple malar bars (barely visible in the dull black of the remainder of the facial plumage), and it possesses a dull purplish white-tipped tail. *C. violaceus* has an even stubbier crest, almost nuchal in origin; the plumage is generally suffused with dull black to brown; and the tail is not white-tipped. The trend of divergence in these plumage characteristics from the proposed older form is from east to west in these living species, roughly along river systems of northern and northeastern South America (fig. 7). They are largely allopatric, but details of ranges are

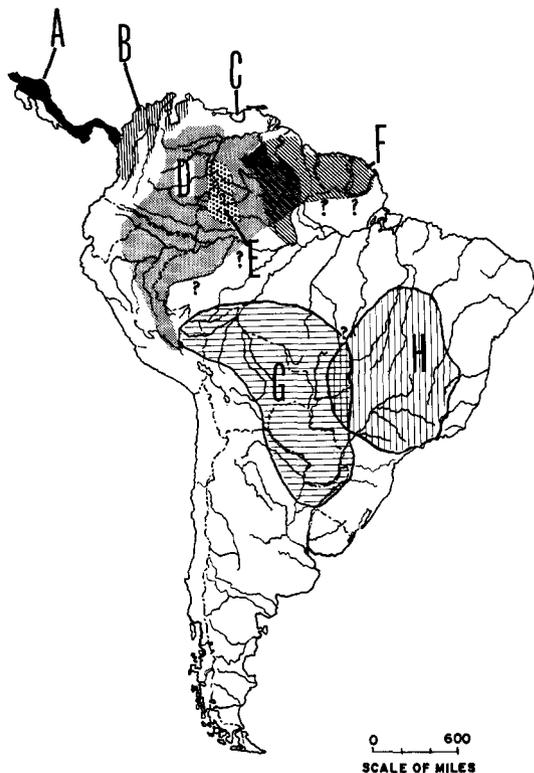


FIGURE 7. Distribution of certain Middle and South American jays, genus *Cyanocorax*. A. *Cyanocorax affinis zeledoni*; B. *C. a. affinis*; C. *C. violaceus pallidus*; D. *C. v. violaceus*; E. *C. heilprini*; F. *C. cayanus*; G. *C. cyanomelas*; H. *C. cristatellus*.

still lacking. There are data now at hand to suggest geographic overlap of *cayanus* with *violaceus* (see Phelps and Phelps 1963:256-7). The range of *heilprini* might well be completely surrounded by that of *violaceus*, in which case the two may be completely sympatric within the range of *heilprini*.

I believe that of the three, *cayanus* is phenotypically closest to the ancestral type, *heilprini* intermediate and second to become differentiated, and *violaceus* farthest diverged and last to evolve. No information is available on vocalizations of *heilprini*, but *cayanus* definitely has a more complex vocal repertoire than does *violaceus*. Note (fig. 2) that *cayanus* has at least six distinct adult call types while *violaceus* has only one.

Species Group III. This polytypic species, *C. yncas* (fig. 6), is an old, independent form closely similar to the three previous species, except that probably simple genetic changes have resulted in its marked phenotypic dissimilarity to them: the blues have been replaced by greens, the whites by yellows. Such differences do not justify giving "*Xanthoura*" Nelson even subgeneric status.



FIGURE 8. Distribution of *Cyanocorax yncas* in Middle and South America. Ranges of races not individually designated.

Populations of *yncas* closest to the probable ancestral region of origin of the ornate line in continental central South America are less greenish and yellowish (more bluish green and creamy white), and the crest, which is short and reduced to nasal tufts in northern populations, is a prominent, erect naso-frontal ornamentation (see for example the race *galeata*). The rich vocal repertoire is very similar in components to those of the forms of Species Group I (fig. 1). Figure 8 shows the range of *C. yncas*.

Species Group IV. Previously I suggested (Hardy 1961:127) that these forms (*Cyanocorax cyanomelas* and *C. caeruleus*) along with *C. violaceus* provided an excellent morphological bridge between the more ornate species and *C. morio* and the "*Cissilopha*" complex. Now, however, I believe that these two species represent parallels respectively to those northern species. It is interesting to note that in geographic distribution they are about as far south of the probable center of origin of the entire assemblages as their counterparts are north of it. *C. cyanomelas*, like *C. morio*, shows a trend toward reduction of crest length and obscureness of the plumage pattern by eumelanins (fig. 6). The strong resemblances had tempted me to imagine that a close common ancestry was involved. Yet, zoogeographically this seems highly unlikely. I am unfamiliar with *C. cyanomelas* in the wild, but Wetmore (1926:364) characterizes its principal vocalization as a cawing note ("car-r-r"). *C. caeruleus* also gives a downwardly inflected note somewhat like that of *C. violaceus* to my ear. The extent of the vocal repertoire in

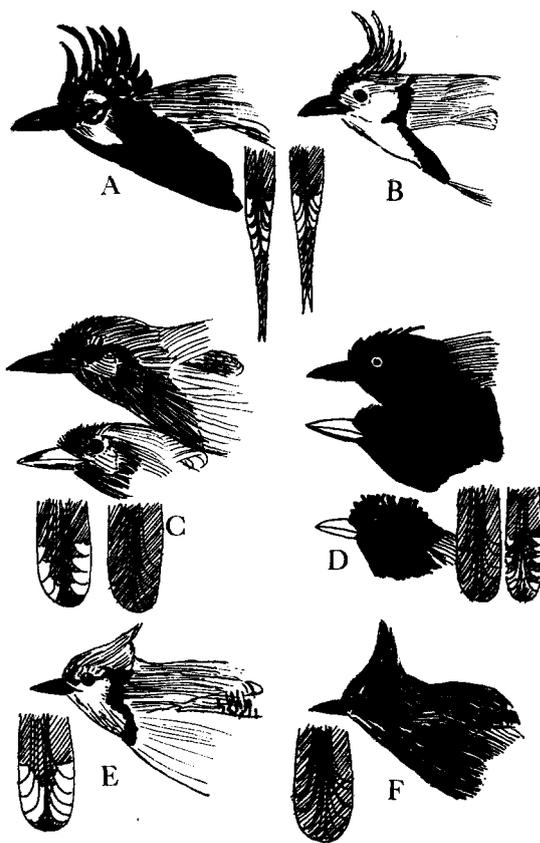


FIGURE 9. Profiles of foreparts and undertail patterns of six jays. A. *Cyanocorax formosa colliciei*; B. *C. f. formosa* and other white-throated races; C. *C. morio* (upper head, adult; lower, subadult; tails of white-tipped and plain-tipped morphs); D. Subgenus *Cissilopha* (upper head, *Cyanocorax sanblasiana*, adult; middle head, adult of eastern races of *C. yucatanica* and subadult *C. sanblasiana* and *melanocyanea*; lower head, juvenile of *C. beecheyi*; left tail, normal for adults and subadults; right tail, juvenile and first-year of *C. yucatanica*); E. *Cyanocitta cristata*; F. *C. stelleri*.

cyanomelas and *caeruleus* is unknown. Apparently no recordings exist of their voices. Figures 5 and 7 show their ranges.

SUBGENUS *UROLEUCA*

The single monotypic species (*Cyanocorax cristatellus*) herein is a distinctive, independent form divergent from the primitive stock. I accord it subgeneric status based upon its long wing-to-tail ratio, peculiar curly crest, and unique combination of patterned body and tail plumage (of primitive type), with immaculate brown to black head, neck, and upper breast (fig. 6). It is certainly a legitimate member of the genus otherwise, with an extremely small repertoire of calls (see discussion, p. 371); the only prominent vocalization (fig. 2) is the downward *jeer* note. Its

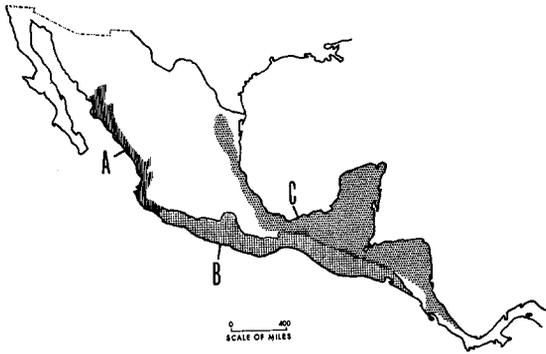


FIGURE 10. Distribution of certain Middle American jays, genus *Cyanocorax*. A. *C. formosa colliei* (black-throated form); B. *C. formosa*, (other three, white-throated forms, separate ranges not individually designated); C. *Cyanocorax morio* (ranges of races not individually designated).

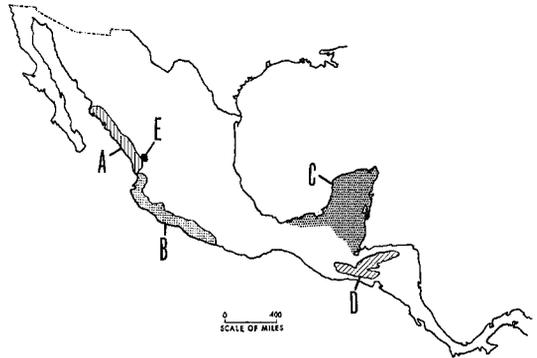


FIGURE 11. Distribution of certain Middle American jays, genus *Cyanocorax*. A. *C. beecheii*; B. *C. sanblasiana*; C. *C. yucatanica*; D. *C. melanocyanea*; E. *C. dickeyi*. Ranges of races not individually designated.

uniquely long wings adapt it to the open cerrado (short tree savannah), a kind of habitat to which no other member of the line is adapted. No living species shows any morphological features intermediate between *crisatellus* and any other known species, and this suggests its early evolutionary separation, and long, independent development. Figure 7 shows its range.

SUBGENERA *Calocitta*, *Psilorhinus*, AND *Cissilopha*

The form, plumage color and pattern (fig. 9), vocalizations (fig. 2), habits and habitats of all of these species, arranged in the generic categories shown as subgenera above, place them well within the currently accepted definition of the genus *Cyanocorax*; that is, within the definition of the ornate line (see p. 360), excluding the characteristics of barred feather pattern and use of mud in the nest peculiar to the genus *Cyanocitta*. They are here discussed together because they are exclusively Middle American in their distribution (figs. 10, 11). I believe, however, that they represent three separate colonizations from South America.

Cyanocorax (Calocitta) formosa is closest to the hypothesized ancestral stock, although the greatly elongate tail and the greatly elaborated crest (with recurved, spatulate feathers) constitute a unique variation on the theme. Despite these elaborations, the species displays the typical facial pattern, white-tipped rectrices, and bold color pattern of the line. Its vocal repertoire (fig. 2) is very similar to that of *chrysops* and *dickeyi*.

The smaller, white-throated races, *Cyanocorax formosa azurea* and *C. f. formosa*, have shorter tails and crests than *C. f. colliei* and are similar to *Cyanocitta cristata* in phenotype.

The strong resemblance between these Magpie-jays and the Blue Jay might, in my opinion, be a basis for accepting *Cyanocitta* as part of the New World assemblage of jays. Both the *colliei* race of *formosa* and *Cyanocitta stelleri*, then, constitute divergences from the typical phenotype (*formosa*, *azurea*, and *crisata*) which is close to the hypothesized ancestral form thought to be exemplified by *Cyanocorax* Species Group I. See p. 360, 363 for further discussion of this point.

The subgenus *Psilorhinus*, with its single polymorphic species, is a specialized, aberrant form, differing from other *Cyanocorax* species in the possession of the furcular pouch of the intraclavicular air sac. So far as I am aware, there is no evidence in the literature for the existence of this structure in other living species of jays. It is not present, according to my own examination of captive and freshly killed specimens, in any Mexican species, or, judging from close observation of living birds, in *Cyanocorax mystacalis*, *chrysops*, *affinis*, *violaceus*, or *caeruleus*.

In personal correspondence with other persons who have observed and collected specimens of the remaining species unfamiliar to me, I have encountered no suggestion that any such pouch exists, as it does in the Brown Jay (*C. morio*), where physically and audibly it is an obvious structure. The Brown Jay exhibits one other extreme characteristic, which, however, is shown in lesser development by some other members of the genus. It has lost the structural blue coloration and is thus brown and whitish or yellowish. I have previously pointed out (Hardy 1961:128) the existence in the Brown Jay of plumage patterns typical of the ornate line: white-tipped rectrices (in one morph) and a faint but

clearly visible facial pattern in some individuals. The Brown Jay may be considered roughly a counterpart of *C. cyanomelas* in its external features, and I believe it represents a fairly recent descendent from ancestors that also gave rise to the forms in northern South America. Resemblances of its simple vocal repertoire to those of *C. violaceus* and *C. affinis* are marked (fig. 2). The repertoire in fact consists completely of variations upon the downwardly inflected *jeer* call, as in *C. violaceus*.

Prior to a recent increase in knowledge concerning habits of some tropical jays, it might have been assumed that the highly social nature of the Brown Jay, including helpers at the nest, could be a generic characteristic, but since such sociality has now been shown to exist in *C. dickeyi* (Crossin 1967), in *C. chrysops*, possibly in *C. cyanomelas* (Crossin, pers. comm.), and probably in *C. violaceus* from my observations of that species (Hardy 1969), the case must rest entirely with the furcular pouch. It is known (Hardy 1961:130) that many other jays show an ability to utter mechanical sounds that seem to originate from respiratory structure other than syringeal apparatus. Although anatomical evidence for the homology of these to the punctuational popping sounds produced by the Brown Jay using its furcular pouch is yet to be gathered, it seems probable to me that some air sac mechanism will be found responsible and will prove homologous to that in the Brown Jay as Amadon (1944b:6) has suggested.

The subgenus *Cissilopha* is composed of four almost, if not completely, allopatric forms. All display suggestions of a crest, and one (*C. yucatanica*) has white-tipped rectrices in juvenal plumage (Hardy 1961:131). The irregular crests are almost undoubtedly vestiges rather than rudiments. This is suggested in *Cyanocorax beecheii* by the fact that the crest appears in the juvenal plumage as a prominent tufted supraorbital growth which then largely disappears in the first pre-basic molt. Thereafter, in the adult plumage there remains a suggestion of a crest only in the tufted erectness of the stubby feathers beginning near the nares and proceeding supraorbitally as an eyebrow. (In study skins, these feathers tend to lie somewhat flatter, thus obscuring the existence of a crested appearance in the living bird.) In *C. sanblasiana* a prominent but sparse and irregular crest composed of nasofrontal feathers up to nearly 2 cm long is present in most yellow-billed subadults and in many black-billed adults. Here again, the

crest is often more obvious in the living bird which exercises erectile control over the feathers; these may be smoothed flat by a preparator of a study skin. *C. melanocyanea* has a crest similar to that in *C. sanblasiana* but it is even sparser and more irregular in occurrence. In study skins, *C. yucatanica* almost always seems to have no crest, but the living bird actually has a striking but short crest beginning at the region of the nares and, as in *C. beecheii*, forming a prominent eyebrow that the bird often depresses and erects in changes of behavioral attitude. Information on the crest in *C. beecheii* and *C. yucatanica* is derived from my studies of both species in the wild and in captivity.

Recordings of the voices of three forms (fig. 2) of "*Cissilopha*" reveal many typical components of ornate line repertoire, including a bell-call, rapid chatter, and in one form (*beecheii*) a downwardly inflected *cawing* call.

These jays are the most melanistic of all the New World assemblage. The infusion of melanin obscures whatever pattern of facial markings might have existed that would give further clues to ancestry. *C. melanocyanea* is the least heavily pigmented in adult plumage. This is expressed in the demarcation of the black breast from the purple abdominal feathering along a regular line which suggests the bold demarcation of pale abdominal area from black breast in the markedly patterned species such as *Cyanocorax mystacalis*. This characteristic, together with the probably vestigial crests, ornate line-type vocalizations, and white-tipped rectrices in first-year *C. yucatanica*, influence me to believe that the black pigment of the heads of all these species has come to hide a facial pattern of the ornate line.

Further comment should be made here concerning the unique and anomalous juvenal plumage of *Cyanocorax yucatanica*. In this form the plumage, except for the mantle, wings, and tail, is snow white. This represents a truly spectacular difference from juvenal plumages of all other New World jays. Yet, in light of *yucatanica's* otherwise close similarity to other members of the subgenus *Cissilopha* and general conformity to the definition of the genus *Cyanocorax*, I see no reason to regard this white plumage stage as other than an anomalous characteristic in no way reflecting a phylogenetic distinctiveness of this form.

It might be argued that the white-tipped rectrices that appear in the first-year plumage

of *C. yucatanica* represent another expression of the factor producing its anomalous white plumage, thereby reducing their valence as characteristics indicating relationship to the ornate line. Yet, the white-tipped rectrices are a part of the first-year adult type plumage persisting until the second pre-basic molt, shortly after the young leave the nest. While this does not obviate the possibility that the two areas of white are causally linked, neither does the possibility of the linkage weaken the suggestion that the white-tipping bespeaks ancestry with an evolutionary line in which this characteristic is widespread, especially when it is taken in company with evidence from crest development and vocalizations.

The rapid-fire alarm chatter of both *C. yucatanica* and *sanblasiana* (fig. 2) is similar to harsh calls of *C. chrysops* and *yncas* (fig. 1) and *Cyanocitta stelleri* (fig. 3, line 1 F). The resonant "bell" and "tin horn" calls of *C. yucatanica* (fig. 2, line 5 F-I) have counterparts in most ornate line species (e.g., *Cyanocitta cristata*, fig. 3, line 2 D; *Cyanocorax dickeyi*, fig. 1, line 3 D; *C. yncas*, fig. 1, line 5 D). The cawing alarm call of *C. beecheii* is similar to the cawing notes of several other species (see fig. 2, line 2 E of *C. cristatellus*). Practically nothing is known of the vocalizations of *C. melanocyanea*, but from information now on hand on the other species it is clear that this subgenus is like other *Cyanocorax* jays in having great variety of vocalizations, cawing calls, and resonant piping calls, and therefore bears no resemblance in vocal characteristics to jays of the inornate line.

GENUS CYANOCITTA

I see no reasonable way at this time to assess the history and relationships of the genus *Cyanocitta*. In my opinion, no one of the several alternative explanations of their position and origin is best supported by the facts concerning their morphology and behavior. In most characteristics these two species (*Cyanocitta stelleri* and *cristata*) are typical of the ornate line. They differ from all other species of New World jays in possessing barred plumage pattern in wings and tail. They also use mud as a nest component. Although the nests of many tropical jays have yet to be described, none of the species whose nests are known have been reported to use mud. Finally, *Cyanocitta* inhabits temperate and boreal forests, mostly at high latitudes.

The fact that some tropical latitude jays, such as *Cyanocorax melanocyanea*, inhabit montane cloud forest of temperate character

suggests an ecological parallelism to *Cyanocitta* rather than a zoogeographically significant fact. Furthermore, the limited extension of the range of *C. yncas* into temperate latitudes, largely into the lower Rio Grande valley subtropical environment along with several other distinctively tropical bird species, cannot be taken as indicating a temperate "invasion" by Green Jays. Thus, the species of *Cyanocitta* stand distinctively together and apart from all other species of the ornate line, zoogeographically and ecologically.

Some workers may be skeptical of viewing zoogeographic distinctiveness as a taxonomic character, or of the importance of either the behavioral feature of using mud in the nest or the morphological one of barred plumage in deciding to retain generic status for these two species. These characteristics are not just differences of degree of development of basic characteristics of the ornate line; they are completely unknown elsewhere in the assemblage. Furthermore, no other species in the ornate line has more than one known morphological or distributional feature at odds with the remainder of the group. Finally, as previously mentioned, the zoogeographic character of *Cyanocitta* suggests a long independent period of evolutionary development.

I regard the following two alternative hypotheses concerning the evolutionary history of *Cyanocitta* to have some degree of feasibility in light of our present knowledge.

1. *Cyanocitta* represents a colonization of the New World separate from and subsequent to that which has produced the other species of the ornate and inornate lines. The earlier colonization first resulted in a widespread ornate-type jay that spread to South America, where a secondary radiation began. The earliest type is most closely approximated in the extant forms by *C. chrysops*, *mystacalis*, and *dickeyi*, the latter two of relict nature as previously discussed. The secondary radiation produced the two lines, ornate and inornate. Some of the former line (subgenera *Calocitta*, *Psilorhinus*, and *Cissilopha*) spread northward supplanting the older *Cyanocorax* in Central America and México except in isolated pockets, where today *C. affinis* and *dickeyi* persist. The inornate line, mostly montane, also extended its range northward, remaining largely in the mountains except at high latitudes. Meanwhile, the second colonization of the New World by jays (*Cyanocitta*) supplanted *Cyanocorax* from the north in much of temperate North America and spread south in high mountain areas to Central America.

2. *Cyanocitta* represents a temperate-boreal latitude radiation from an ancestor common to it and the Magpie-jays (subgenus *Calocitta*). The Blue Jay and the white-throated races of the Magpie-jay are closely similar in external morphology except for size. Both the Black-throated Magpie-jay and Steller's Jay then represent parallel divergences from the white-throated Magpie-jay and the Blue Jay, respectively.

Brodkorb (1957:132-3) has described *Protocitta dixi* from the Pleistocene deposits of Reddick, Florida. From his description it can be gathered that this early form was somewhat similar to the Magpie-jay osteologically, of slightly smaller size, but in general of a *Cyanocorax* form rather than resembling true magpies (*Pica*) to which he also compares it. This fossil suggests that a form possibly ancestral to *Calocitta* once existed in lowland habitats in the southern United States. Perhaps this form was ancestral to *Cyanocitta cristata*, which had emerged to colonize temperate eastern North America, while *Cyanocorax formosa* evolved from this same ancestor to fill the arid tropical deciduous forest niche of México and part of Central America. This hypothesis makes the evolution and present wide distribution of *Cyanocitta stelleri* less easily explained. It would not do so if we knew that in the Temperate Zone Pleistocene, there were widespread jays of the *Protocitta* type, from which *C. stelleri* evolved contemporaneously with the evolution of *C. cristata*. Under such circumstances, the present extensive distribution and racial variation *C. stelleri* would seem possible.

No data at hand support a hypothesis placing *Cyanocitta* stock at the phylogenetic stem of New World jays. Very early in my approach to the reconstruction of New World jay phylogeny I considered such a possibility with an objectivity that I can no longer muster when faced with information gathered in the interim and presented in this paper.

EVOLUTIONARY TRENDS IN THE ORNATE LINE

Previously (p. 363) I stated that I believed an evolutionary trend toward simplification is evident in the morphology and vocalizations of the ornate jays, if one considers the living forms to consist of species some of which have old, some intermediate, and some more recently acquired characteristics. Facts concerning the ontogeny of plumage development in the subgenus *Cissilopha* (p. 369), the specimens of *Cyanocorax morio* exhibiting the

ornate pattern of the facial area showing through the melanin, and the trend of obscuration of such pattern and shortening of the crest to be seen in Species Group IV (figs. 4 F and 6 C, D) offer good evidence of this. (One could hardly propose that the pattern is emerging in this latter group in sequence from *C. violaceus* to *cayanus*.)

Vocal trends are seemingly more complicated, but here also several different expressions of complex to simple within subgenera or groups are evident. *Cyanocorax cayanus* has a rich repertoire and *C. violaceus* a limited one. The more complexly ornate *C. chrysops* and *C. dickeyi* have large vocabularies while the similar but simpler *C. affinis* has a smaller one. *Cyanocorax formosa*, the most ornate of the line, has an immense repertoire of sounds, but its close plain relative (a hybrid is known; see Pitelka et al. 1956:98-106) has a small vocabulary. So, in fact, do the relatively inornate Black and Blue Jays of the subgenus *Cissilopha*; and the simplest plumaged of these, *C. beecheii*, has the smallest repertoire. Problems in evolutionary interpretation of vocalizations may be imposed in two instances by habitat adaptations. Most of the ornate line are forest or dense woodland dwellers. The fact that two and only two highly ornate species, *C. mystacalis* and *C. cristatellus*, are open scrub inhabitants may explain their simple repertoires and instead a reliance on visual communication. In summary, with what seem to be explainable exceptions, the hypothesis of an evolutionary trend from complex to simple in external features and voice in the ornate line seems to be a logical one.

INORNATE LINE

Genus *Aphelocoma* Cabanis

Subgenus *Cyanolyca* Cabanis

Aphelocoma viridicyana Lafresnaye and d'Orbigny

A. pulchra (Lawrence)

A. cucullata (Ridgway)

A. pumilo (Strickland)

A. argentigula (Lawrence)

A. mirabilis (Nelson)

A. nana (Du Bus)

Subgenus *Aphelocoma* Cabanis

A. unicolor (Du Bus)

A. ultramarina (Bonaparte)

A. coerulescens (Bosc)

I have already discussed in part the relationships between the two sections of this genus (Hardy 1964), and have further indicated (1967) that the vocalizations of *A.*

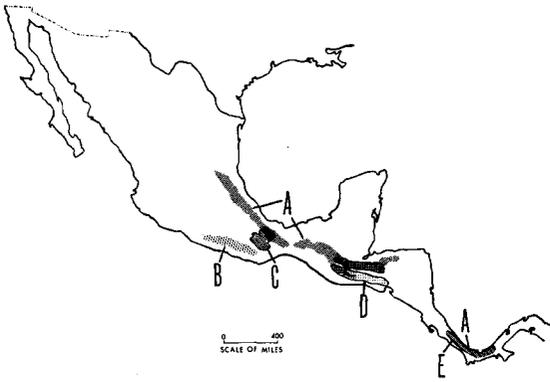


FIGURE 12. Distribution of certain Middle American Jays, genus *Aphelocoma*. A. *A. cucullata*; B. *A. mirabilis*; C. *A. nana*; D. *A. pumilo*; E. *A. argentigula*. Ranges of races not individually designated.

viridicyana meridana of the Venezuelan Andes suggest the former existence of a common ancestor for the two lines of New World jays. Many *A. v. meridana* vocalizations are strictly of the inornate type, many others are quite non-jaylike, and a few are like those of the ornate line. Morphologically this form is, however, wholly within the defined limits of the inornate jays, making reconstruction of an ancestor common to both lines a difficult abstraction. Considering the trend of simplification hypothesized to exist in evolution of the ornate line, the entire inornate line represents an advancement. Ignoring time as a factor, one could extend the hypothesis to suggest that such species as *Cyanocorax violaceus* and *C. cyanomelas* are close to the ancestral stock from which the inornate line arose. But time is certainly a factor, and because of it, I believe that evolution of the two lines must be considered as parallel and overlapping events, the ornate line largely in lowlands, the inornate largely in highland areas.

The evolutionary trend in the inornate line has also, I believe, been one of simplification. The more northern species, such as *A. nana*, *coerulescens*, and *ultramarina*, with the more inornate external morphology, also have the simplest basic vocal repertoires (Hardy 1964). One of the southern forms, *A. v. meridana*, is of more ornate type morphologically and has a complex repertoire as stated above. Among other forms, only *A. pulchra* and *cucullata* bear any morphological suggestion of the ornate line; they possess short tufted feathers in the nasal, loreal, and extreme frontal areas, a fact which I had failed to appreciate until very recently. These suggest a vestigial crest, even less prominent than those of *Cyanocorax morio* and *caeruleus* of the ornate

line. All other inornate line jays have less or no tufting. I see the inornate assemblage as comparable to the ornate assemblage minus its most ornate forms, such as *C. mystacalis*, *dickeyi*, and *chrysops*. Therefore, I suggest that the ancestral inornate link to the ornate line resembled *Aphelocoma pulchra* and *A. cucullata* but had a longer tufted crest.

The living forms of the inornate line seem to represent the following three, possibly four, radiations from the hypothesized ancestor: (1) the radiation to the northwest Andean region (Pacific slope) and thence north through subtropical-temperate highlands to México, as represented by *A. pulchra* and *A. cucullata* (figs. 5, 12); (2) the main eastern slope, high Andean radiation, represented by the paler races of *A. viridicyana*, *quindiuna* south through *viridicyana* (fig. 5); and (3) the northward temperate highland radiation of the complex that consists of *A. argentigula*, *mirabilis*, and *pumilo*, all small closely-related allopatric species.

The three species of the subgenus *Aphelocoma* (*unicolor*, *ultramarina*, and *coerulescens*) may represent a two-branched radiation from the stock that produced this temperate highland complex. In its southern latitude distribution *A. coerulescens* remains a highland form, but, like *C. yncas* of the ornate line, it thrives in open, disturbed, or scrub vegetation and was thus well suited to explore extensively the more northern latitudes into the southern United States. The other branch of the subgenus consists of two very closely related species of much more arboreal preferences. *A. unicolor* occurs in the interior of mature temperate, cloud, and montane tropical forests in its range and at least occasionally is syntopic with each of the species *A. nana*, *pumilo*, and *mirabilis*. *A. ultramarina* is widespread but local throughout much the same geographic range as that occupied by *A. coerulescens*. The two are seldom syntopic (although frequently sympatric) because of *A. ultramarina*'s preference for more arborescent vegetation.

REMARKS ON CORRELATION OF SOCIALITY AND EVOLUTION

Earlier (Hardy 1961:118-129) I made what I believed was a strong case for the correlation of degree of sociality, age differences in bill coloration, and primitiveness of social nesting habits in the inornate line. I postulated that sociality was the primitive state (as exemplified by some races of *Aphelocoma ultramarina* and *A. unicolor*). In these species, sexual maturation is delayed for as long as

three or four years (Pitelka, pers. comm., and my observation of captives of *A. u. arizonae*). The sexually immature individuals in highly social flocks are often helpers at the nests of sexually mature individuals. The signal characteristic of their immaturity and social status is the parti-colored bill, which becomes solid black in color as the individual matures and actively assumes breeding status. In two races of *A. ultramarina* (*sordida*, *couchii*) and in *A. coerulescens*, parti-coloredness disappears exteriorly by the time the young leave the nest, and in these forms there is no evidence of helpers at the nest, while *A. coerulescens* is, moreover, strongly territorial. The main basis for suggesting that sociality and parti-coloredness are more primitive was the fact that parti-coloredness still remains on the inside of the bills in the first year of life (where it seemingly has no signal value) in these less social forms.

In attempting to extend this hypothesis to cover other New World jays, I cited the correlation of parti-colored bills in young and helpers at the nest in the Brown Jay and the lack of such parti-coloredness and helpers at the nest in the territorial *Cyanocitta*, among others. I then suggested that in other New World jays of which the habits were poorly known one might predict that, in those in which parti-coloredness persists in full-grown birds, highly social habits would exist in the breeding season (as perhaps in the subgenus *Cissilopha*). Conversely I suggested that in those species in which such signal characters for age classes are lacking, territorial habits or other forms of low sociality in the nesting season could be expected. Evidence from the subgenus *Cyanolyca*, inornate line, confirms the reliability of the correlation of bill color and sociality in the inornate line, but the pattern of behavior in the ornate line jays seemingly is far less predictable. Crossin (1967) has demonstrated a high degree of sociality in the breeding season for *Cyanocorax dickeyi*, in which the bill in post-nestling stages is always black, and has recently detected similar sociality in *C. chrysops* (other signal characteristics of non-breeding adults do exist in these forms and remain to be accurately understood). Moreover, my own observations of *Cyanocorax cristatellus*, *chrysops*, *violaceus*, and *mystacalis* lead me to suspect that these species are highly social in the nesting season, yet none of them show bill-color signal characters of age and sexual maturity. The specific hypothesis expressed earlier (1961:118-129) must be discarded and the

evolutionary relationships of territoriality and sociality plus the correlation of signal characters of maturation and their evolution subjected to more study.

OLD WORLD ANCESTORS OF NEW WORLD JAYS

No extant Old World jays seem clearly related to the New World assemblage discussed in this paper, in the way, for example, that Old World *Perisoreus* or *Nucifraga* species are obviously close to New World ones. I believe colonization that produced lines discussed in this paper must have occurred so early that subsequent divergence of the entire New World assemblage from Old World stock obscured the relationship. I cannot entertain a hypothesis that *Cyanocitta* is in fact a New World descendent of stock such as *Garrulus*, because vocalizations of *Cyanocitta* do not closely resemble those of Old World forms, and because the barring in the plumage of *Garrulus* is checkered in contrast to continuous barring across adjacent feathers in *Cyanocitta*, thereby in my view diminishing the value of this oft-cited character similarity. Superficially at least, species of the *Urocissa* and *Cissa* bear a resemblance to ornate types such as the Magpie-jays. But the former have coral red bills and legs, vocalizations quite different from any New World species and no facial pattern suggesting that of the ornate line. Although one must guardedly employ color as a taxonomic character, the uniform absence of bright red color on soft parts of all New World jays and its uniform presence in *Urocissa* and *Cissa* strengthen the validity of its use here. My knowledge of vocalizations of Old World forms comes from captive individuals in zoos, where I have no reason to believe that they are not as representative of their fellows in the wild as are vocalizations of New World forms familiar to me.

SUMMARY AND CONCLUSIONS

Two major lines of jay evolution, the ornate and inornate, are thought to have taken place in the New World, while the genus *Cyanocitta* may be an offshoot of the former line or represent a separate colonization of the hemisphere. The ornate line thus consists of the largely neotropical *Cyanocorax* (in which *Uroleuca*, *Calocitta*, *Psilorhinus*, and *Cissilopha* are here submerged) and possibly *Cyanocitta*.

Only one genus, *Aphelocoma* (in which is submerged *Cyanolyca*), comprises the inornate line. The subgenus *Cyanolyca* is

thought to be more primitive than the subgenus *Aphelocoma*, the vocal repertoire of *A. viridicyana meridana* and the short tufted feathers of the forehead of *A. pulchra* and *A. cucullata* suggesting that they are living near relatives of ancestral forms linking the two lines. A previous hypothesis concerning the evolutionary relationships of low and high sociality and signal characteristics of sexual maturation must be restudied.

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LITERATURE CITED

- AMADON, D. 1944a. The genera of Corvidae and their relationships. *Amer. Mus. Novitates*, no. 1251.
- AMADON, D. 1944b. A preliminary life history study of the Florida Jay, *Cyanocitta c. coerulea*. *Amer. Mus. Novitates*, no. 1252.
- BLAKE, E. R. 1962. In E. Mayr and J. C. Greenway, Jr. [eds.] Checklist of birds of the world (Peters). Vol. 15. Museum of Comparative Zoology, Cambridge, Mass.
- BRODKORB, P. 1957. New passerine birds from the Pleistocene of Reddick, Florida. *J. Paleontol.* 31:129-138.
- CROSSIN, R. 1967. The breeding biology of the Tufted Jay. *Proc. W. Found. Vertabr. Zool.* 1(5):265-300.
- DE SCHAUENSEE, R. M. 1966. The species of birds of South America and their distribution. *Acad. Nat. Sci. Philadelphia, Philadelphia, Pennsylvania.*
- HARDY, J. W. 1961. Studies in behavior and phylogeny of certain New World jays (Garulinae). *Univ. Kansas Sci. Bull.* 42:13-149.
- HARDY, J. W. 1964. Behavior, habitat and relationships of jays of the genus *Cyanolyca*. *Occ. Papers Adams Center Ecol. Stud.* no. 11:1-14.
- HARDY, J. W. 1967. The puzzling vocal repertoire of the South American Collared Jay, *Cyanolyca viridicyana meridana*. *Condor* 69:513-521.
- HARDY, J. W. 1969. Habits and habitats of certain South American jays. *Los Angeles Co. Mus. Contrib. Sci.*, no. 165:1-16.
- HELLMAYR, C. E. 1934. Catalogue of birds of the Americas. Part 7. *Field Mus. Nat. Hist. Publ.* 330, Zool. Ser., 13.
- PHELPS, W. H., AND W. H. PHELPS, JR. 1963. Lista de las aves de Venezuela con su distribución. Vol. 1, part 2. *Boletín de la Sociedad Venezolana de Ciencias Naturales* 24 (104-105):1-479.
- PHILLIPS, A. R. 1950. The San Blas Jay in Arizona. *Condor* 52:86.
- PHILLIPS, A. R. 1966. Further systematic notes on Mexican birds. *Bull. British Ornithol. Club* 86:103-112.
- PHILLIPS, A. R., J. MARSHALL, AND G. MONSON. 1964. The birds of Arizona. Univ. Arizona Press, Tucson.
- PITELKA, F. A., R. K. SELANDER, AND M. ALVAREZ DEL TORO. 1956. A hybrid jay from Chiapas, México. *Condor* 58:98-106.
- PINTO, O. 1954. Resultados ornitológicos de duas viagens científicas ao estado de Alagoas. *Pap. dep. zool. sec. agric. Sao Paulo*, 12:1-98.
- SCHWARTZ, P. Bird songs from the tropics. [No date.] 33 $\frac{1}{2}$ RPM disc recording. Neotropical Inst., Caracas, Venezuela.
- SHARPE, R. B. 1877. Catalogue of the birds in the British museum. Vol. 3, 343 pp.
- WETMORE, A. 1926. Observations on the birds of Argentina, Paraguay, Uruguay, and Chile. *U. S. Natl. Mus., Bull.* 133:1-448.

Appendix:

Recording Data for figures 1-3. Note: In legends to sonograms, CC-C equals Cornell University Library of Natural Sounds Catalogue cut (followed by the number of the cut); MLZ equals Moore Laboratory Sound Library (followed by the number of master tape); NI-C equals Neotropical Institute cut (followed by the number of the cut).

Fig. 1. Line 1 and line 2A. *Cyanocorax chrysops*. MLZ master 14, 15, Brasília, Brazil; 30 km NE Tres Lagoas, Matto Grosso, Brazil; Tres Lagoas zoo; Ranch of Jose Carlos Reis de Magalhaes, 150 km NW São Paulo, Brazil, July 1965, J. W. Hardy. **Line 2B-D.** *Cyanocorax mystacalis*. **B, C.** MLZ master 16, Hacienda San Jacinto, 12 km SW Piura, Perú, 6 August 1965, J. W. Hardy. **D.** Porto Pizarro, near Tumbes, extreme NW Perú, 5 August 1965, J. W. Hardy. **Line 3.** *Cyanocorax dickeyi*. MLZ master 10, 2 mi. NW El Palmito, Sinaloa, México, 5 July 1965, J. W. Hardy. **Line 4.** *Cyanocorax affinis*. MLZ master 14, 6 mi. N La Fria, state of Táchira, Venezuela, 12 July 1965, J. W. Hardy. **Lines 5 and 6.** *Cyanocorax yncas*. **5A, C, E, and 6B.** From Schwartz (longplay recording "Bird Songs from the Tropics"—see Lit. Cited). **5B.** CC-C 5, Tucson, Arizona, 17 April 1959, A. A. and D. G. A. Allen. **D.** CC-C 1, Harlingen, Texas, 5 February 1955, A. A. and E. G. Allen. **6A.** CC-C 7, Mérida, Yucatán, México, 1 May 1961, L. I. Davis and B. Guion. **C.** CC-C 3, Tamulipas, México, 5 April 1959, L. I. Davis. **D, E.** CC-C 4, Chiapas, 24 April 1959, L. I. Davis.

Fig. 2. Line 1 and line 2A, B. *Cyanocorax cayanus*. **1A, B, C, D, F.** NI-C 3, Santa María (Upata) Bolívar, Venezuela, 4 May 1966, P. Schwartz. **E.** NI-C 5, Río Grande, 10 km E river (El Palmar) Bolívar, Venezuela, 6 July 1966, Paul Schwartz. **G, 2A, B.** NI-C 1, near Ciudad Bolívar, Venezuela, June and July 1965, P. Schwartz. NI-C 6, 13 km E river (El Palmar) Bolívar, Venezuela, 8 July 1966, Paul

Schwartz. **Line 2C, D.** *Cyanocorax violaceus*. MLZ master 14, 6 mi. W Barinas, state of Barinas, Venezuela, 10 July 1965, J. W. Hardy. **Line 2E, F.** *Cyanocorax cristatellus*. MLZ master 15, 30 km NE Tres Lagoas, state of Matto Grosso, Brazil, 28 July 1965, J. W. Hardy. **Lines 3 and 4.** *Cyanocorax formosa*. **3A and 4B.** CC-C 2, Tuxtla Gutierrez, Chiapas, México, 10 May 1953, L. I. Davis and J. Morony. **3B, C, E.** CC-C 1, S. Tonalá, Chiapas, 21 May 1953, L. I. Davis. **3D and 4A.** CC-C 11, Tehuántepec, Oaxaca, 25 February 1961, L. I. Davis and B. Guion. **3F and 4G, H.** CC-C 4, Puerto Vallarta, Jalisco, 21 June 1957, L. I. Davis and E. Kincaid. **4C, D, E, F.** CC-C 9, Tehuántepec, Oaxaca, 25 June 1959, L. I. Davis and R. Fowler. **4I.** CC-C 3, Tuxtla Gutiérrez, Chiapas, 1 July 1950, L. I. Davis and M. Johnston. **4J.** CC-C 5, Puerto Vallarta, Jalisco, 22 June 1957, L. I. Davis and E. Kincaid. **4K.** CC-C 8, Comitán, Chiapas, 24 April 1959, L. I. Davis. **Line 5A, B.** *Cyanocorax morio*. CC-C 1-4, Veracruz, México, 24 February, 2 March 1955, 26 March 1954, 20 May 1961, A. A. and E. G. Allen, L. I. Davis and B. Guion. **Line 5C, D.** *Cyanocorax*

beecheii. **C.** CC-C 1, near Mazatlán, Sinaloa, 21 June 1953, L. I. Davis. **D.** MLZ master 34, captives at MLZ, summer, 1968, J. W. Hardy. **Line 5 E-I.** *Cyanocorax yucatanica*. **E.** CC-C 11, Piste, Yucatán, 11 May 1961, L. I. Davis and B. Guion. **F, G, H.** CC-C 12, Progreso, Yucatán, 12 May 1961, L. I. Davis and B. Guion. **I.** MLZ master 29, near Zoh Laguna, Campeche, 9 April 1968, J. W. Hardy.

Figure 3. Line 1. *Cyanocitta stelleri*. **A, C.** CC-C 10, Guatemala, 20 March 1962, L. I. Davis and D. Davis. **B, E.** CC-C 3, Mt. Lemmon, Arizona, 24 July 1958, L. I. Davis and C. Aiken. **D.** CC-C 8, Las Casas, Chiapas, 16 March 1961, L. I. Davis and B. Guion. **F.** CC-C 7, Crater Lake, Oregon, 31 May 1961, L. I. Davis and B. Guion. **Line 2.** *Cyanocitta cristata*. **A.** CC-C 5, Richmond, Florida, 5 July 1950, Byrl J. Kellogg. **B, D.** CC-C 8, Thomasville, Georgia, 6 February 1958, A. A. and E. G. Allen. **C.** CC-C 9, Gulfport, Mississippi, 21 April 1961, R. C. Stein and R. B. Angstadt.

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