



FIGURE 3. The percentage of food consumed (grams) which was converted to body weight (grams) during the first 6 weeks after hatching in Ferruginous (F), Red-tailed (R), and Swainson's (S) Hawks. % = body weight increase times 100 divided by food consumption.

An analysis of body weight increase per gram of food consumed (fig. 3) by the birds reared during this study does not support Sumner's conclusions. The highest efficiency of weight gain occurred during the first week of life and decreased throughout the growth period. Efficiency is here defined as the amount of weight gained per gram of food consumed. There was a slightly greater decrease in the percentage of food utilized for growth during the fifth week in all species studied. Body weight and most body parts began the decay phase of growth or reached asymptotes during the fifth week after hatching.

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## COMMENTS ON THE SYSTEMATIC RELATIONSHIPS OF THE PIÑON JAY (*GYMNORHINUS CYANOCEPHALUS*)

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Relationships of the Piñon Jay (*Gymnorhinus cyanocephalus*) within the family Corvidae have never been studied in depth and still are not well understood. Recently, Hardy (1969), in his taxonomic revision of the New World jays, stated unequivocally that the Piñon Jay "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." Hardy apparently based this conclusion on one fact: Piñon Jays typically walk rather than hop. Other authors have concluded tentatively that *Gymnorhinus* is a New World jay (Ashley 1941; Amadon 1944; Pitelka 1951:205). Since a stated goal of Hardy's 1969 revision of the New World jays is to influence the format of the forthcoming revised A.O.U. *Check-list of North American birds*, it is thought worthwhile to present information which casts doubt on his views regarding the Piñon Jay.

### COMPARISONS WITH OTHER CORVINES

*Walking versus hopping.* Walking is the only character used by Hardy (1961:113) to separate

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*Gymnorhinus* from other jays. Many passerines, including the Piñon Jay (Balda and Bateman 1971), which walk rather than hop as adults often hop as juveniles, suggesting that walking passerines are derived from hopping ancestors. The transition from hopping to walking is not a major "step." In fact, I often see walking and hopping in my captive Piñon Jays (typically a walker), Mexican Jays (*Aphelocoma ultramarina*) (hopper), and Clark's Nutcracker (*Nucifraga columbiana*) (hopper). The Mexican Jays walk when engaged in agonistic encounters. The nutcrackers hop almost exclusively. Furthermore, magpies (*Pica*) walk like crows, but are considered "garulines" rather than "corvines" by the A.O.U. Check-list (1957). These observations seem to negate Hardy's sole basis for concluding that the Piñon Jay "is not a jay at all. . ."

*Pterylography and molt.* Thorough studies have been conducted on pterylography and molt of aphelocomine jays (Pitelka 1945), Clark's Nutcracker (Mewaldt 1958), and the Piñon Jay (Ligon and White 1974). Table 1 presents some comparisons of these three taxa. Both Pitelka and Mewaldt compared the species they studied with other corvids and the interested reader is referred to their papers for more general accounts of corvid pterylography and molt.

The presence of mid-dorsal apterium in both *Gymnorhinus* and *Nucifraga* is not of particular systematic significance, as it is present in *Calocitta* and *Cyanocorax chrysops* and is absent in *Aphelocoma*, *Cissilopha*, and *Cyanocitta* (Mewaldt 1958), all of which are unquestioned New World jays (Amadon

TABLE 1. Comparisons of pterylography and molt in three genera of corvids.

Character	<i>Aphelocoma</i> <sup>a</sup>	<i>Gymnorhinus</i> <sup>b</sup>	<i>Nucifraga</i> <sup>c</sup>
Natal down	absent	absent	present
Underwing coverts at fledging	absent	absent	present
Postjuvénal molt <sup>a</sup> of greater secondary coverts	all replaced in some populations; some replaced in all	variable number molted (0-all), correlated with time of hatching	usually not molted
Postjuvénal molt <sup>a</sup> of secondaries	secondaries 7-10 sometimes replaced (2 races)	secondaries 6 or 7-11, or fewer, sometimes replaced	none
Number of secondaries	10	11	10
Mid-dorsal apterium	absent	present	present
Incubation patch in males	none	none	fully developed

<sup>a</sup> From Pitelka 1945.

<sup>b</sup> From Ligon and White 1974.

<sup>c</sup> From Mewaldt 1958.

1944; Hardy 1969). The absence of natal down in *Gymnorhinus* perhaps is significant. Absence of natal down seems to be a consistent character in New World jays, whereas down is present in *Nucifraga* and members of the genus *Corvus*.

**Plumage characters.** The blue color of the Piñon Jay, together with the pale throat, in general resembles color patterns of the Mexican Jay. It in no way resembles either species of *Nucifraga* or any species of *Corvus*.

The absence of feathering over the nostrils in Piñon Jays may reflect a specific adaptation. Piñon Jays open green, resinous cones of piñon pines (*Pinus edulis* group) to extract the seeds. Reduction of feathering over the bill may be related to use of such cones. The presence of such feathering in nutcrackers weakens this argument, as they also open green cones. The character of unfeathered nostrils is shared with two Neotropical jays (*Calocitta* and *Psilorhinus*) and thus may indicate systematic affinities. Amadon (1944) mentioned that this trait is rare or absent in Old World corvids.

**Osteology.** Amadon (1944) pointed out that Schufeldt (1888, original not seen), in his study of the osteology of the Corvidae, found *Gymnorhinus* to resemble the jays more closely than the "corvines." Ashley (1941), basing his conclusions on a study of the humerus, likewise placed the Piñon Jay closest to the other New World jays. Pitelka (1951:205), on the basis of preliminary osteological studies, considered *Gymnorhinus* to be a member of the complex of American jays.

**Vocalizations.** This is a very complex topic in this group. Female Piñon Jays, Scrub Jays (*A. coerulescens*), Steller's Jays (*Cyanocitta stelleri*), and Clark's Nutcrackers give a rattle or "churring" call not given by males (Ligon, unpubl. data; Brown 1963). This call may be characteristic of many corvids (J. W. Hardy, pers. comm.). Reference to calls of Piñon Jays as being like those of "miniature crows" (e.g., Westcott 1969) is not indicative of special relationship since many New World jays "caw" (Hardy 1967; 1969).

**Ecological convergence.** Several characteristics shared by Piñon Jays and Clark's Nutcrackers may

be related to similarities in their modes of life (Amadon 1944). Both are highly dependent on an unpredictable food—seeds of conifers, particularly, in the case of the Piñon Jay, those of the piñon pine. I suggest, like Amadon (1944), that similarities between the two in body proportions (long wings, short tail) may be a result of convergence. Both are well suited for long distance flight and both wander widely in response to food shortage (e.g., Westcott 1964).

Bill shapes of Piñon Jays and nutcrackers apparently are modified as a result of selective pressures associated with their dependence on hard seeds, although they are not strikingly similar. Bills of Scrub Jays of the Great Basin (where dependence of this species on piñon seeds is thought to be the greatest) are modified toward bill shape of *Gymnorhinus* (Pitelka 1951:296).

Nests of Piñon Jays and Clark's Nutcrackers are more warmly constructed than those of aphelocomine jays, presumably as an adaptation to early nesting. Early nesting is possible in some years as a result of dependence on conifer seeds. In this and several other respects, both are like the Red Crossbill (*Loxia curvirostra*) in their annual cycle (see Tordoff and Dawson 1965; Ligon 1971).

Although both Piñon Jays and nutcrackers are dependent on seeds of conifers, the nutcrackers seem to be more specialized anatomically and physiologically for this mode of life. Both species carry and store large numbers of seeds, but only *Nucifraga* (both species) possesses a specialized structure, the sublingual pouch (Sinety 1853 and Portenko 1948 in Turcek and Kelso 1968; Bock et al. 1973); the Piñon Jay has only a distensible esophagus (pers. observ.; Bock et al. 1973). The different morphological features related to seed-carrying suggest that *Nucifraga* and *Gymnorhinus* independently acquired their specialized dependence on conifer seeds. In Clark's Nutcracker, both sexes incubate (Mewaldt 1952), whereas in Piñon Jays only the female incubates, as is true of most other corvids. Finally, nestling Piñon Jays cannot survive on a diet composed exclusively of piñon seeds (Ligon, unpubl. observ.) whereas young nutcrackers reportedly can exist on seeds of ponderosa pine (*P. ponderosa*) (Mewaldt 1956).

## DISCUSSION

Baird et al. (1874), Coues (1903), and Ridgway (1904) divided the Corvidae represented in America into two subfamilies, the Garrulinae (which includes the New World jays of Hardy 1961; 1969) and Corvinae (in America includes only *Corvus*, *Nucifraga*, and *Gymnorhinus*); however, Sharpe (1877) did not recognize these divisions. This split is based solely, so far as I can determine, on extremely trivial characters related to (1) tail-wing length ratios; (2) primaries exceeding longest secondaries by more or less tarsus length; and (3) which three primaries are longest (Ridgway 1904). Amadon (1944) pointed out the poor reliability of these traits and related them to the mode of life of the species in question.

## SUMMARY

Relationships of *Gymnorhinus* are less clear-cut than indicated by Hardy (1969), in his revision of the New World jays. Considerations of plumage color and pattern, characters of pterylography, and especially the similar selective pressures placed on Piñon Jays and nutcrackers suggest that *Gymnorhinus* may be a specialized and perhaps early offshoot of the lineage known as the New World jays. In any case, there is no sound basis for considering it as "corvine" in the sense of Hardy (1969), far removed from the New World jays. The procedure followed in the *Check-list of birds of the world* (Blake 1962), placing the Piñon Jay earliest in a linear sequence of the New World jays, appears to reflect more accurately its relationships than does the A.O.U. Check-list (1957).

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