

## Variation in the Vertebral Column and Ribs of Songbirds

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### Abstract

*Gross anatomy of vertebrae and ribs of 159 individuals of 47 species belonging to 14 families of oscine passeriform birds is compared. Number of cervico-dorsal ribs, number of free caudal vertebrae, and other characters supposed by various authors to be of taxonomic value are tabulated. Intraspecific variation essentially equals interspecific variation; no taxonomically useful characters at the generic or familial levels are found.*

In the nineteenth century, some authors such as Shufeldt (9,10) stated or implied, at least part of the time, that there was little variation in the ribs and vertebrae of birds of a single species. Even Gadow (5, 6) left little room for variation in the vertebrae, although he emphasized that, "There are no taxonomic characters in the ribs." Brodkorb (4) used the number of cervical vertebrae as a diagnostic character of the suborder Passeres, and number of free caudal vertebrae as a taxonomic character of some songbird families. Berger suggested (2) that the numbers of cervico-dorsal and thoraco-dorsal ribs might be characteristic of certain songbird families.

Other authors (e.g. Lucas, 7, 8) have emphasized variability in the axial skeleton. Berger (2, 3) described some variation in the vertebral columns of cuckoos and starlings, with taxonomic implications in the variability. Webster (ms.) studying skeletons of warblers (Parulidae) noted a great deal of intraspecific variation in cervico-dorsal ribs—which led to the present study.

Only articulated skeletons could be used for this work. Using a dissecting microscope, we examined the entire vertebral column, with ribs; each vertebra was designated by number on each specimen, beginning with the atlas as #1. One hundred fifty-nine specimens of 47 species were studied. Earlier, Webster had studied many additional specimens and species for cervico-dorsal ribs only. Gadow (5, 6) was followed for anatomical terms, with one exception noted below.

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Our data was collected under the following headings: (a) *Number and position of free ribs*. These include the cervico-dorsal ribs (#13 and #14), which are movably articulated, but floating and lacking ventral parts or articulations; the cervico-dorsal rib on vertebra #13 was marked present if it was bone,

whether it was a tiny fragment 1 mm long and monocipital or a well-developed, 10 mm long (*Molothrus ater*), bicipital rib, but it was absent on 58% of the specimens. Farther posterior are the "true" or dorsal ribs (#15 to #18, #19 or #20), of these, the first four always articulate with the sternum. The rib of #19, if it belongs to this group, sometimes articulates with the sternum and sometimes with the ventral segment of the rib of #18. The rib of #20, if it belongs to this group, articulates with the ventral segment of the rib of #19. Most posterior are one or two thoracodorsal ribs which depend from the first one or two vertebrae of the synsacrum. All of our specimens but two had 14 cervical vertebrae, including cervico-dorsals. These two, *Meliphaga analoga*, had 13 and 15 cervicals, respectively.

(b) *Ribs articulating with sternum.* The ribs from the dorsal vertebrae ("dorsal ribs") have dorsal and ventral parts and articulations. Sometimes the most posterior one or two articulate with preceding ribs, rather than with the sternum.

(c) *Thoraco-dorsal ribs.* There are 3 or 4 thoraco-dorsal vertebrae (beginning with #19, #20, or #21) forming the medial part of the anterior region of the synsacrum. Of these, the anterior one or two bear free ribs, which usually have dorsal and ventral parts. The ventral segment, if present, articulates with the rib of the preceding segment. Gadow (5) called these anterior pelvic vertebrae and ribs. We have followed the terminology of Bellairs and Jenkin (1.) In five specimens (of three species) the rib from the most anterior vertebra in the synsacrum articulated ventrally with the sternum; that is, the most anterior thoraco-dorsal vertebra-with-rib was also the most posterior dorsal!

(d) *Uncinate processes.* These bones aren't ankylosed to the ribs in song

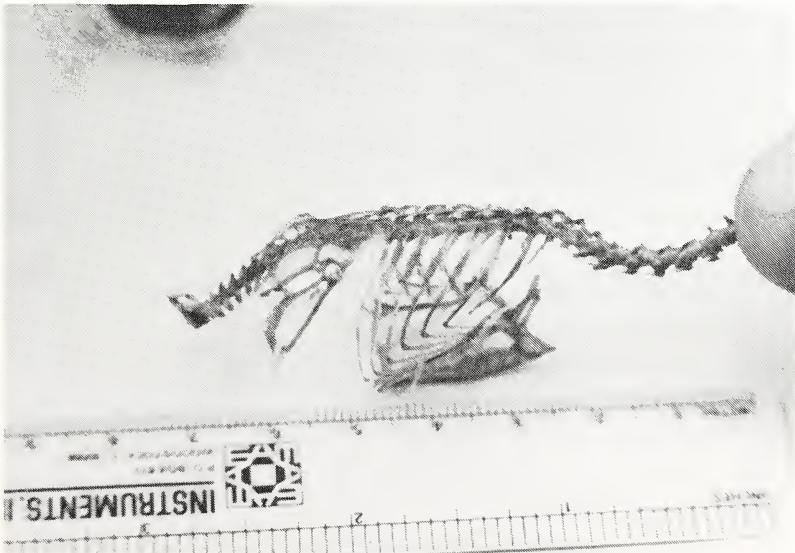


FIGURE 1. Vertebral column, ribs, sternum, and synsacrum of *Passer domesticus* in right lateral aspect. Free ribs can be seen attached to vertebrae #13 through #20 and uncinate processes on ribs #14 through #18. Six free caudal vertebrae are evident.

TABLE 1. *Songbird Ribs and Vertebrae*

Species	Number of free ribs; range and (mean).	Free rib from vertebra #13; proportion of specimens with	Number of ribs articulating with sternum; range and (mean).	Number of free thoracic ribs; range and (mean).	Number of ribs with uncinate processes; range and (mean).	First vertebra of synsacrum; range and (mean).	Number of vertebrae in synsacrum; range and (mean).	Number of free caudal vertebrae; range and (mean).
Paridae: <i>Parus atricapillus</i> (5)	7-8 (7.4) #13 or 14- #20 or 21	.4	5	1-2 (1.2)	5-6 (5.8)	#20	10-11 (10.8)	6-7 (6.2)
Troglodytidae: <i>Troglodytes troglodytes</i> (1)	7 #14-#20	0	5	1	6	#20	11	7
Turdidae: <i>Turdus migratorius</i> (9)	7-9 (7.9) #13 or 14- #20 or 21	.7	5-6 (5.2)	1-2 (1.2)	5-6 (5.8)	#20	11-12 (11.1)	5-6 (5.9)
Sylviidae: <i>Regulus calendula</i> (5)	7-8 (7.4) #13 or 14- #20 or 21	.2	5	1-2 (1.2)	4-6 (5)	#20	10-11 (10.2)	6
Zosteropidae: <i>Zosterops palpebrosa</i> (4)	7-9 (8.2) #13 or 14- #20 or 21	.5	5-6 (5.2)	1-2 (1.8)	3-6 (4.5)	#20	11-12 (11.5)	5-7 (6)



<i>Vernivora</i> <i>crissalis</i> (2)	7-8 (7.5) #13 or 14- #20	.5	5	1	5	#20	N	N
<i>Parula</i> <i>pitayumi</i> (1)	7 #14-#20	0	5	1	5	#20	N	N
<i>Dendroica</i> <i>cerulea</i> (2)	8 #13-#20	1.0	5	1	6	#20	N	N
<i>Dendroica</i> <i>caerulescens</i> (1)	7 #14-#20	0	5	1	5	#20	N	N
<i>Dendroica</i> <i>plumbea</i> (7)	7-8 (7.3) #13 or #14-#20	.3	5	1	4-5 (4.9)	#20	N	N
<i>Dendroica</i> <i>pinus</i> (1)	8 #13-#20	1.0	5	1	6	#20	N	N
<i>Dendroica</i> <i>adeilaidae</i> (1)	8 #13-#20	1.0	5	1	6	#20	N	N
<i>Oporornis</i> <i>philadelphia</i> (2)	8 #13-#20	1.0	5	1	6	#20	N	N
<i>Basileuterus</i> <i>luteoviridis</i> (15)	7-8 (7.7) #13 or 14- #20 or 21	.5	4-6 (5)	1-2 (1.2)	5-6 (5.4)	#19-21 (20)	N	N
<i>Basileuterus</i> <i>chrysogaster</i> (1)	8 #13-#20	1.0	5	1	6	#20	11	6
<i>Basileuterus</i> <i>leucoblepharus</i> (1)	7 #14-#20	0	5	1	5	#20	N	N
<i>Basileuterus</i> <i>rivularis</i> (2)	8 #13-#20	1.0	4½-5 (4.8)	1	4-5 (4.5)	#20	11	6
<i>Geothlypis</i> <i>trichas</i> (6)	7-8 (7.8) #13 or 14- #20	.8	5	1	4-6 (5)	#20	10-11 (10.5)	6-7 (6.3)

<i>Geothlypis</i> <i>spectiosa</i> (2)	7 #14-#20	0	5-6 (5.5)	1	5-6 (5.5)	#20	11	5	
<i>Geothlypis</i> <i>nelsoni</i> (1)	7 #14-#20	0	5	1	6	#20	11	6	
<i>Icteria</i> <i>virens</i> (1)	7 #14-#20	0	5	2	5	#19	N	N	
Thraupidae:									
<i>Granatellus</i> <i>venustus</i> (1)	8 #14-#21	0	5	1	5	#21	10	5	
<i>Microligea</i> <i>palustris</i> (2)	7 #14-#20	0	5-6 (5.5)	1	N	#20-21 (20.5)	11	6	
<i>Piranga</i> <i>ludoviciana</i> (3)	7 #14-#20	0	5	1	6	#20	11	6	
Icteridae:									
<i>Molothrus</i> <i>ater</i> (12)	7-8 (7.7) #13 or 14- #19 to 21	.7	4-6 (5)	1-2 (1.1)	5-6 (5.8)	#19-20 (19.9)	10-11 (10.8)	5-6 (5.6)	
<i>Agelaius</i> <i>phoeniceus</i> (5)	7-8 (7.2) #14-#20 or 21	0	5	1	5-6 (5.6)	#20-21 (20.2)	10-11 (10.8)	5-6 (5.8)	
Fringillidae:									
<i>Spinus</i> <i>tristis</i> (5)	7-8 (7.4) #13 or 14- #20 or 21	.2	5-5½ (5.1)	1-2 (1.2)	5-6 (5.4)	#20	10-11 (10.4)	5-6 (5.8)	
<i>Passerina</i> <i>cyanea</i> (3)	7-8 (7.3) #13 or 14- #20	.3	5	1	5-6 (5.3)	#20	11	6-7 (6.7)	

<i>Pipilo erythrophthalmus</i> (5)	7-8 (7.6) #13 or 14- #20	.6	5-6 (5.4)	1	5-6 (5.8)	#20	11	5-6 (5.8)
<i>Passerella iliaca</i> (2)	7-8 (7.5) #13 or 14- #20	.5	6	2	5-6 (5.5)	#19	11	5-6 (5.5)

birds, but tightly attached by ligaments. Usually they are found only on the dorsal ribs, but often, also, on the cervico-dorsal rib of #14. Frequently an uncinete process is lacking on #19.

(e) *Synsacrum*. The first vertebra in the synsacrum is usually #20.

(f) *Number of vertebrae in synsacrum*. The lateral processes or ribs are counted in ventral aspect.

(g) *Number of free caudals*. Posterior to those caudal vertebrae fused into the synsacrum and anterior to the pygostyle are a variable number of free caudal vertebrae.

Our results can be seen in Tables 1 and 2. The number in parenthesis following the species name is the number of specimens examined. Unless variation is indicated, all specimens of that species were the same for that character. The symbol "N" denotes that that character wasn't studied in the species or was imperfect in the specimen. The symbol "#" shows the number of the vertebra in that skeleton. The fractional " $\frac{1}{2}$ " is used for an asymmetrical specimen, in which a condition was different on left and right sides of the body.

Really, our effort was an exercise in futility as far as finding differential taxonomic characters was concerned. The only generic character among 8 genera of warblers in Table 1 is the free rib on vertebra #13, which is less common in *Vermivora* than in the other genera. Variation within 15 specimens of one species (*Basileuterus luteoviridis*) exceeds that among 42 specimens of 20 other species of the family in 5 of the 6 characters. As for possible familial characters, none are clear. However, there is a tendency for more uncinete processes in Vireonidae than in other families, and for fewer uncinete processes in Zosteropidae and Sylviidae than in the other families. As to number of free caudal vertebrae, the average is fewest in Sylviidae and most in Sturnidae, with all other families intermediate.

Investigation of the hypapophyses began later than our study of other structures, and involved fewer specimens because several loans had been returned to their owners in the meantime. Moreover, Table 2 glosses over our difficulty, oftentimes, in trying to decide whether a certain vertebra did or did not bear a distinct hypapophysis. The data suggest to us no taxonomic information.

Our observations are consonant with Brodkorb's (4) use of one character for the suborder Passeres: All but two of our specimens had 14 cervical (including cervico-dorsal) vertebrae. Shufeldt (10) tabulated some of the same rib and vertebral data we did for some species of songbirds. Our data are consistent with Shufeldt's (although showing more variation) except at one point—the number of cervical vertebrae, where Shufeldt found 13 in most Corvidae and Icteridae. Gadow (5) tabulated numbers of vertebrae in the various regions for several groups of birds. Our counts are consistent with Gadow's, but show more variation.



TABLE 2. *Songbirds, Vertebral Hypapophyses*

Species	Vertebrae #'s 2-5; number of hypapo- physes pres- ent; range and (mean).	Vertebrae #'s 9-17; number of hypapo- physes pres- ent; range and (mean).	Free caudal vertebrae; number of hypapophyses present; range and (mean).
<b>Corvidae:</b>			
<i>Corvus brachyrhynchos</i> (1)	3	7	N
<b>Paridae:</b>			
<i>Parus atricapillus</i> (5)	3	7-9 (8)	2-4 (3.2)
<b>Troglodytidae:</b>			
<i>Troglodytes troglodytes</i> (1)	3	8	4
<b>Turdidae:</b>			
<i>Turdus migratorius</i> (9)	3	7	2-4 (2.8)
<b>Sylviidae:</b>			
<i>Regulus calendula</i> (5)	3	6-7 (6.4)	2-3 (2.5)
<b>Meliphagidae:</b>			
<i>Meliphaga analoga</i> (5)	3	6-8 (6.6)	3
<b>Zosteropidae</b>			
<i>Zosterops palpebrosa</i> (4)	3	6-8 (6.8)	3-4 (3.5)
<b>Sturnidae:</b>			
<i>Sturnus vulgaris</i> (7)	3-4 (3.8)	5-7 (6.1)	3-4 (3.3)
<b>Polceidae:</b>			
<i>Passer domesticus</i> (6)	4	6-8 (7)	5
<b>Vireonidae:</b>			
<i>Vireo olivaceus</i> (5)	3	5-7 (6.4)	2-4 (3)
<i>Hylophilus poicilotis</i> (2)	3	7	3
<b>Ploceidae:</b>			
<i>Protonotaria citrea</i> (1)	3	6	3
<i>Vermivora pinus</i> (5)	2-3 (2.8)	6-7 (6.8)	3-4 (3.2)
<i>Dendroica coronata</i> (2)	3	6	3
<i>Basileuterus chrysogaster</i> (1)	3	6	3
<i>Basileuterus rivularis</i> (2)	3	6	2-3 (2.5)
<i>Geothlysis trichas</i> (6)	3-4 (3.8)	6-7 (6.5)	3-4 (3.2)
<b>Thraupidae:</b>			
<i>Granatellus venustus</i> (1)	3	8	4
<i>Microligea palustris</i> (2)	3-4 (3.5)	6-7 (6.5)	3-4 (3.5)
<i>Piranga ludoviciana</i> (5)	3	5-7 (5.8)	3-4 (3.4)
<b>Icteridae:</b>			
<i>Molothrus ater</i> (12)	3-4 (3.9)	7	2-3 (2.7)
<i>Agelaius phoeniceus</i> (5)	3	6-7 (6.6)	2-4 (3)
<b>Fringillidae:</b>			
<i>Spinus tristis</i> (5)	3	6-8 (7)	3-4 (3.2)
<i>Passerina cyanea</i> (3)	3	6	3-4 (3.7)
<i>Pipilo erythrophthalmus</i> (3)	3	6-7 (6.2)	3
<i>Junco hyemalis</i> (3)	3	6	3
<i>Spizella passerina</i> (5)	4	6-7 (6.8)	3
<i>Passerella iliaca</i> (2)	3	6-7 (6.5)	3

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