ANALYSIS OF VARIATION IN WESTERN RACES OF THE WHITE-BREASTED NUTHATCH

By ALBERT C. HAWBECKER

This study has been undertaken to clarify the status and the ranges of the races of the White-breasted Nuthatch (*Sitta carolinensis*) which occur in the far western United States and Canada and in northern Lower California. Interest was directed toward the problem of racial differentiation in this species by the appearance of Aldrich's (1944) discussion of it. His conclusions concerning the races *nelsoni, aculeata, tenuissima,* and *alexandrae* were so at variance with those of Grinnell (1926) and Grinnell and Miller (1944:314) that further study seemed to be indicated.

Lack of material forbids the consideration of the entire range of *nelsoni* of the Rocky Mountain area, but the location of its western boundary is deemed pertinent to this investigation. The other three races are covered in their entirety although material is lacking from the northern portion of the range of *aculeata.*

The following persons loaned specimens under their care for this study: Mr. Laurence M. Huey, San Diego Society of Natural History; Dr. Robert T. Orr, California Academy of Sciences; and Mr. A. J. van Rossem, Donald R. Dickey Collections. I wish to express my thanks to them for their cooperation. The bulk of the specimens examined were in the Museum of Vertebrate Zoology where the study was carried on. Dr. Alden H. Miller gave freely of his time and experience in guiding me in this problem. Dr. Frank A. Pitelka offered many suggestions during the course of the study which added to its value. Mr. George C. Jensen assisted in checking the statistics and did the drafting on the maps and charts.

REVIEW OF CLASSIFICATION

The first White-breasted Nuthatch described from the Pacific coast area was *aculeata,* named by Cassin (1856:255) from specimens collected by Gambel (1846:112). Grinnell (1932) fixed the type locality as Monterey, California. Mearns (1902) described the race *nelsoni* from the Huachuca Mountains of southern Arizona. Grinnell (1918) described the race *tenuissima* from the Panamint and White mountains of east-central California. Grinnell (1926) also described the race *alexandrae* from the Sierra San Pedro Mártir of northern Lower California. The ranges of these races were not fully indicated at the times of their description. Grinnell and Miller in 1944 outlined the ranges of the races thought to inhabit California. Aldrich (1944)using a large number of specimens outlined, for the first time, the ranges of all races of the species. He indicated extensive changes in ranges in the far west compared with the previously accepted picture of distribution. These changes involved reduction of *alexandrae* to the synonymy of *tenuissima;* this was justified by placing the birds of southern California with the latter race, whereas previously they had been considered a part of *aculeata.* He believed that the size of southern California birds linked them more closely with the larger race, *tenuissima,* than with the smaller race, *aculeata.* Furthermore, he failed to detect significant differences between *tenuissima* and *alexandrae.*

While Aldrich's paper has resulted in a much better understanding of the ranges of the races in general, careful examination of specimens reveals that the status of *alexandrae* and of the adjacent portions of the ranges of *aculeata* and *tenuissima* are not properly shown by his work. His extension of the range of *tenuissima* to include northeastern California, eastern Oregon, and eastern British Columbia seems quite justifiable. Aldrich did not examine specimens of *nelsoni* from eastern Nevada but based his extension of its range into this area on Linsdale's (1936:89) work.

The crux of the most important problem, the status of the southern California birds, lies in the identification of the size gradient of which they are a part—the one involved in *aculeata* or the one involved in *tenuissima*.

METHODS

In the course of my work 613 birds from the Pacific coast and Rocky Mountains were examined and measured. The measurements taken from most of the specimens were length of closed wing, length of tail, length of bill from nostril, length of tarsus, and length of middle toe. These measurements followed specifications laid down by Baldwin, Oberholser, and Worley (1931). As measuring progressed some attempt was made to evaluate the accuracy and reliability of methods and the results obtained. Wing length and length of bill appeared to be the most reliable measurements and showed the least error when retaken and the least variation due to make of skin. The act of measuring the tail and tarsus left something to the judgment of the measurer, but every effort was made to standardize these measurements. The other measurements were discarded as unreliable. It is probable that the greatest reliance should be placed on statistics obtained from measurements of wing length and bill length.

An attempt was made to find a visual means of distinguishing birds of the year from adults, but without success. In the early summer adults can be distinguished by their worn flight feathers but after their late summer molt it is impossible to tell adults and immatures by means of plumage. Measurements of birds of known ages, so labeled by competent collectors who had examined skull structure, were made to find possible size variations due to age. It was soon apparent that birds labeled "juvenile" had bills that were much shorter either than those labeled "adult," or than those of late summer birds which are often labeled "immature." Other measurements of juveniles closely approximated those of adults. These facts showed that as long as juvenile birds were not used in statistical analysis, age made little difference in the final figures.

An attempt was made to find constant color variations within the races so that color might enter into the consideration. It was found, however, that the plumage of birds even within the same area wore unevenly and that the amount of wear made a significant difference in the shade of color. The wings and undersides of breeding birds in particular showed a great deal of variation in amount of wear. If it were possible to have a good series of fall birds from each area, significant color differences could probably be readily determined. Disagreement between Aldrich and Grinnell on variations in color, particularly in the race *alexandrae*, suggested that such variables in these races are largely a matter of personal evaluation. All the aforementioned factors seemed to indicate that minute variations in shades and amounts of color could not be safely used as criteria for distinguishing these races.

Grinnell and Miller (1944:314) state that these nuthatches are resident but that there is movement up and down slopes as well as some fall wandering. Some evidence of such activity is apparent as a result of this study also. It appears, however, that there is not sufficient migration into the area occupied by another race to cloud the picture as far as that race is concerned; thus adults of all seasons were used in the computations.

All birds known to be immature, significantly worn, or molting were eliminated from statistical consideration.

Specimens examined.—Specimens in the Dickey Collections are designated "DC," those in the San Diego Museum of Natural History as "SDM" and those in the California Academy of Sciences, "CAS." All other specimens are in the Museum of Vertebrate Zoology, University of California.

British Columbia. Okanagan, 2 (DC) 9; Okanagan Landing, 1; Kootenay, 2 (DC); East Kootenay, 1.

Washington. PIERCE CO.: Tacoma, 1.

Oregon. JACKSON CO.: Eagle Point, 2. DESCHUTES CO.: 11 mi. W Bend, 1; 3 mi. W Paulina Lake, 2; 7 mi. NW Sisters, 6. WHEELER CO.: 11 mi. W, 7 mi. S Mitchell, 10. COOK CO.: Grizzly Mt., 2; Ochoco Ranger Sta., 1. GRANT CO.: 12 mi. S Canyon City, 3; 21 mi. SE Prairie City, 12. CLACKAMAS CO.: Mulino, 1 (DC).

California. SISKIYOU CO.: Bray, 2 (CAS); Seiad Valley P.O., 3; Scott River, 2; Park Creek, 1. MODOC CO.: 12 mi. SW Eagleville, 1 (CAS); Jess Valley, 1 (CAS); Patterson Mill, 1 (CAS); Head North Fork Parker Creek, 2; Head Pine Creek, 1; E face Warner Pk., 2. LASSEN CO.: Bogard Ranger Sta., 1 (CAS); Eagle Lake, 1; 3 mi. W Susanville, 5. TRINITY CO.: Hayfork, 1; 8 mi. NE Hyampom, 1; 1 mi. W Hyampom, 1; 4 mi. N Mad River Rock, 2; Reilley's Ranch, 10; Norse Butte, 1; 5 mi. S. King, 1. TEHAMA CO.: 1 mi. NE Red Bluff, 3; 2 mi. NE Tehama, 2; 2 mi. SE Beegum, 1; Payne Creek P.O., 10; Inskip Hill, 1; 2 mi. W Black Butte, 2. MENDOCINO CO.: Sanhedrin Mt., 1; Sherwood, 1. BUTTE CO.: 4 mi. SE Chico, 3; 10 mi. SW Chico, 3; 4 mi. N Oroville, 1. SIERRA CO.: Sierra City, 1 (DC) 1 (CAS). NEVADA CO.: Grass Valley, 2; Independence Lake, 2; Penn Valley, 1. LAKE CO.: 3 mi. N Upper Lake, 1. PLACER CO.: Cisco, 4; Applegate, 1 (CAS). ELDORADO CO.: Lake Audrain, 3 (DC); "Eldorado County," 2. ALPINE CO.: 4 mi. W Lookout Pk., 1. SAN JOAQUIN CO.: Tracy, 1. MONO CO.: Mono Mills, 3; Eva Bella Mine, 1; Prospector Meadow, 7; SW Benton, 3; NW Benton, 6; 5 mi. W Benton, 5; 4 mi. NE Benton, 2; 9 mi. W Benton, 2; 5 mi. E Mono Mills, 2; Cottonwood Creek, 1. ALAMEDA CO.: Arroyo Mocho, 6; Cedar Mt., 2. CONTRA COSTA CO.: Mt. Diablo, 1; Lafayette, 1. MARIPOSA CO.: Dudley, 10; Echo Creek, 1; Mono Meadow, 1; 2 mi. NW Pleasant Valley, 1. STANISLAUS CO.: 3 mi. N LaGrange, 2; 1 mi. SW LaGrange, 1. MERCED CO.: 1 mi. S Merced Falls, 1. SANTA CLARA CO.: 2 mi. E Mt. Hamilton, 1. MADERA CO.: Raymond, 1. SAN BENITO CO.: 5 mi. NE San Benito, 4; San Benito Mt., 3; 4 mi. S Hernandez, 7; 6 mi. SE San Benito, 6; 4 mi. NW Pinnacles P.O., 1; Mulberry, 1 (DC). MONTEREY CO.: Jolon, 7; Abbot Ranch, 3; Santa Lucia Pk., 3; 9 mi. W Jamesburg, 1; Peachtree Valley, 1; San Lucas, 1. FRESNO CO.: Bubbs Creek, 1; Hume, 1; Waltham Creek, 1. INYO CO.: Cedar Flat, 1; Cottonwood Lake, 5; SW Big Pine, 3; White Mts., 1; 7 mi. E Laws, 3; Poison Creek, 4; 3 mi. E Jackass Spring, 1; E base Waucoba Mts., 1; Wyman Creek, 2 (DC) 1. TULARE CO.: Whitney Creek, 1; Whitney Meadow, 4; Olancha Pk., 1; Jackass Meadow, 2; Trout Creek, 3; Siretta Meadows, 1; Cannell Meadows, 2; Long Meadow, 1; Taylor Meadow, 3; Little Lake, 1; Smith Meadow, 1; Golden Trout Creek, 1; 1 mi. S Aukland, 1. KERN CO.: Ft. Tejon, 1; 8 mi. W Isabella, 2; 12 mi. W Bodfish, 3; French Gulch, 3; Thompson Canyon, 2; Walker Basin, 3; Buena Vista Lake, 1 (DC); 14 mi. W, 6 mi. N McKittrick, 1. SAN LUIS OBISPO CO.: San Miguel, 1; Cambria, 1; Santa Margarita, 2; Cammatti Creek, 10; 5 mi. E, 4 mi. S Shandon, 1; 3 mi. E McChesney Mt., 2; McChesney Mt., 1. SANTA BARBARA CO.: Santa Cruz Island, 1 (DC). VENTURA CO.: Mt. Pinos, 3 (DC). LOS ANGELES CO.: Newhall, 1; Pasadena, 2; San Antonio Canyon, 1; Mt. Wilson, 5 (CAS) 8; Chileo, 1; Buckhorn, 2; Mint Canyon, 1. SAN BERNARDINO CO.: Victorville, 4 (CAS); Bluff Lake, 5 (SDM) 1; Hog Canyon, 1; Sugarloaf, 1; Santa Ana, 8; San Bernardino Mts., 4 (SDM) 2; San Servaine Flats, 1 (DC); Oak Glenn, 6 (DC); Big Bear Valley, 1 (DC); Barstow, 1; Fish Creek, 1. RIVERSIDE CO.: Fuller's Mill, 3; Hidden Lake, 1; Tahquitz Valley, 1; Strawberry Valley, 2; Garnet Queen Mine, 6; Thomas Mt., 1; Schain's Ranch, 4; San Jacinto Mts., 5 (DC) 2 (SDM); Round Valley, 1; Riverside, 3. SAN DIEGO CO.: Witch Creek, 2 (CAS) 1 (SDM) 2; Volcan Mts., 3 (CAS) 4; Julian, 1 (DC) 2; Cuyumaca Mts., 2 (DC) 2 (SDM) 5; Laguna Mts., 1 (SDM); Descanso, 1 (DC); 15 mi. N San Diego, 1.

Nevada. WASHOE CO.: Incline, 6; Galena Creek, 7. LANDER CO.: Mahogany Canyon, 2; Bunker Hill, 2; E Kingston Ranger Sta., 2; Ridge W Kingston Ranger Sta., 1. WHITE PINE CO.: Lehman Creek, 4; Baker Creek, 1. ESMERALDA CO.: Pinchot Creek, 1; Pine Grove, 3. NYE CO.: Grapevine Pk., 4; Burned Corral Canyon, 4; CLARK CO.: Potosi Mt., 1; Lee Canyon, 4 (DC); Hidden Forest, 2 (DC); St. Thomas, 1 (DC). LINCOLN CO.: Mt. Irish, 2.

Arizona. COCONINO CO.: Mormon Lake, 1; San Francisco Pk., 2; 8 mi. SE Flagstaff, 1. MOHAVE CO.: Mt. Trumbull, 1. YUMA CO.: Alamo, 1 (DC). GILA CO.: Carr's Ranch, 3; Mazatzal Pk., 1. PIMA CO.: Soldier Camp Sta., 1; Fort Lowell, 2; E slope Baboquivari Mts., 2 (DC); Madera Canyon, 1; Rincon Mt., 1 (CAS). SANTA CRUZ CO.: Pena Blanca Spring, 3 (DC) 3; Yank Spring, 8 (DC); Int. Boundary Mon. 31, 1 (DC); Tumacacori Mission, 1 (DC); 4 mi. S Patagonia, 1 (CAS); 7 mi. N Patagonia, 2 (CAS); 3 mi. SW Patagonia, 1 (CAS). COCHISE CO.: Chiricahua Mts., 3; Huachuca Mts., 2 (DC) 4 (CAS); Paradise, 2 (CAS).

Wyoming. SUBLETTE CO.: Green River Lakes, 3.

Utah. SAN JUAN CO.: Navajo Mt., 1.

Colorado. EL PASO CO.: 10 mi. N Colorado Springs, 2. DENVER CO.: Denver, 1.

Manitoba. Gimli, 1.

Lower California. Laguna Hanson, 8; La Grulla, 12; Vallecitos, 10.

Localities of materials used for comparison only.—Lower California. Laguna Valley, 12; El Sauz, 13.

Sinaloa. Pinos Gordo, 1 (CAS).

Chihuahua. La Union, 1.

GEOGRAPHIC VARIATION

After some trial segregation the birds were divided into five populations within each of which there was no important geographic variation. These groups were based on the dimensions of the birds. The five groups occupy the following geographic areas: northern and central California between the Sierra Nevada-Cascade chain and the humid coastal strip; southern California from Los Angeles to San Diego counties; Sierra San Pedro Mártir of Lower California; eastern California and western Nevada; and the Rocky Mountain area of Arizona. Excluded from these populations were birds from known intergradational areas and such small groups as those of east-central Oregon and the Sierra Juárez of Lower California. The plan was to derive statistics for birds of these areas without influence of intergradient or isolated populations.

Study of table 1 and figures 7 and 8 shows the gradual increase in measurements of the variables from north to south in the coastal groups and those immediately adjacent on the east. It can be seen that at any equivalent latitude the interior group is significantly larger than the coastal one. Greatest measurements for the interior populations are found in the southern Sierra Nevada and adjacent ranges. The coastal populations increase gradually, but not uniformly, in size until southern San Diego county is reached and from there the increase in size is sharply upward culminating in a large-sized group in the Sierra San Pedro Mártir. The birds in the Sierra Juárez of Lower California, although much larger generally than those of adjacent San Diego County, are still more closely allied to them in measurements than to the Sierra San Pedro Mártir population. The extremes of the Sierra Juárez group slightly overlap those of the two adjacent populations.

In comparing specimens from southern California it is found that although they are significantly larger than the coastal population immediately to the north, they are also significantly smaller than those from the interior. Thus the population from southern California does not fit in as a clinal link between the large-dimensioned interior population and the equally large or larger birds found in the Sierra San Pedro Mártir. A careful study of the range of the coastal groups shows that specimens are rarely taken above the Transition Zone, that is, above the pine-oak associations that are found on the west slope of the Sierra Nevada and westward. A similar study of the interior population shows that specimens are seldom taken below the Canadian Zone, that is, the lodgepole pine association. If habitat conditions characteristic of this plant belt are necessary for birds of this group, they would not be expected to be present in southern California where such habitat is limited.

It is believed that the population of southern California is subject to two influences. It is not improbable that pioneers from the interior population reach this area as they are found on peaks in Nevada widely separated by areas of a much lower life-zone. Fall birds have been taken from the San Bernardino Mountains that resemble the interior group more than this southern one. It seems very possible that birds from the northern coastal group by infiltration influence the characters of the group of southern California as specimens closely approximating the northern group have been taken in southern California also. Due to similarity in habitat and easier access it seems that the northern coastal group may have the greatest influence. Some winter birds taken in San Diego County are quite large which might be indicative of influence from the Sierra San Pedro Mártir. There is no evidence other than this, however, of that possibility.

Not enough specimens are available to study gradients in the Rocky Mountain population. Among the three populations, coastal, interior, and Rocky Mountain, it can be seen that wing length increases from west to east, but other variables do not correlate with this.

Table 1
Statistical Comparisons of Means of Populations

	Males				
	No.	Mean	σ	σM	d/σ_d
Wing					
No. Calif.	54	84.55	1.74	0.23	
					4.40
So. Calif.	36	86.18	1.75	0.29	
					6.44
Lo. Calif.	14	89.72	1.88	0.50	
					1.62
Interior	35	88.72	2.05	0.34	
					2.94
Arizona	21	90.22	1.63	0.35	
Tail					
No. Calif.	54	45.02	1.57	0.21	
					3.16
So. Calif.	35	46.16	1.83	0.30	
					7.67
Lo. Calif.	14	50.15	1.38	0.36	
					2.76
Interior	38	48.50	2.01	0.32	
					2.64
Arizona	19	47.23	1.09	0.25	
Bill					
No. Calif.	52	14.80	0.59	0.08	
					6.78
So. Calif.	34	15.75	0.63	0.10	
					8.95
Lo. Calif.	11	17.72	0.77	0.23	
					5.81
Interior	34	16.44	0.67	0.11	
					8.29
Arizona	21	15.03	0.70	0.15	
Tarsus					
No. Calif.	51	17.34	0.46	0.06	
					1.14
So. Calif.	8	17.18	0.45	0.15	
					3.85
Lo. Calif.	12	17.95	0.46	0.13	
					3.52
Interior	28	17.35	0.57	0.10	
					0.37
Arizona	5	17.26	0.42	0.18	

Characters of size of the major populations are clear and unmistakable as can be seen by referring to figures 7 and 8. The coastal one is the smallest in all respects. The San Pedro Mártir group has the longest bill of all and a much longer wing than the coastal group to the north. The wing and bill of the interior population are longer than those of the coastal one whereas the wing is shorter but the bill longer than those of the Arizona specimens. Using these characters it is possible to designate the races and to recognize possible intergrades.

On the basis of the foregoing account the following available names are applied to the originally mentioned populations. Two groups, the one from northern coastal California and the one from southern California, can be designated as *aculeata*. The interior group is designated as *tenuissima* and the Sierra San Pedro Mártir population as *alexandrae*. It might be argued that if this latter named population is the end of the coastal cline, the groups of large-sized and small-sized birds at opposite ends of the interior cline within *tenuissima* should also each be recognized by a race name. However, the

Table 1 (continued)

Statistical Comparisons of Means of Populations

	Females				
	No.	Mean	σ	σM	d/σ_d
Wing					
No. Calif.	21	82.94	1.12	0.24	
					3.14
So. Calif.	18	84.42	1.64	0.38	
					5.26
Lo. Calif.	8	88.21	1.89	0.67	
					0.95
Interior	19	87.31	2.40	0.55	
					2.55
Arizona	17	89.12	1.85	0.44	
Tail					
No. Calif.	19	44.28	1.43	0.32	
					2.27
So. Calif.	18	45.51	1.88	0.44	
					4.85
Lo. Calif.	7	49.15	1.14	0.43	
					1.58
Interior	20	48.23	1.42	0.31	
					1.62
Arizona	17	47.50	1.41	0.34	
Bill					
No. Calif.	25	14.29	0.46	0.09	
					5.11
So. Calif.	24	15.16	0.81	0.16	
					6.67
Lo. Calif.	8	17.03	0.44	0.15	
					3.12
Interior	17	16.28	0.68	0.16	
					7.88
Arizona	15	14.94	0.51	0.13	
Tarsus					
No. Calif.	19	17.32	0.43	0.09	
					0.11
So. Calif.	10	17.30	0.62	0.19	
					2.50
Lo. Calif.	7	17.95	0.37	0.14	
					4.57
Interior	17	17.31	0.37	0.08	
					0.64
Arizona	5	17.40	0.14	0.06	

Where d/σ_d is 2.50 or more the difference between the means is probably significant and where it is 3.00 or more the difference is surely significant. Formulae for statistical analysis from Simpson and Roe (1939).

Values for d/σ_d between southern Californian and interior populations are as follows: Males—wing, 5.64; tail, 5.20; bill, 4.92; tarsus, 0.85. Females—wing, 4.31; tail, 5.23; bill, 5.09; tarsus, 0.05.

southward increase in the gradient in the interior, although especially marked in the wing, occurs over a long distance whereas the increase in size from *aculeata* to *alexandrae* is very great and occurs over a short distance. The population in southern California might also be considered a separate race as it is significantly different from the adjacent populations. However, it fits in well with the gradient for size as exhibited by the rest of the race *aculeata* and should for practical reasons of classification be contained within that group. It would be possible to pick small groups out of the populations of either *aculeata* or *tenuissima* and compare them with other small groups much farther north or south in the same population and find small average differences. If the population is studied as a whole, however, relationships and trends in size which tie the members of a group together become apparent.

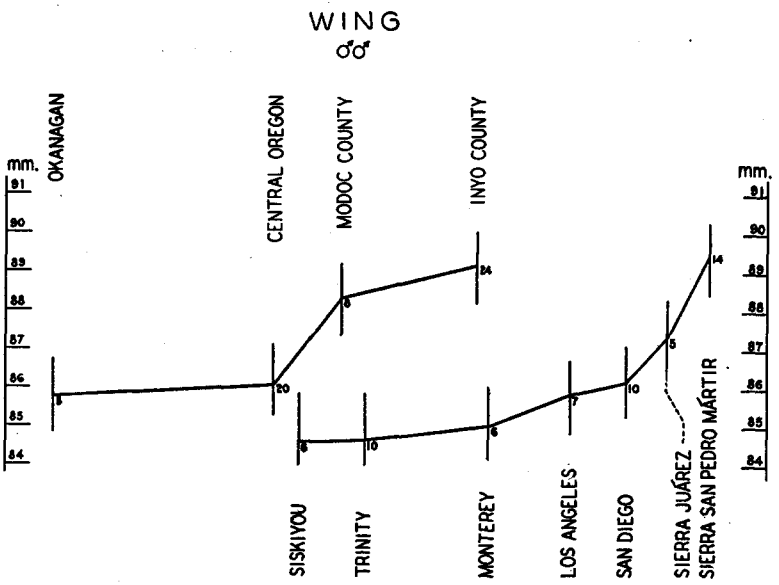

Fig. 7. Clines for wing length in populations of White-breasted Nuthatches. Lines connect averages; vertical bars indicate range; numbers by cross bars indicate number of specimens.

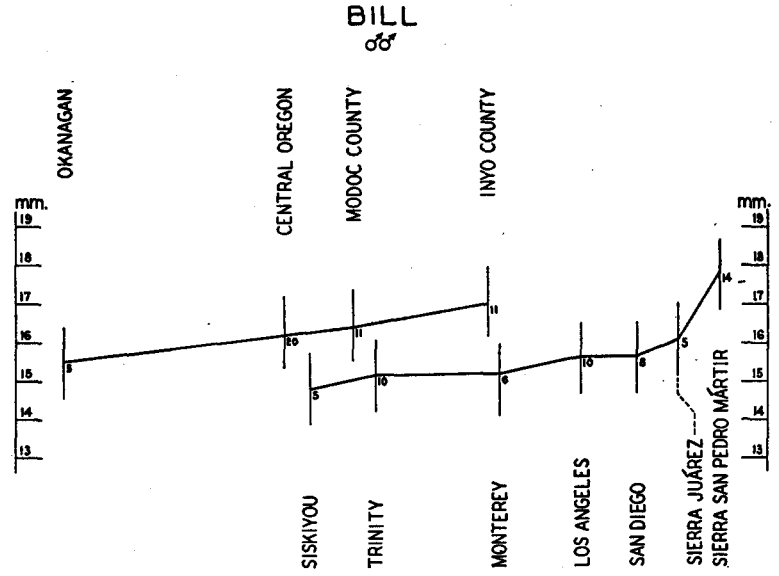

Fig. 8. Clines for bill length in populations of White-breasted Nuthatches. Lines connect averages; vertical bars indicate range; numbers by cross bars indicate number of specimens.

RACES

Sitta carolinensis nelsoni Mearns

Sitta aculeata, Baird (1858:375), part; Coues (1866:78).
Sitta carolinensis aculeata, Allen (1872:161); Coues (1872:83), part; Coues (1874:24), part.

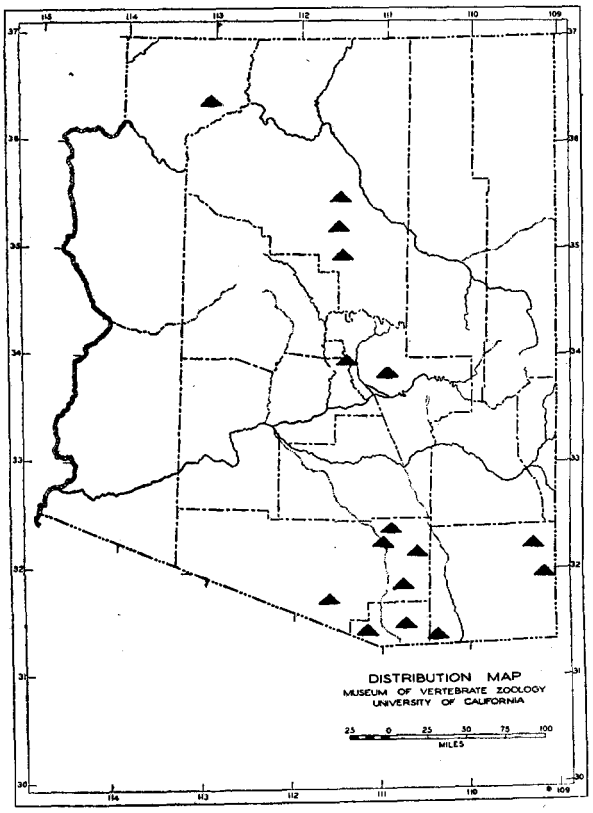

Fig. 9. Distribution of *Sitta carolinensis nelsoni* in Arizona. Triangles indicate localities from which specimens have been examined.

Sitta carolinensis nelsoni Mearns (1902:923), original description, type locality, Huachuca Mountains, Arizona; Ridgway (1904:447), part; Hellmayr (1934:94), part; Linsdale (1936:89); van Rossem (1936:37); Aldrich (1944:94).

Subspecific characters.—The wing of this race averages the longest of the western races. Both the bill and the tail average shorter, the bill extremely so, than those of *tenuissima,* its nearest neighbor on the west.

Measurements.—Specimens from Arizona.

	No.	Range	Mean	σ	V
Wing					
Males	21	87.2-94.0	90.22±0.35	1.63	1.80±0.29
Females	17	84.6-92.8	89.12±0.44	1.85	2.07±0.35
Tail					
Males	19	44.8-48.8	47.23±0.25	1.09	2.30±0.37
Females	17	45.3-50.6	47.50±0.34	1.41	2.96±0.50
Bill					
Males	21	13.3-16.5	15.03±0.15	0.70	4.65±0.71
Females	15	13.9-15.6	14.94±0.13	0.51	3.34±0.51
Tarsus					
Males	5	16.7-17.9	17.25±0.18	0.42	2.43±0.76
Females	5	17.2-17.6	17.40±0.06	0.14	0.80±0.11

In the present study interest in the distribution of this race is concerned only with Nevada and California. Some breeding birds of the Toyabe Mountains of central Ne-

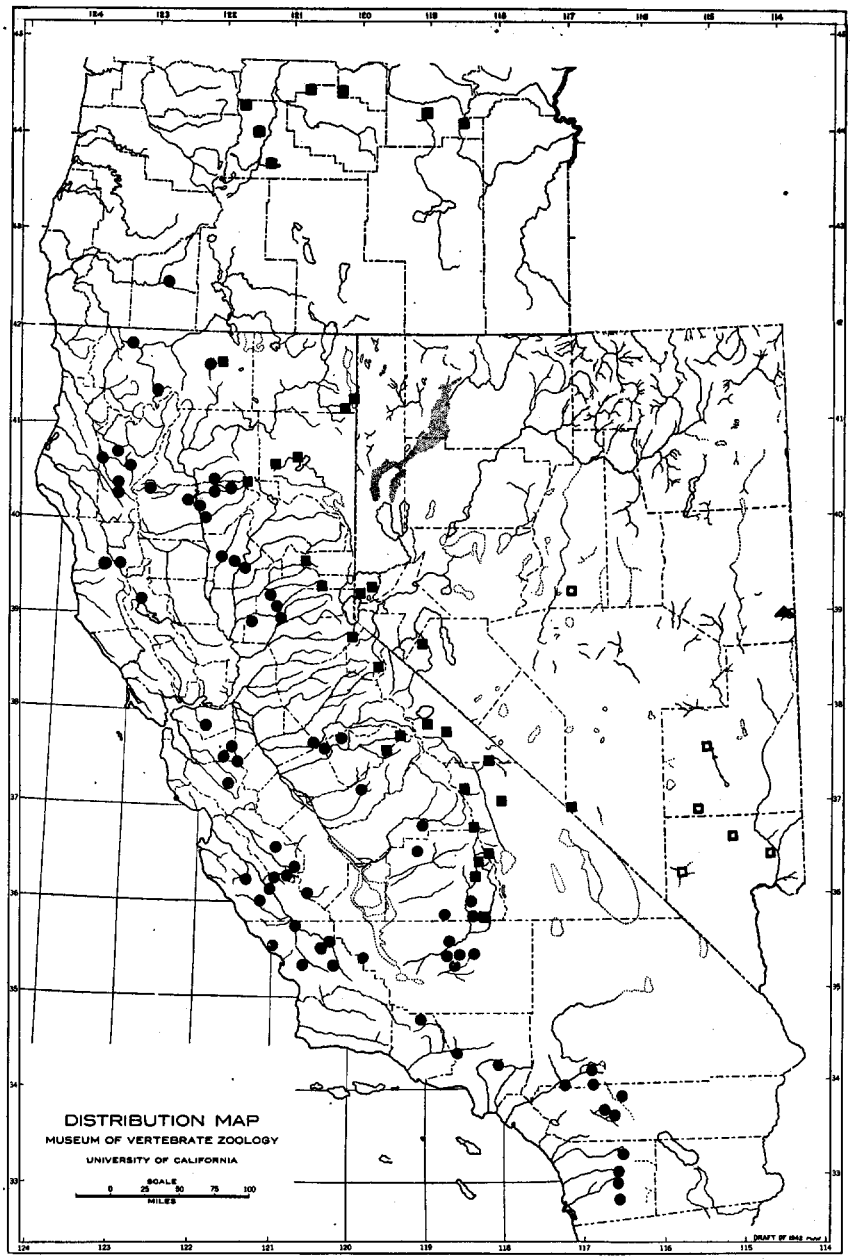

Fig. 10. Distribution of races of *Sitta carolinensis* in Oregon, Nevada and California. Symbols indicate localities from which specimens have been examined. Triangles, *S. c. nelsoni*; solid squares, *S. c. tenuissima*; open squares, intergrades between *nelsoni* and *tenuissima*; dots, *S. c. aculeata*.

vada are of wing and bill length that would relate them to *nelsoni*. In this same range other breeding birds closely approximate *tenuissima* in size. Birds were taken in southeastern Nevada on Mount Irish in September, some of which conform to *nelsoni* in size

and some to *tenuissima*. Fall birds from the Charleston Mountains in extreme southeastern Nevada conform closely to *nelsoni* in size, which would confirm van Rossem's (1936:37) identification of them. An October-taken bird from Alamo, Yuma County, Arizona, might be considered intermediate, but seems more nearly related to *nelsoni* on the basis of bill length. This bird is probably a fall wanderer. Specimens from eastern White Pine County, Nevada, are typically *nelsoni*. There appears to be a broad zone of intergradation in the mountains of central to eastern Nevada, and there is also probably wandering of non-breeding *tenuissima* eastward, and of *nelsoni* westward. By comparing measurements shown in figures 7 and 8 and table 1, it can be seen that specimens from northeastern California conform more closely in size with *tenuissima* than with *nelsoni*, although there is a single, winter-taken specimen from that locality that resembles *nelsoni*.

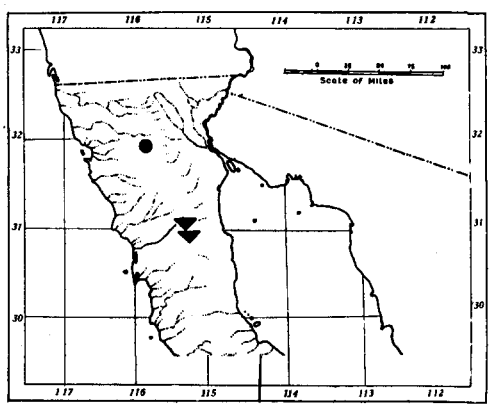

Fig. 11. Distribution of *Sitta carolinensis* in northern Lower California. Symbols indicate localities from which specimens have been examined. Dot, *S. c. aculeata*; inverted triangles, *S. c. alexandrae*.

Sitta carolinensis aculeata Cassin

Sitta aculeata Cassin (1856:254), original description, type locality, Monterey, California; see Grinnell (1932:290); Baird (1858:374), part.

Sitta carolinensis aculeata, Baird, Brewer, and Ridgway (1874:117), part; Dawson (1923:638); Grinnell (1929:219); Hellmayr (1934:94); Grinnell and Miller (1944:315), part; Aldrich (1944:594), part.

Subspecific characters.—This race averages the smallest, in all variables, of the races under consideration. It is closest to *nelsoni* in bill length, but its wing length does not approach that of any of the other races.

Measurements.—Specimens from northern and central California west of the Sierra Nevada have been used. Measurements for birds from southern California may be found in table 1.

	No.	Range	Mean	σ	V
Wing					
Males	54	80.2-89.8	84.55±0.32	1.74	2.05±0.18
Females	21	80.7-84.8	82.94±0.24	1.12	1.35±0.28
Tail					
Males	54	41.2-48.7	45.02±0.21	1.57	3.48±0.33
Females	19	42.0-47.5	44.28±0.32	1.43	3.22±0.52
Bill					
Males	52	13.3-16.6	14.80±0.08	0.59	3.98±0.39
Females	17	13.3-15.1	14.25±0.09	0.46	3.22±0.55
Tarsus					
Males	51	16.3-18.7	17.34±0.06	0.46	2.64±0.26
Females	19	16.4-18.2	17.32±0.10	0.43	2.47±0.40

Specimens from the extreme northern part of the range are few, but the range appears to be from Puget Sound, Washington, south to the Sierra Juárez, Lower California, and from the western slopes of the Sierra Nevada and Cascade Mountains, to, but generally not including, the coastal humid belt. This population seems to be more of a lowland type with birds generally occurring in oaks or ponderosa pine, although there are occasional specimens that have been taken in lodgepole pine. It appears that this race is separated from *tenuissima* by the heavy fir forest belt of the Sierra Nevada-Cascade chain. The only places where there is some evidence of intergradation is in northeastern California where topographic conditions are favorable for intermingling, and in southern California where there is some habitat favorable to *tenuissima* as well as *aculeata*. Birds found in the passes of the Sierra Nevada, such as at Cisco, Placer County, and farther south in Tulare County, more nearly approximate *tenuissima*, although the two races appear to be but slightly separated at such points. Birds from farther south along the Kern River and in the Walker Basin closely resemble *aculeata*. Specimens from southern California, even at higher elevations, are almost all significantly smaller than *tenuissima*. Winter birds taken from Victorville, San Bernardino County, have a longer bill resembling *tenuissima*, but the wing length is average for *aculeata*. Specimens from the Sierra Juárez, Lower California, although greater in dimensions than typical *aculeata*, are somewhat closer in average measurements to that race than to *alexandrae* on the south.

Sitta carolinensis tenuissima Grinnell

Sitta aculeata, Baird (1858:375), part.

Sitta carolinensis aculeata, Coues (1872:83), part; Coues (1874:24), part; Baird, Brewer, and Ridgway (1874:117), part; Brooks and Swarth (1925:114).

Sitta carolinensis nelsoni, Ridgway (1904:447), part; Grinnell, Dixon, and Linsdale (1930:319); Grinnell and Miller (1944:314).

Sitta carolinensis tenuissima Grinnell (1918:88), original description, type locality, Hanaupah Canyon, 8700 feet., Panamint Mountains, Inyo County, California; Dawson (1923:642); Hellmayr (1934:95); Linsdale (1936:89); van Rossem (1936:37); Grinnell and Miller (1944:317); Aldrich (1944:595), part.

Subspecific characters.—The wing and the bill of this race average much longer than those of *aculeata*, as can be seen in figures 7 and 8. The wing of *tenuissima* is shorter on the average than in *nelsoni*, but the bill is longer. Except for bill length *tenuissima* compares favorably in measurements with *alexandrae*, from which it is separated geographically by *aculeata*.

Measurements.—Specimens from east-central California and west-central Nevada.

	No.	Range	Mean	σ	V
Wing					
Males	35	83.3-93.2	88.72±0.34	2.05	2.31±0.27
Females	19	82.2-91.3	87.31±0.55	2.40	2.74±0.44
Tail					
Males	38	44.5-51.9	48.50±0.32	2.01	4.14±0.47
Females	20	45.3-50.6	48.23±0.31	1.42	2.94±0.46
Bill					
Males	34	14.5-17.6	16.44±0.11	0.67	4.08±0.49
Females	17	15.3-17.0	16.28±0.16	0.68	4.17±0.71
Tarsus					
Males	28	16.4-18.5	17.35±0.10	0.57	3.28±0.43
Females	17	15.3-17.0	17.31±0.08	0.37	2.13±0.36

This race ranges from southern British Columbia to east-central California and southern Nevada, and from central Nevada, where it appears to intergrade with *nelsoni*, to open wooded portions of the high Sierra Nevada and Cascade Mountains, but not across them. There is some evidence of intergradation with *aculeata* in northeastern California, and *aculeata* seems to wander into that area in the winter. There is little

evidence of intergradation with *aculeata* in the passes of the Sierra Nevada, but this seems possible. The great majority of the specimens assignable to this race have been taken in the Canadian and Hudsonian life-zones, usually in the more open pine stands. According to Brooks and Swarth (1925:114), however, those of the interior of southern British Columbia are found in ponderosa pine, which is regarded as Transition Life-zone. The specimens from this locality conformed more closely to *tenuissima* in dimensions than they did to *aculeata* to which race they had been assigned until Aldrich (1944) shifted them. This race apparently does not extend (except for possible winter wanderers) into the mountains of southern California, possibly due to the scarcity of suitable nesting grounds. As shown in figure 7 this race is the smallest in southern Canada and reaches its greatest size in the southern Sierra Nevada and adjacent mountains.

Sitta carolinensis alexandrae Grinnell

Sitta carolinensis aculeata, Anthony (1893:246); Ridgway (1904:444), part.

Sitta carolinensis alexandrae Grinnell (1926:405), original description, type locality, near Arroyo La Encantada, 7200 ft., 3 miles north of La Grulla, Sierra San Pedro Mártir, Lower California, Mexico; Grinnell (1928:220); Hellmayr (1934:95).

Sitta carolinensis tenuissima, Aldrich (1944:596), part.

Subspecific characters.—The bill of this race averages much the longest of any of the races under consideration. All measurements average far more than those of *aculeata,* the nearest neighbor, and than those of the race *lagunae* of the Cape district of Lower California.

Measurements.—Specimens from La Grulla and Vallecitos in the Sierra San Pedro Mártir only.

	No.	Range	Mean	σ	V
Wing					
Males	14	86.7-93.9	89.72±0.50	1.88	2.09±0.39
Females	8	84.3-90.7	88.21±0.67	1.89	2.14±0.53
Tail					
Males	14	47.8-52.7	50.15±0.36	1.38	2.75±0.51
Females	7	48.1-51.0	49.15±0.43	1.14	2.31±0.61
Bill					
Males	11	16.5-18.9	17.72±0.23	0.77	4.34±0.92
Females	8	16.4-17.9	17.03±0.14	0.44	2.58±0.64
Tarsus					
Males	12	16.9-18.6	17.95±0.13	0.46	2.56±0.52
Females	7	17.2-18.3	17.95±0.14	0.37	2.06±0.55

Known from the Sierra San Pedro Mártir only. Specimens from the Sierra Juárez to the north are larger than *aculeata* of San Diego County, but still average shorter in all variables than *alexandrae,* whereas, the aforementioned *lagunae* is also smaller in all respects. This would then limit this race to the Sierra San Pedro Mártir.

SUMMARY

Four distinct races of the White-breasted Nuthatch are present in the western United States and adjacent portions of Canada and Lower California.

The race *nelsoni* is the longest-winged race and reaches its western limit in the mountains of eastern Nevada. It intergrades with *tenuissima* as far west as central Nevada. Except for possible winter wanderers there is but little evidence that *nelsoni* ever reaches northeastern California, a point already made by Aldrich (1944).

The race *aculeata* averages the smallest in all respects and is found west of the Sierra Nevada-Cascade chain, but east of the humid coastal belt. It is seldom found above the Transition Life-zone. This race, as herein conceived, includes the group of birds from southern California.

The race *tenuissima* averages larger than *aculeata* and is longer-billed but shorter-winged than *nelsoni.* Its range is from southern British Columbia to the southern Sierra Nevada and adjacent ranges. It intergrades with *nelsoni* from central to eastern Nevada

and ranges westward to the Canadian and Hudsonian life-zones of the Sierra Nevada-Cascade Mountain system.

The race *alexandrae* is, except in wing length, the largest race, being approached only by *tenuissima* from which it is separated by *aculeata* of southern California. It is found in the Sierra San Pedro Mártir and may range northward toward the Sierra Juárez, although there is no specimen from there equal to this race in bill length.

As pointed out by Aldrich (1944) there is a general increase in size from north to south in both *aculeata* and *tenuissima*. Contrary to his findings, however, it was found that the population of southern California is significantly smaller than that of *tenuissima*. It is more closely linked to the cline represented in *aculeata*. Thus the gradient in *tenuissima* reaches its greatest extent in the high levels of the southern Sierra Nevada and adjacent mountains, rather than in the Sierra San Pedro Mártir. The gradient in *aculeata* takes an abrupt turn upward toward its southern extreme and culminates in the terminal race, *alexandrae*.

LITERATURE CITED

Aldrich, J. W.
1944. Notes on the races of the white-breasted nuthatch. Auk, 61:592-604.

Allen, J. A.
1872. Notes of an ornithological reconnoissance of portions of Kansas, Colorado, Wyoming, and Utah. Bull. Mus. Comp. Zool., 3:113-183.

Anthony, A. W.
1893. Birds of San Pedro Mártir, Lower California. Zoe, 4:228-247.

Baird, S. F.
1858. Birds. Pac. R. R. Repts., 9:lvi + 1005.

Baird, S. F., Brewer, T. M., and Ridgway, R.
1874. History of North American birds (Boston, Little, Brown and Co.), 1:xxvii + 596 + vi.

Baldwin, S. P., Oberholser, H. C., and Worley, L. G.
1931. Measurements of birds. Sci. Publ. Cleveland Mus. Nat. Hist., 2:ix + 165.

Brooks, A., and Swarth, H. S.
1925. A distributional list of the birds of British Columbia. Pac. Coast Avif. No. 17:1-158.

Cassin, J.
1856. Descriptions and notes on birds in the collection of the Academy of Natural Sciences of Philadelphia, and in the National Museum, Washington. Proc. Acad. Nat. Sci. Phila., 3:254-255.

Coues, E.
1866. Ornithology of the Arizona territory. Proc. Acad. Nat. Sci. Phila., 1866:39-100.
1872. Key to North American birds (New York, Dodd and Mead; Boston, Estes and Lauriat), viii + 361.
1874. Birds of the northwest. U. S. Geol. Surv. Misc. Publ., 3:xi + 791.

Dawson, W. L.
1923. The birds of California. Booklovers' ed. (San Diego, Los Angeles, San Francisco: South Moulton Co.), 2:xi + 523-1034.

Gambel, W.
1846. Remarks on the birds observed in Upper California. Proc. Acad. Nat. Sci., 3:110-115.

Grinnell, J.
1918. Seven new or noteworthy birds from east-central California. Condor, 20:88-90.
1926. A new race of the white-breasted nuthatch from Lower California. Univ. Calif. Publ. Zool., 21:405-410.
1928. A distributional summation of the ornithology of Lower California. Univ. Calif. Publ. Zool., 32:1-300.
1932. Type localities of birds described from California. Univ. Calif. Publ. Zool., 38:243-324.

Grinnell, J., Dixon, J., and Linsdale, J. M.
1930. Vertebrate natural history of a section of northern California through the Lassen Peak region. Univ. Calif. Publ. Zool., 35:vi + 594.

Grinnell, J., and Miller, A. H.
1944. The distribution of the birds of California. Pac. Coast Avif. No. 27:1-608.

Hellmayr, C. E.
1934. Catalogue of birds of the Americas and the adjacent islands. Field Mus. Nat. Hist., Zool. Ser., 13, pt. 8:vi + 541.
Linsdale, J. M.
1936. The birds of Nevada. Pac. Coast Avif. No. 23:1-145.
Mearns, E. A.
1902. Descriptions of three new birds from the southern United States. Proc. U. S. Nat. Mus., 24:915-926.
Ridgway, R.
1904. The birds of North and Middle America. Bull. U. S. Nat. Mus. No. 50, pt. 3:xx + 801.
Simpson, G. G., and Roe, A.
1939. Quantitative zoology (New York and London, McGraw-Hill), xvii + 414.
Van Rossem, A. J.
1936. Birds of the Charleston Mountains, Nevada. Pac. Coast Avif. No. 24:1-65.

Fresno State College, Fresno, California, September 20, 1947.

LIBRARY
UNIV OF IDAHO
MOSCOW