SYSTEMATIC REVIEW, INTERGRADATION, AND CLINAL VARIATION IN CLIFF SWALLOWS

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SIX geographic races or subspecies of the Cliff Swallow (*Petrochelidon pyrrhonota*) have been described. The diagnostic characters used pertain to size (which is most evident in length of wing), color and extent of forehead stripe or frontal band, rump color, amount and clarity of white on the ventral surface, and the degree of grayness on chest and flanks. A brief résumé of each race follows:

P. p. pyrrhonota (Vieillot). Type locality: Paraguay. Breeding range: eastern United States west to Rocky Mountains, Canada west to Manitoba (except southwestern part), southwestern British Columbia south through Washington, Oregon, and California west of the Cascade-Sierra Nevada cordillera to northwestern Baja California. Racial characters: intermediate size (winglength 108.6 (105–115) mm), forehead varies individually from white to pale cinnamon brown but generally cream color; as compared with *hypopolia*, pectoral region buffier (less gray), underparts darker (less clear white), rump darker (rustier), frontal stripe less white (cream color) and does not extend so high on the forehead; as compared with *tachina*, forehead whiter.

P. p. tachina Oberholser (1903). Type locality: Langtry, Texas. Breeding range: extreme southwestern Utah south through lower Colorado River Valley to extreme northeastern Baja California, northern Arizona, central New Mexico to southwestern Texas. Racial characters: similar to *pyrrhonota* but smaller (winglength 102 (99–108) mm), forehead light cinnamon or fawn color rather than cream color.

P. p. hypopolia Oberholser (1919). Type locality Fort Norman, Mackenzie. Breeding range: central Alaska, Yukon, Mackenzie, Alberta, Saskatchewan, and extreme southwestern Manitoba south through central and southeastern British Columbia, eastern Washington, eastern Oregon to east central California, central Nevada, northern Utah, Montana and northwestern Wyoming. Racial characters: largest of races (winglength 112.1 (110–115) mm); as compared with *pyrrhonota*, larger, frontal band whiter and deeper, breast whiter (less rusty), flanks grayer, pectoral region darker, grayer and in many examples terminates abruptly posteriorly thus forming a band, rump paler.

P. p. aprophata Oberholser (1932). Type locality: mouth of Twenty Mile Creek, Warner Valley, 9 miles south of Adel, Oregon. Alleged breeding range: Warner Valley region of central southern Oregon. Alleged racial characters: similar to *hypopolia* but forehead more buffy (less clearly whitish), lower parts paler and white more extensive, gray of chest and flanks less extensive (see Aldrich *in* Jewett et al. 1953: 452).

P. p. minima van Rossem and Hachisuka (1938). Type locality: Pichicuate [= Cuchujaqui] River, 7 miles east of Alamos, southern Sonora, Mexico. Alleged breeding range southeastern Arizona south to Sinaloa and Nayarit. Alleged racial characters: similar to *melanogaster* but smaller (winglength 99 (96–102) mm); pectoral region and flanks paler and more grayish (less brownish).

P. p. melanogaster (Swainson). Type locality: table land of Mexico. Breeding range: vicinity of United States border in southeastern Arizona and New Mexico south over Mexican plateau to Oaxaca and the Pacific plains to Nayarit. Racial characters: similar to *tachina* in size but differs in having the forehead a deep cinnamon-rufous or chestnut color, thus being the same color as the sides of head and throat, rump deep cinnamon.

One of the races described (*aprophata*) has not been accepted by the A.O.U. committee on Classification and Nomenclature (1957) but nevertheless some clarification of variation has long been needed. The subspecies *minima* is included in the A.O.U. check-list but has been questioned. The present study analyzes the geographic variation and distribution of the subspecies in western North America. In addition to considering the problems of the status of *minima* and *aprophata* the situation in Utah has been detailed because of the wealth of material available and the circumstance that three races come together there. Clinal variation in size is evident to a marked degree. One race (*pyrrhonota*) has an unusual split range. Large areas of intergradation exist between the several races.

Western Limits of *pyrrhonota* in Rocky Mountain Region and Split Range Embracing the Pacific Coast Area

The western limits of *pyrrhonota* are reached in the Rocky Mountain region. Bailey and Niedrach (1965: 547) referred birds from Colorado to this race. Bailey (1928: 462) found that New Mexico was a meeting ground for three races, *pyrrhonota* in the northern portion, *tachina* in a restricted area along the Pecos River from the Roswell area south through Carlsbad to the Mexican border, while in the extreme southwestern corner the race *melanogaster* occurs. Phillips et al. (1964: 99) state that *pyrrhonota* intergrades with *tachina* in northeastern Arizona while *tachina* occurs across central Arizona. Godfrey (1966: 270) indicates that *pyrrhonota* occurs in Canada west to Manitoba (except southwestern part) before integrading with *hypopolia.* However, a puzzling distributional feature for *pyrrhonota* is a split geographic range, for Cliff Swallows from southwestern British Columbia southward west of the Cascade-Sierra Nevada cordillera through Washington, Oregon, and California to northern Baja California have been referred to this race. In between the eastern and western portions of the range of *pyrrhonota,* the *hypopolia-aprophata* complex extends from Alaska and the Yukon south into the Great Basin. Aldrich (*in* Jewett et al. 1953: 452) comments on the situation as follows: "Cliff Swallows from west of the Cascades are markedly different from those to the east. The latter seem referable to the Great Basin race, *aprophata* Oberholser (1932: 6), but the specimens from west of the Cascades appear to be almost indistinguishable from examples of *pyrrhonota* from the eastern United States and must be referred to that form until the variations of this species have been more thoroughly studied with more adequate material." The

divided range is corroborated by Godfrey (1966: 270) who refers examples from extreme southwestern British Columbia to *pyrrhonota*.

DISTRIBUTION AND VARIATION IN THE GREAT BASIN–WESTERN CANADA REGION

Considerable differences of opinion have been expressed as to the validity of the race *aprophata*. Van Rossem (1936: 33) was the first to question the alleged subspecies commenting that he did not believe it practical to acknowledge more than one large, light-colored race from the Great Basin and northwest interior. Miller (1941) and Grinnell and Miller (1944: 278) also felt that *aprophata* should be considered a synonym of *hypopolia*. Miller (1941), studying a sample of topotypes different from those that Oberholser had, diagnosed the Warner Valley birds as being intermediate between *hypopolia* and California coastal birds representing *pyrrhonota*, but he commented that more needed to be known of the relation of Great Basin birds and those of the Mackenzie region. Gabrielson and Jewett (1940: 411) did not discuss variation in Cliff Swallows in Oregon and simply referred all of their birds to *pyrrhonota*. Linsdale (1936: 82) initially placed the breeding Cliff Swallows of Nevada with *pyrrhonota* but later (1951: 239), doubtless influenced by Miller's study, changed the racial designation to *hypopolia*. In contrast, Aldrich (*in* Jewett et al. 1953: 452) in connection with his study of the birds of Washington, accepted the race *aprophata*, referring examples from the eastern part of the state to this race. Burleigh (1972: 237) did not recognize *aprophata* for the birds of Idaho and referred all his breeding material after a thorough study to *hypopolia*.

Thus there was agreement on the part of van Rossem, Miller, and Aldrich that Cliff Swallows from the interior region east of the Cascade-Sierra Nevada cordillera differ from those of the coastal area west of the mountain chain. They pointed out that examples from the Great Basin and northward into eastern Oregon and Washington are larger and have the underparts and rump paler. Intergradation was detected between *pyrrhonota* and the population east of the Sierra Nevada, for van Rossem pointed out that examples from Truckee are of large size as in the Great Basin population but have the coloration of the coastal form. Grinnell and Miller state that known breeding populations in California immediately east of the Cascade Sierran divide as well as those from Modoc County are intergradient but closer to the coastal *pyrrhonota*. Differences of opinion existed only as to what to call the interior population, or whether to recognize the race *aprophata* as distinct from *hypopolia*.

As Aldrich recognized the race, in opposition to Miller who denied it but had not made comparisons with far northern birds, Miller's

topotypes of *aprophata* from the mouth of Twenty Mile Creek, 9 miles south of Adel, Oregon were borrowed as well as Canadian examples that were representative of *hypopolia*. The northern material consisted of specimens from Igiak Bay, Alaska; Fort Simpson, NWT; Dezadeash Lake, Yukon; Lake St. Martin Reservior, Manitoba; and the following localities in British Columbia: Dease Lake, Lac la Hache, Nulki Lake, Boundary Bay, Okanagan, and Okanagan Landing. The results of the comparison of this material with topotypical specimens of *aprophata* and examples from northern Utah follows. This is in the nature of an analysis of each difference attributed to *aprophata*.

Frontal stripe.—Oberholser claimed that the forehead color of his topotypes of *aprophata* was more buffy and therefore less clearly white than in *hypopolia*. A suggestion of this is apparent in Miller's topotypical series also, but the character is so highly variable individually that it is not a good racial character. More significantly birds with deep, white frontal stripes occur from Alaska south into Utah. Four examples from the Deep Creek Mountains of central western Utah have foreheads just as deep and white as any Canadian or Alaskan representatives examined. This suggests that the buffier color of the frontal stripe of topotypes of *aprophata* is to be attributed to their being intergrades with *pyrrhonota*, having received the cream-colored foreheads from that parental stock. Incidentally Aldrich makes no mention of a racial differences between *aprophata* and *hypopolia* as regards the frontal stripe. The present study shows forehead color is not a distinguishing character for *aprophata*.

Color of abdomen.—Both Oberholser and Aldrich state that *aprophata* differs from *hypopolia* in having the underparts paler with the white areas more extensive. Just the opposite conditions were found. Many representatives of the Adel, Oregon series show darker abdomens because of a wash of buff color. Examples from northern and central Utah have whiter abdomens as do Canadian and Alaskan representatives of *hypopolia*. The ochraceous breast color of topotypes of *aprophata* can also be attributed to their being intergrades with coastal *pyrrhonota*, rather than their representing a separate race.

Color of flanks.—Aldrich states that the gray of the flanks is less extensive in *aprophata* than in *hypopolia*. It is true that many representatives of *hypopolia* show much gray while topotypes of *aprophata* have a wash of buff color, but this difference, as in the case of the frontal stripe and breast color, is best explained by the topotypes being intergrades that received the buffiness from the *pyrrhonota* gene pool.

Color of pectoral region.—Aldrich comments that the gray of the chest of *aprophata* is less extensive than in *hypopolia*. This character is too variable individually to permit general sweeping conclusions. Some

northern representatives of *hypopolia* are darker and grayer in the pectoral region and some are furthermore distinctive in having the gray cut off abruptly posteriorly to form a line of demarkation from the white of the breast. This character changes gradually, as one progresses southward. Examples from northern Utah have the white of the breast extending farther anteriorly with a gradual transition of the white of the breast into the gray of the pectoral region. Topotypes of *aprophata* are somewhat intermediate in this character, but closest to the Utah birds. My general conclusion is that this character is too subtle and inconstant to serve as a criterion for racial differentiation.

Rump color.—The color of the rump does not appear to be a good racial character in northern birds because of a high incidence of individual variability and the suggestion of a very gradual but ill-defined cline from light color in the north to darker pigmentation to the south. It is not until southern Arizona is reached that a difference is readily apparent. For all practical purposes I detected no differences in rump color between Canadian, Utah, or topotypical examples of *aprophata.*

This study corroborates the opinion expressed by Miller and others that *aprophata* does not constitute a race distinct from *hypopolia.* Like Miller I regard Cliff Swallows from the type locality of *aprophata* as intergrades between *pyrrhonota* and *hypopolia.* It seems that at the southern limits of *hypopolia* where it comes in contact with *pyrrhonota* there are crosscurrents in the gene flow resulting in slight regional differences in character combinations but no center of differentiation for Cliff Swallows in the Great Basin or to the north in eastern Oregon.

VARIATION SHOWN IN CLIFF SWALLOWS FROM UTAH

When I was satisfied that *aprophata* was invalid and that *hypopolia* extended from Canada south to the Great Basin, attention then turned to an analysis of the geographic variation in birds from Utah, as this area was a meeting ground of two or more races. On a previous occasion (Behle 1948, see also Behle 1960) I reported on geographic variation shown by Cliff Swallows in Utah. My sample of 38 specimens showed the intermediate nature of Utah birds, but I concluded that two races were represented, *hypopolia* in the western Great Basin portion and *pyrrhonota* in the eastern portion with a transition occurring along the west base of the Wasatch Mountains that form the east rim of the Great Basin. The much larger sample now at hand shows the earlier conclusions to have been in error in two respects. It is now evident that the race *tachina* occurs in extreme southwestern Utah and, instead of a break existing between two races in the central and northern portions of the state, a widespread intermediate population extends across the state.

In the present study I have found that Cliff Swallows from Utah are highly variable as regards coloration of the frontal band. In a series from the Raft River Mountains in northwestern Utah and the adjacent location City of the Rocks in Idaho, most have white frontal stripes that extend well back on the forehead, much as in specimens from Igiak Bay, Alaska. A large series from the Bear River Refuge, four individuals from the Deep Creek Mountains in northwestern Utah, and a large series from the Delta area, Millard County in central western Utah conform to the Raft River sample. More variation in color of the forehead is found in a series from a still more southern locality, namely 10–13 miles north of Cedar City. In 25 birds from here 10 have the foreheads white, 14 have the frontal stripe washed with varying degrees of buff color, while 1 is definitely cinnamon. The cinnamon condition suggests an approach to the population in the St. George-Beaver Dam Wash region of extreme southwestern Utah that is referable to the race *tachina*. Of 34 specimens from southwestern Utah only two have white foreheads; the others have the forehead color cinnamon.

Birds from the Salt Lake City and Lehi areas along the west base of the Wasatch Mountains generally have darker foreheads than do Great Basin birds from western Utah, but one taken on 27 May 1969 has a whiter forehead than any of the Raft River series. This individual may have been a late migrant, but it was taken at a colony of breeding birds. It was moderately fat, weighed 23 g and testes size was 7 × 6 mm.

The assemblage from Midway, Peoa, and Oakley localities close together in the Wasatch Mountains east of Salt Lake City near the western spur of the Uinta Mountains are highly variable in forehead color, some being white, others having various degrees of buff color, but in most specimens the frontal band extends farther back than in *pyrrhonota*. In this respect the frontal band is like Great Basin birds. Incidentally, Utah examples generally have deeper frontal stripes than Pacific Coastal *pyrrhonota* that I have examined. The more extensive frontal band continues in specimens taken still farther east in Utah as shown by a large series from Strawberry Valley, Myton, and elsewhere in the Uinta Basin as well as from the Tavaputs Plateau area south of the basin. Fewer birds have white foreheads in eastern Utah, most being buff colored. Examples from Dry Creek in the Uinta Mountains in the Vernal area and a few from southwestern Wyoming have the frontal stripe less deep and more uniformly buff colored, while the rump is darker in some individuals. So the subtle transition across northern Utah from west to east seems to have proceeded to a point in the extreme eastern Uinta Basin and in southwestern Wyoming where the birds are a bit closer to the eastern *pyrrhonota* than to the Great Basin population.

In central Utah, representatives from Fairview, Antimony, and the Fremont River near Bicknell are highly variable both in rump color and frontal patch. The forehead stripe in some specimens is whiter and deeper than in examples from Salt Lake City, being more like the birds from the Raft River Mountains. In a series from Kanab in central southern Utah the frontal stripe character is variable, but there are more white ones (5 out of 17) in this sample than in the St. George series to the west. In most Kanab specimens the forehead stripe is deep. As a whole, the Kanab series is like the Fremont River and Strawberry Valley series taken much farther north. In other words these specimens do not represent *tachina*. Cliff Swallows from the Dewey Bridge location north of Moab, those from Bluff, and a few from northern Arizona are much like the Kanab series. Only 4 of 28 have white foreheads.

In summary, in comparing examples from the western Great Basin portion of Utah with those from central and eastern Utah I get the impression that en masse Great Basin birds are slightly paler on the underparts with the white of the abdominal region being clearer and the breast and flanks slightly grayer. In contrast birds from the mountainous area of eastern Utah have a wash of ochraceous on the underparts. These characters are so variable individually that this is a highly subjective judgment, but I feel that breeding Cliff Swallows from the extreme western Great Basin portion of Utah are closet to *hypopolia* while those from extreme eastern Utah are closest to *pyrrhonota*.

DISTRIBUTION AND VARIATION IN THE ARIZONA-SONORA REGION

When van Rossem and Hachisuka (1938) described *minima* the breeding range attributed to it was the southwestern United States and northwestern Mexico from southern Arizona south to southern Sonora. Thus the range of *melanogaster* was restricted to the southern portion of the Mexican tableland. The description of *minima* was based largely on a series from southern Sonora. They characterized *minima* as being smaller than *melanogaster* with a winglength averaging 99 (96–102) mm as compared with that for *melanogaster*, which they gave as 106 (104–108). Van Rossem and Hachisuka commented that typical *melanogaster* is not a particularly small race, being only slightly smaller than *pyrrhonota*. Other characters attributed to *minima* were the pectoral region and flanks being paler and more grayish.

Miller et al. (1957: 109) considered *minima* a synonym of *melanogaster*, stating that the color and size differences claimed were not substantiated in good series of breeding birds from Sonora and Sinaloa compared with typical *melanogaster* from Morelos. Phillips et al. (1964: 100) did not accept the race *minima* either, adding that there is a cline

of decreasing winglength toward the south that is exactly the reverse of that claimed for *minima*. With *minima* synonymized under *melanogaster*, the breeding range of *melanogaster* apparently includes southwestern New Mexico (Bailey 1928: 464) and southeastern Arizona (Phillips et al. 1964: 100), south over the Mexican Plateau to Oaxaca and in the Pacific plains region to Nayarit (Miller et al. 1957: 109). Details of the behavior of characters in areas of impingement of *tachina* and *melanogaster*, areas of intergradation, and the exact range of the latter remain to be worked out. *P. p. melanogaster* is the most distinct race of all. If the uniform color of forehead, sides of head, and throat were invariably the case the population could be considered a different taxon of species rank as some have suggested, but extreme variants of *melanogaster* have the forehead fawn colored. The rump color is also a deep cinnamon.

Sexual and Clinal Variation in Mensural Characters

No one to my knowledge has postulated any distinctions between sexes in coloration, nor have I detected any. Early figures on measurements of wing and tail based on small samples suggested slight differences in size between males and females. Van Rossem and Hachisuka (1938) stated that while in this species females average very slightly larger than males, the difference is so small that it may be disregarded. They therefore lumped together their measurements of males and females in making comparisons of their small samples of *minima* and *melanogaster*. In my much larger samples pertaining to other races I found no statistically significant difference in size between males and females in any of the series from Utah or elsewhere except in the sample from the Uinta Basin of northeastern Utah which may be correlated with a very large sample ($N = 99$). The data for the Uinta Basin birds were pooled despite the sex difference indicated ($t = 2.26$; $df = 97$; $P < 0.05$). Thus in Tables 1 and 2 the measurements of males and females have been lumped together for comparing the samples from different geographic localities. As regards body weight 72 males from scattered localities averaged 23.0 g while 46 females averaged 22.7 g.

Clinal Variation in Mensural Characters

A comparison of three bill measurements, namely length of bill from nostril, width of bill at base, and depth of bill at base showed no significant variation between populations or samples from western North America, suggesting, therefore, that these are stable characters that have not been selected for on a regional basis. The same is true for tarsus length. In contrast, two characters do show geographic variation, namely winglength and taillength. For winglength the variation is pronounced. It

TABLE 1

WINGLENGTH (IN MM) OF SEVERAL POPULATIONS OF ADULT BREEDING CLIFF SWALLOWS

Population	Sample size (N)	Range	Mean with SE	SD	Coefficient of variation
P. p. hypopolia (Oberholser 1919)	5	110.0–115.0	112.1	–	–
Igiak Bay, Alaska	5	110.0–116.4	113.26±1.132	2.530	2.2
Yukon, NWT, Manitoba	12	106.7–116.0	111.09±0.892	3.088	2.8
British Columbia	18	106.8–116.5	111.23±0.645	2.736	2.5
P. p. aprophata (Oberholser 1932)	7	109.0–113.3	111.2	–	–
SE Oregon, NE California	15	105.1–111.1	108.31±0.446	1.727	1.6
Raft River Mts., NW Utah	43	106.4–113.6	109.69±0.347	2.273	2.1
Deep Creek Mts., central W Utah	4	110.1–112.7	111.62±0.708	1.415	1.3
Bear River Refuge, NW Utah	23	106.0–113.0	109.79±0.379	1.818	1.7
Salt Lake City, Utah	54	104.8–115.1	109.40±0.342	2.518	2.3
Delta, central W Utah	28	104.3–113.4	109.95±0.453	2.399	2.2
Cedar City, SW Utah	25	104.3–116.9	109.07±0.604	3.022	2.8
SW Wyoming	4	108.1–110.8	109.55±0.595	1.190	1.1
Uinta Basin, NE Utah	99	104.3–116.2	109.66±0.253	2.515	2.3
Fairview area, central Utah	35	103.5–112.5	108.54±0.407	2.406	2.2
Bicknell, S central Utah	13	104.5–109.9	107.66±0.506	1.824	1.7
Escalante area, central S Utah	13	103.2–110.5	107.70±0.690	2.487	2.3
Kanab, central S Utah	18	104.1–113.3	108.16±0.598	2.537	2.4
Moab area, SE Utah	24	104.2–116.2	108.55±0.552	2.703	2.5
P. p. pyrrhonota (Oberholser 1919)	7	105.0–112.0	107.6	–	–
P. p. tachina (Oberholser 1903)	7	–	102.1	–	–
Arizona-New Mexico	10	102.6–107.5	104.78±0.469	1.483	1.4
St. George area, SW Utah	34	100.5–110.2	104.32±0.441	2.572	2.5
Colorado R. near Pilot Knob, Calif.	17	100.2–107.8	103.06±0.475	1.957	1.9
Southern California	15	102.0–108.5	105.35±0.588	2.277	2.2
San Pedro Martir, Lower Calif.	7	103.4–107.1	105.2 ±0.508	1.344	1.3
P. p. melanogaster (van Rossem and Hachisuka 1938)	10	104.0–108.0	106.0	–	–
P. p. melanogaster (Oberholser 1903)	8	–	103.0	–	–
P. p. minima (van Rossem and Hachisuka 1938)	18	96.0–102.0	99.0	–	–

is less apparent in taillength. In each case clinal variation is shown whereby large birds in the north progress toward smaller sized birds in the south. Examples from Utah are intermediate along the cline. A slight gradient even appears from north to south in Utah especially in the western part of the state.

The data pertaining to winglength are presented in Table 1. Small samples from Igiak Bay, Alaska (the westernmost locality at which Cliff Swallows have been taken), and Okanagan Landing and other localities in Canada corroborate Oberholser's (1919) data that northern Cliff Swallows have long wings (averaging 113 mm). The southern samples from Arizona, New Mexico, and elsewhere have wings that average shorter (105 mm). Thus the difference in average winglength

TABLE 2

TAILLENGTH (IN MM) OF SEVERAL POPULATIONS OF ADULT BREEDING CLIFF SWALLOWS

Population	Sample size (N)	Range	Mean with SE	SD	Coefficient of variation
P. p. hypopolia (Oberholser 1919)	5	49.0–52.0	50.7	–	–
Igiak Bay, Alaska	5	46.6–52.2	50.32±0.996	2.226	4.4
Yukon, NWT, Manitoba	12	44.4–56.0	49.98±0.877	3.039	6.1
British Columbia	19	44.2–52.0	48.68±0.506	2.204	4.5
P. p. aprophata (Oberholser 1932)	7	49.0–52.5	50.2	–	–
SE Oregon, NE California	15	46.7–52.6	48.83±0.446	1.727	3.5
Raft River Mts., NW Utah	43	44.8–53.1	49.04±0.339	2.222	4.5
Deep Creek Mts., central W Utah	4	50.0–52.8	51.75±0.702	1.404	2.7
Bear River Refuge, NW Utah	23	46.6–51.7	49.22±0.331	1.588	3.2
Salt Lake City, Utah	54	44.6–52.0	48.59±0.331	2.436	5.0
Delta, central W Utah	28	46.5–54.0	49.49±0.331	1.751	3.5
Cedar City, SW Utah	25	45.9–51.8	48.86±0.314	1.568	3.2
SW Wyoming	4	44.5–50.5	47.08±1.251	2.501	5.3
Uinta Basin, NE Utah	98	45.0–52.7	48.51±0.185	1.835	3.8
Fairview area, central Utah	35	45.5–52.2	48.59±0.273	1.615	3.3
Bicknell area, S central Utah	14	46.1–50.8	48.21±0.302	1.132	2.4
Escalante area, central S Utah	13	44.8–50.5	48.70±0.494	1.781	3.7
Kanab, central S Utah	18	44.9–53.8	48.51±0.573	2.430	5.0
Moab area, SE Utah	24	44.7–49.9	47.72±0.552	2.703	5.7
P. p. pyrrhonota (Oberholser 1919)	7	47.0–51.0	44.9	–	–
P. p. tachina (Oberholser 1903)	7	–	45.3	–	–
Arizona-New Mexico	10	44.0–48.0	46.03±0.409	1.293	2.8
St. George area, SW Utah	34	42.7–49.5	46.61±0.288	1.680	3.6
Colorado R. near Pilot Knob, Calif.	15	43.0–48.7	46.35±0.413	1.600	3.4
San Pedro Martir, Lower Calif.	7	44.9–50.2	47.61±0.686	1.814	3.8
P. p. melanogaster (van Rossem and Hachisuka 1938)	10	44.0–48.0	46.0	–	–
P. p. melanogaster (Oberholser 1903)	8	–	46.4	–	–
P. p. minima (van Rossem and Hachisuka 1938)	18	40.0–46.0	43.0	–	–

between Alaskan and Arizonian birds is about 8 mm. Birds from northern and central Utah are about midway along the cline, averaging about 109 mm. Birds from the St. George area average 103.8 mm, which is about 5 mm shorter than the averages of samples from points farther north in Utah. The average winglength of the southwestern Utah sample is comparable to the Colorado River series near Pilot Knob.

The figures for taillength are summarized in Table 2. The data show a tendency for northern birds to be longer tailed on the average than southern birds, but the average difference is only 2 to 3 mm. Birds from southwestern Utah have tails slightly shorter than those from elsewhere in the state, but the average is a little longer than that for the small sample from Arizona and New Mexico.

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SUMMARY AND CONCLUSIONS

This study of geographic variation in Cliff Swallows reveals a pattern of clinal variation in size from large birds in the north (Alaska and western Canada) to smaller birds in the south (southern Arizona and northern Mexico). This is most apparent in length of wing, less so in length of tail, but does not appear in bill size or length of tarsus. Examples from northern, central, and southeastern Utah are midway along the north-south cline in wing and taillengths while those from southwestern Utah are of small size. No significant differences in size were found between males and females, nor do the sexes differ in coloration.

As regards color characters, northern examples have the frontal stripe predominantly white, a condition that not only typifies birds from Alaska and the Yukon but also extends south through British Columbia (except southwest portion), eastern Washington, Idaho, and eastern Oregon to the Great Basin. In birds from eastern North America, the midcontinental region and the west coastal area, the frontal stripe is cream-colored and less extensive. In southwestern Utah, the lower Colorado River, Arizona, and parts of New Mexico and Texas it is light cinnamon and in Mexico it becomes deep cinnamon or chestnut. Northern birds have lighter rump patches than Arizona and Mexican birds. The underparts are lighter in northern birds, the white clearer and more extensive, and the chest and flanks grayer. Southern birds have the white below less clear and less extensive and the chest and flanks show a tinge of rust.

A comparison of Cliff Swallows from the Great Basin and eastern Oregon with those from Alaska, the Yukon, and eastern British Columbia confirms that *aprophata* is not a distinct subspecies from *hypopolia*. The race *hypopolia* extends south into the Great Basin, thus dividing the range of *pyrrhonota* into eastern and western portions. An area of intergradation between *pyrrhonota* and *hypopolia* extends from south central Oregon southward through northeastern California along the east side of the Sierra Nevada into Inyo County. Examples from northwestern Utah are closest in their characters to *hypopolia*. Intergradation between *hypopolia* and *pyrrhonota* occurs across central northern Utah. Examples from extreme northeastern Utah and southwestern Wyoming are slightly closer to *pyrrhonota*. Examples from southeastern Utah are similar to the intergrades of central northern Utah. The breeding population of

extreme southwestern Utah represents the race *tachina*. Thus Utah is a meeting ground for three of the four races presently accepted. The alleged race *minima* is considered a synonym of *melanogaster*.

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