

THE GEOGRAPHICAL AND ECOLOGICAL DISTRIBUTION OF THE BLACK SWIFT IN COLORADO

OWEN A. KNORR

THE northern race of the Black Swift (*Cypseloides niger borealis*) remained undescribed until the year 1857, at which time it was reported by Kennerly, a member of the Pacific Northwest Boundary Survey Expedition, who collected a specimen in the Puget Sound region. It seems remarkable that it could have escaped notice for so long. However, history seems to have repeated itself on a more limited geographical scale, for it was not established that the bird is a breeding species in Colorado until 1949.

The breeding range of the northern form of the Black Swift extends from southeastern Alaska southward to southern Mexico, and eastward to much of mountainous Colorado. However, within this vast area, the bird occurs only in isolated colonies due to certain ecological considerations to be discussed later. As far as the winter range is concerned, Bent (1940), who has written the only fairly complete account of the species, states that it is unknown. Whether the bird spends the winter with the resident form in Central America or goes on to South America is still to be determined.

The credit for the initial discovery of the Black Swift in Colorado goes to Frank M. Drew (1881) who collected a specimen along the Animas River a few miles east of the present site of the town of Silverton in San Juan County. He stated that it bred in this locality, but this was an inferential conclusion since he found no nests. This is further borne out by the fact that the nest and egg of the Black Swift were unknown to science until 1901, when A. G. Vrooman found the species nesting along the Pacific Coast west of Santa Cruz, California. Nevertheless, Colorado has been included in the breeding range in the AOU Check-list and elsewhere on this basis up to the present time.

The years following Drew's discovery produced very few Colorado records, some authentic and some doubtful. In 1882, Drew returned to substantially the same locality and collected a series of 10 individuals, publishing some notes on their plumages during that year. Again, in 1885, he published a short paper on the vertical ranges of birds in Colorado giving 14,000 feet as the upper limit for the Black Swift and stating that it breeds between 10,000 and 12,000 feet. Bendire (1895), in his "Life Histories of North American Birds," said that the bird seemed confined to San Juan County and mentioned Anthony's correspondence with him concerning observations of the Black Swift around Silverton in the summer of 1883; he also noted Fisher's observations of swifts of this species about the cliffs near Trinidad in July 1892, although they have not since been seen there.

In 1897, Cooke, in "The Birds of Colorado," merely repeated Drew's and Bendire's statements, managing to confuse the word "saw" with "taken" in the process, as regards Fisher's observations at Trinidad. In the third supplement to his original work, Cooke (1909) mentions that "a female in the collection of George B. Sennett is labelled as taken at Denver, June 26, 1884." Despite all efforts of the staff of the Museum of Natural History at Denver, this specimen has never been located, and Black Swifts have been recorded but once out on the plains—one was found dead near Fort Morgan in Morgan County.

The next reference to the Black Swift in Colorado was by Widmann (1911) who published a list of birds observed in Estes Park, reporting several swifts over Glacier Meadow in July of 1910. This report, along with that of Drew, is interesting in that it provided a concrete location from which to start searching for the actual nesting sites of the swift. One year after Widmann, Sclater (1912) published "A History of the Birds of Colorado," presenting a digest of the work on the Black Swift to date and contributing nothing new. Betts (1913) included the bird in his list of the birds of Boulder County on the basis of Widmann's report of the Black Swift in Estes Park (just outside the county) and some notes by Gale which were unsupported by data. In 1928, Bergtold published a small guide to the birds of Colorado in which he stated that the bird occurs "north and east as far as Golden." This is the first mention of Golden as a locality for the Black Swift, but unfortunately there are no data. This area has been the subject of considerable attention by ornithologists in recent years including three years of intensive field work by me, but the bird does not seem to occur there. Alexander (1937), who revised Betts' list of the birds of Boulder County, permitted the Black Swift to remain on the hypothetical list in the absence of the demonstrated presence of the bird in this area. Niedrach and Rockwell (1939) in their "Birds of Denver and Mountain Parks" repeated Cooke's statement of the specimen in the Sennett collection. In 1940, Bent monographed the species as completely as possible with the data then available, citing all the work done up to that time but contributing no new material so far as Colorado was concerned.

More recently, Knorr and Baily (1950) discovered two nesting colonies in the San Juan mountains of southwestern Colorado during the summer of 1949, taking the first nest and egg for the state. Encouraged by this initial success and fascinated by the bird itself, I undertook the task of determining its geographical distribution in Colorado and the ecological factors of the environment affecting this distribution, restricting the latter to the physiographic and physical aspects. At present, a comprehensive life history of the species is under way, a type of study yet to be done for this bird.

I should like to take this opportunity to acknowledge the assistance given me during

the 10 years I have been engaged in this problem. In 1949, the Denver Museum of Natural History, in the persons of Alfred M. Bailey and Robert J. Niedrach, provided the funds for the field expedition which resulted in the initial discovery of nesting Black Swifts in Colorado. The American Museum of Natural History awarded me a grant in 1951 from the Chapman Memorial Fund which permitted continuation of the rather costly field investigations, and for which I am extremely grateful. I am indebted to the staff of the Department of Biology of the University of Colorado, which awarded me a sum from the Gardner-O'Dell Scholarship Fund in 1952 to pursue my field work, and especially to Gordon Alexander, T. Paul Maslin, and Robert W. Pennak whose generous assistance brought the manuscript to its final form. Finally, the Council on Research and Creative Work of the University of Colorado awarded me a Faculty Grant to finish the distributional studies during the summers of 1958 and 1959.

FIELD INVESTIGATIONS

In order to chronicle more completely the search for the Black Swift in Colorado in recent years, it is necessary to go back to 1948. In the summer of that year, John A. Murphy and the late Robert Landberg, staff members of the Denver Museum of Natural History, were sent by the Director to San Juan County. The main purpose of the trip was to secure photographs of the Black Swift to augment the pictorial records of Colorado birds at the museum. Operating out of Silverton as a headquarters, they covered most of the territory between Red Mountain Pass on the north and Molas Divide on the south. Although they spent a number of weeks in this area, the search for the nesting sites of the swifts proved fruitless. Indeed, only a few birds were sighted during the entire period. The reasons for their failure are not clear.

It might be appropriate to mention here that the Black Swift is a very elusive bird. Its marvelous powers of flight make it extremely mobile and prohibit the establishment of any set pattern of comings and goings which often leads the observer to the nests of other species. It often feeds at great altitudes, sometimes appearing as a mere speck through a good 8× glass when directly overhead. When one considers that the bird can be easily confused with the White-throated Swift unless the light is perfect, and that the two species occur together in Colorado, the difficulties in locating a nesting site become apparent. Finally, it must be remembered that the Black Swift is far from common except on its breeding grounds, and in point of numbers of individuals probably stands near the bottom of the list among the breeding Colorado birds.

Since 1937, I had worked from time to time with Robert J. Niedrach, Curator of Birds at the Denver Museum of Natural History, and dean of Rocky Mountain region ornithologists. In the spring of 1949 he suggested that I take up the search for the Black Swift, and consequently plans were laid for a field trip to the San Juans the following summer. A. Lang Baily, a staff member of the Museum, was to accompany me on the trip. Numerous consultations were held and the literature was carefully reviewed for helpful clues. This latter point may have been overlooked by the previously unsuccessful in-

vestigators. Gradually, a method of operation evolved. In general, there are three ways to find a bird's nest. First, follow the bird to the nest. With a species as mobile as the Black Swift, this is almost out of the question without the use of hovering equipment. Secondly, be familiar with the type of locale where the bird has nested before, such as a certain species of tree or bush, and look there. Since the literature indicated that one of the keys to the problem was water, especially falling water, this seemed a step in the right direction but the checking of every cascade in San Juan County was also out of the question. Thirdly, one might stumble across the nest accidentally. The method finally adopted combined features of the first two. We decided to station ourselves where swifts had been seen on many previous occasions and to observe their flights. Then we would move in the direction of these flights in progressive stages, and when we were reasonably sure that we were in the general vicinity of the nesting site we would switch to the second method and examine all the likely spots in that vicinity.

We arrived in Silverton on 19 July 1949, and proceeded up the Animas River canyon to the approximate location of Drew's observations of 70 years before. Almost immediately three Black Swifts were observed flying up the canyon. No more were seen that day. The following day we moved up the canyon several miles above the first location and sat down to watch. After several fruitless hours five swifts appeared and proceeded to fly up and down the canyon, feeding at a considerable altitude. They finally disappeared up the canyon. We moved another mile upstream and saw more swifts feeding as before. Darkness concluded the day's observations.

Convinced now that we were on the right track, we decided to explore some of the tributaries of the Animas for possible nesting sites and to watch for any swift activity about them. The Animas Canyon had been heavily glaciated at this point, leaving many hanging valleys from which the tributary streams dropped into the canyon, producing some spectacular waterfalls. The plan was for Baily to ascend the ridge flanking Edith Gulch while I was to proceed up the canyon on foot to the ghost-town of Eureka to see if we were still too far downstream. Upon reaching Eureka I noticed five swifts orbiting the town. I climbed a rooftop for better vision and noticed that periodically they would fly up Niagara Gulch and return. Thinking I could see better from the mine dump across the canyon from the famous old defunct Sunnyside Mill, I climbed it. By this time the five swifts were joined by a sixth which apparently came down Niagara Gulch. Since Niagara was hidden from my view by the shoulder of the mountain, I left the mine dump and proceeded up Niagara Gulch. The ascent was very difficult but it soon became apparent that this was the end of the trail for Drew's swifts since the number of birds now increased to eight or nine and they were continually flying back and forth from the innermost part of the gorge. Upon reaching a point 50 yards below the falls, which have a free drop of almost 100 feet, I saw more than 12 swifts apparently flying to a large rock, which faced the falls, and clinging there. With some maneuvering I managed to assume a semi-reclining position on the

side of the gorge 12 feet from the cascade on a slippery ledge. From this position I could observe with binoculars the actions of the swifts. They flew out over the canyon, returned, and circled the cavern at the bottom of the falls. Occasionally they would land on the aforementioned rock. One landed in full view on the side of the cavern. By this time it was getting quite dark and the swifts were coming to roost. Some tried to cling to the side of the chasm near me but my presence seemed to frighten them off. Several passed within a few feet of my head. One clung to the wall about eight feet away and I shone my flashlight on it before it flew away.

The descent was negotiated with considerable difficulty. Niagara Gulch is very steep and filled with a rushing stream. The upper falls are about 1,000 feet above the valley floor and the Gulch itself is over 100 feet deep, almost vertical-sided, and drenched with spray. Moss and some small ferns constitute the plant life. No nests were actually seen, but since the swifts were coming in to roost at darkness, it seemed safe to assume that I was within several hundred feet of the nests, perhaps much closer. The colony was estimated at this time to consist of at least 12 pairs.

On the following day, 22 July, we went up Niagara Gulch to see about the possibilities of reaching the chasm at the bottom of the falls to actually view the nests. This proved impossible without pitons and rope, items of equipment we had not brought along. We tried improvising with old railroad spikes and a sledge, but the spikes would not hold. Hoping to see the nests from the side we climbed the west ridge but the extreme steepness and the rotten character of the rock prevented us from reaching a suitable position. (More recently I was able to reach the face of the nesting rock by a difficult rappel from the top of the east ridge and counted seven nests in as many cavities sprinkled across the face of the rock.)

To ensure the success of our mission, the only line of action open to us was to find another site which would be accessible to simple climbing. We investigated Arraistes, Cunningham, and Cement Creeks all in the vicinity of Silverton without success. We walked down the railroad track along the Animas south of the town for a considerable distance but saw no swifts. While checking the South Fork of the Mineral River we observed two swifts flying up and down the valley and seeming to center about Cataract Gulch. We forded the river and climbed part way up the gulch, noticing that the number of birds had increased. In addition to feeding up and down the valley, occasionally they would swing into the gulch and fly out again. One swift came in and apparently landed just above my position in the gorge. Darkness prevented further observations.

The next morning, 24 July, we returned for more investigation. There are two falls in Cataract Gulch. We planned to examine the lower falls and then



FIG. 1. Typical Black Swift nest site.

go on to the upper falls. Upon reaching the base of the lower falls we flushed a bird from a nesting hole in the rock. By climbing part way up the side of the gulch we were able to see the nest. It was about 15 feet above the pool at the base of the falls on the sheer side of the gulch and about seven feet from the falling water. The pocket in which the nest was located was about one foot wide, 10 inches high, and 10 inches deep. It appeared to have been constructed of moss and mud and the layering indicated several years of use. In the nest was a single white egg. This then was the first nest and egg of the Black Swift to be found in Colorado and vindicated Drew's assumption that the bird bred in Colorado.

We notified the museum in Denver of our discovery and they decided to send John A. Murphy, the staff photographer, to photograph the nest. Meanwhile, we took our own photographs. On the 26th of July we explored the upper falls and found two more nests, one at the base of the falls and one at the top of the falls, and on the next day we collected the nest, egg, and female from the former location (Fig. 1), the first to be taken in Colorado. They are now in the Denver Museum of Natural History collection (DMNH No. 25,551).

Both the Niagara and Cataract Gulch nesting sites were in the Upper Canadian zone about 10,000 feet above sea level. All the nests were in the close

proximity of rushing water and were subject to a cold spray, although one was drier than the rest being 20 feet from the water. The egg in the nest which was photographed felt cold to the touch after the incubating bird had been gone for some time but it later developed into a young swift. We judged the colony to be smaller than that at the Niagara location, perhaps only five pairs of swifts.

This concluded the field work for the summer of 1949, but on the trip back to Denver a stop was made in Ouray. I was surprised to see a dozen or more Black Swifts feeding over the town and I made a note to investigate Ouray County the following summer.

Limited funds reduced to a minimum the amount of field work accomplished during the summer of 1950. However, a trip was made through the San Juan Mountains in August, which resulted in the discovery of a new breeding colony in a new locality. This was near Ouray where the swifts had been sighted the year before. Employing the same method used so successfully before, the colony was located on the day of arrival, 24 August, on one of the tributaries of Canyon Creek. It was adjacent to a waterfall and there were approximately 10 pairs in the colony. The elevation was about 7,800 feet.

Recalling the fact that the wintering grounds of the Chimney Swift had remained a mystery until 1944 when some bands were recovered in Peru, and that the winter range of the Black Swift was also unknown, equipment had been brought along to band the swifts. But capturing the birds posed quite a problem. Seth Low, Director of the Bird-banding Division of the United States Fish and Wildlife Service, had informed me that the species had never been banded and he therefore could offer no help as to the matter of traps. A box to place over the nests, insect nets, and cheesecloth were all tried to no avail at both the Cataract Gulch and Ouray locations. Finally it was decided to attempt the banding at night, blinding the birds at the nest and in the roosting spots with a bright flashlight. The Ouray site was chosen for the experiment because of its proximity to the town in case of accident. Just at dusk, the climb up to the top of the gorge was made. The descent of the vertical wall was accomplished by means of a double rappel to a series of ledges and then another rappel to the nesting location. The whole procedure was complicated by darkness, wet rotten rock, and the fact that the nests were in a large chamber which was overhung by the cliff above. A flashlight held by a companion from the opposite side of the gorge illuminated a group of three nests and about six swifts, one of which was a young bird in the nest. The driving of the pitons into the rock and the swinging on the rope to get in under the overhang had not flushed them. Apparently the six-cell flashlight was bright enough to divert them. Four adults and a young bird were placed in a shirt and the descent to the bottom of the gorge was

made by finishing the rappel. The birds were banded and since the adults fly as well at night as by day, they were liberated. The young bird was placed back in the nest by my companion whom I belayed back up the wall on the rope which had been left hanging from the last piton. Thus a modest start was made in the plan to band a few swifts each summer in the hope of solving the mystery of their winter whereabouts.

On the return trip a few swifts were observed at dusk near Pagosa Springs in Archuleta County near the southern border of Colorado. The presence of the birds during the breeding season indicated the possibility of a colony in the vicinity and several were found during the summer of 1958.

During the summer of 1951 a field trip was made through the Elk, San Juan, and San Miguel Mountains of west-central and southwestern Colorado with Dr. C. W. T. Penland, Professor of Botany at Colorado College. The trip had a dual purpose: to collect specimens of the genus *Penstemon* which Penland was monographing, and to locate more nesting colonies of the Black Swift. Such a colony was discovered on the west side of McClure's Pass in the Elk Mountains west of the town of Aspen. It was of medium size (about six pairs) and was notable for the fact that the stream consisted mainly of cascades rather than the waterfalls I had come to expect. It was only the first week in August and so the eggs in the nests observed had not yet hatched. The elevation was about 8,500 feet. It was in an area unmapped by the United States Geological Survey and therefore the stream had no official name, although the few human inhabitants of the region refer to it as "West Creek." The finding of this nesting site was important in the project of mapping the geographical distribution of the swift in Colorado since it extended the known breeding range of the swifts in Colorado northward by almost 100 miles.

On the 8th of August the Ouray nesting colony was visited again, and adults were observed either incubating or covering young in the nests discovered the year before. On the 9th and 10th, many swifts were observed in the Mt. Sneffels and Camp Bird Mill area west of Ouray and although no nesting sites were located, the area was thoroughly investigated during the summer of 1952 with good results.

On the 15th of August two large colonies of at least 15 pairs were found on Bridal Veil Creek and another on Ingram Creek within sight of the town of Telluride in San Miguel County at about 10,400 feet. More colonies were suspected in Bridal Veil Basin but time limitations prevented further investigation in the San Miguel Mountains.

The two basic references in the literature concerning the occurrence of the Black Swift in Colorado are the observations of Drew in southwestern Colorado and those of Widmann in north-central Colorado near what is now Rocky Mountain National Park. As the former location had been quite fully

exploited I decided to investigate the latter. This proved to be a most vexing problem. Widmann reported that his birds were observed "over Glacier Meadow," in the vicinity of Estes Park in 1911. Park personnel knew of no Glacier Meadow. In fact, they had never seen a Black Swift. Assuming that the present day Glacier Basin was Widmann's meadow, camp was made in this area. Thus began two full weeks of dawn-to-dusk hiking and observation. Most of the area of the Park lying north of Long's Peak and east of the Continental Divide was covered. Swifts were observed at scattered locations throughout the area but they were most numerous in the territory east of Flattop Mountain and Hallett and Taylor Peaks, especially in Moraine Park, Glacier Basin, and along Mill Creek. It should be mentioned here that the character of the terrain in Rocky Mountain National Park is quite different from that of the San Juan Massif. In the Park there is only one main ridge, the Continental Divide, which runs northwest and southeast with the streams draining it at right angles. In the San Juans the mountain range is much wider with ridges and valleys running in all directions. The ridges are higher and the valleys are deeper so that the San Juans resemble the Alps more than most American mountains. Consequently, the swifts tend to fly up and down the valleys rather than over the ridges when travelling to and from the nesting sites. This is not true of the terrain east of the Continental Divide in the Park which tends to be more rolling by comparison. This made it almost impossible to establish any sort of flyways or flight patterns and thwarted the progressive following of the birds which had worked before, since they just seemed to wander over the entire area. The method which finally resulted in solving the problem consisted of plotting the daily swift sightings on a topographic map, and by the middle of the third week a funnel-shaped pattern began to emerge with the apex pointing at Loch Vale. Camp was set up at the bottom of a wet, dripping cliff in the Vale, which seemed a likely spot. The following day three nests were located by binocular from a rise opposite the cliff, two with young and one empty. The elevation was 10,500 feet. By San Juan standards the water was rather meager but there were many excellent damp nesting crannies available.

From the standpoint of the distribution study, this was the most important discovery of four years of field work, moving the breeding range north and east by 200 miles from the original Silverton location.

The summer of 1952 was by far the most successful in the search for the Black Swift in Colorado. The field work was started in Rocky Mountain National Park because it seemed that from the number of swifts observed the previous summer, more nesting colonies should exist than the small one I had found. Operating on the theory that Glacier Basin was not the "Glacier Meadow" mentioned by Widmann, I went back to the literature and found

that Widmann had been staying at the Long's Peak Inn when his Black Swift observation was made. A long-time resident of this area provided the information that Glacier Meadow had been renamed Tahosa Valley in later years. This was only four miles to the southeast of Glacier Basin but due east of Long's Peak and in an area not as yet investigated. This clue led to a series of long vigils, watching and waiting for swifts, and after about five days of work a very small colony was found on the Roaring Fork at 11,500 feet on the east slope of Long's Peak, the highest Black Swift colony located at the date of this writing. This was unusual in that timberline is some hundreds of feet lower at this latitude than in the San Juans, and the present colony was situated just at or slightly above timberline. The date of discovery was July 12th but a 100 yard-long snow bank still remained, the lower end of which was a scant 12 feet from the nest, adjacent to a small cascade. An adult was incubating at this time. The nest was kept under observation from time to time and by the 8th of August the young bird was quite visible above the rim of the nest.

Since the stream came over a glacial step on a rather broad front at this point it was necessary to enlist the aid of another person so that the main cascade and another one 70 yards to the south could be kept under observation at the same time. Douglas Alexander of Boulder kindly consented to help, and at least one and possibly more swifts were seen landing in the vicinity of the second cascade at the same time that the adults were clinging to the nest at the first cascade. However, another nest was never found although an abandoned one was observed at the second site. Whether the other birds constituted a family unit and the nest was too cleverly hidden to be located or whether they were part of a floating population coming to roost is open to conjecture. If the latter is true, the word "colonial" as usually applied to the nesting of the Black Swift is open to question.

The final observation was made at this site on the 10th of September in a swirling, early-season snowstorm. The young bird was still in the nest but was seen to be exercising its wings at frequent intervals preparatory to flying away. From the condition of the plumage and the length of the wings it was estimated that the bird had no more than a week left in the nest.

Shortly after the Long's Peak site was discovered, a short trip into the Wild Basin area resulted in the sighting of a considerable number of swifts. Wild Basin is in the extreme southeast corner of Rocky Mountain National Park and in Boulder County, as is the Long's Peak nesting site. A field trip to the San Miguel area prevented further work here but it is felt that future investigation will produce at least one more colony in this region.

Returning to the Ouray County area, five more colonies were discovered during the third week in July. They were located east of the Sneffels ghost-

town and were all of small to medium size. One colony was notable in that the volume of water present was extremely small, consisting of only a steady dripping, although roaring Canyon Creek was only several hundred yards away. The elevations of the newly found colonies were all just above or just below 10,500 feet. The old original Ouray site was checked again on the 24th of July, and of four nests visible, three had eggs and the fourth was impossible to observe because of its position.

Just prior to leaving on this last Ouray County trip, a popular article on Colorado was noticed in the *Colorado Wonderland* magazine (1952). In it was a photograph of a series of falls on Dead Horse Creek in the Glenwood Springs area which appeared to be excellent locations for Black Swift colonies. Accordingly, the return from Ouray was routed through this region and the results justified the investigation. Three colonies were discovered, one at each of the falls. Three nests were located at the upper falls, three at the middle falls, and two at the lower. The nests at the upper falls were at least 20 feet from the nearest water although they were subject to considerable spray. However, the birds at the middle and lower falls had to fly through a curtain of falling water to reach their nests, which were located under the lip over which the water rushed. At least one nest was placed within eight inches of this torrent and in order to reach it the birds would fly headlong through a thinner portion of the water curtain, make an abrupt right-angle turn, then fly parallel to the water in the narrow space between the falling water and the rock until reaching the nest, a most remarkable demonstration of aerial agility. These colonies were the lowest to be found in Colorado, the elevation being approximately 7,200 feet above sea level. Although a day's work produced only eight nests, it was felt that the total strength of the three colonies was in the neighborhood of 15 pairs. Those nests permitting direct observation still contained eggs since it was only the 26th of July.

By this time I had found that I could predict the occurrence of swift colonies from photographs or topographic maps with a fair degree of accuracy. By this means, a suitable location was indicated on Clear Creek northwest of the town of Creede in Mineral County. On the 4th of September a large colony was discovered at 10,000 feet with nests flanking both sides of a waterfall. Similarly, another swift area was discovered in the extreme southwest corner of the state. Many swifts were seen in the vicinity of Mystic Falls on the Rio Dolores, but bad weather had become general and no attempt was made to locate the nests.

On the return trip a stop was made in Ouray to investigate Cascade Falls northeast of the town. This is a magnificent cataract with a free fall of over 100 feet when the stream is running heavily. Two nests were observed, both behind the falling water. The upper nest was very high but the lower nest

permitted the observation by binocular that the young bird which it contained was still downy. Since it was the 6th of September, this indicated that there may be a considerable spread of time during which nesting is initiated. The remainder of the return trip resulted in the sighting of swifts in an entirely new area, that of Climax and Alma, but time limitations prevented the location of nesting colonies.

During the summer, in a conversation with T. Paul Maslin of the Department of Biology staff, I had described the places in which Black Swifts nest. He recalled a location in the Sangre de Cristo Mountains which seemed to fit the description, a cascade or falls on the eastern slope of the mountains in Wet Mountain Valley. Since this was more than 100 miles away from the nearest swift colony, I decided to visit it next.

On the 12th of September, the day of arrival, a heavy snowstorm hampered field work but on the following day Alvarado Creek was investigated up to about 10,000 feet. At this point a series of cascades came down through a small gorge. One nest was discovered under an overhang on a tiny ledge about 20 feet above the stream level, but it was empty, which might be expected at such a late date. About 35 feet away was an adult roosting niche, a common thing about swift colonies, identified by the droppings. No other nests were found but from the number of birds observed in the air at one time, another colony must have been in the vicinity. However, two occupied nests were found at this site in later years. This discovery was especially significant in that it was the farthest east that the Black Swift had ever been found nesting, being 105 degrees 30 minutes west longitude.

Using field methods similar to those described above, many more swift colonies were discovered in Colorado during the summers of 1953 through 1958. In Boulder County, swifts were sighted over University Camp, Caribou Ranch, Brainard Lake Basin, and Rainbow Lake Basin, all presumably from a colony situated below Arapahoe Glacier. Two more occupied nests were found at the Wet Mountain Valley site. The summer of 1958 was especially productive in closing gaps in the distribution map. Some years before, on a swift-hunting trip to Ouray, I had seen an early photograph in a hotel there of a beautiful "swifty" waterfall in the Black Canyon of the Gunnison River. A trip to the falls disclosed a small colony, the first for this general area. During the same summer three more colonies were found near Vail Pass and two more were located in the Wolf Creek Pass region.

This brought to a close 10 years of field work to determine the geographical and ecological distribution of the bird within the borders of the state. Some 15,000 miles had been traveled by automobile and it was estimated that 120 miles had been covered on foot during the course of the project.

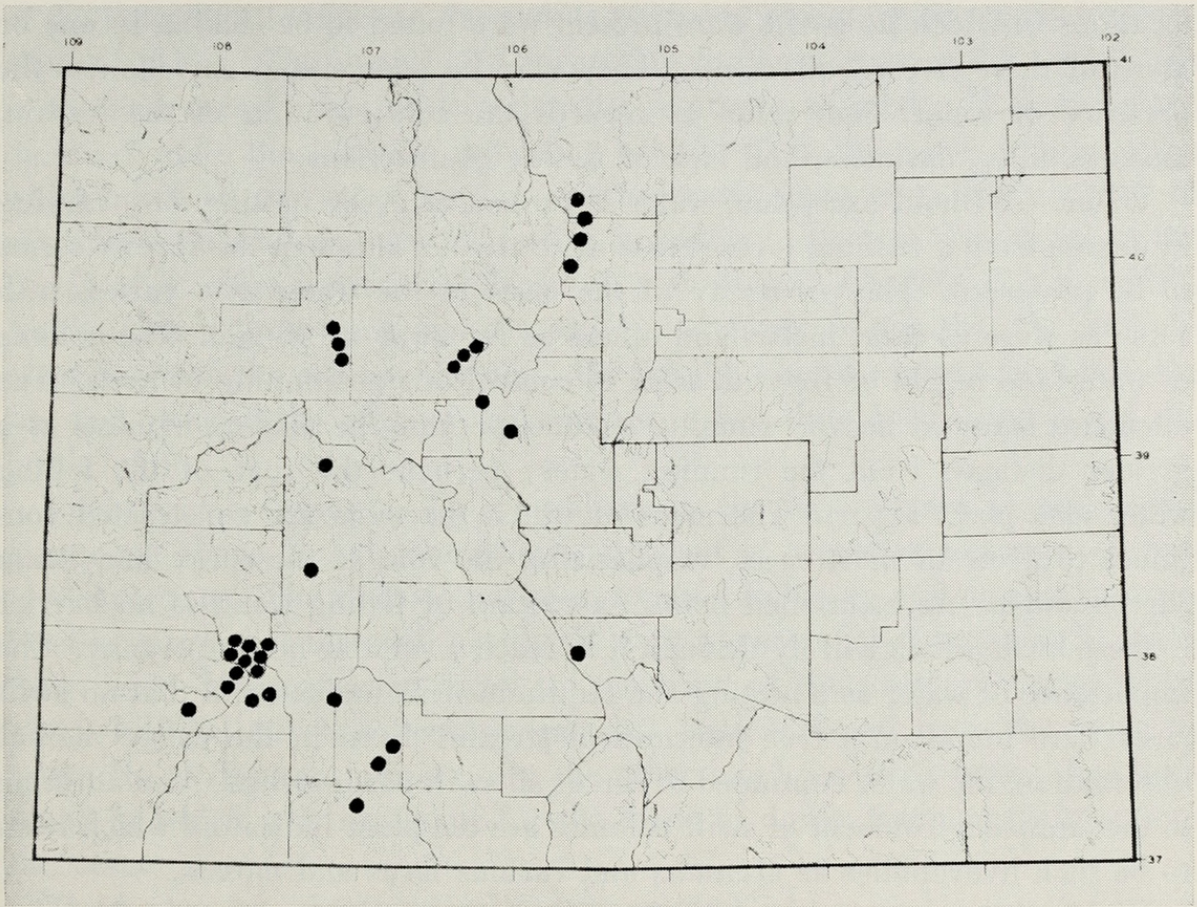


FIG. 2. Locations of active Black Swift breeding colonies and breeding season sightings in Colorado.

DISCUSSION

Geographical Distribution.—As a result of these investigations, 27 active breeding colonies consisting of approximately 80 nests were discovered at scattered locations throughout the Colorado Rockies in the counties of Larimer, Boulder, Eagle, Garfield, Gunnison, Custer, Mineral, San Juan, Ouray, and San Miguel. In addition, sightings were made in areas which should produce nesting colonies upon future field investigation. These were in Boulder, Lake, Park, Archuleta, and Dolores counties. The total area encompassed is approximately 19,500 square miles. It may be seen that the distribution brackets a major portion of the mountainous part of the state (Fig. 2), and there is little doubt that future work will show that the Black Swift will nest anywhere in the Colorado mountains that its ecological requirements are met. The nature of these requirements as established by these investigations is discussed below.

Ecological Requirements.—As the field work proceeded and the notes on the nesting colonies accumulated, an ecological pattern began to emerge. Upon analysis of these data, five physical factors were found to be present to a greater or lesser degree in all the colonies. Furthermore, seemingly suitable

locations in which no swifts were present were found to be lacking in one or more of these five requirements. They may be enumerated as follows: the presence of water, high relief as regards the configuration of the terrain, inaccessibility, darkness, and lack of flyway obstructions.

Water.—Without exception, water is present at every nesting site, varying in degree from a rushing torrent to a mere trickle, although the former seems to be preferred. The proximity of the nests to the water also varies, with some as close as eight inches and others as far away as 35 feet. The volume of water and height of free fall seem to control this positioning of nests. The attendant spray at heavily running streams permits the placing of nests at a greater distance from the running water; perhaps the roar of the falling water also plays a part. The moss of which the nests are constructed continues to grow in most cases, emphasizing the role of the spray and damp surroundings. As mentioned before, a curtain of falling water is no barrier to these birds which will fly through it to reach a suitable nesting cranny. The importance of water as a nesting site requirement is indicated in that no swift nests were found on a true intermittent stream. Even in the driest year of observation, the water continued to run at all swift nesting sites. Also attesting to the damp environment of swift colonies are the plant indicators which seem to be such hydrophiles as *Mimulus* and various ferns and mosses.

High relief.—A term borrowed from the cartographer most aptly describes the requirement that the nesting site have a commanding position above the surrounding terrain so that birds flying out from the nests on a horizontal course find themselves automatically at feeding altitude above the adjacent valley. This is to be expected since the bird habitually feeds at high altitudes and is often observed taking airborne insects which are being sucked up by the violent updrafts existing under clouds of vertical development. Some apparently suitable locations fulfilling all the other requirements but situated just at the valley floor are ignored by the swifts. The appreciation of this need for sharp contrast in the terrain surrounding swift colonies greatly simplified the search for nesting sites toward the end of the project.

Inaccessibility.—The requirement that a Black Swift nest be inaccessible to terrestrial marauders appears to be inflexible. No nest was ever found which was accessible to anything without wings. A human being with a rope or ladder is a possible exception, but at most sites this is an extremely hazardous undertaking. The fact that the bird lays only a single egg indicates that its enemies are few. However, the very inaccessibility of the nests operates as a disadvantage at times since at least one young bird has been observed to fall out of the nest to be swept away in the stream.

Darkness.—The sun rarely shines on the nest of a Black Swift. I have never found an occupied nest upon which the sun shone. Furthermore, the gloom

of the innermost recesses in the rock is preferred to lighter situations in more exposed places. The young bird invariably faces away from the light while in the nest except when anticipating the return of an adult. However, since there are more Black Swifts at nesting colonies than there are dark crannies which meet all the other nesting requirements, some nests are exposed to more light than others. An interesting borderline case was discovered in the Ouray area where a nest was placed on a sheer wall adjacent to a waterfall. As the season progressed and the sun swung lower in the sky, the sunlight crept closer to the edge of the nest. On the day that the young bird left, the sun had reached the edge of the nest and a few days later, illuminated the inside of it.

Unobstructed flyways.—As a corollary to the requirement of high relief mentioned above, the air immediately in front of a nesting site must be free of obstructions. The birds do not seem to mind flying up and down a narrow, twisting gorge, but they will not fly through a maze of tree branches to reach their nests. Many excellent sites (to the mind of the observer) were found which fulfilled all other requirements but were screened from the front by trees. No swifts were present. On the other hand, no swift colony has been found in which it is necessary for the birds to dodge trees on their way to the nests.

There may be other physical factors present which operate in the choice of nesting sites but the five mentioned above seem to be the obvious ones as established by these investigations. The impossibility of seeing the nests from above, or putting it differently, the protection from weather in the form of precipitation is another physical factor present in all cases but it is not to be ranked with the others. An additional requirement may be sound, since I have never seen, read about, or heard about a Black Swift nest which was not within range of the sound of water in motion, usually violent motion. This need not be merely a tribute to the type of environment required for a mossy nest since many permanently damp and humid crannies can be found quite remote from noisy water and which harbor no swifts. However, sound has not been generally established as an ecological factor for nonhuman animals except perhaps colonial sea birds. Future investigation will probably see the establishment of additional ecological criteria for the Black Swift. A comprehensive life history of the species is presently under way toward this end.

SUMMARY

During the summers of 1949 through 1958, field investigations were carried on to determine the geographical distribution of the Black Swift in Colorado and the ecological factors affecting this distribution. Fifteen thousand miles were traveled by automobile and 120 miles were covered on foot.

Twenty-seven active breeding colonies were located at scattered points in 10 counties

throughout most of the mountainous portion of Colorado. A nest, egg, and associated female were taken, the first to be recorded for Colorado. Additional sightings of the Black Swift were made during the breeding season in five other counties.

Five physical ecological factors were found to be present to a greater or lesser degree in all the colonies: the presence of water, high relief as regards the configuration of the terrain, inaccessibility to terrestrial marauders, darkness, and the lack of flyway obstructions in the vicinity of the nest.

It is believed that the Black Swift will nest anywhere that these ecological requirements are met.

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