total number) contained lead shot, unfortunately the bodies of these birds were not available for examination, so that no information regarding their physical condition was obtained. In this connection it should be mentioned that three mallards, each with shot in the gizzard, taken at Pitt Meadows, December 16, 1923, were fat and apparently in normal condition. In two, the shot pellets were considerably abraded, indicating that the birds had been subjected to the poisonous effect of the lead for some time. It would seem then that Mallards may develop a resistance to lead poisoning when only a small quantity of shot is ingested.

Grateful acknowledgment is made to the Bureau of Biological Survey, Washington, D. C., for valuable assistance in the identification of seeds.

Okanagan Landing, B. C., March 6, 1936.

COLORATION OF DOWNY YOUNG BIRDS AND OF NEST LININGS

By JEAN M. LINSDALE

On a field trip to western Nevada in 1927, my attention was attracted to the strikingly whitish linings in several nests of Black-throated Sparrows. The observation so impressed me that I began to wonder if this feature might not have some special significance in the lives of the birds. Next I noticed that the down of nestlings of this species exhibited a similar whitish appearance, and this aroused the idea that both these peculiarities might be responses to some single item in the environment of the bird. When opportunity came, in 1930, to make more careful study of Great Basin birds, at a locality in central Nevada, particular attention was directed to this phase of bird life.

For as many as possible of the passerine species of birds found nesting in the Toyabe Mountains region, I recorded the prevailing color of nest lining and the color of the down on the nestlings. Also for each species it proved pertinent to consider the nature of the usual nest site—whether hidden in a protected place, partly screened, or completely exposed. Another trait of each bird, given consideration, was whether it was northern or southern in its general distribution.

Finally, it became apparent that coloration of down on nestling birds and of the lining of their nests is evidence, in each kind, of an intimate relation to the physical environment. This is separate from any responses which these characters may show to biotic influences such as would be revealed by examples of concealing coloration. Aside from recognition of its existence I am not here concerned with this latter phase of the life of a bird. I wish, rather, to direct attention to the general nature of the adaptive response made in structure and habits to one environmental factor—the heat which comes in sunlight.

It is generally supposed that young birds have a narrower range of toleration to extremes of their physical surroundings than have adults. At least they are less able to escape unfavorable conditions than are their parents. It would not be surprising then to find that special devices have resulted which tend to allay the harmful effects of extremes of heat or cold during this early stage. In this connection, see Kendeigh's "The rôle of environment in the life of birds" (Ecol. Mon., vol. 4, 1934, pp. 299-417). It seems obvious that if the devices here described are really effective in protecting young birds from harmful conditions, they may be among the means by which birds are segregated into different kinds of habitat or even larger units of distribution. Thus, two species may live in two different climates because of differ-

ences in the shade of the down on their young and in the shade of the inner layer of nest material. Baldwin and Kendeigh (Sci. Publ. Cleveland Mus. Nat. Hist., vol. 3, 1932, p. 121) have already suggested that feathers may serve birds by shielding them from direct solar radiation.

Before the problem outlined here can be satisfactorily clarified it will be necessary to have considerably more information bearing on it than I now possess. Because it is difficult for one person, with few opportunities to work in the field, to accumulate the kinds of facts desired and because other observers, in their bird study, may desire to pay attention to this topic, I have prepared this incomplete account in advance of any possible final demonstration of the validity of the principle. Some observers must have neglected to record facts of the kind needed because they assumed that no adaptive modifications could be involved and that these characters could have no special significance in the economy of any bird. I believe that a thorough study of the problem will demonstrate that these adaptations rank high in the nesting successes and in determining the ranges of the birds.

In order to make this discussion less diffuse, I have picked out fifteen species in two families (Icteridae and Fringillidae). All these are numerous in the Great Basin so that abundant evidence regarding them is available. Also the group contains pairs of close relatives, thus offering opportunity to test the effect of consanguinity as contrasted with the environment in regulating coloration of the two structures—down and nest lining. Abstracts from notes made upon them are given in the following paragraphs.

Western Meadowlark (*Sturnella neglecta*). Only two nests were found; both were in open parts of a meadow, but each was covered by a dome-shaped roof. The lining of one was small grass stems, of the other small yellowish brown grass stems. Concealment was obviously an important factor in the nest construction. In other localities I have observed that nestlings appear conspicuously whitish.

Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*). The forty-two nests studied in Smoky Valley were placed directly over water, some in cattails and some in small willows, but all in exposed situations. The linings were uniformly of light yellowish brown material.

Red-winged Blackbird (*Agelaius phoeniceus*). More than one hundred nests were studied in Smoky Valley as well as many hundreds at other localities. Nests in that vicinity were all in cattails or sedges on wet, open ground where they would be fully exposed to the sun. Pale yellowish or grayish materials in the linings were conspicuous in the nests. The whitish nestling plumage was also prominent in the young birds. It is worth mentioning that color of these nestlings apparently is not influenced by the black plumage of adults.

Bullock Oriole (*Icterus bullockii*). Two nests were examined both in the center of crowns of cottonwood trees. These were an old and a new one, probably built by the same pair. The new one was made of plant fibers and black horsehair but lined with wool and white horsehair. Down on small young in this nest was recorded as white.

Brewer Blackbird (*Euphagus cyanocephalus*). Approximately seventy-five nests of this species were studied in central Nevada. Locations varied considerably. Some were sunk in hummocks on wet ground, many were in bushes, and some were in cavities in the sides of hay stacks, but all were rather closely screened from the sunlight. Linings were composed of mixed grass stems, dark rootlets and horsehairs, but they were predominantly black. My notes indicate that the down was nearly black, contrasting with the whitish down of redwings which nest in much more exposed

places. Brewer blackbirds reached the peak of their nesting several days after the redwings reached theirs—possibly another indication of differing adjustment to heat from the sun. This circumstance suggests an adaptation to colder surroundings than those of the red-wing.

Green-tailed Towhee (*Oberholseria chlorura*). This bird lived high in the mountains. Five nests were found in sage bushes and the nest lining, where recorded, was partly of black horsehair.

Spotted Towhee (*Pipilo maculatus*). The belt between 6000 and 8000 feet in the mountains was inhabited by a few spotted towhees; only two nests were found and these, though fairly well concealed, were probably in much more open places than is normal for the species.

Savannah Sparrow (*Passerculus sandwichensis*). Six nests of this meadow-inhabiting bird were found, all of them on the ground but well concealed by grasses.

Black-throated Sparrow (*Amphispiza bilineata*). This species was scarce in the Toyabe area; a few pairs inhabited the driest, hottest parts of the valley. Three nests were in small bushes on the desert. Each was lined with conspicuously whitish material although one had a few black horsehairs. Down on the young birds was white, slightly grayish, and very fluffy.

Sage Sparrow (*Amphispiza belli*). This sparrow was more numerous than the Black-throated Sparrow; it occupied a higher level and was widespread throughout the sagebrush. The only nest discovered was beneath and near the center of a small, rounded bush.

Red-backed Junco (*Junco caniceps*). Juncos were common in summer in higher parts of the Toyabe Mountains. Four nests were studied, each on the ground and well-protected. The linings were dark, but not more so than some kinds of nests ordinarily in more open situations. Down on the young birds was recorded as dark, slate-colored. At one nest, not completely shaded, the young juncos were noted holding their mouths open, apparently on account of the heat.

Chipping Sparrow (*Spizella passerina*). This species was numerous on upper slopes of the mountains, especially so in the belt of mountain mahogany trees. The only nest examined was in the extremity of a limb of that kind of tree. Nest lining of this species is characteristically dark and the down is darker than the average for other passerine birds.

Brewer Sparrow (*Spizella breweri*). This was one of the most numerous birds in the Toyabe area; it occurred all through the mountains, wherever sagebrush grew. Nearly all of the fifteen nests were placed in sage bushes where not especially well concealed. Nest linings varied from brownish gray to dark with much black horsehair. The color of nestlings was recorded as dark, slaty gray.

Fox Sparrow (*Passerella iliaca*). Fox Sparrows were numerous along the streams high in the mountains. Six nests were placed in bushy thickets of birch, willow or rose; they usually were well screened. Color of the lining was not conspicuous, but it tended to be dark.

Song Sparrow (*Passerella melodia*). This close relative of the Fox Sparrow occupied a belt which extended a little below the range of that species. The five nests were close to the ground and seemed to be more completely covered than were the Fox Sparrow nests at higher altitudes.

The information just reviewed, along with some other items, has been summarized in table 1. The column headed nest lining gives readings of light reflected from the linings of nests as registered with a Weston photronic exposure meter, model 650. The readings are in foot candles per square foot and this series is low because it was recorded

on a cloudy day when a comparable reading of light from a white cardboard was only 16. Each nest was placed on a table where light conditions were uniformly the same. Only one example was used for each species, but each one was one from the Great Basin region, and typified the species. It should be pointed out, however, that the contrast between the kinds of nests is much reduced by placing them together. Naturally they differ as much in site (as indicated in the table) as in the color of the lining itself. And these characters are highly specific.

Table 1. Items in the Nesting of Fifteen Species of Birds in the Great Basin. Light Reflected from Nest Lining Shown in Foot Candles per Square Foot.

		Nest lining	Down	Site	Range
1.	Sturnella neglecta	6	Pallid	Part exposed	Austral
2.	Xanthocephalus xanthocephalus	6.5	Pallid	Part exposed	Austral
3.	Agelaius phoeniceus	6.5	Pallid	Exposed	Austral
4.	Icterus bullockii	4	Pale	Part exposed	Austral
5.	Euphagus cyanocephalus	2	Deep	Part covered	Transition
6.	Oberholseria chlorura	2	Deep	Average	Boreal
7.	Pipilo maculatus	4	Pale	Average	Transition
8.	Passerculus sandwichensis	5	Light	Part covered	Boreal
9.	Amphispiza bilineata	6	Pallid	Part exposed	Austral
10.	Amphispiza nevadensis	3	Pale	Average	Transition
11.	Junco oreganus	4	Dark	Covered	Boreal
12.	Spizella passerina	3	Light	Average	Boreal
13.	Spizella breweri	4	Pale	Average	Transition
14.	Passerella iliaca	3	Deep	Covered	Boreal
15.	Passerella melodia	3	Light	Covered	Transition

The entries in the table for color of down are not as satisfactory as desired because they were not obtained by any uniform standard. Where available the terms given here are from some other authority. Thus I hope to avoid any possibility of influence of personal bias. Even so, they are sufficiently exact to show the nature of this character in each species. Five degrees are recognized—dark, deep, light, pale, and pallid. The advantage of more refined descriptive terms likely would be small.

The notations on site are merely concise summaries of the information already reviewed for the Toyabe district. They are intended to indicate how much the nest of each species is exposed to the sun's rays. The five terms (covered, part covered, average, part exposed, and exposed) represent the range of exposure observed.

The last column shows the distributional relations of each species as it is usually designated by life-zone terminology. For this purpose only the terms Boreal, Transition, and Austral are employed, and where a bird occupies more than one it is aimed to indicate the one most characteristic for the Great Basin. These terms may be thought of not only as suggesting the kind of area now occupied by the birds, but as revealing something of the history of the species with respect to climate. Species marked Boreal have their nearest relatives in northern regions and Austral ones are obviously of southern stock.

Thus the table represents for this series of birds two important elements in the environment and two important elements of structure and behavior in the birds themselves. The nest lining results directly from the exercise of sets of habits peculiar to each species, and these have definite, if not recognizable, counterparts in the nervous systems. A considerable amount of variation may be detected in the nature of the lining in a series of nests, but this is less remarkable than the obvious tendency toward a specific type.

Color of down, although fairly uniform within a species, is highly variable other-

wise. For this reason, possibly, this kind of character has not been employed generally for purposes of interpreting phylogeny. This fact alone is sufficient to suggest that this circumstance may come from widespread adaptive modification of this feature.

A chart was prepared (see below) on which columns from left to right represent decreasing degrees of down color, and lines from top to bottom represent increasing degrees of exposure of nest site. The numbers correspond to those given in the list of species in table 1. When all the numbers are filled in, it is apparent that a high degree of positive correlation is indicated between color of nestling plumage and exposure of the nest site. Moreover the materials represented are such that it would seem to be a rather easy task to determine the mathematical relation between these two variables for a series of species.

Chart Indicating Relation Between Nature of Nest Site and Down Color in the Fifteen Species Listed in Table 1.

Site					
Exposed					3
Part exposed				4	1-2-9
Average		6	12	7-10-13	
Part covered		5	8		
Covered	11	14	15		
Down color:	Dark	Deep	Light	Pale	Pallid

One advantage in recognizing the working of these relations between structure and habit and the avian environment is that it makes unnecessary the invention of such remotely reasonable hypotheses as the following which is expressed in a recent book by Pycraft (Birds of Great Britain, 1934, p. 164). In a discussion of migration, after pointing out that "birds which are incubating, and young in the nest alike, have been seen, time and again, showing every sign of distress from the heat," he wrote as follows.

"We may well consider the possibility of the existence of some subtle climatic agency which 'tempers' or 'sensitizes' the tissues, including the all-important 'germplasm' during the early stages of life in birds, whereby they become so 'sensitized' that they cannot thrive, save in what we may call a 'climatic range,' or 'atmosphere,' which on the average agrees with that in which they are engendered and reared. This assumption helps us to understand a little more clearly what is meant when we say that such and such an animal or plant, brought into a new area foreign to its experience, must be given time to become 'acclimatized' before its reproductive powers will become functional. As we know, in many cases this never happens. The alien survives, but begets no offspring."

It seems much simpler to suppose, instead of any such simply acquired sensitivity to various kinds of climate, that birds in any single area are much alike in the range of heat which they can tolerate. They differ in their responses to the same climate, however, because of differing equipment with which they cope with it. To me the nature of the nest lining and the down color of nestlings are important in this equipment. Moreover, both these features appear to be easily modified or easily adapted

to the surroundings of the bird. In other words these seem to be materials that respond to agencies of natural selection. They happen to be more conspicuous and more readily observed than many traits of habit and structure involved in the adaptation of birds to their surroundings.

Many points can be cited which at first seem to detract from the validity of these relationships, but these do not necessarily contradict the principles involved. Thus, the fact that many birds which nest in holes or covered nests have no down may indicate that in such circumstances the main requirement for down is no longer effective and the whole structure is lost or greatly reduced. In other birds nestlings at early stages may be nearly naked, but they may be closely brooded by the parents and thus live in a place equivalent to a dark cavity. Later these young birds may have equivalent protection from their juvenal plumage, for this seems to respond much as does down to the degree of light which ordinarily reaches the nest contents. Seasonal delay or advance in nesting time may have some significance in protecting the young ones from the sun.

Also it is possible to find nests obviously not adapted, in this respect, to their surroundings—for example, a chipping sparrow's nest lined with pale material or a junco's nest exposed to strong sunlight; but my search has revealed few nests which seem to be out of place.

Another thing to be remembered is that the relations apply most strictly to species whose young are helpless and have to stay for some time in the nest. Precocial young that can move about soon after hatching have less need for any device to protect them from extremes of heat and cold. They can seek more suitable surroundings by moving. It is in such young birds that concealing coloration appears to have developed to a greater degree than has adjustment of down color to warmth. Only plain gray patterns modified toward black or white are needed for the latter purpose.

It is not possible to say whether the type of nest site results from the nature of nestling plumage or this plumage stage is adapted to the conditions at a traditional nest site; the latter seems the more likely explanation. The parallel adaptation observed in the nest linings, which are selected and assembled by the adults, indicates that the nature of the nest surroundings came first in establishing this relationship. Once established it seems obvious that mechanisms of natural selection would tend to maintain the balance among these adjustments. Thus, a species would continue to live where these, along with other sorts of adaptations, permit it to exist.

Habitat choice has been considered by some workers as largely a psychological manifestation with no means of identifying its physical basis. Coloration of young and of nest lining provides an avenue for simple structural responses to a single environmental factor, one which is widely effective among birds. Naturalists have wondered for a long time how any manifestation of heat could result in so varied a pattern of distribution as they observed in birds. The observations sketched here seem to show a way part of this regulation may be accomplished. It is not to be implied that this type of adaptation explains life zones or any other device for describing distributional occurrences, but a thorough examination of avian distribution from this point of view might leave fewer "mysteries" to be explained.

Summary.—Observations on the nesting of birds, especially in the Great Basin of western United States, have provided basis for the suggestion that discernible modifications have been made which enable nestlings to withstand subjection to extremes of insolation. In a series of species at least five degrees of shade are distinguished in coloration of nestling plumages (mainly down) and these are paralleled by color of

the nest lining in the same species. A high positive correlation is observed between these characteristics and the kind of cover at the nest site and the general climatic ranges of the birds. Apparently those kinds of birds which nest in exposed situations and which live in hot regions have pale or pallid nestling plumages and nest linings which reflect and counteract the harmful effects of sun rays. Kinds which live in opposite conditions are dark in both these respects and thus are able to absorb and take advantage of warmth from the sun.

Museum of Vertebrate Zoology, University of California, Berkeley, February 27, 1936.

THE ORANGE-BELLIED REDSTART OF WESTERN CENTRAL AMERICA

By A. J. VAN ROSSEM

Thanks to the investigations of Hellmayr (see Catalogue of Birds of the Americas, Part 8, 1935, p. 460), who has recently determined the status of Hartlaub's type of *Setophaga intermedia,* it is possible to provide, it is hoped, names which will be permanent for the three geographic variations of *Myioborus miniatus* which inhabit the mountains of central and northern Central America.

These three races are, briefly, one of relatively small size and orange-red or flame-scarlet underparts in the central and eastern parts of Guatemala, one of larger size and reddish orange or "bittersweet orange" underparts in the Pacific Cordillera of Guatemala and western El Salvador, and, finally, one of small size (in this respect similar to the race of central Guatemala) but with underparts similar to the western Guatemala birds in color, though averaging even more orange in series. The names applied to these races have been, respectively, *flammeus* Kaup, *intermedius* Hartlaub, and *connectens* Dickey and van Rossem. (In regard to the application of these names see Griscom, Distribution of Bird Life in Guatemala, 1932, pp. 341-342.) Hellmayr, however, has shown conclusively that Hartlaub's type of *intermedius* belongs to the smaller, central Guatemala race and, since this name has priority, *flammeus* Kaup of course becomes a synonym. This leaves nameless the Orange-bellied Redstart of western Guatemala and I therefore propose for it

Myioborus miniatus hellmayri, new subspecies

Pacific Orange-bellied Redstart

Type.—Breeding male adult, number 19050 Dickey collection; Volcan de Santa Ana, Depto. Sonsonate, El Salvador, altitude 6000 feet in the Humid Upper Tropical Zone, May 8, 1927; collected by A. J. van Rossem, original number, 11927.

Subspecific characters.—Nearest in color to *Myioborus miniatus connectens* Dickey and van Rossem, of the interior Cordillera of El Salvador and south central Honduras, but underparts averaging even more orange in series; size, however, larger, with particularly longer tail.

Range.—Mountains of western Guatemala and extreme southwestern El Salvador.

Remarks.—Dr. Hellmayr referred specimens from the range of *hellmayri* to *connectens* because of the similarity in color. The only two specimens of true *connectens* available to him were two from Volcan de Puca—scarcely enough to bring out what is so apparent in series, namely the decided size differences between the two races. In addition to the original series of *connectens* I have recently (November, 1933) had the advantage of inspecting, in company with Mr. Ludlow Griscom, a splendid series of that race from the mountains of south-central Honduras in the Museum of Comparative Zoölogy.