PRELIMINARY STUDIES OF WESTERN HERMIT THRUSHES

WITH FOUR ILLUSTRATIONS

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The following paper covers certain factors indicative of the present-day relationships of the Hermit Thrushes (species *Hylocichla guttata*) of the west. While studying a series of the birds collected near Barkerville, in central British Columbia, the authors became interested in the problem of these vaguely fluctuating forms, and ended by bringing together a rather large number of skins, of which some three hundred breeding specimens have been used in the present paper. No fresh or anatomical material has been available, no special studies of the factors of environment or habit have been attempted, and no material on the delimitation of winter ranges will be introduced at the present time. Other tasks prevent our following up the subject for the time being, but rather than distribute this collection fruitlessly, we ventured upon a revision of the group as far as possible on the basis of skins alone and these sadly limited in quantity and distribution. We hope soon to add further studies based on additional and fresh material which will fill up the geographic gaps and complete the mathematical analysis of variation in size and form, as well as a paper on migratory movements and winter ranges.

We believe that in the United States at least, a new race of bird should now be named only from its metropolis or optimum region and only as seems advisable after the most exhaustive revision of the whole species and comprehension of the relationships of the proposed sub-division. As the present paper hardly measures up to these requirements, we merely refer to such hitherto unremarked phases in geographic terms, without naming them.

CRITERIA

Color. The value of identifications of Hermit Thrushes can be gauged as in inverse proportion to the reliance on color. Almost invariably between *small* series from different ranges, especially if the lots are homogeneous as to locality, date, and collector, differences both in hue and value seem unquestionable. Only when large series are assembled which cover not only the whole season but (since undoubtedly birds from certain habitats show more wear than others) numerous localities, and only when these are watched and manipulated until we realize the full magic of light and the astonishing metamorphoses its modification can effect, does the hopelessly fugitive character of the color factor appear. The warmer grays and more neutral browns are at best, after the carnations, the most subtle and evasive of colors. In the case in point such foundation-hues are overlaid in fresh plumages by still more delicate and evanescent overtones of highly neutralized greens and reds. Add to these an unusual range of individual variation, incipient races of extreme proximity, the greatest tendency to wear we know of (we have some birds whose backs are covered with hair-like, nearly naked, feather-shafts), sensitive prismatic changes of color, including the disappearance of the reds of *nanus* and *faxoni*, with every degree and type of breakage, the power of the slightest film of grease, blood, or even water not only to turn a light olivaceous or reddish bird nearly black, but radically to modify such pattern as is present, substituting an effect of few and narrow in place of broad and numerous breast markings and obliterating the buffy band,—and we have some comprehension of the amount of error which has been perpetrated on museum labels and in check-lists as the result of color identifications. Color is of scant use, even in

large series, for separating the closely-allied intra-montane forms, that is, all those other than the eastern and western coastal races. Color characters in general are too variable and too vague to be susceptible of definite genetic analysis even if the races could be interbred in captivity. With the exception of a single race, color and size appear to be unlinked characters and tend to vary quite independently.

Size. The tarsus was measured from the second line of scutellar divisions above the unions of the toes to the center of the upper joint; the middle toe from the same division to the upper base of the claw; the bill from the anterior corner of the aperture of the nostril, without breaking the membrane, to the tip of the upper mandible; the tail from the basal bridge of integument between the deck pair to the end of the longest rectrix. All measurements were made with a fine slide-micrometer reading by dial to .10 mm. and by interpolation with fair accuracy to .01 mm. No measurements but our own have been used. Owing to the limited amount of statistical material most measurements have been tabulated in a somewhat undigested form as the means and simple extremes of races and localities. Standard deviation and its probable error have been computed and tabulated when the number of specimens justified some hope of their significance.

Sex. The only differences between the sexes which we have detected are quantitative. The following table shows the indices female over male for the five most abundantly represented races, and offers interesting comparisons with the graphs of the inter-racial variations. It is noticeable that while inter-racial variability is similar in wing, tail, and bill, between the sexes the wing and tail show a fairly constant differentiation in all races, with a suggestion of greater difference in *polionota*, while the bill-indices, considering the chance of error in so small a measurement, are amazingly close to 100%, or equality, in all races. Both inter-racially and intersexually middle-toe and tarsus vary vaguely, and hardly to a significant degree. One is left with the impression that wing, tail, and bill possess a certain constancy and significance, that they vary or remain constant purposefully, as though in response to a definite control.

Race	Wing	Tail	Tarsus	Middle toe	Bill
guttata	.961	.950	.991	.963	1.008
Southern B. C.	.952	.960	.980	.983	.999
nanus	.964	.955	.970	.979	1.003
sequoiensis	.951	.963	.998	.982	1.023
polionota	.944	.930	.978	.991	.993

Males are used for the ensuing tabulations both because the series are larger and because the three male curves, in the graphs, are decidedly more uniform.

It must in general be borne in mind that our object has been to lay the foundation for studies such as might produce some evidence of the course of genetic development of the races of the Hermit Thrushes and explain the present composition of the species, not to reapportion names or provide guaranteed recognition-marks. For instance, we are interested in the evidence that factors, genetic or environmental, are or have been at work with discernible results on the birds which breed in the Coast and Cascade ranges of the United States, along the humid northwest coast, and in other parts of Alaska, and we believe these well worth analysis; but we do not for a moment suggest that individual specimens of *slevini, guttata,* or somewhat worn *nanus* can be distinguished individually, in a large number of cases, without reference to the geographic data.

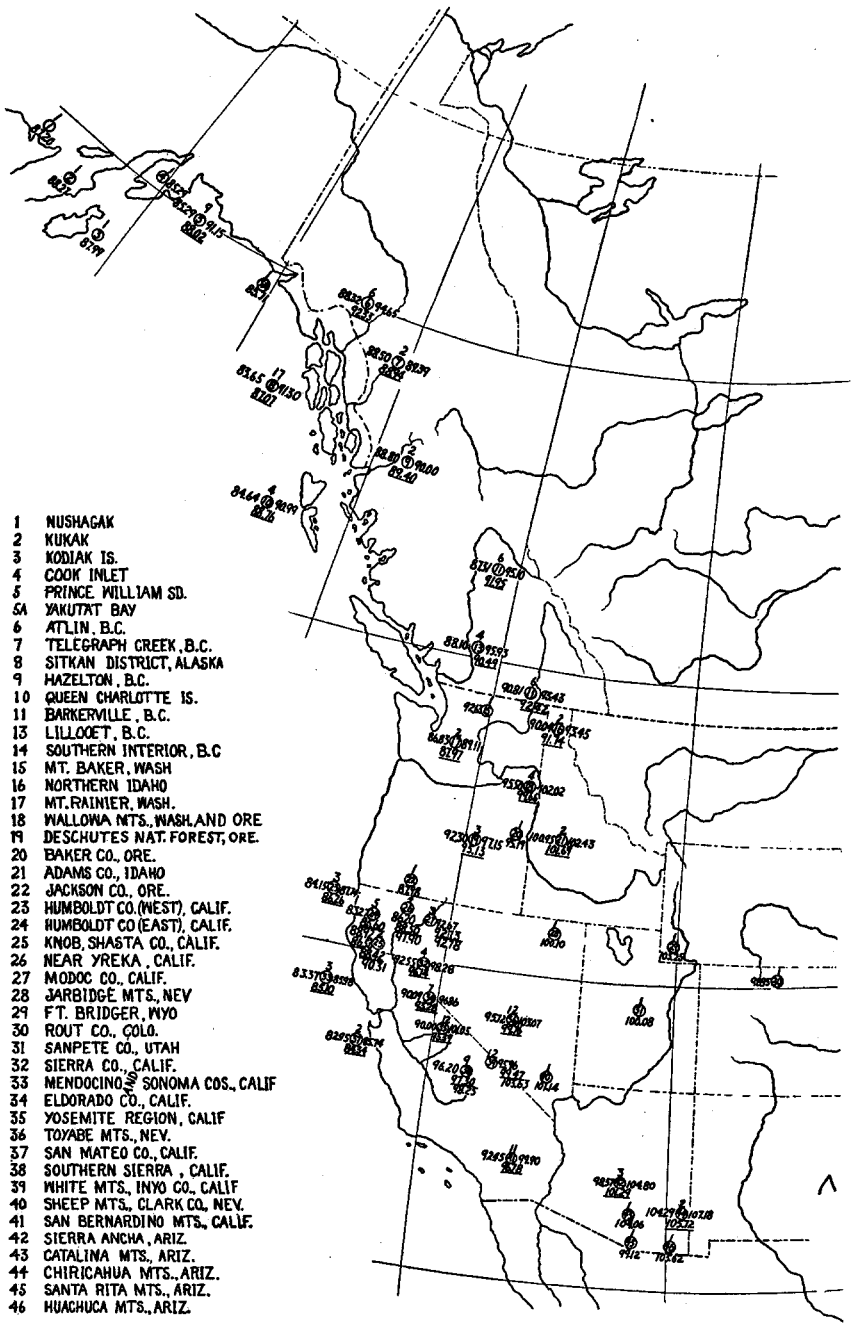

Fig. 4. WING MEASUREMENTS OF MALES OF *Hylocichla guttata* IN THE WEST. FIGURES WITHIN CIRCLES REFER TO THE LIST OF LOCALITIES. OTHER FIGURES GIVE THE NUMBERS OF SPECIMENS, THE MEANS (UNDERLINED) AND THE EXTREMES.

ALASKA AND THE NORTHERN INTERIOR

Hylocichla guttata guttata; Hylocichla guttata nanus; Hylocichla guttata faxoni. With the dwindling and disappearance of the coastal rain belt northwestward from the great Alaskan archipelago to and beyond Prince William Sound, the reddish tone of the coast birds tends to weaken (with no correlative variation which can be superficially detected), yielding to the somewhat more neutral average shade which prevails over the northern outposts of the species to and beyond the base of the Alaska Peninsula. Yet while the modification of the *average* color is distinct in large series, the degree of variability from red to gray remains striking. In our series of seven birds from beyond Prince William Sound there is a brilliantly red bird from Cook Inlet, and our only usable topotype from Kodiak Island would itself probably be referred to the red side of any rigid racial division. Inland and farther south, in spite of tight pinching, and even, in the valleys about Atlin, near-obliteration between the eastern and coastal forms, the same phase recurs in the mountains to north-central British Columbia.

As between this race and the most typical *nanus* of the coastal rain-forests, a considerable proportion of *fresh-plumaged* specimens, such as show the contrasting character to a marked degree, can be separated at sight. After mixing fifty skins, which represented all stages of the breeding season, 18 from Prince William Sound and 32 from the northern archipelagoes and adjacent mainland, we were able to pick out, in two attempts, seventy and seventy-five per cent of the total number correctly. The residue, though it chanced to contain many fresh plumages, seemed to be perfectly inseparable. It is possible that the perceptible distinctions might rise far higher, if not to one hundred per cent, between series of young birds passing or just passed from the juvenile into the immature plumage, and showing the latter, unbroken and unsullied, over the dorsal area. Of such specimens we have only three from the Sitkan district and two from Prince William Sound, but between these inadequate groups the difference in saturation is distinct.

Thus we may venture to contemplate, in southern Alaska and north-central British Columbia, two populations, differing slightly in color and almost imperceptibly in size, exhibiting perhaps the earliest visible results of radically differentiated environments, more or less isolated for long distances by the naked summits of the coast range, but intermingling in half a dozen great river valleys and half a hundred high timbered passes. Farther north and west occurs the disappearance of the factor of topographical isolation, with the environment reduced to something like a mean in the straggling margin of forest which extends for a thousand miles along the coast and islands of Alaska from Cross Sound to the shores of Bering Sea. Since the humid coast bird tends to show, in its red color, the positive modification, and since the coast forest itself is a most radically differentiated environment, it is natural, when we grope for causes, to link the two and to predict the gradual disappearance of the one with the other, that is, of the reduction of the red tone north of Sitka.

Of the more neutral phase, in its southern and inland range, east of the coast forests, we know only too little. Small series from Telegraph Creek on the upper Stikine and from Hazelton on the Skeena are indeed indistinguishable from those of Prince William Sound and beyond; but our simple picture of parallel interior and coastal races combining on the northern coast is complicated by the presence in the large valleys which surround Atlin, where such combination might be expected to begin, of a completely foreign quantitative factor in a majority of large birds, exceeding any so far considered by five per cent, and agreeing perfectly in size with the eastern form which we know to breed in the Mackenzie Valley and presume to

press westward, as it does in southern Alberta, to and into the mountains. In respect to this invasion Atlin must represent the very point of the spear, as no other known localities, either on the nearby coasts or southward in the upper valleys of the Stikine, where similar exposure to eastern invasion might be expected, tend, during the breeding season, toward this admirably concrete and measurable variation.

Before leaving the discussion of the northwestern races we must admit that while the differentiation of the coast bird depends on a single evidently incipient color-character, and the mere suggestion, in large series, of a reduction in size, yet within the southern limits of its range a sudden and isolated change in the size-character occurs which may indicate southerly connection with the small coastal race of the United States, which Grinnell has called *slevini,* and will probably be responsible for some future description of a new Vancouver Island race. Swarth (1912, p. 80) speaks of six juvenile birds taken on Vancouver Island as being far darker than juveniles from more northern points in the Sitkan district. We believe the single supersaturated bird which is responsible for this impression should be treated as a mutant or a rare extreme, and we do not find this distinction between other strictly comparable skins. On measurement, however, the six birds in question (all females) prove to be smaller by between four and five per cent than the females of any other group of *nanus* of like or unlike age, and so uniformly separable that the extremes overlap in only a single case, and then by only .03 mm. We have no fully adult birds of breeding date from Vancouver Island, and there is an almost complete lack of all ornithological material from the southern Canadian mainland coast. Two very small migrants taken at Portland, Oregon, on April 27, in 1908 and 1927, respectively, by S. G. Jewett and J. C. Braly, respectively, are almost certainly of this race.

It is an interesting fact which speaks for a mutative or genetic rather than directly environmental origin for these racial characters that such a variation should occur on Vancouver Island but not on the Queen Charlotte Islands, where so many common environmental factors recur in an enhanced degree.

SOUTHERN BRITISH COLUMBIA

As we follow southward in the northern interior into the watersheds of the Fraser and the Columbia and the closely adjacent parts of the northwestern states the curves which follow the relative variations of wing, bill, and tail do not keep to the average of the northern *guttata*, but rise to a new and higher level, which a detailed study of five scattered series proves to be consistent.

This becomes unmistakable in the series from the Barkerville region in the northeastern Cariboo district, in the great bend of the upper Fraser. Thence southward individual birds in the majority of cases may be identified not only by increased size but by a distinctly darker color, while the red variants, so common among the northern *guttata*, seem to have been eliminated, unless on contact with the eastern bird in the main ranges of the Rockies. Our usual lack of material from intermediate areas prevents an analysis of the southern termination or transition of this well-defined phase, but the racial map suggests a rather sharp break, across central Washington and Idaho, to the large race of the scattered ranges of the Great Basin.

In the discussion of the northern forms we saw that two races, coastal and interior, which we have every reason to believe of the closest possible genetic connection, differed slightly in color without differing materially in size. The present race, on the other hand, is the only example in the western field in which two well-developed characters, color and size, vary in apparent correlation, both appearing and

disappearing together, which constitutes an argument for the unity of the race as opposed to its interpretation as merely transitional in size between the birds of the north and south.

At first glance this apparent racial integrity is an embarrassing consideration to the student who wishes to analyze these races and regions by the methods of ecological correlation. It would be far easier to think in exclusively genetic terms of the propinquity of the large southern races. It is not easy to understand why a race which has persisted for some fifteen hundred miles in spite of intermittent susceptibility to neighboring genetic influences, and which, by means of a more and more elevated habitat can still occupy almost unchanged surroundings, should begin to vary without the intervention of any obvious geographic barrier.

Yet it is a striking fact that while at first, on the northern margin of the new racial area, the changes in environment appear to lie below and apart from the habitat of the Hermit Thrushes, none the less the northern limits of perceptible variation in the birds correspond closely with the first appearance, after the long monotony of the spruce, alpine-fir, and lodgepole-pine types, of a group of fundamentally new factors which foreshadow changes of continental importance. Such intrusive elements from the south and west are the far-reaching Douglas fir, which penetrates well into the chill humidity of the Cariboo and Selkirk mountains and becomes suddenly dominant on the benches and plateaus of the Fraser, the incipient grass-and-sage-brush, with true "bad-lands," alkali basins and even a widespread cactus, as far north as the junction of the Chilcotin River, and the first substantial appearance of the yellow-pine a few miles farther south. Farther still, in the southern interior of the province, with the progressive elevation of the forest belt, it seems unquestionable that yellow-pine, Douglas fir and western red cedar crowd more and more into the habitat of the thrushes, the average physical condition and appearance of the timber undergoes a change, and the increasing aridity of the lowlands breaks up the timbered zones into smaller and smaller "island" units which tend toward the conditions of the scattered ranges of the Great Basin.

It is from such more or less isolated interior mountain-masses that our series of the southern British Columbia race is derived. It is possible as we enter the great ranges of the Selkirks on the east, from which not a single bird is available, that modifications will be found, which might consist in decreased size (that is, more southern persistence of the unmodified *guttata* strain), but which will more probably show intergradation toward the eastern bird. When finally we cross the last intervening valley, where the headwaters of the Kootenay River are divided from those of the Columbia, and enter the Canadian Rockies proper, evidence of the influence of *faxoni* certainly appears, though our specimens illustrating such a condition are all from the eastern slopes, beyond the continental divide. These will probably be described by some future systematist as a new race. A series of seven birds which represent the eastern slopes of the rockies on the latitude of the present interior race and localities northward in the mountains and northeastward into the transcontinental forest as far as Lake Athabasca are very uniform and close to the Atlantic seaboard phase, though with distinct modifications toward the intramontane races just discussed. These modifications are notably the loss of the warm browns in the flanks and most of the buffy chest band, with a perceptible general graying above. The extent of these tendencies eastward and the manner of their disappearance in the dark western race remain to be investigated as material accumulates. It is probably rather more than intuitive imagination to detect consanguinity with these intergrades in our northern Cariboo series, close as it is to the great passes at the headwaters

of the Fraser and the Athabasca, and in the small series from Telegraph Creek, as well as the prepotence of the eastern form in the Atlin series.

THE COAST AND CASCADE MOUNTAINS OF THE UNITED STATES

Hylocichla guttata selvini. In the whole field under discussion there is no more acute shortage of material than in the two northwestern states. With the exception of two worn birds from Mt. Rainier we have no evidence to what degree the *nanus* strain carries its color phase across the straits of Juan de Fuca or the lower Fraser. Our suspicion, somewhat reinforced by the two Rainier birds, is that it does so little or not at all. Among the most interesting questions still to be answered is whether the transition above the mouth of the Columbia between the northern and southern coast forest types can be correlated with a *nanus-slevini* transition.

The race *slevini*, described, as seems to be the fate of Hermit Thrushes, from the extremest limit of its breeding range in Monterey County, California, shows a thoroughly constant population northward along the California coast and into southern Oregon. Since we are ignorant of its northern termination, it requires present discussion only in so far as it appears, north of the great interior valleys of California and with the reestablishment of high altitude lines of communication between the coastal and Cascade mountains, to affect the size of the nearest large inland group, whether *sequoiensis* or *polionota*, among the extreme southern Cascades.

SIERRA NEVADA, GREAT BASIN, AND ROCKY MOUNTAINS

Hylocichla guttata sequoiensis; Hylocichla guttata polionota; Hylocichla guttata auduboni. Whether the scattered specimens from central and eastern Oregon are to be interpreted as intergradational between the coast and Great Basin forms, or as a northward extension of the Sierran strain, freed from the temporary contact with *slevini*, can only be determined by the discovery of new anatomical differentiating characters.

Even when the neighboring populations lie on opposite slopes of the narrow Owens Valley, the Sierran and Great Basin races remain distinct, and within the Great Basin specimens from six widely separated ranges in California, Nevada,

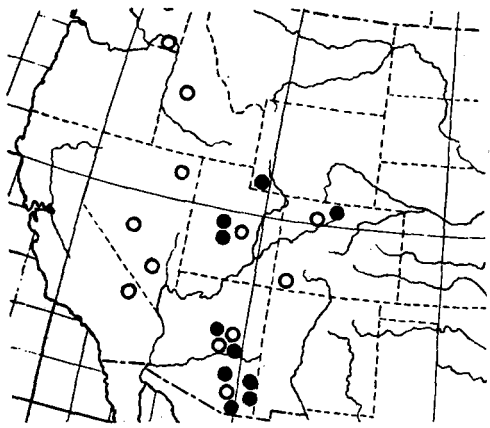

Fig. 5.

Idaho, and extreme southeastern Washington, show no tendency to vary. Thus Grinnell's *polionota*, described from the White Mountains of Inyo County in southeastern California, becomes the name of a widespread race. The clear demarcation in size of the races in question, along the eastern base of the Sierra Nevada, in spite of the close geographic proximity, is in sharp contrast to the baffling interpenetration which appears to exist farther east between *polionota* and the largest form of all, the rarely-collected *auduboni* of the southern Rockies.

A series of six adults, two males and four females, collected for William Brewster by M. Abbott Frazar between May 11 and June 8, 1887, in the Sierra de La Laguna in extreme southern Lower California, has been the subject of some comment in the literature of the species. The series, only five of which have wings and tail in a measurable condition, divides in a curious manner, as the two males are clear *polionota* and the three measurable females equally clear *auduboni*, which in itself suggests a migratory group rather than a breeding population. Of the five birds in question, three (one male and two females), were collected between May 25 and June 8, and should normally have been on their breeding ground. The two others, taken on May 11, are too early to require consideration. Since 1887, however, a considerable amount of collecting in Lower California, as well as Grinnell's (1928) ransacking of the ornithological records, has produced no further records of breeding Hermit Thrushes within the peninsula. We place particular reliance on the report of Mr. C. C. Lamb, who has worked the Sierra de la Laguna itself at the height of the breeding season. Pending further discoveries, therefore, we must content ourselves with speculation as to possibilities of delayed migration or abnormal conditions, and regard the series rather as an ornithological curiosity than as evidence of a resident population.

As to the status and distribution of *auduboni*, we can only suspend judgment and offer the scanty evidence available. A separate map (fig. 7) is added for this purpose, since it is necessary to use all material, of both sexes. As to the substantial existence of the race we can have little doubt, considering the easterly location of all our largest measurements, and the fact that their size is hardly approached in the several characteristic series of *polionota*. On the other hand there is less suggestion of intergradation than of a mixture of the two means in single populations, as in the Sierra Ancha. This is probably due, in such inadequate numbers, to chance failure to secure intermediate sizes.

The large male type, taken at Fort Bridger, Wyoming, on May 22, 1858, by C. Drexler, and kindly lent us by the National Museum, is quite indistinguishable from two males from the Chiricahua, one from the Huachuca, and one from the Catalina mountain ranges in southeastern Arizona. Between these geographic extremes, one female from Jackson County in northeastern Colorado and two from "Parley's Park," doubtless the present-day "Parley," in Juab County, Utah (Tintic Hills), taken by Ridgway in 1869, exceed the females of *polionota* by a corresponding amount. On the other hand a male from Rout County, Colorado (barely across the summits of the Park Range from the Jackson County bird just mentioned), a male from Sanpete County, Utah (just *east* of the Juab County bird), a female from Montezuma County in extreme southwestern Colorado, and one from the Santa Rita Mountains in Arizona, are of typical Great Basin dimensions. Furthermore, four birds from the Sierra Ancha, where intergradation might reasonably occur, divide two and two into distinct *auduboni* and *polionota* orders of magnitude! The only suggestion of intergradation we find is not in the area of contact, but in the maximum extremes of the large Toyabe Mountains series from central Nevada, and of the White Mountains series.

All three of these large southern races are light in color value; but our series of *sequoiensis* and *auduboni* are far more variable between a more neutral and a faintly reddish hue (though never to the *guttata* degree) than *polionota*, which is distinctly more consistent and more neutral, and recalls in both respects the unnamed race of south-central British Columbia.

RELATIONSHIPS OF RACES

When we try to detect such evidence of consanguinity between these races as might shadow forth a genetic theory of their relationships, the most confusing factor is the occurrence of the reddish hue in populations geographically and metrically so widely sundered. The two reds in question differ markedly, that of the northwest coast being rather dark and relatively neutral, that of the east light and relatively intense; but in so far as our chromatic sense can isolate it, the essential character of the basic red pigment does not change. Aside from the faint and very fugitive greenish cast which is present in the fresh body plumage of several forms, we may say that in color Hermit Thrushes vary in two principal ways: First, in hue, according to the concentration of the red pigment. Second, in value, according to the concentration of the gray or black pigment. Now since *nanus* is surrounded by and resembles in size three small and relatively dark forms, and since *faxoni* tends to group itself geographically and according to size with three large and relatively light forms, it seems natural to suggest that the difference in the two reds depends upon the amount of gray with which they are mixed, or upon the equilibrium of the two colors. Further, if, mindful of the probably more primitive character of the universal gray, and of the probably more conservative character of skeletal and size changes, we consider the red variations as late and superficial, the races fall at once into two highly satisfactory minor groups—the Pacific group, with its four small, dark, phases, three of which are so faintly discernible, and the central group, with its four large, light-colored forms, all more trenchantly divided. Each contains a single form which tends to a certain red hue, in one case faintly incipient and presumably imposed upon the darker gray, in the other case strongly developed and imposed upon the lighter gray.

This group division helps us to some understanding of the relationships and probable history of the races. The groups should not be confused with the "race-groups" (*Rassenkreise* or *Formenkreise*) of Rensch, Kleinschmidt and Hartert, which, if applied to the present case, would certainly include the whole species, and might be found to exceed its limits.

The weakness of a categorical system lies in the assumption of equality among the categories. In the present case neither the races nor the groups should be considered equal as to age or degree of divergence. The evidence suggests that the Pacific group as a whole is perhaps more nearly equivalent in these respects to the individual races of the continental group.

It would be futile on the basis of present knowledge to speculate further upon racial origins. It may, however, be worth while to call attention to the strikingly regular increase in size from northwest to southeast, and the possibilities of interpretation which this may offer in connection with a detailed study of the genetic relationships of *Hylocichla* with *Catharus, Erithacus, Ianthia,* and possibly other genera.

STATISTICAL TREATMENT

A large part of the material used in this paper is either barely sufficient or definitely insufficient to warrant the application of elaborate statistical treatment.

The following table of standard deviations, applied to the three most important measurements of the six most numerous racial series, gives a fairly definite idea of the degree of variation found in this material. The mean values are give in table I.

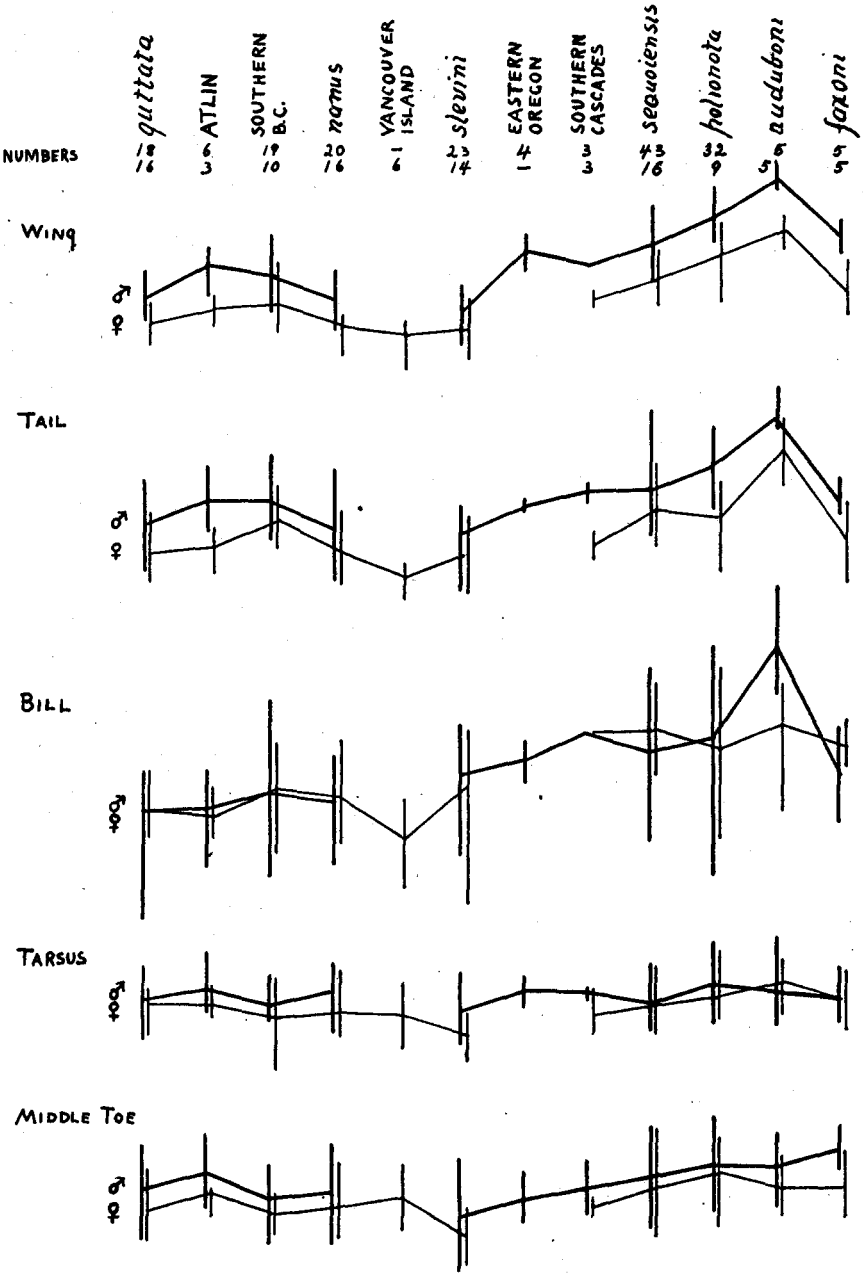

Fig. 6. GEOGRAPHIC AND INDIVIDUAL VARIATION IN MALES AND FEMALES OF *Hylocichla guttata*. CURVES FOLLOW THE VARIATIONS (PERCENT) FROM THE MEANS OF *guttata* OF THE MEANS OF OTHER GROUPS. VERTICAL LINES CONNECT THE EXTREMES OF EACH GROUP, WHICH ARE SHOWN AS PERCENT VARIATIONS FROM THE MEAN OF THE GROUP.

Race	Number	Wing	Tail	Bill
guttata	18	3.04 ± .342	3.20 ± .384	1.67 ± .130
Southern B. C.	19	4.40 ± .481	4.03 ± .480	1.04 ± .113
nanus	20	3.08 ± .328	4.09 ± .505	.65 ± .069
slevini	23	3.04 ± .308	3.34 ± .350	1.76 ± .178
sequoiensis	43	3.22 ± .234	6.14 ± .451	1.46 ± .107
polionota	32	3.52 ± .301	5.76 ± .519	1.19 ± .099

THE SIGNIFICANCE OF VARIATION

When these races have been analyzed for significant differences, especially those of size, the question arises of the interpretation of the latter as determinants of the essential character of the bird and therefore of their possible adaptive history or relationship to environment or migratory habits. Therein lies the descriptive weakness of appendicular measurements unsubstantiated by fresh or skeletal material. While we can show that the wings of the Hermit Thrushes of the southern Rocky Mountains and of those of the Great Basin exceed the races of the northwest by about 17 percent and about 12 percent respectively, and the tails by about 15 percent and 8 percent respectively, we still cannot state concretely whether the bird is consistently larger or whether it merely possesses longer wings, tail, and bill. The fact that the corresponding graphs of the tarsus and middle toe are flat may indicate stability

DIAGRAM OF DIFFERENTIATING CHARACTERS

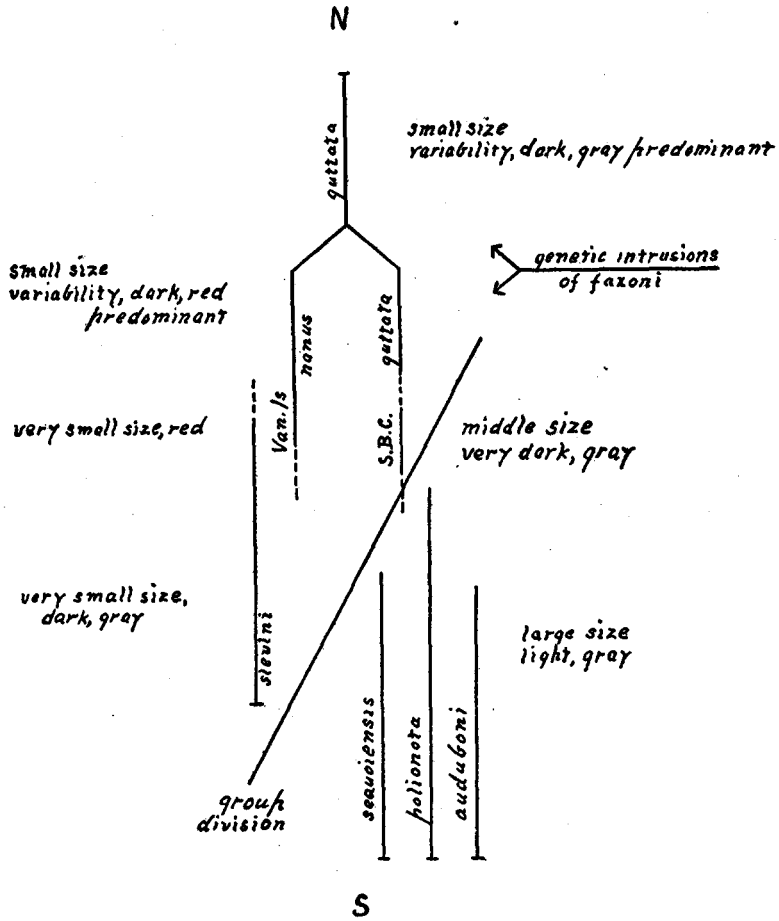

Fig. 7.

of essential size, or, on the contrary, that while the bird as a whole increases, these elements undergo relative retrogression. Since material for a full geometric analysis is lacking, there remains only one resource, that of mass. Of weights of specimens, thanks to the careful field technique of the Museum of Vertebrate Zoology, we have a fair number for certain races and seasons. Unfortunately, however, our total ignorance of the laws which govern weight, construction, type of flight and wing area, prevents the ensuing correlations from having much significance.

In order to develop some conception of the nature and reliability of the unfamiliar material we may start with a preliminary examination of the only large series of weights available, of California-taken October, November, and December birds of the *guttata-nanus* order of magnitude, of which we have 45 weights, distributed as follows. Weights are in grams.

Age and Sex	Number	Minimum	Mean	Maximum
ad. ♂	20	22.30	25.02	28.50
ad. ♀	12	19.90	23.42	25.50
im. ♂	8	22.20	24.77	27.00
im. ♀	5	22.50	23.62	25.50

When arranged in order of date, these weights show no progressive change.

From the amount of material available we are restricted to gross comparisons and need anticipate no difficulties from possible differences in weight between birds of the *guttata* and *nanus* breeding areas or even from the few possible Vancouver Island or southern coastal (*slevini*) birds which may be included. The table just given represents fairly enough the small western and northwestern races, and its purpose is to indicate roughly the degree of individual variability and the degree of variation between sexes and between adults and immatures, and to substantiate, with due allowance for variations under the stress of breeding conditions, the following tables of less significant numbers of breeding male birds.

Place	Number	Minimum	Mean	Maximum
Telegraph Creek, B. C.....	2	22.70	23.90	25.10
Humboldt Co., Calif.....	3	21.50	23.43	26.30
Central Sierra Nevada.....	4	24.50	25.77	26.70
Great Basin (Toyabe Mts.)	ad. 9	24.50	27.80	30.80
Great Basin (White Mts.)	jv. 4	29.10	30.20	30.80

The outstanding single item of reliable information to be derived from these tables is that the Great Basin race, which exceeds the small races in wing-length by about 12 percent exceeds them in weight by between 10 and 15 percent. Of this (since the weight of the whole wing from the distal end of the humerus is only about 2 percent of the total weight), the actual increment to the wings is a negligible fraction. Obviously the two variations are differential, as considering the relation between the mass and diameter of any roughly spherical object, a directly proportional increase in body size would be reflected in a far greater increase in body weight. We dare not, however, conclude from this that the change is really one of relative *utility* of wing or functional modification, because we know too little of the laws which control the factors involved. It is quite conceivable, for instance, that for a given type of flight [such, for instance, as those established by Böker (1930) in his analysis of flight-groups and flight-construction], there exists a relationship between weight and alar surface in which the latter increases either at a rapidly magnified or rapidly reduced ratio to the former. A rapidly magnified ratio would be consistent with the obvious fact that rapid and highly controlled flight of the passerine type is achieved by no large bird, and deteriorates rapidly with increased size even among the Passeriformes.

TABLE I. MEASUREMENTS

SHOWING RACIAL MEANS AND EXTREMES, IN MILLIMETERS

MALES

Place	Number	Wing Min.	Wing Mean	Wing Max.	Tail Min.	Tail Mean	Tail Max.	Tarsus Min.	Tarsus Mean	Tarsus Max.	Middle toe Min.	Middle toe Mean	Middle toe Max.	Bill Min.	Bill Mean	Bill Max.
Alaska Peninsula	3	85.29	86.22	88.27	63.42	66.07	67.65	27.61	28.33	28.76	15.82	16.59	17.12	8.48	8.80	9.13
Kodiak Island	1		87.99			69.12			30.06			16.00			9.13	
Prince William Sound	9	85.51	88.02	91.65	65.20	68.32	72.45	27.15	28.77	29.64	15.19	16.42	17.77	7.40	8.70	9.40
Yakutat	1		85.71			69.43			29.80			16.73			9.54	
Telegraph Creek, B. C.	2	88.50	88.94	89.39	69.38	69.62	69.87	28.00	28.40	28.80	15.80	16.22	16.64	8.50	8.80	9.10
Hazelton, B. C.	2	88.80	89.40	90.00	67.18	67.89	68.60	27.62	28.66	29.70	16.84	17.07	17.30	9.20	9.30	9.40
guttata	18		87.62			68.11			28.74			16.43			8.87	
Atlin, B. C.	6	88.32	92.33	94.65	67.30	70.32	74.00	28.33	29.39	31.00	16.30	17.16	17.80	8.04	8.82	9.40
Barkerville, B. C.	6	87.31	91.95	95.40	66.43	69.69	75.23	27.73	28.58	29.54	15.80	16.57	17.16	8.50	9.20	10.00
Lillooet, B. C.	4	88.10	90.49	95.93	67.40	71.08	75.84	28.10	29.10	29.92	15.92	16.18	16.40	8.70	9.30	10.50
Southern interior of B. C.	6	90.81	92.42	93.43	68.70	72.02	73.55	27.10	28.88	30.62	15.36	16.03	16.68	8.35	9.16	10.00
Mt. Baker, Washington	1		92.63			——			——			——			9.30	
Northern Idaho	2	90.04	91.74	93.45	68.30	69.05	69.80	26.30	27.50	28.70	15.73	15.91	16.10	7.92	8.67	9.43
Southern B. C.	19		91.75			70.57			28.62			16.18			9.13	
Sitkan district	17	83.65	87.07	91.30	64.96	68.08	73.90	27.50	29.19	30.00	15.10	16.39	17.74	8.50	8.99	9.63
Queen Charlotte Islands	4	84.64	88.76	90.99	62.38	68.41	71.75	28.15	29.02	29.78	15.90	16.84	17.49	8.70	9.31	10.13
nanus	20		87.20			67.32			29.15			16.46			9.00	
Mt. Rainier, Washington	2	86.83	87.97	89.11	66.20	67.95	69.70	27.92	28.37	28.83	16.23	16.73	17.23	9.55	9.56	9.58
Jackson Co., Oregon	1		87.98			66.85			27.58			16.03			9.50	
Near Yreka, California	4	86.20	88.50	91.90	65.89	69.94	72.43	27.80	28.18	28.75	15.20	15.93	16.57	9.23	9.66	10.15
Humboldt Co., Calif. (fog belt)	3	84.15	86.26	87.74	66.70	68.26	69.30	27.73	28.22	29.20	15.60	15.69	15.84	9.00	9.42	9.77
Humboldt Co., Calif. (interior)	5	83.27	85.60	88.92	64.42	68.94	69.26	28.32	29.01	29.33	15.00	15.75	16.70	8.98	9.51	9.85
Near Knob, Shasta Co., Calif.	2	86.53	88.42	90.31	69.10	69.20	69.31	28.10	28.12	28.14	14.99	15.15	15.32	9.77	9.93	10.10
Central California coast	6	82.95	84.80	85.94	62.15	65.78	67.82	26.32	27.74	29.77	14.52	15.18	16.23	7.60	9.27	10.10
slevini	23		86.61			67.76			28.24			15.67			9.50	

Place	Number	Wing			Tail			Tarsus			Middle toe			Bill		
		Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.
East central Oregon	4	92.30	95.35	97.15	69.12	69.79	70.10	28.93	29.52	30.24	15.77	16.29	16.88	9.30	9.76	10.20
Southern Cascades	3	92.67	92.73	92.78	70.10	71.58	72.91	28.75	28.89	29.13	15.80	16.44	17.21	10.10	10.10	10.10
Northern Sierra Nevada	11	90.09	94.32	98.28	62.56	70.96	75.61	27.18	29.03	30.41	15.72	16.65	18.10	8.81	9.86	11.05
Central Sierra Nevada	12	90.00	95.39	101.05	67.80	71.56	74.97	27.27	28.89	30.40	16.00	16.92	18.20	8.40	9.88	10.70
Southern Sierra Nevada	9	96.20	97.30	98.25	70.70	72.95	75.89	27.93	28,72	29.99	16.21	16.83	17.65	8.30	9.35	10.68
San Bernardino Mts.	11	92.45	96.78	99.90	65.86	72.39	77.35	27.12	28.82	29.68	15.58	16.72	18.02	9.00	9.87	10.83
sequoiensis	43		95.94			71.88			28.73			16.78			9.76	
Wallowa Mts., Wash. and Ore.	4	95.50	99.66	102.02	71.94	74.00	76.50	28.17	29.57	31.48	16.00	17.14	18.10	9.80	10.23	11.00
Smith Mts., Adams Co., Idaho	2	100.95	101.69	102.43	78.42	78.71	79.00	29.13	29.56	30.00	16.52	16.98	17.44	9.78	10.34	10.91
Jarbidge Mts., NE Nevada	1		100.10			76.48			29.64			16.62			9.38	
Toyabe Mts., Nevada	12	95.72	99.76	103.07	69.38	73.03	76.32	28.30	29.95	31.80	16.40	17.43	18.31	9.50	10.34	11.27
Clark Co., Nevada	1		101.14			72.86			29.88			18.20			10.05	
White Mountains, California	12	95.96	99.47	103.63	70.10	74.03	78.74	29.00	29.63	30.61	15.82	17.06	18.25	7.76	9.04	9.83
polionota	32		99.75			74.00			29.77			17.24			9.78	
Rout Co., Colorado	1		98.95			72.57			29.36			17.40			10.39	
Sanpete Co., Utah	1		100.08			70.74			28.35			17.02			10.78	
Sierra Ancha, Arizona	3	98.57	101.29	104.80	73.60	75.39	78.70	27.18	28.41	29.65	16.20	16.84	17.82	9.80	10.25	10.58
Santa Rita Mts., Arizona	1		99.12			72.28			31.60			18.20			10.10	
Fort Bridger, Wyoming	1		105.25			78.08			32.07			17.65			11.00	
Chiricahua Mts., Arizona	2	104.29	105.72	107.18	78.88	80.65	82.42	28.81	29.25	29.70	17.10	17.50	17.90	11.63	11.93	12.23
Huachuca Mts., Arizona	1		105.62			78.75			28.35			17.20			10.58	
Catalina Mts., Arizona	1		104.06			79.10			29.50			17.45			10.52	
auduboni	5		105.28			79.45			29.69			17.46			11.19	
FEMALES																
guttata	16	81.80	84.09	86.92	62.00	64.72	68.76	27.31	28.52	29.28	15.20	15.88	16.90	8.50	8.88	9.40
Atlin	3	84.21	86.10	87.99	63.00	65.10	67.20	28.00	28.45	29.12	15.77	16.31	16.75	8.50	8.75	9.15
Southern B. C.	10	83.60	87.34	93.45	64.85	67.78	71.66	25.42	28.06	29.88	14.63	15.90	16.88	8.20	9.12	9.60
nanus	16	80.43	84.09	86.30	61.31	64.29	68.50	27.30	28.26	30.10	15.31	16.11	17.10	8.30	9.03	9.78
Vancouver Island	6	79.33	80.69	82.35	60.50	62.38	63.88	26.73	28.19	29.20	15.43	16.27	17.10	7.81	8.38	8.97
Warner Mts., Calif.	3	84.95	85.62	86.48	64.18	65.64	67.10	27.52	28.22	29.30	15.77	16.03	16.30	10.00	10.13	10.40
slevini	14	79.15	83.10	85.05	60.88	64.41	66.84	26.20	27.29	29.50	14.67	15.49	16.17	8.60	9.24	10.00
sequoiensis	16	87.09	91.17	95.46	66.06	69.24	73.97	27.45	28.70	30.10	15.35	16.48	18.09	9.34	9.98	10.70
polionota	9	91.49	94.21	98.80	67.52	68.68	70.30	28.10	29.16	31.05	16.20	17.04	17.80	8.90	9.78	10.98
auduboni	5	96.31	98.69	101.36	70.37	74.01	78.15	28.10	29.55	30.54	16.35	17.00	17.95	8.71	10.09	10.64
faxoni	5	85.56	88.69	92.57	61.70	66.26	70.40	27.45	28.80	30.28	16.42	17.08	18.10	9.50	9.76	10.17

One resource remains which is probably capable of indicating a definite relationship, if such exists, between wing and weight. In the winter males and females of the races which breed in the northwest we have two groups of different sizes and weights but of like physical condition, in winter at least, and of like construction as far as our measurements can reveal it—of identical migratory habit, and identical environment at all seasons. Unequal division of labor during the period of laying and brooding are the only apparent differences in habits. In other words, we have two birds of different sizes in which we may believe that flight-power and flight-adaptation are identical. If therefore there exists anything like a constantly variable relationship between weight and wing-length in Hermit Thrushes, we might expect the same degree of relative differentiation to hold for a third form (in this case *polionota*), *if the third form is identical as to power of flight.* In other words we may set up the following proportion:

$$\frac{\textit{Wing. Pac. Group } \delta}{\text{Wing. Pac. Group } \varphi} : \frac{\textit{Weight. Pac. Group } \delta}{\text{Weight. Pac. Group } \varphi} :: \frac{\textit{Wing. Pac. Group } \delta}{\text{Wing. polionota } \delta} : x$$

That is: 1.040 : 1.068 :: .873 : x ; or, x equals .890. X, considered for the moment as the unknown, represents on this basis the ideal ratio of weights between the males of the northwestern races and of the Great Basin race, and works out as .890, or a difference of 11 percent.

In point of fact the actual index of the means of our weights works out as .900, if we use the large winter series of the Pacific group, and as .850 if we use the five breeding birds of those races. Undoubtedly the former figure is too large owing to winter condition and the smaller too small owing to preponderance of *slevini*, so that the results are strikingly close and suggest, within the limitations of such material, that a rather constant relationship of wing-length and weight exists between the two races in question.

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