Is Bumpus' study an example of natural selection in the wild?
or
Now you try it: one more look at Bumpus' sparrows.

Readings for Discussion:
Bumpus, H.C. 1899. The elimination of the unfit as illustrated by the introduced sparrow, ***Passer domesicus***. Biol. Lectures.Marine Biol. Lab, Woods Hole, MA: 209-226. (Appendix A)

Objectives:
· To learn a few things about the use of inferential statistics in biology.
· To critically evaluate a study often regarded as being the first demonstration of Darwin's theory of natural selection in wild animals.

From Bumpus (1899)-

In 1899 H. C. Bumpus demonstrated natural selection in the wild!

" ... on February 1 of the present year (1898), when, after an uncommonly severe storm of snow, rain, and sleet, a number of English sparrows [= House Sparrows, ***Passer domesticus***] were brought to the Anatomical Laboratory of Brown University [,Providence, Rhode Island]. Seventy-two of these birds revived; sixty-four perished; ... " (p. 209).

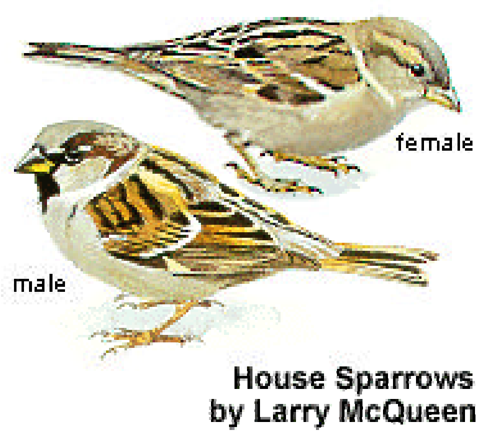
"... the storm was of long duration, and the birds were picked up, not in one locality, but in several localities; ... " (p. 212).

Or did he?

"It is quite as dangerous to be conspicuously above a certain standard of organic excellence as it is to be conspicuously below the standard. It is the ***type*** that nature favors." (p. 218).

Assignment:
Hermon Bumpus came to his conclusions based upon the available statistical tools of his time. In this lab exercise you will determine if the Bumpus data set actually supports the conclusions drawn using modern statistical tools.

Study Organism



Description: Although House Sparrows belong to a different family of birds, they closely resemble North American sparrows. They are short and stocky with shorter legs and thicker bills than native sparrows. The back is brown with black streaking. The breast and belly are unstreaked dull gray. Males in breeding plumage have a gray crown, with chestnut bordering the crown and extending down the back of the neck. The cheek and side of the neck are white. A black bib extends to the throat and meets the black stripe in front of the eye. The bill is dark gray black, and the legs are pale brown. The rump is gray, the shoulders are chestnut, and the wings are brownish with a white wing bar. The tail is dusky gray brown. Fall and winter males may lack the bright colors and black bib.

Females have a grayish brown crown and a grayish buff superciliary stripe. They lack the chestnut and black colors of the male, and their upperparts and wings are much grayer than the male. The back is light brown with black streaks; the rest of the head, breast, and sides are grayish brown. The belly is dull white. The bill and legs are pale brown. Immature males resemble females, except for the darker crown and a faint grayish bib.

Attached is the data set collected in 1898 and published in 1899 by Dr. Hermon Bumpus (Bumpus 1899). The paper also may be found in Bajema's more recent collection (Bajema 1983). I suggest you read his paper, for it makes a fascinating contrast to current scientific publications. Not only does it not have the modern format but it lacks the standard statistical techniques that we have come to expect. Nevertheless, it has become a classic paper in evolutionary studies and is well worth examination.

Some brief background: in February, 1898, there was a severe winter storm with rain, sleet, and snow near Providence, RI. One hundred thirty six English sparrows were found freezing and brought to Dr. Bumpus' laboratory at Brown University. Of those, 72 survived and 64 died. Bumpus took advantage of the opportunity to study an episode of natural selection. He measured a number of characteristics of the birds and analyzed them to find differences between the survivors and those that perished. His general conclusion was that the sparrows were subjected to ***stabilizing selection*** -- birds that were markedly different from the average were more likely to have died. In Bumpus' quaint phrasing:

> "The process of selective elimination is most severe with extremely variable individuals, no matter in what direction the variations may occur. It is quite as dangerous to be conspicuously above a certain standard of organic excellence as it is to be conspicuously below the standard. It is the ***type*** that nature favors."

Bumpus seems to have expected his raw data to be useful to others, for he published them (Appendix B). Indeed, as statistical methods have improved, a number of scientists have reexamined his data (Harris 1911; Calhoun 1947; Grant 1972; Johnston, Niles et al. 1972; O'Donald 1973; Manly 1976; Manly 1985; Crespi and Bookstein 1989). Bumpus' complete paper is reproduced in Appendix A. The data from Bumpus' Tables I through IIIa are also reproduced in Appendix B without his superscripted notations and averages.

We will assign one or more variables to you or your team and ask that you use the statistical methods you know to test Bumpus' conclusions. Before you do that, however, you will need to give some thought to how you wish to organize the data for analysis -- Bumpus' organization is not suited to modern methods. How you reorganize, enter, and verify your copy of his data is one point of this exercise.

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Appendix A

ELEVENTH LECTURE.

THE ELIMINATION OF THE UNFIT AS ILLUS–TRATED BY THE INTRODUCED SPARROW, *PASSER DOMESTICUS*.

(A FOURTH CONTRIBUTION TO THE STUDY OF VARIATION)

HERMON C. BUMPUS.

WE are so in the habit of referring carelessly to the process of natural selection, and of invoking its aid whenever some pet theory seems a little feeble, that we forget we are really using a hypothesis that still remains unproved, and that specific examples of the destruction of animals of known physical disability are very infrequent. Even if the theory of natural selection were as firmly established as Newton's theory of the attraction of gravity, scientific method would still require frequent examination of its claims, and scientific honesty should welcome such examination and insist on its thoroughness.

A possible instance of the operation of natural selection, through the process of the elimination of the unfit, was brought to our notice on February 1 of the present year (1898), when, after an uncommonly severe storm of snow, rain, and sleet, a number of English sparrows were brought to the Anatomical Laboratory of Brown University. Seventy–two of these birds revived; sixty–four perished; and it is the purpose of this lecture to show that the birds which perished, perished not through accident, but because they were physically disqualified, and that the birds which survived, survived because they possessed certain physical characters. These characters enabled them to withstand the intensity of this particular phase of selective elimination, and distinguish them from their more unfortunate companions. It will be convenient for us to arrange our material in the form of tests, as follows.

Test 1: Sex.—It will be noted by reference to the tables that of the *surviving* birds the males are much more numerous than the females. Of the former there are fifty–one (thirty–five adults and sixteen young), while of the latter there are only twenty-one. Among the birds which perished, the females are absolutely and relatively more numerous than they are among the birds which survived, although more than one–half (thirty–six out of sixty–four) of the unfortunate birds are males. Of course it may be that male birds are naturally more abundant than females, but the present question is not one of distribution of sex, but rather of distribution of fitness, and the inference is that the females are less competent to resist severe winter weather than are the males, for, while only 28% of the survivors are females, they constitute 43% of those that perished.

Test 2: Length — The first column of figures on the several tables gives, in millimeters, the lengths of the birds from the tip of the beak to the tip of the tail. An examination of the averages, printed at the bottom of each column, will prove particularly instructive. It will be noted on Tables I and I[a] that the average length of the adult males which survived (159 mm.) is really less than that of the adult males which perished (**162** mm.)[1] Similar figures, 159 mm. and **162** mm. on Tables II and II[a], indicate the same relative lengths of the young males of the two groups. The average lengths of the females of the two groups, 157 mm. and **158** mm., Tables III and III[a], also indicate an excess in the average length of the birds which perished. The birds which perished, then, males or females, adult or young, are longer than those which endured, and we are justified in concluding that when nature selects, through the agency of winter storms of this particular kind of severity, those sparrows which are relatively short stand a better chance of surviving.

Test 3: Alar Extent.— Averages based on measurements from tip to tip of the extended wings fail to bring out any striking difference between the two classes of birds. Both have an indicated average of 2.45 mm., although, to be more exact, the birds which perished averaged **2.449**, while those that survived averaged 2.455, a difference too slight to be of material significance. This similarity of the two groups is not to

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[1] The numbers printed in light type, both in the text and in the tables, refer to birds which survived; those printed in heavy type refer to birds which perished.

be wondered at, since it is not to be expected that one eliminative agent will express itself in all possible anatomical features. Were the eliminative agent, for example, a severe northerly wind of protracted duration, the alar extent might then enter in as a factor of considerable selective value, and survivors would then have an alar extent materially different from that of the birds eliminated.

The alar extent of the females, corresponding with their smaller size, is less than that of the males.

Test 4: Weight.—Had I been called upon to express an opinion as to whether heavy or light birds would be more successful in resisting the severity of the February storm, I should have declared unhesitatingly in favor of the heavy birds. An examination of the third column of measurements, however, will show that the birds which survived invariably average less in weight than those which perished, and that among the males this difference amounts to more than a gram; that is, to about one twenty–fifth of the weight. The surviving birds of both sexes had an average weight of 25.2 grams, and those which succumbed had an average weight of **25.8** grams.

It may not be out of place to call attention here to certain objections which may be raised to the method which I have adopted, and to the conclusions thus far derived therefrom. One may claim that the greater relative number of females in the group of birds which perished vitiates the numerical result, since the females are of less stature than the males. But it will be noted that this objection answers itself, for the birds which perished are not shorter, but longer, than those which survived; and again, that the birds which perished, though having a disproportionate number of the lighter sex, nevertheless have an average weight considerably greater than that of the birds which survived. Moreover, comparing, in the two groups, adult males with adult males, young males with young males, and females with females, we find that the differences between the two classes of birds are expressed in these three smaller divisions, and I think we are justified in concluding that the differences are really significant.

The explanation that the birds which lived were those which sought, or at least enjoyed, better shelter cannot be entertained, for the storm was of long duration, and the birds were picked up, not in one locality, but in several localities; and, moreover, it is a fact that the survivors are *structurally different* from those which perished. If to these structural characters one desires to add also the intellectual character that the birds knew enough to go in out of the storm, the difference between the two groups becomes so much the greater.

Test 5: Length of Head.—A comparison of the average lengths of head, from the tip of the beak to the occiput, shows only a similarity between the survivors and those which perished, and indicates that under the present environmental conditions this feature is not sufficiently prominent to be expressed by this method of computation.

Test 6: Length of Humerus.—An examination of the fifth column of figures will show that the length of the arm bones of the birds which perished always averages less than that of the survivors. This difference is most conspicuous in the adult males, where the surviving birds have an average length of humerus of .738 of an inch, considerably more than that of their unfortunate companions, **.727**.

Here again I wish to emphasize the fact that these differences cannot be merely accidental, because they so often tend in the same direction. If among the survivors it is the proper thing for adult males to have a long humerus, then the young males have a long humerus, and the females follow the prevailing fashion with characteristic servitude. If a short humerus is an index of inferiority, all three groups of eliminated birds (adult males, young males, and females) bear this same mark of inferiority. This fact is the more striking since the averages are established on a relatively small number of birds, while usually in the statistical methods of the study of variation an abundance of material is necessary.

Test 7: Length of Femur.—An examination of the general averages on Tables III and III[a] shows that the survivors possess longer thigh bones than do the birds which succumbed. The average length of femur in the former is .716 inch; in the latter **.709**. This difference in the averages cannot be ascribed to the large number of dead females, since the difference prevails also for both the adult and young males.

Test 8: Length of Tibio–Tarsus.—Measurement of the tibio-tarsus yields practically the same comparative data as the measurement of the upper bone of the leg, although in both groups of birds this bone in the females is considerably longer than in the adult males, notwithstanding that the females are smaller. This series of measurements agrees with the sixth, in that the young males have longer legs than the adult males.

Test 9.—Measurements across the skull, from the postorbital bone of one side to the postorbital bone of the other, are given in the eighth column, and are less satisfactory, perhaps, than those of other portions of the skeleton. The breadth of the cranium, as thus indicated, is somewhat less in the females than in the males. The averages denote that the birds which survived had wider heads than those which perished, but these averages are considerably influenced by data furnished by the young males. The irregularities in the subordinate groups induce me to place less confidence in these numerical results than in the results from measurements of other structures.

Test 10: Length of Sternum.—This test differs from other tests in that it relates to measurements in the longitudinal axis of the body. In the males the sternum is long, and in the females it is short. In the birds which survived it has a general average length of .845 inch; in those which perished it has a general average length of only **.834**.

I think these tests prove that there are fundamental differences between the birds which survived and those which perished. While the former are shorter and weigh less (i.e., are of smaller body), they have longer wing bones, longer legs, longer sternums, and greater brain capacity. These characters are in accordance with our ideas of physical fitness; their defective development is evidently a mark of inferiority, and we are justified in concluding that the birds so handicapped failed to pass one of Nature's rigorous tests and perished.

In an earlier lecture, on the “Variations and Mutations of the Introduced Sparrow,” facts were adduced which, it was claimed, were sufficient to show that the English sparrow, since its introduction into this country, has found life so easy that the operation of natural selection has been practically suspended, and that the American type consequently has become degenerate. No active agent had eliminated anomalies, and certain “freaks” had increased in number, until they had become over four times as numerous as in England.

When calling attention to the occurrence of these variations, and to the fact that they were an indication of the absence of an active eliminative factor, I little thought that within a few months I might witness the action of an eliminating factor that would test the structural qualifications of *all* the birds: destroy those which had departed unduly from the ideal type, and thus raise the general standard of excellence.

It will be recalled that, after the storm of February 1, one hundred and thirty–six birds were taken, and that, of these, seventy–two revived, while sixty–four failed to recover. But the fact that the birds which perished had in the *average* longer and larger bodies, and shorter head, wing, and leg bones, does not tell all the story of selective elimination.

Reference to the tables will show, not only that the longest bird perished, but also that the shortest bird perished. The longest bird was No. **33**, the shortest No. **40**. (In these and other cases of extreme departure from the mean, the exponent I is placed in the table beside the number of the bird.)

Again, if we examine the columns of figures which indicate the alar extent of the different birds, we find that both the bird with greatest spread of wings, No. **32**, and the one with least spread of wings, No. **52**, perished.

The heaviest bird, No. **23**, weighed 31 grams; it perished. The honors for lightness are evenly divided; No. 53, among the survivors, and No. **60**, among the eliminated, have the same weight, *viz*., 22.6 grams.

The bird (No. **55**) whose head was longest (measured from the tip of the beak to the occiput) suffered elimination. The extreme variant in the opposite direction (No. 9) survived.

The honors for the longest humerus, .780 mm., are divided, Nos. 6 and **44**. The bird with the shortest humerus, No. **21**, perished.

The longest femur was possessed by bird No. **55**, the shortest by No. **51**. The surviving birds represent both extremes of variation of the tibio–tarsus (Nos. 18 and 41). In respect to all other columns of measurements the survivors possess exclusively never more than one of the *extreme* forms.

Both extremes of variation in width of cranium (Nos. **55** and **52**) are found among the eliminated birds.

The longest sternum is found in one of the surviving birds (No. **15**), and it will be remembered that a long sternum was considered a mark of excellence. The shortest sternum (No. **52**) is found among the eliminated birds where the standard is low.

These extremes of variation are represented on Table IV, and by counting the dark numbers we find that eleven extreme positions (maximum or minimum) are occupied exclusively by the birds which perished, whereas the light numbers show that only five extreme positions are occupied by those which survived. In two cases (the minimum weight and the maximum length of humerus) the extreme positions are occupied alike by birds of both groups, and consequently I have left the spaces blank. In three cases two birds of the same group occupy the same extreme position, but the table is designed to indicate only the *extreme positions* and not the number of birds occupying them. The *number* of birds occupying these extreme positions is represented on the previous tables by the exponent 1, and if we count up these exponents, we shall find that among the surviving birds there are nine cases of this extreme type, whereas among the birds which perished there are fourteen cases. These numbers are the more impressive when one considers that, inasmuch as there are seventy–two of the former birds and only sixty–four of the latter, the chances for the occurrence of extreme variation are not equal in the two groups. The birds which perished are at a decided disadvantage because of their smaller representation, yet there are many more "freaks" among them than among the surviving birds.

If it is thought that the association of the larger number of *extreme* variants with the eliminated birds is merely a matter of accident, we will not stop to argue the matter, but will apply the same test to the birds that remain after these extreme examples have been removed. We find even after the removal of these twenty–three examples, that extreme examples of the second order, indicated by the exponent 2, show the same tendency to occur more frequently among the eliminated birds.

The longest birds now are 166 mm.; the shortest, 153 mm. Of the former, Nos. **22**, **24**, **28**, **32**, **35**, perished, and No. 18 survived; of the latter, Nos. **45** and **62** perished, and Nos. 35, 54, and 55 survived.

If we count the times that the exponent 2 occurs in the tables, we shall find that there are ten birds of extreme abnormality of this second grade which survived, while there are twenty of the same grade which perished.

These figures indicate that the amplitude of variation of the surviving birds is less than that of the birds which perished. Were we to attempt the arrangement of the data into curves of distribution, the curve representing the distribution before the storm would be found to have a broad base, whereas the curve representing the distribution after the storm would be found to have a narrow base, for the eliminative process concentrated its energy on the individuals which occupied extreme positions.

Lest there remain some doubt as to the importance of this eliminative process, and of its efficiency in exterminating extreme variants, let us examine our figures again and see whether the group of birds which has already contributed thirty–four of the extremes of variation has still an excess of variability.

If we count up the exponents (3) of this third order of variable individuals, we find that the birds which survive give eleven examples, whereas those which perished give twenty–one. — It appears unnecessary to carry our investigations further along this line, for our results point always in one direction.

Natural selection is most destructive of those birds which have departed most from the ideal type, and its activity raises the general standard of excellence by favoring those birds which approach the structural ideal.

Inasmuch as the variation in structure in the birds which perished tends to centre about certain individuals, as, for example, Nos. **45**, **52**, and **55**, it might be claimed that the accidental presence of a few of these extremely abnormal individuals in this group is what really makes all the difference. Let us see.

There are twenty–three birds among the seventy–two survivors whose measurements bear exponents of extreme variation, and there are twenty–four birds similarly distinguished among the sixty–four which perished. But none of the birds in the first group has more than three exceptional features, whereas several of the birds which perished have a considerably larger number of exceptional features: four, five, and in one case, No. **52**, even six.

Of the twenty–three survivors which bear exponents, nineteen have only one exceptional character, and it is not surprising, considering the high standard of excellence possessed by these birds as a whole, that a single unfavorable feature does not prove fatal. There are but ten of the eliminated birds which have only one exceptional character, and the fact that some are burdened with more than one is apparently the reason for their mortality.

In an earlier contribution to the Study of Variation I called attention to a coincidence which may have considerable significance. When specimens of *Necturus* varied in respect to any one feature, there was a tendency for such specimens to present other and not necessarily correlated variations. Stated in another way, instability in respect to any one feature is an index of general organic instability. A similar coincidence of variations occurs among the sparrows.

Of the one hundred and thirty–six birds, five (Nos. 3, 47, 70, **21**, **52**) had albino feathers. Like other abnormalities endured by the surviving birds, albinism in two out of the three cases is the only affliction. But among those that were eliminated, where albinism twice occurs, it affects in one case a bird marked by four other abnormalities (No. 21), and in the other a bird (No. **52**) already cursed by six abnormalities, the most miserable individual in the entire collection.

While we have shown that the birds which perished have certain average structural peculiarities which distinguish them from the survivors, and that the intensity of selective elimination has been felt most by birds of extreme structure, it remains to be shown that a *general instability* of structure is as characteristic of the birds which perished as a *general stability* of structure is characteristic of those which survived. If we had sufficient data, this fundamental difference in the two groups of birds might be indicated by curves of distribution, one curve narrow and elevated, showing that its components are closely crowded around an ideal mean, the other broad and low, showing that its components are relatively indifferent to any ideal. But in the absence of sufficient data to illustrate the differences in this manner, we can arrive at a numerical result equally instructive by another method.

Having determined the ideal means for the several characters in each group of birds, we can then find the distance that each individual departs from this ideal. By adding these degrees of departure in respect to the several characters, and dividing by the number of individuals, we shall have numbers which represent the *average* departures from the ideal means. These numbers will be large if the members of a group of birds show a general tendency towards *disregard* of the ideals, and they will be small if the birds tend to crowd around the ideals. If all the birds actually attain the ideals, the number will be zero. — This is simply following out the principle that one man at the end of a ten–foot lever can do as much work as ten men at the end of a one–foot lever. A bird removed ten units from the mean exerts the same divergent influence upon its group that ten birds would exercise if removed one unit.

The results of this test, numerically expressed in Table V, are most instructive. In every case but one the numbers indicating the average departure from the ideal mean are smaller for the birds which survived, and thus indicate a general tendency toward conservatism on the part of the survivors. In the single exceptional case the numbers are not very different, 32 and **31**. Granting this exception to the uniformity in the figures, it is exceedingly interesting to examine the series. In respect to length, the birds which perished had an average departure from the ideal mean expressed by the number **3.48**, while the average departure of the birds which survived was only 2.51, or, expressed in tabular form:

In	respect	to	length,			**8.48**	is	greater	than 2.51
"	"	"	alar extent,			**4.60**	"	"	" 4.20
"	"	"	weight,			**12.5**	"	"	" 1.09
"	"	"	length	of	head,	**5.64**	"	"	" 5.51.
"	"	"	"	"	humerus,	**20.1**	"	"	" 16.0.
"	"	"	"	"	femur,	**20.0**	"	"	" 14.0.
"	"	"	"	"	tibio–tarsus,	**38.8**	"	"	" 29.4
"	"	"	width	of	head,	**12**.	"	"	" 10., but
"	"	"	length	of	keel,	**31.**	"	less	" 32.

A series of eight consecutive cases like the above, all pointing in the same direction, can hardly be considered accidental.

To summarize:

(I) We have found that there are fundamental differences between the surviving birds and those eliminated, and we conclude that the birds which survived survived because they possessed certain structural characters, and that the birds which perished perished not through accident, but because they did not possess certain structural characters which would have enabled them to withstand the severity of the test imposed by nature; they were eliminated because they were unfit.

(2) The process of selective elimination is most severe with extremely variable individuals, no matter in what direction the variations may occur. It is quite as dangerous to be conspicuously above a certain standard of organic excellence as it is to be conspicuously below the standard. It is the *type* that nature favors.

(3) Disregard of structural qualifications finally produces a throng of degenerates, whose destruction will follow the arrival of adversity.

Table I.
Measurements of Thirty-five Males which Survived

	Total Length	Alar Extent	Weight	Length of beak and Head	Length of Humerus	Length of Femur	Length of Tibio-Tarsus	Width of Skull	Length of Keel of Sternum
1 ♂	154[3]	241	24.5	31.2	0.687	0.668	1.022[2]	0.587	0.830
2 ♂	160	252	26.9	30.8	0.736	0.709	1.180	0.602	0.841
3 ♂	155	243	26.9	30.6	0.733	0.704	1.151	0.602	0.846
4 ♂	154[3]	245	24.3	31.7	0.741	0.688	1.146	0.584	0.839
5 ♂	156	247	24.1	31.5	0.715	0.706	1.129	0.575	0.821
6 ♂	161	253	26.5	31.8	0.780[1]	0.743	1.144	0.607	0.893
7 ♂	157	251	24.6	31.1	0.741	0.736	1.153	0.610	0.862
8 ♂	159	247	24.2	31.4	0.728	0.718	1.126	0.609	0.793
9 ♂	158	247	23.6	29.8[1]	0.703	0.673	1.079	0.602	0.820
10 ♂	158	252	26.2	32.	0.749	0.739	1.153	0.614	0.857
11 ♂	160	252	26.2	32.	0.741	0.723	1.129	0.624	0.892
12 ♂	162	253	24.8	32.3	0.766	0.752	1.134	0.633	0.923[2]
13 ♂	161	243	25.4	31.8	0.721	0.722	1.126	0.597	0.891
14 ♂	160	250	23.7	29.8[1]	0.730	0.703	1.103	0.590	0.820
15 ♂	159	247	25.7	31.4	0.729	0.717	1.141	0.592	0.927[1]
16 ♂	158	253	25.7	31.9	0.743	0.699	1.150	0.600	0.860
17 ♂	159	247	26.5	31.6	0.733	0.714	1.155	0.611	0.923[2]
18 ♂	166[2]	253	26.7	32.5	0.767	0.765[2]	1.230[1]	0.600	0.878
19 ♂	159	247	23.9	31.4	0.752	0.723	1.113	0.602	0.825
20 ♂	160	248	24.7	31.3	0.752	0.737	1.176	0.603	0.803
21 ♂	161	252	28.	31.8	0.770[2]	0.731	1.190	0.590	0.885
22 ♂	163	251	27.9	31.9	0.769[3]	0.745	1.168	0.622	0.860
23 ♂	156	242	25.9	32.	0.723	0.711	1.116	0.609	0.886
24 ♂	165[3]	251	25.7	32.2	0.751	0.742	1.161	0.613	0.865
25 ♂	160	247	26.6	32.4	0.728	0.707	1.108	0.590	0.836
26 ♂	158	244	23.2[3]	31.6	0.730	0.713	1.142	0.585	0.888
27 ♂	160	242	25.7	31.6	0.709	0.705	1.124	0.620	0.788
28 ♂	157	245	26.3	32.2	0.741	0.726	1.143	0.595	0.850
29 ♂	159	244	24.3	31.5	0.723	0.698	1.107	0.615	0.847
30 ♂	160	253	26.7	32.1	0.739	0.714	1.117	0.592	0.864
31 ♂	158	245	24.9	31.4	0.726	0.703	1.119	0.580	0.854
32 ♂	161	247	23.8	31.4	0.735	0.694	1.101	0.602	0.789
33 ♂	160	247	24.6	32.3	0.756	0.745	1.135	0.607	0.905
34 ♂	160	247	27.	32.	0.755	0.736	1.174	0.631	0.873
35 ♂	153[2]	241	24.7	32.2	0.728	0.680	1.092	0.592	0.884
Average	159	247	25.4	31.6	.738	.716	1.135	.602	.857

Table Ia.

Measurements of Twenty-four Adult Males which Perished

	Total Length	Alar Extent	Weight	Length of beak and Head	Length of Humerus	Length of Femur	Length of Tibio-Tarsus	Width of Skull	Length of Keel of Sternum
1 ♂	**165[3]**	**249**	**26.5**	**31.**	**0.738**	**0.704**	**1.095**	**0.606**	**0.847**
2 ♂	**160**	**245**	**26.1**	**32.**	**0.736**	**0.709**	**1.109**	**0.611**	**0.842**
3 ♂	**161**	**249**	**25.6**	**32.3**	**0.743**	**0.718**	**1.128**	**0.602**	**0.828**
4 ♂	**162**	**246**	**25.9**	**32.3**	**0.738**	**0.709**	**1.135**	**0.607**	**0.869**
5 ♂	**163**	**250**	**25.5**	**32.5**	**0.752**	**0.731**	**1.197**	**0.623**	**0.888**
6 ♂	**162**	**247**	**27.6**	**31.8**	**0.731**	**0.719**	**1.113**	**0.597**	**0.869**
7 ♂	**163**	**246**	**25.8**	**31.4**	**0.689**	**0.662[3]**	**1.073**	**0.604**	**0.836**
8 ♂	**161**	**246**	**24.9**	**30.5**	**0.739**	**0.726**	**1.138**	**0.580**	**0.803**
9 ♂	**160**	**242**	**26.**	**31.**	**0.745**	**0.713**	**1.105**	**0.600**	**0.803**
10 ♂	**162**	**246**	**26.5**	**31.5**	**0.720**	**0.696**	**1.092**	**0.606**	**0.809**
11 ♂	**160**	**249**	**26.**	**31.4**	**0.726**	**0.689**	**1.097**	**0.602**	**0.850**
12 ♂	**161**	**250**	**27.1**	**31.6**	**0.737**	**0.711**	**1.120**	**0.631**	**0.852**
13 ♂	**162**	**248**	**25.1**	**31.9**	**0.744**	**0.722**	**1.154**	**0.591**	**0.839**
14 ♂	**165[3]**	**252**	**26.**	**32.3**	**0.726**	**0.710**	**1.145**	**0.609**	**0.887**
15 ♂	**161**	**243**	**25.6**	**32.5**	**0.709**	**0.707**	**1.122**	**0.607**	**0.832**
16 ♂	**161**	**244**	**25.**	**31.3**	**0.702**	**0.685**	**1.082**	**0.595**	**0.874**
17 ♂	**162**	**248**	**24.6**	**31.**	**0.713**	**0.700**	**1.086**	**0.590**	**0.837**
18 ♂	**164**	**244**	**25.**	**31.2**	**0.703**	**0.690**	**1.074**	**0.608**	**0.795**
19 ♂	**158**	**247**	**26.**	**32.**	**0.729**	**0.710**	**1.145**	**0.607**	**0.803**
20 ♂	**162**	**253**	**28.3**	**31.8**	**0.752**	**0.718**	**1.152**	**0.600**	**0.857**
21 ♂	**156**	**239**	**24.6**	**30.5**	**0.659[1]**	**0.658[2]**	**1.042[3]**	**0.570[3]**	**0.810**
22 ♂	**166**	**251**	**27.5**	**31.5**	**0.720**	**0.691**	**1.118**	**0.612**	**0.847**
23 ♂	**165[3]**	**253**	**31.[1]**	**32.4**	**0.765**	**0.750**	**1.183**	**0.613**	**0.905**
24 ♂	**166[2]**	**250**	**28.3**	**32.4**	**0.754**	**0.718**	**1.179**	**0.607**	**0.916[3]**
Average	**162**	**247**	**26.2**	**31.6**	**.727**	**.706**	**1.120**	**.603**	**.845**

Table II.
Measurements of Sixteen Young Males which Survived

	Total Length	Alar Extent	Weight	Length of beak and Head	Length of Humerus	Length of Femur	Length of Tibio-Tarsus	Width of Skull	Length of Keel of Sternum
36 Juv. ♂	156	246	24.6	32.	0.741	0.735	1.167	0.592	0.849
37 Juv. ♂	156	245	25.5	32.1	0.761	0.717	1.147	0.620	0.816
38 Juv. ♂	163	248	24.8	32.2	0.742	0.733	1.165	0.606	0.854
39 Juv. ♂	163	248	26.3	33.	0.736	0.704	1.148	0.609	0.839
40 Juv. ♂	160	250	24.4	31.5	0.746	0.715	1.173	0.604	0.893
41 Juv. ♂	156	237	23.3	30.6	0.692	0.664	1.011	0.588	0.774
42 Juv. ♂	162	253	26.7	32.	0.759	0.734	1.197	0.630	0.878
43 Juv. ♂	163	2543	26.4	32.	0.766	0.750	1.165	0.605	0.886
44 Juv. ♂	164	251	26.9	32.	0.755	0.742	1.171	0.620	0.886
45 Juv. ♂	163	244	24.3	31.3	0.718	0.680	1.082	0.610	0.892
46 Juv. ♂	160	247	27.	31.5	0.764	0.732	1.177	0.617	0.846
47 Juv. ♂	160	250	26.8	32.5	0.764	0.729	1.123	0.6353	0.842
48 Juv. ♂	158	247	24.9	32.4	0.745	0.724	1.139	0.588	0.865
49 Juv. ♂	158	249	26.1	32.2	0.742	0.736	1.148	0.602	0.817
50 Juv. ♂	158	243	26.6	32.4	0.747	0.711	1.163	0.612	0.891
51 Juv. ♂	155	237	23.3	30.23	0.685	0.653	1.0111	0.587	0.794
Average	159	246	25.4	31.8	.741	.716	1.136	.607	.851

Table II[a]

Measurements of Twelve Young Males which Perished

	Total Length	Alar Extent	Weight	Length of beak and Head	Length of Humerus	Length of Femur	Length of Tibio-Tarsus	Width of Skull	Length of Keel of Sternum
25 Juv. ♂	**160**	**249**	**24.2**	**30.4**	**0.740**	**0.717**	**1.130**	**0.620**	**0.840**
26 Juv. ♂	**156**	**236**	**26.8**	**30.0**[2]	**0.690**	**0.671**	**1.067**	**0.563**[2]	**0.832**
27 Juv. ♂	**158**	**240**	**23.5**	**31.**	**0.715**	**0.702**	**1.113**	**0.595**	**0.805**
28 Juv. ♂	**166**	**245**	**26.9**	**31.7**	**0.715**	**0.695**	**1.107**	**0.604**	**0.847**
29 Juv. ♂	**165**	**255**[2]	**28.6**	**31.5**	**0.766**	**0.744**	**1.175**	**0.613**	**0.854**
30 Juv. ♂	**157**	**238**	**24.7**	**31.2**	**0.680**[3]	**0.677**	**1.156**	**0.599**	**0.769**
31 Juv. ♂	**164**	**250**	**27.3**	**31.8**	**0.764**	**0.726**	**1.171**	**0.588**	**0.860**
32 Juv. ♂	**166**[2]	**256**[1]	**25.7**	**31.7**	**0.752**	**0.751**	**1.187**	**0.595**	**0.858**
33 Juv. ♂	**167**[1]	**255**[2]	**29.**[3]	**32.2**	**0.765**	**0.745**	**1.197**	**0.638**	**0.855**
34 Juv. ♂	**161**	**246**	**25.**	**31.5**	**0.739**	**0.707**	**1.123**	**0.587**	**0.850**
35 Juv. ♂	**166**[2]	**254**[3]	**27.5**	**31.4**	**0.760**	**0.742**	**1.124**	**0.604**	**0.914**
36 Juv. ♂	**161**	**251**	**26.**	**31.5**	**0.731**	**0.707**	**1.122**	**0.589**	**0.828**
Average	**162**	**248**	**26.2**	**31.5**	**.734**	**.715**	**1.141**	**.599**	**.842**

Table III.
Measurements of Twenty-one Adult and Young Females which Survived

	Total Length	Alar Extent	Weight	Length of beak and Head	Length of Humerus	Length of Femur	Length of Tibio-Tarsus	Width of Skull	Length of Keel of Sternum
52 ♀	156	245	25.3	31.6	0.729	0.710	1.152	0.620	0.809
53 ♀	154[3]	240	22.6[1]	30.4	0.705	0.686	1.103	0.584	0.770
54 ♀	153[2]	240	25.1	31.	0.724	0.713	1.123	0.585	0.812
55 ♀	153[2]	236	23.2[3]	30.9	0.698	0.678	1.132	0.596	0.795
56 ♀	155	243	24.4	31.5	0.734	0.736	1.170	0.596	0.801
57 ♀	163	247	25.1	32.	0.748	0.734	1.166	0.602	0.821
58 ♀	157	238	24.6	30.9	0.726	0.727	1.175	0.588	0.797
59 ♀	155	239	24.	32.8	0.732	0.742	1.175	0.601	0.835
60 ♀	164	248	24.2	32.7	0.752	0.752	1.201	0.604	0.830
61 ♀	158	238	24.9	31.	0.741	0.689	1.091	0.592	0.866
62 ♀	158	240	24.1	31.3	0.733	0.706	1.107	0.591	0.867
63 ♀	160	244	24.	31.1	0.731	0.730	1.152	0.589	0.808
64 ♀	161	246	26.	32.3	0.758	0.732	1.154	0.623	0.859
65 ♀	157	245	24.9	32.	0.752	0.740	1.186	0.593	0.787
66 ♀	157	235	25.5	31.5	0.712	0.704	1.132	0.611	0.781
67 ♀	156	237	23.4	30.9	0.708	0.691	1.123	0.613	0.798
68 ♀	158	244	25.9	31.4	0.729	0.705	1.146	0.597	0.851
69 ♀	153[2]	238	24.2	30.5	0.715	0.707	1.116	0.595	0.821
70 ♀	155	236	24.2	30.3	0.727	0.705	1.120	0.585	0.790
71 ♀	163	246	27.4	32.5	0.732	0.711	1.163	0.630	0.862
72 ♀	159	236	24.	31.5	0.709	0.713	1.129	0.607	0.845
Average	158	241	24.6	31.4	.728	.714	1.143	.600	.819
General average for 72 birds	158	245	25.2	31.6	.736	.716	1.138	.603	.845

Table III[a].

Measurements of Twenty-eight Adult and Young Females which Perished

	Total Length	Alar Extent	Weight	Length of beak and Head	Length of Humerus	Length of Femur	Length of Tibio-Tarsus	Width of Skull	Length of Keel of Sternum
37 ♀	**155**	**240**	**26.3**	**31.4**	**0.709**	**0.710**	**1.123**	**0.614**	**0.815**
38 ♀	**156**	**240**	**25.8**	**31.5**	**0.715**	**0.678**	**1.127**	**0.597**	**0.812**
39 ♀	**160**	**242**	**26.**	**32.6**	**0.740**	**0.732**	**1.157**	**0.597**	**0.854**
40 ♀	**152**[1]	**232**[3]	**23.2**[3]	**30.3**	**0.676**[2]	**0.683**	**1.048**	**0.590**	**0.780**
41 ♀	**160**	**250**	**26.5**	**31.7**	**0.741**	**0.731**	**1.187**	**0.615**	**0.886**
42 ♀	**155**	**237**	**24.2**	**31.**	**0.727**	**0.723**	**1.118**	**0.610**	**0.787**
43 ♀	**157**	**245**	**26.9**	**32.2**	**0.766**	**0.751**	**1.227**[2]	**0.620**	**0.841**
44 ♀	**165**[3]	**245**	**27.7**	**33.1**[2]	**0.780**[1]	**0.757**[3]	**1.195**	**0.633**	**0.865**
45 ♀	**153**[2]	**231**[2]	**23.9**	**30.1**	**0.680**	**0.662**[3]	**1.042**[3]	**0.592**	**0.781**
46 ♀	**162**	**239**	**26.1**	**30.3**	**0.709**	**0.685**	**1.092**	**0.587**	**0.911**
47 ♀	**162**	**243**	**24.6**	**31.6**	**0.741**	**0.729**	**1.162**	**0.605**	**0.840**
48 ♀	**159**	**245**	**23.6**	**31.8**	**0.727**	**0.700**	**1.129**	**0.610**	**0.855**
49 ♀	**159**	**247**	**26.**	**30.9**	**0.711**	**0.666**	**1.098**	**0.580**	**0.749**[2]
50 ♀	**155**	**243**	**25.**	**30.9**	**0.730**	**0.711**	**1.127**	**0.598**	**0.839**
51 ♀	**162**	**252**	**24.8**	**31.9**	**0.752**	**0.738**	**1.180**	**0.615**	**0.875**
52 ♀	**152**[1]	**230**[1]	**22.8**[2]	**30.4**	**0.682**	**0.664**	**1.042**[3]	**0.551**[1]	**0.734**[1]
53 ♀	**159**	**242**	**24.8**	**30.8**	**0.717**	**0.667**	**1.090**	**0.575**	**0.809**
54 ♀	**155**	**238**	**24.6**	**31.2**	**0.706**	**0.702**	**1.102**	**0.588**	**0.758**[3]
55 ♀	**163**	**249**	**30.5**[2]	**33.4**[1]	**0.767**	**0.767**[1]	**1.207**[3]	**0.640**	**0.896**
56 ♀	**163**	**242**	**24.8**	**31.**	**0.713**	**0.713**	**1.128**	**0.607**	**0.813**
57 ♀	**156**	**237**	**23.9**	**31.7**	**0.718**	**0.716**	**1.090**	**0.611**	**0.800**
58 ♀	**159**	**238**	**24.7**	**31.5**	**0.726**	**0.701**	**1.145**	**0.600**	**0.800**
59 ♀	**161**	**245**	**26.9**	**32.1**	**0.751**	**0.704**	**1.142**	**0.607**	**0.819**
60 ♀	**155**	**235**	**22.6**	**30.7**	**0.695**	**0.692**	**1.119**	**0.584**	**0.771**
61 ♀	**162**	**247**	**26.1**	**31.9**	**0.751**	**0.735**	**1.157**	**0.618**	**0.802**
62 ♀	**153**[2]	**237**	**24.8**	**30.6**	**0.732**	**0.718**	**1.172**	**0.594**	**0.802**
63 ♀	**162**	**245**	**26.2**	**32.5**	**0.728**	**0.731**	**1.102**	**0.614**	**0.832**
64 ♀	**164**	**248**	**26.1**	**32.3**	**0.739**	**0.707**	**1.159**	**0.592**	**0.823**
Average	**158**	**241**	**25.3**	**31.4**	**.726**	**.709**	**1.1.31**	**.601**	**.820**
General average for 64 birds	**160**	**245**	**25.8**	**31.5**	**.728**	**.709**	**1.128**	**.601**	**.834**

Table IV.
The Maximum and Minimum Measurements

	Total Length	Alar Extent	Weight	Length of beak and Head	Length of Humerus	Length of Femur	Length of Tibio-Tarsus	Width of Skull	Length of Keel of Sternum
Maximum	**167**	**256**	**31**	**33.4**	(d)	**.767**	1.230	**.640**	.927
Minimum	(a) **152**	**230**	(b)	(c) 29.8	**.659**	.653	(c) 1.011	**.551**	**.734**

(a) The minimum length (152 mm.) occurs twice among the birds which perished: Nos. 40 and 52.
(b) The minimum weight (22.6 grams) occurs in each group: Nos. 53 and 60, and therefore is not entered.
(c) The minimum length of head (29.8 mm.) and of tibio-tarsus (1.011 inch) occurs twice among the surviving birds: Nos. 9 and 14, 41 and 51.
(d) The maximum length of humerus (.780 inch) occurs in each group: Nos. 6 and 44, and therefore is not entered.

Table V.
Average Departures from Ideal Mean

	Total Length	Alar Extent	Weight	Length of beak and Head	Length of Humerus	Length of Femur	Length of Tibio-Tarsus	Width of Skull	Length of Keel of Sternum
Seventy-two which survived	2.51	4.20	10.9	2.51	16.	14.	29.4	10.	32.
Sixty-four which perished	**3.48**	**4.60**	**12.6**	**5.64**	**20.1**	**20.**	**33.8**	**12.**	**31.**

Appendix B

The data in this appendix are the same as those in Appendix A, but the formatting, lines, and superscripted notations have been removed.

Table I.
Measurements of Thirty-five Males which Survived

Bird ID	(mm) Total Length	(mm) Alar Extent	(g) Weight	(mm) Length of Skull	(in) Length of Humerus	(in) Length of Femur	(in) Length of Tibio-Tarsus	(in) Width of Skull	(in) Length of Keel of Sternum
1	154	241	24.5	31.2	0.687	0.668	1.022	0.587	0.830
2	160	252	26.9	30.8	0.736	0.709	1.180	0.602	0.841
3	155	243	26.9	30.6	0.733	0.704	1.151	0.602	0.846
4	154	245	24.3	31.7	0.741	0.688	1.146	0.584	0.839
5	156	247	24.1	31.5	0.715	0.706	1.129	0.575	0.821
6	161	253	26.5	31.8	0.780	0.743	1.144	0.607	0.893
7	157	251	24.6	31.1	0.741	0.736	1.153	0.610	0.862
8	159	247	24.2	31.4	0.728	0.718	1.126	0.609	0.793
9	158	247	23.6	29.8	0.703	0.673	1.079	0.602	0.820
10	158	252	26.2	32.0	0.749	0.739	1.153	0.614	0.857
11	160	252	26.2	32.0	0.741	0.723	1.129	0.624	0.892
12	162	253	24.8	32.3	0.766	0.752	1.134	0.633	0.923
13	161	243	25.4	31.8	0.721	0.722	1.126	0.597	0.891
14	160	250	23.7	29.8	0.730	0.703	1.103	0.590	0.820
15	159	247	25.7	31.4	0.729	0.717	1.141	0.592	0.927
16	158	253	25.7	31.9	0.743	0.699	1.150	0.600	0.860
17	159	247	26.5	31.6	0.733	0.714	1.155	0.611	0.923
18	166	253	26.7	32.5	0.767	0.765	1.230	0.600	0.878
19	159	247	23.9	31.4	0.752	0.723	1.113	0.602	0.825
20	160	248	24.7	31.3	0.752	0.737	1.176	0.603	0.803
21	161	252	28.0	31.8	0.770	0.731	1.190	0.590	0.885
22	163	251	27.9	31.9	0.769	0.745	1.168	0.622	0.860
23	156	242	25.9	32.0	0.723	0.711	1.116	0.609	0.886
24	165	251	25.7	32.2	0.751	0.742	1.161	0.613	0.865
25	160	247	26.6	32.4	0.728	0.707	1.108	0.590	0.836
26	158	244	23.2	31.6	0.730	0.713	1.142	0.585	0.888
27	160	242	25.7	31.6	0.709	0.705	1.124	0.620	0.788
28	157	245	26.3	32.2	0.741	0.726	1.143	0.595	0.850
29	159	244	24.3	31.5	0.723	0.698	1.107	0.615	0.847
30	160	253	26.7	32.1	0.739	0.714	1.117	0.592	0.864
31	158	245	24.9	31.4	0.726	0.703	1.119	0.580	0.854
32	161	247	23.8	31.4	0.735	0.694	1.101	0.602	0.789
33	160	247	24.6	32.3	0.756	0.745	1.135	0.607	0.905
34	160	247	27.0	32.0	0.755	0.736	1.174	0.631	0.873
35	153	241	24.7	32.2	0.728	0.680	1.092	0.592	0.884

Table Ia.
Measurements of Twenty-four Adult Males which Perished

Bird ID	Total Length	Alar Extent	Weight	Length of Skull	Length of Humerus	Length of Femur	Length of Tibio-Tarsus	Width of Skull	Length of Keel of Sternum
1	165	249	26.5	31.0	0.738	0.704	1.095	0.606	0.847
2	160	245	26.1	32.0	0.736	0.709	1.109	0.611	0.842
3	161	249	25.6	32.3	0.743	0.718	1.128	0.602	0.828
4	162	246	25.9	32.3	0.738	0.709	1.135	0.607	0.869
5	163	250	25.5	32.5	0.752	0.731	1.197	0.623	0.888
6	162	247	27.6	31.8	0.731	0.719	1.113	0.597	0.869
7	163	246	25.8	31.4	0.689	0.662	1.073	0.604	0.836
8	161	246	24.9	30.5	0.739	0.726	1.138	0.580	0.803
9	160	242	26.0	31.0	0.745	0.713	1.105	0.600	0.803
10	162	246	26.5	31.5	0.720	0.696	1.092	0.606	0.809
11	160	249	26.0	31.4	0.726	0.689	1.097	0.602	0.850
12	161	250	27.1	31.6	0.737	0.711	1.120	0.631	0.852
13	162	248	25.1	31.9	0.744	0.722	1.154	0.591	0.839
14	165	252	26.0	32.3	0.726	0.710	1.145	0.609	0.887
15	161	243	25.6	32.5	0.709	0.707	1.122	0.607	0.832
16	161	244	25.0	31.3	0.702	0.685	1.082	0.595	0.874
17	162	248	24.6	31.0	0.713	0.700	1.086	0.590	0.837
18	164	244	25.0	31.2	0.703	0.690	1.074	0.608	0.795
19	158	247	26.0	32.0	0.729	0.710	1.145	0.607	0.803
20	162	253	28.3	31.8	0.752	0.718	1.152	0.600	0.857
21	156	239	24.6	30.5	0.659	0.658	1.042	0.570	0.810
22	166	251	27.5	31.5	0.720	0.691	1.118	0.612	0.847
23	165	253	31.0	32.4	0.765	0.750	1.183	0.613	0.905
24	166	250	28.3	32.4	0.754	0.718	1.179	0.607	0.916

Table II.
Measurements of Sixteen Young Males which Survived

Bird ID	Total Length	Alar Extent	Weight	Length of Skull	Length of Humerus	Length of Femur	Length of Tibio-Tarsus	Width of Skull	Length of Keel of Sternum
36	156	246	24.6	32.0	0.741	0.735	1.167	0.592	0.849
37	156	245	25.5	32.1	0.761	0.717	1.147	0.620	0.816
38	163	248	24.8	32.2	0.742	0.733	1.165	0.606	0.854
39	163	248	26.3	33.0	0.736	0.704	1.148	0.609	0.839
40	160	250	24.4	31.5	0.746	0.715	1.173	0.604	0.893
41	156	237	23.3	30.6	0.692	0.664	1.011	0.588	0.774
42	162	253	26.7	32.0	0.759	0.734	1.197	0.630	0.878
43	163	254	26.4	32.0	0.766	0.750	1.165	0.605	0.886
44	164	251	26.9	32.0	0.755	0.742	1.171	0.620	0.886
45	163	244	24.3	31.3	0.718	0.680	1.082	0.610	0.892
46	160	247	27.0	31.5	0.764	0.732	1.177	0.617	0.846
47	160	250	26.8	32.5	0.764	0.729	1.123	0.635	0.842
48	158	247	24.9	32.4	0.745	0.724	1.139	0.588	0.865
49	158	249	26.1	32.2	0.742	0.736	1.148	0.602	0.817
50	158	243	26.6	32.4	0.747	0.711	1.163	0.612	0.891
51	155	237	23.3	30.2	0.685	0.653	1.011	0.587	0.794

Table IIa
Measurements of Twelve Young Males which Perished

Bird ID	Total Length	Alar Extent	Weight	Length of Skull	Length of Humerus	Length of Femur	Length of Tibio-Tarsus	Width of Skull	Length of Keel of Sternum
25	160	249	24.2	30.4	0.740	0.717	1.130	0.620	0.840
26	156	236	26.8	30.0	0.690	0.671	1.067	0.563	0.832
27	158	240	23.5	31.0	0.715	0.702	1.113	0.595	0.805
28	166	245	26.9	31.7	0.715	0.695	1.107	0.604	0.847
29	165	255	28.6	31.5	0.766	0.744	1.175	0.613	0.854
30	157	238	24.7	31.2	0.680	0.677	1.156	0.599	0.769
31	164	250	27.3	31.8	0.764	0.726	1.171	0.588	0.860
32	166	256	25.7	31.7	0.752	0.751	1.187	0.595	0.858
33	167	255	29.0	32.2	0.765	0.745	1.197	0.638	0.855
34	161	246	25.0	31.5	0.739	0.707	1.123	0.587	0.850
35	166	254	27.5	31.4	0.760	0.742	1.124	0.604	0.914
36	161	251	26.0	31.5	0.731	0.707	1.122	0.589	0.828

Table III.
Measurements of Twenty-one Adult and Young Females which Survived

Bird ID	Total Length	Alar Extent	Weight	Length of Skull	Length of Humerus	Length of Femur	Length of Tibio-Tarsus	Width of Skull	Length of Keel of Sternum
52	156	245	25.3	31.6	0.729	0.710	1.152	0.620	0.809
53	154	240	22.6	30.4	0.705	0.686	1.103	0.584	0.770
54	153	240	25.1	31.0	0.724	0.713	1.123	0.585	0.812
55	153	236	23.2	30.9	0.698	0.678	1.132	0.596	0.795
56	155	243	24.4	31.5	0.734	0.736	1.170	0.596	0.801
57	163	247	25.1	32.0	0.748	0.734	1.166	0.602	0.821
58	157	238	24.6	30.9	0.726	0.727	1.175	0.588	0.797
59	155	239	24.0	32.8	0.732	0.742	1.175	0.601	0.835
60	164	248	24.2	32.7	0.752	0.752	1.201	0.604	0.830
61	158	238	24.9	31.0	0.741	0.689	1.091	0.592	0.866
62	158	240	24.1	31.3	0.733	0.706	1.107	0.591	0.867
63	160	244	24.0	31.1	0.731	0.730	1.152	0.589	0.808
64	161	246	26.0	32.3	0.758	0.732	1.154	0.623	0.859
65	157	245	24.9	32.0	0.752	0.740	1.186	0.593	0.787
66	157	235	25.5	31.5	0.712	0.704	1.132	0.611	0.781
67	156	237	23.4	30.9	0.708	0.691	1.123	0.613	0.798
68	158	244	25.9	31.4	0.729	0.705	1.146	0.597	0.851
69	153	238	24.2	30.5	0.715	0.707	1.116	0.595	0.821
70	155	236	24.2	30.3	0.727	0.705	1.120	0.585	0.790
71	163	246	27.4	32.5	0.732	0.711	1.163	0.630	0.862
72	159	236	24.0	31.5	0.709	0.713	1.129	0.607	0.845

Table IIIa.
Measurements of Twenty-eight Adult and Young Females which Perished

Bird ID	Total Length	Alar Extent	Weight	Length of Skull	Length of Humerus	Length of Femur	Length of Tibio-Tarsus	Width of Skull	Length of Keel of Sternum
37	155	240	26.3	31.4	0.709	0.710	1.123	0.614	0.815
38	156	240	25.8	31.5	0.715	0.678	1.127	0.597	0.812
39	160	242	26.0	32.6	0.740	0.732	1.157	0.597	0.854
40	152	232	23.2	30.3	0.676	0.683	1.048	0.590	0.780
41	160	250	26.5	31.7	0.741	0.731	1.187	0.615	0.886
42	155	237	24.2	31.0	0.727	0.723	1.118	0.610	0.787
43	157	245	26.9	32.2	0.766	0.751	1.227	0.620	0.841
44	165	245	27.7	33.1	0.780	0.757	1.195	0.633	0.865
45	153	231	23.9	30.1	0.680	0.662	1.042	0.592	0.781
46	162	239	26.1	30.3	0.709	0.685	1.092	0.587	0.911
47	162	243	24.6	31.6	0.741	0.729	1.162	0.605	0.840
48	159	245	23.6	31.8	0.727	0.700	1.129	0.610	0.855
49	159	247	26.0	30.9	0.711	0.666	1.098	0.580	0.749
50	155	243	25.0	30.9	0.730	0.711	1.127	0.598	0.839
51	162	252	24.8	31.9	0.752	0.738	1.180	0.615	0.875
52	152	230	22.8	30.4	0.682	0.664	1.042	0.551	0.734
53	159	242	24.8	30.8	0.717	0.667	1.090	0.575	0.809
54	155	238	24.6	31.2	0.706	0.702	1.102	0.588	0.758
55	163	249	30.5	33.4	0.767	0.767	1.207	0.640	0.896
56	163	242	24.8	31.0	0.713	0.713	1.128	0.607	0.813
57	156	237	23.9	31.7	0.718	0.716	1.090	0.611	0.800
58	159	238	24.7	31.5	0.726	0.701	1.145	0.600	0.800
59	161	245	26.9	32.1	0.751	0.704	1.142	0.607	0.819
60	155	235	22.6	30.7	0.695	0.692	1.119	0.584	0.771
61	162	247	26.1	31.9	0.751	0.735	1.157	0.618	0.802
62	153	237	24.8	30.6	0.732	0.718	1.172	0.594	0.802
63	162	245	26.2	32.5	0.728	0.731	1.102	0.614	0.832
64	164	248	26.1	32.3	0.739	0.707	1.159	0.592	0.823