Many of these were banded as adults, consequently one year only can be added to their age, some were probably older. We do find in this species as in most other small song birds we band that few get beyond four years of age.

It must be kept in mind while considering these data that many more returns will probably be taken in the next year or two from those banded two or three years previously, thus the record is not complete and the book is never closed as long as your station continues to operate. *131 N. Whitehall Road, Norristown, Penna.*

LEG SIZES AND BAND SIZES: SECOND REPORT

BY CHARLES H. BLAKE

So many more data have accumulated since the writing of the first report (Blake 1954) that a sequel is indicated. Even more than the previous report, this is a cooperative undertaking. Mr. and Mrs. Parker C. Reed (Lexington, Mass.), Mr. E. Alexander Bergstrom (West Hartford, Conn.), Mr. and Mrs. James R. Downs (South Londonderry, Vt.), and Mrs. Richard Adams (Belmont, Mass.) have generously contributed data. In general, measurements from any one locality have been separately examined and later combined with those of other localities when the differences seemed insignificant. This course was rendered necessary by the implications of a recent article (Bergstrom 1954). The methods used are those of the report already referred to. In some cases I have used only the greater diameters provided by Mr. Bergstrom since, by direct comparison, it was found that his method of reading the lesser diameters gave results which differed systematically from the data of other observers. The data are summarized in Table I.

Eastern Mourning Dove *(Zenaidura c. carolinensis)*. If the small series of measurements is taken at face value, it appears that 91 per cent of the birds would take size 3 at exact fit. However, the rather soft, nearly cylindrical legs of doves are hard to measure. The somewhat high value of the standard deviation suggests some inaccuracy in the measurements as well as variability in size. A too tight band would tend to directly constrict the leg because there is no thin and flexible lamella to take up the pressure by its deformation. Even for the smallest leg measured the clearance within a 3A band is only 1.5 mm. or 0.06 inches. The 3A band should be used until there is clear evidence of thin-legged populations that will safely accept a smaller band.

Northern Flicker *(Colaptes auratus luteus)*. A series of 11 birds yields exactly the same greater diameter and percentages of band sizes as given previously.

Northern Downy Woodpecker *(Dendrocopos pubescens medianus)*. The comments on the Mourning Dove apply almost as strongly to this species. Size 1B is recommended. About one bird in 25 appears small enough to take a 0 band. If this proves true we have the rare situation of four possible band sizes for a single species.

TABLE I. LEG SIZES AND BAND SIZES

Species	Sample Size	Aver. Greater Diam. & σ	Obs. Range	99% Range	Aver. Lesser Diam.	Obs. Range	Majority Band Size: %	Next Smaller Size: %	Next Larger Size: %
Leach's Petrel	1	2.0	-	-	1.4	-	1:	-	-
Spotted Sandpiper (Bergstrom, Blake)	2	2.21	2.2-2.3	-	1.6	1.6-1.7	1B:	-	-
E. Mourning Dove (Reed, Bergstrom)	8	4.4 ±0.3	4.0-5.0	3.7 -5.1	-	-	3:57	-	3A:43
(Reed)	4	-	-	-	3.3	2.8-4.0	-	-	-
Yellow-billed Cuckoo (Reed)	2	3.5	3.3-3.7	-	2.0	1.9-2.2	2:	-	-
Whip-poor-will (approx. measurements)	1	4	-	-	2½	-	3:	-	-
Yellow-bellied Sapsucker (Adams)	1	2.3	-	-	1.4	-	1B:	-	-
E. Hairy Woodpecker	1	2.9	-	-	2.1	-	1A:	-	-
N. Downy Woodpecker (Reed, Bergstrom, Blake)	12	2.2 ±0.2	1.8-2.3	1.8 -2.6	1.5	1.2-1.5	1B:48	1:46	1A:2
Tree Swallow (Bergstrom, Blake)	10	1.5 ±0.03	1.4-1.7	1.4 -1.6	1.2	1.2-1.3	0:100	-	-
Bank Swallow, adults (Bergstrom)	32	1.3 ±0.1	1.1-1.4	1.1 -1.5	1.1	0.9-1.2	0:100	-	-
immatures (Bergstrom)	26	1.3 ±0.07	1.2-1.4	1.1 -1.5	1.2	1.1-1.5	0:100	-	-
N. Blue Jay (Reed, Blake)	19	3.7 ±0.2	3.4-4.1	3.25-4.15	2.3	1.9-2.8	2:62	-	3:38
(Bergstrom)	19	3.6 ±0.2	3.2-4.0	3.15-4.05	-	-	2:81	-	3:19
Acadian Chickadee (Reed)	1	1.7	-	-	1.0	-	0:	-	-
White-breasted Nuthatch (least) (Reed, Blake)	10	1.9 ±0.1	1.6-2.1	1.7 -2.1	-	-	-	-	-
(distal) (Reed, Blake)	10	2.4 ±0.3	2.0-3.0	1.7 -3.1	1.5	1.2-1.7	1B:52	1:21	1A:27
E. House Wren	10	1.7 ±0.02	1.6-1.8	1.6 -1.8	1.1	0.9-1.2	0:100	-	-
E. Winter Wren	1	1.7	-	-	1.1	-	0:	-	-
Wood Thrush	2	2.8	2.7-2.9	-	1.6	1.6-1.7	1A:	-	-

TABLE I. (CONTINUED)

Species	Sample Size	Aver. Greater Diam. & σ	Obs. Range	99% Range	Aver. Lesser Diam.	Obs. Range	Majority Band Size: %	Next Smaller Size: %	Next Larger Size: %
E. Hermit Thrush	14	2.3 ±0.15	2.0-2.5	2.0 -2.6	1.3	1.2-1.4	1B:67	1:31	1A:2
Olive-backed Thrush	16	2.1 ±0.1	1.9-2.5	1.9 -2.3	1.3	1.2-1.5	1:87	0:1	1B:12
Gray-cheeked Thrush	1	2.0	-	-	1.3	-	1:	-	-
Bicknell's Thrush	4	2.2	2.0-2.3	-	1.2	1.1-1.4	1:	-	-
Veery	5	2.4 ±0.1	2.3-2.5	2.2 -2.6	1.2	1.2-1.4	1B:95	1:1	1A:4
Bluebird	10	2.0 ±0.1	1.9-2.1	-	1.3	1.2-1.4	1:87	0:12	1B:1
E. Golden-crowned Kinglet	8	1.1 ±0.1	1.0-1.3	0.9 -1.3	0.7	0.7	0:100	-	-
E. Ruby-crowned Kinglet	12	1.1 ±0.06	1.0-1.2	0.9 -1.3	0.7	0.6-0.8	0:100	-	-
Starling (Reed, Blake)	8	3.7 ±0.2	3.3-4.0	3.3 -4.1	2.1	1.8-2.6	2:62	-	3:38
(Bergstrom)	7	3.8 ±0.05	3.6-3.8	3.7 -3.9	-	-	3:88	2:12	-
Red-eyed Vireo	5	1.8 ±0.05	1.7-1.8	1.7 -1.9	1.1	1.1-1.2	0:99	-	1:1
Black & White Warbler (Bergstrom, Blake)	5	1.7 ±0.15	1.5-1.9	1.4 -2.0	1.0	0.9-1.1	0:94	-	1:6
Blue-winged Warbler (Bergstrom)	1	1.5	-	-	1.0	-	0:	-	-
Tennessee Warbler	3	1.6	1.3-1.7	-	0.9	0.8-1.0	0:	-	-
Orange-crowned Warbler	1	1.7	-	-	0.9	-	0:	-	-
Nashville Warbler	6	1.4 ±0.06	1.3-1.5	1.3 -1.5	0.9	0.7-1.0	0:100	-	-
N. Parula Warbler	2	1.4	1.2-1.7	-	0.8	0.7-0.9	0:	-	-
Cape May Warbler (Reed)	2	1.6	1.6	-	0.9	0.9-1.0	0:	-	-
Black-throated Blue Warbler	3	1.6	1.6	-	1.0	0.9-1.0	0:	-	-
Myrtle Warbler	36	1.6 ±0.07	1.4-1.7	1.4 -1.8	1.0	0.8-1.1	0:100	-	-
Bay-breasted Warbler	3	1.8	1.7-2.0	-	1.0	0.9-1.0	0:	-	-
Blackpoll Warbler	23	1.7 ±0.08	1.6-2.0	1.5 -1.9	1.1	0.9-1.1	0:100	-	-
Black-throated Green Warbler	2	1.3	1.3-1.4	-	0.8	0.8-0.9	0:	-	-
Yellow Palm Warbler	2	1.5	1.5-1.6	-	0.8	0.8-0.9	0:	-	-
Ovenbird	6	2.1 ±0.2	1.9-2.4	1.7 -2.5	1.2	1.1-1.3	1:61	0:12	1B:27
House Sparrow (Reed, Blake)	5	2.4 ±0.2	2.2-2.7	2.0 -2.8	1.3	1.2-1.5	1B:69	1:12	1A:19

TABLE I. (CONTINUED)

Species	Sample Size	Aver. Greater Diam. & σ	Obs. Range	99% Range	Aver. Lesser Diam.	Obs. Range	Majority Band Size: %	Next Smaller Size: %	Next Larger Size: %
E. Redwinged Blackbird	1	3.5	-	-	1.9	-	2:	-	-
Bronzed Grackle (Reed) (immatures)	15	4.0 ±0.2	3.7-4.3	3.6 -4.4	-	1.6-2.4	3:91	2:8	3A:1
Cowbird (Reed, Blake) (males)	9	2.8 ±0.2	2.5-3.2	2.4 -3.2	1.6	1.6-1.8	1A:80	1B:8	2:12
(females)	13	2.55±0.2	2.2-2.8	2.15-2.95	1.5	1.4-1.6	1A:49	1B:47	2:1
(immature males) (Blake)	8	3.1 ±0.2	2.8-3.3	2.7 -3.5	1.7	1.6-1.9	2:73	1A:27	-
(both sexes) (Bergstrom)	15	2.8 ±0.15	2.4-3.0	2.5 -3.1	-	-	1A:91	1B:3	2:6
Scarlet Tanager (Bergstrom, Blake)	7	2.3 ±0.25	2.0-2.6	1.7 -2.9	-	-	1B:57	1:31	1A:12
(Blake)	4	-	-	-	1.5	1.3-1.6	-	-	-
Rose-breasted Grosbeak (Reed, Blake)	16	2.7 ±0.25	2.2-3.0	2.1 -3.3	1.7	1.5-1.9	1A:69	1B:23	2:8
Red-eyed Towhee	36	3.2 ±0.15	2.8-3.4	2.9 -3.5	1.7	1.6-1.9	2:93	1A:7	-
(Bergstrom)	14	3.0 ±0.2	2.7-3.3	2.6 -3.4	-	-	2:50	1A:50	-
E. Chipping Sparrow	15	1.7 ±0.1	1.5-1.8	1.5 -1.9	1.0	0.8-1.2	0:99	-	1:1
E. Field Sparrow (Downs, Blake)	7	1.7 ±0.2	1.6-1.9	1.3 -2.1	1.1	0.9-1.4	0:88	-	1:12
E. Fox Sparrow	11	2.7 ±0.2	2.3-2.8	2.3 -3.1	1.5	1.3-1.6	1A:78	1B:18	2:4
(Bergstrom)	17	2.7 ±0.1	2.5-2.9	2.5 -2.9	-	-	1A:96	1B:4	-
E. Lincoln Sparrow	2	2.0	2.0-2.1	-	1.2	1.2-1.3	1:	-	-
E. Swamp Sparrow (Bergstrom, Blake)	2	1.9	1.8-2.0	-	1.3	1.3-1.4	1:	0:	-
E. Song Sparrow (Reed, Blake)	9	2.2 ±0.1	2.0-2.3	2.0 -2.4	1.3	1.1-1.4	1B:50	1:50	-
(Bergstrom)	6	2.3 ±0.15	2.1-2.4	2.0 -2.6	-	-	1B:74	1:23	1A:3
(Downs)	12	2.3 ±0.07	2.1-2.4	2.15-2.45	1.3	1.2-1.4	1B:95	1:5	-

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Bank Swallow *(Riparia r. riparia)*. Mr. Bergstrom notes that the immatures were of flying age but definitely birds of the year. The individual with a lesser diameter of 1.5 mm. had a greater diameter of only 1.4. The ratio of average greater diameter to average lesser diameter for these immatures is 1.08:1.

Northern Blue Jay *(Cyanocitta c. cristata)*. The two sets of percentages for band sizes illustrate the point that similar arrays differing insignificantly as to their means may show great differences of proportion when they are partitioned into sections of arbitrary width whose boundaries are unrelated to the statistical distributions of the arrays. For other examples see Red-eyed Towhee and Song Sparrow. For either population of jays better than 99 per cent will take size 2 bands at exact fit. I cannot yet regard the problem of populations of diverse size in this species as completely resolved.

White-breasted Nuthatch *(Sitta c. carolinensis)*. I have (loc. cit.) commented on the unusual shape of the tarsus. This point is demonstrated by the figures here given. It appears that, at exact fit, only 8 per cent of the birds require 1A bands. Since this only means that a 1B band would ride slightly higher on the tarsus in such cases, I recommend using 1B bands for all individuals.

Carolina Wren *(Thryothorus l. ludovicianus)*. I now believe the individual of this species called *miamensis* in the first report is better referred to the nominate race.

Eastern Bluebird *(Sialia s. sialis)*. There has already been a suggestion that size 1 is best for this species. With this view I now concur.

Eastern Golden-crowned Kinglet *(Regulus s. satrapa)*. This species and the Ruby-crowned Kinglet *(R. c. calendula)* are but two of several small passerines whose greater tarsal diameters are less than that of the Ruby-throated Hummingbird *(Archilochus colubris)*. The tarsus of the latter is nearly circular in section and measures about 1.3 mm. in diameter. It is possible that the kinglets have the most slender tarsi among living birds.

Starling *(Sturnus vulgaris)*. If we allow banding to exact fit, only 4 per cent will require size 3 bands. The variability of leg size in this species seems rather great. The ratio of the diameters is unusually high, 1.76:1.

Blackpoll Warbler *(Dendroica striata)*. Although the average greater diameter is not larger than that of some other small warblers, it is more variable. One bird in 500 should need a size 1 band.

Ovenbird *(Seiurus aurocapillus* subsp.). At exact fit the percentage requiring 1B bands is reduced to 4. I have not yet found it possible to distinguish *furvior* from *aurocapillus* and do not know whether the two races differ in leg size.

Cowbird *(Molothrus a. ater)*. It is rather remarkable that immature males taken on 10 September should still have their legs about 10 per

cent larger than do adult males. This is also the first species studied in which a clear sexual difference in leg size has been found. Since 3 per cent of females may take size 1 we have the second instance of four admissible band sizes.

Scarlet Tanager *(Piranga olivacea)*. The best size is 1B; only 2 per cent would be larger than exact fit.

Rose-breasted Grosbeak *(Pheucticus ludovicianus)*. Almost all individuals (99%) would accept 1B bands but this should not be risked on birds with so powerful a bite.

Red-eyed Towhee *(Pipilo e. erythophthalmus)*. My series was examined for differences assignable to age and sex but none were found.

Eastern Song Sparrow *(Melospiza m. melodia)*. The present species illustrates differences in distribution among band sizes arising largely from differing standard deviations. The three could be combined into one with a greater diameter of 2.3 ± 0.1, which would mean 1B, 88 per cent and 1, 12 per cent, with less than one in 500 requiring 1A.

In the preceding discussion I have been, perhaps, too free in using trinomials but it has been done advisedly to emphasize that the results may not apply outside eastern North America.

We may obtain a clue to the differences to be expected between adjacent (geographically) subspecies by noting that they often differ in wing length or tarsal length by five to 10 per cent. If tarsal diameters vary proportionately the differences between means for such subspecies would be of the order of one standard deviation. It is by no means certain that tarsal diameters should vary in the same proportion as the lengths. Suppose that the larger (and heavier) subspecies does require longer tarsal and tibial levers. Does this also mean that the diameters of the bones must be greater to withstand the greater bending moments or that the tendons in the tarsal segment must have greater cross-section to take the increased tension? Are the factors of safety in the legs so small that a small increase in stress must be met by an increase in size? Even if the answers were affirmative the diametral increases would be much less than the cross-sectional increases. If the cross-section were increased by 10 per cent the diameter would be increased about 4½ per cent.

In this same connection we should mention Allen's 'rule' which is that, in cooler regions, the projecting parts, ears, legs, tails, of otherwise similar animals are diminished. I have never been convinced that there is any great justification for supposing this rule to apply to the primary wing segment or to the tarsus. Ostensibly the reduction of projecting parts decreases heat loss. As far as I know it has never been shown that Allen's rule applies to the more proximal leg or wing segments of birds where heat loss could be of some significance. The most I can do here is to raise questions which can only be resolved by more comprehensive measurements in the flesh by both banders and collectors.

The danger from placing two metal bands on the same leg which leads to flanging of the bands and reduction of leg diameter is now known (Reed 1953). Three sets of measurements are available bearing on the point (Table II).

TABLE II. EFFECT OF TWO ALUMINUM BANDS ON SAME LEG

	Double-banded leg mm.	Other leg mm.
Blue Jay	3.2 x 2.3	3.4 x 2.2
Rose-breasted Grosbeak	1.9 x 1.4	2.4 x 1.4
Evening Grosbeak	2.7 x 1.7	2.9 x 1.7

So far we have found one quite clear case of variation with age and sex (Cowbird) in which the young examples were fully independent. In a second case (Bank Swallow) the young were hardly independent and certainly relatively younger than the young Cowbirds. Geographic variation has not yet been shown with adequate plausibility even though, in some species very small average differences exist between the samples.

There are some differences in the ratio of the two diameters between the various species. We may adopt as a standard expression the ratio of the greater diameter to the lesser. On this basis a larger ratio means a narrower tarsus. Evidently much of the variation depends on the presence or absence of a posterior lamella. If we restrict our attention to the oscinine perching birds (all the Passeres except Tyrannidae) we include the great majority of species for which data are available. For this group I offer two quite tentative conclusions: 1) the larger the greater diameter the narrower the tarsus, and 2) arboreal species have relatively broader tarsi than have terrestrial species.

The species so far studied whose greater diameters are 3 mm. and above show ratios of 1.6 to 1.9. Those with greater diameters not over 1.5 mm. have ratios, except Yellow Palm Warbler, of 1.2 to 1.7. The more arboreal Fringillidae run from 1.4 to 1.6 while the terrestrial species show 1.5 to 1.9.

It may also be that species with relatively short tarsi (e.g., swallows) have broad tarsi. The conclusions just drawn are by no means without exceptions. Further there is still no information on the variation in dimensions which may be caused by differing positions of the tarsus and toes at the moment of measuring.

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