ADRENAL AND THYROID WEIGHTS IN BIRDS

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LITTLE study has been made of the relative sizes of adrenal and thyroid glands in different species of birds. One of us (Hartman, 1946) reported such a study on birds collected in the United States some years ago. In this paper, results on birds collected in Panamá include a number of families and species not found in the United States, some migrants from the United States, and two domestic species, *Gallus gallus* and *Coturnix coturnix*.

Data from 249 species in 49 families are reported. Specimens were obtained during December and January near sea level on the Río Chagres and during February and March at 1,300 meters elevation near the village of El Volcán in the Province of Chiriquí.

This material was also used to study the muscles of locomotion as well as to furnish skins of the rare forms.

METHODS

All specimens were kept in plastic, waterproof bags to prevent drying until weighed at the field station. Small birds were weighed on a torsion balance of 120 grams capacity. Larger ones were weighed on Chatillon spring balances, the most sensitive one for the weight involved being used: 6,000 grams capacity with 24 grams sensitivity; 500 grams capacity with 10 grams sensitivity; and 250 grams capacity with 5 grams sensitivity. The adrenals and thyroids were carefully dissected free of extraneous tissue with the aid of a binocular loupe and promptly weighed on a Roller-Smith balance of either 30 mg. or 1,500 mg. capacity, depending upon the size of the specimen. The thoroughness of the dissection is extremely important because more or less extraneous tissue may adhere to the gland, especially the adrenal, thus contributing to the error. Only birds of healthy appearance were used. Most birds were collected between 0700 and 1100.

RESULTS

Mean body weights and weights of adrenal and thyroid glands as percentages of body weights are given in the table. The number of individuals of each species is indicated in parentheses. Additional data on species in which the number of individuals is too small for inclusion in the table are listed in the text. Species are arranged according to Peters' Check-List (Peters, 1931-1951) or Eisenmann's List (Eisenmann, 1955).

Individual Variation

There was great range among the individuals of many species in both adrenal and thyroid weights, perhaps more often in the adrenals than in the thyroids. It is this factor that makes it difficult to determine the typical mean unless a large series is available. However, some species do not show this wide range. These are: Anhinga, Snowy Egret, Cattle Egret, Least Bittern, Broad-winged Hawk, Barred Forest Falcon, Jaçana, Scaled Pigeon, Smooth-billed Ani, Lineated Woodpecker, Red-crowned Woodpecker, Lineated Foliage-gleaner, Red-capped Manakin, Turquoise Cotinga, Bright-rumped Attila, Masked Tityra, Streaked Flycatcher, Yellow-rumped Cacique, White-lined Tanager, and Thick-billed Seed Finch.

Adrenals

The adrenals are larger than the thyroids in 176 species, while the reverse is true in 42 species, the remainder being nearly the same. With a larger number of samples these values might change somewhat but never enough to reverse the picture. For representative species of each family, adrenal weights are plotted against body weight in Figure 1, the species starred in Table 1 being employed. It will be noted that the adrenal weights of birds weighing 200 grams or less are essentially a linear function of body weight, whereas larger birds show a great divergence, a few being below the line but more being above. The relatively largest adrenals were found in the Olivaceous Cormorant, Barred Forest Falcon, Scintillant Hummingbird, Green Kingfisher, Pygmy Kingfisher, Red-headed Barbet, Red-faced Spinetail, Bright-rumped Attila, Scale-crested Pygmy Tyrant, Yellow Tyrannulet, Rough-winged Swallow, Southern House Wren, Olive-backed Thrush, Scrub Greenlet, and Red-legged Honeycreeper.

In a few species the adrenals were relatively rather small. These were the American Jaçana, some pigeons, Fiery-billed Araçari, *Momotus subrufescens*, Golden-olive Woodpecker, Lineated Woodpecker, Fasciated Antshrike, and Crested Oropendola.

No sex differences were noted, nor was a significant difference found in birds that were collected with an egg in the oviduct ready to be laid.

Thyroid

Thyroid weights for representative members (the same species as for adrenals) of each family are plotted in Figure 2 as a function of body weight. Although the general trend is linear, unlike the adrenals, there is greater divergence all along the line, small species diverging as much as large ones.

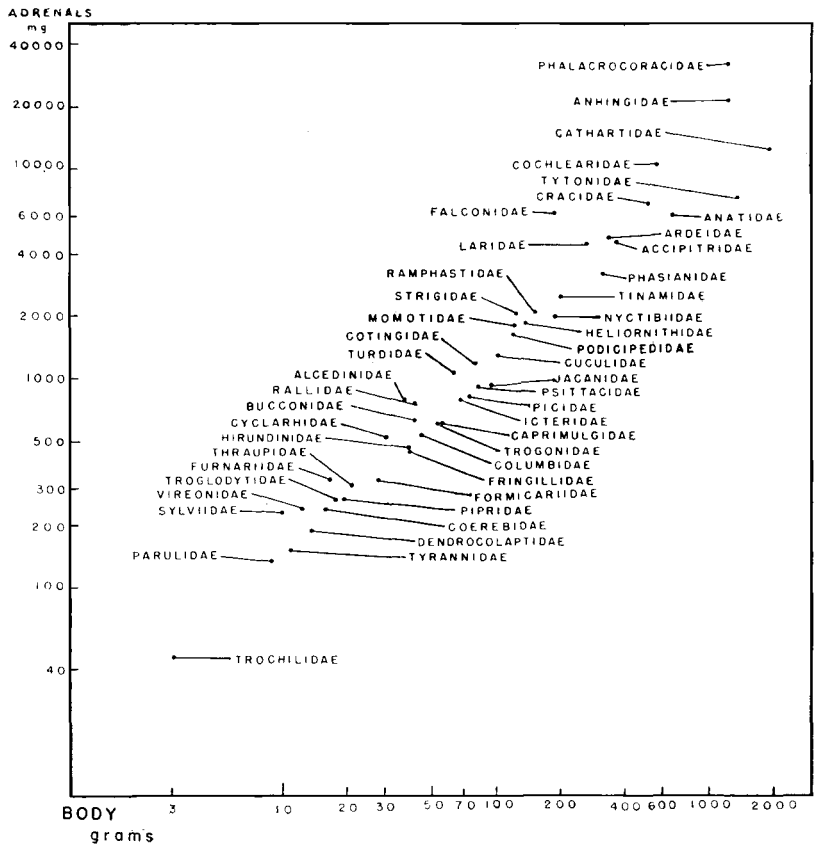

Figure 1. Selected plottings of adrenal weights against body weights.

The relatively largest thyroids were found in the Common Egret, Violet Sabrewing, Scintillant Hummingbird, Pale-breasted Spinetail, Rough-winged Swallow, White-throated Robin, Long-billed Gnatwren, Green Honeycreeper, Black-throated Green Warbler, Pileolated Warbler, Rose-breasted Grosbeak, and Yellow-faced Grassquit. The relatively smallest thyroids were obtained from the Anhinga, Broad-winged Hawk, Brown-hooded Parrot, Barn Owl, Common Potoo, Collared Araçari, and Golden-olive Woodpecker. Occasionally one thyroid was much larger than the other, so much so that the smaller of the two appeared as a mere fragment. This difference appeared to be much less common in the adrenals.

Data from a number of species that appeared to differ in adrenal or thyroid size have been analyzed statistically, using Student's *t* test

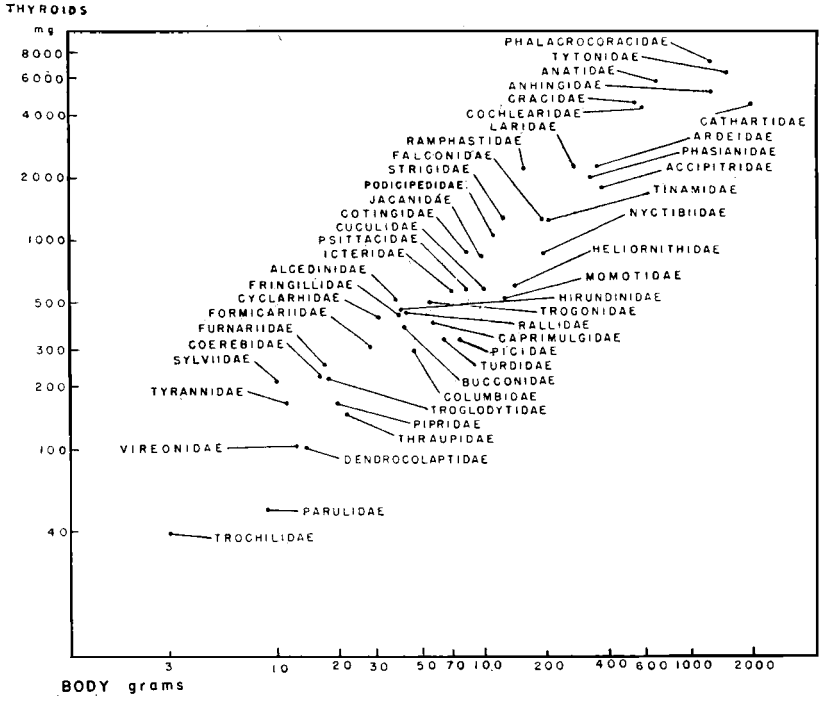

Figure 2. Selected plottings of thyroid weights against body weights.

(Student, 1908). The adrenals of the White-throated Crake were larger ($P<0.05$) than those of the Gray-necked Wood Rail. The adrenals of the Scaled Pigeon were smaller ($P<0.05$) than those of the Rufous-breasted Quail Dove. The adrenals of the Smooth-billed Ani were larger ($P<0.05$) than those of the Greater Ani. The adrenals of the Yellow-rumped Cacique were larger ($P<0.01$) than those of the Crested Oropendola. The adrenals of the Gray-breasted Martin ($P<0.05$) and the Spot-crowned Woodhewer ($P<0.01$) were smaller than those of the Red-legged Honeycreeper. The adrenals of the Common Bush-tanager were larger than those of the White-lined Tanager ($P<0.01$), Rose-breasted Thrush Tanager ($P<0.05$), Variable Seedeater ($P<0.01$), and the Thick-billed Seed-finch ($P<0.01$).

DISCUSSION

In this survey it should be noted that there was an absence of any manifestations of disease in the specimens included and that they were collected mostly in the morning hours during which they had been

feeding. This was also done at the time of the year when most of them were not breeding. A few were northern migrants.

In those species that show great individual variation, large numbers are required to demonstrate whether there are differences in the adrenals or thyroids due to sex, season, or climate. Latimer (1924) found no sex difference in the adrenals in an extensive study of White Leghorn chickens at different ages. Riddle (1925) reported an increase in the size of the adrenal of pigeons and doves at the time of ovulation. However, he used closely inbred strains in a controlled environment. Riddle (1927) also found that pigeon thyroids were largest in autumn and winter and smallest in the summer.

In an earlier paper by one of us (Hartman, 1946), data were reported for 79 species in 12 families that are not covered in this study. The range of variation for both adrenals and thyroids in some species was as great as we find in this study. Among all species included in this and the previous communication few showed great distinction in the relative size of the adrenals. None are relatively as large as those of the Brown Pelican, those of the Barred Forest Falcon being next in relative size. It is also interesting to note that the adrenals and thyroids in Panamá migrants from the United States showed no significant difference from the glands in the same species collected in the summer in the United States. This was true for the Black-and-White Warbler, the Black-throated Green Warbler, the Chestnut-sided Warbler, and the Rose-breasted Grosbeak. However, we do find differences in a few Panamá and Florida birds. The adrenals of the Olivaceus Cormorant were larger than those of the Double-crested Cormorant collected in Florida. The reverse was true for the thyroids. This inverse relationship between adrenal and thyroid weights brings to mind Harris' (1955) discussion of the reciprocal relation between thyroid and adrenal cortical secretion in mammals under the control of the anterior pituitary. As he points out, this occurs particularly in response to stressful situations when the adrenal secretory activity increases and that of the thyroid decreases. However, there was no evidence to indicate that the Olivaceus Cormorant group had been subjected to any greater stress than had Double-crested Cormorants. On the other hand, the thyroids were larger ($P<0.01$) in the Common Egret collected in Panamá compared with those in the same species from Florida.

That species of the same family may differ greatly in relative adrenal size is shown by the Snowy Egret in the Ardeidae, the White-throated Crake in the Rallidae, the Rufous-breasted Quail Dove in the

Columbidae, the Bright-rumped Attila in the Cotingidae, the Scale-crested Pygmy Tyrant and the Yellow Tyrannulet in the Tyrannidae, and the Rough-winged Swallow in the Hirundinidae.

This is also true for thyroids as shown by the Lesser Nighthawk in the Caprimulgidae, the Emerald Toucanet in the Ramphastidae, the Wedge-billed Woodhewer in the Dendrocolaptidae, Red-faced Spinetail in the Furnariidae, and the Rough-winged Swallow in the Hirundinidae.

The variation in relative thyroid size in some species is not surprising in light of Riddle's (1927) investigations in which he was able to establish races of ring doves characterized by large thyroids and other races by small thyroids. Riddle and Fisher (1925) found that seasonal change in thyroid size was greater in the common pigeon than in the ring dove. Thus under controlled environmental conditions the thyroids of some species are more susceptible to change than are others.

The question of the variable size of the thyroid and the adrenal is an interesting one. Variation in size of the thyroid is perhaps less important than variation in adrenal size because a small thyroid can meet extra demand better than can a small adrenal, since the thyroid can store considerable hormone while the adrenal depends more upon its immediate output. Although the two adrenals occasionally differ in size, this does not occur so often or so markedly as it does in the thyroids. Both are under the control of the anterior pituitary and the hypothalamus.

The variation in adrenal size in birds appears to be much greater than in mammals. Christian (1953) found that adrenal weight in mammals follows a definite logarithmic relationship to body size for a large number of mammalian species.

If adrenal and thyroid size reflect the metabolic activity of the organism, it should be shown among birds of different species, since they include some of the most active in the animal kingdom. However, such reflection does not occur. Hummingbirds possess adrenals and thyroids of very ordinary size, while cormorants and pelicans have very large adrenals and ordinary thyroids.

We must conclude that the relative sizes of the adrenals and thyroids, when comparing one species with another, bear no relation to the activity of the bird, since some of the most active species may have small glands or glands of only moderate size while those with the largest glands may not be unusually active. Even within the species there may be considerable variation among individuals. This, however, does not mean that external factors do not influence the size and activity of the glands, since they are controlled at least in part through the nervous system

via the hypothalamus. In order to prove such effect it would be necessary to employ a large series under standardized conditions.

ACKNOWLEDGMENTS

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SUMMARY

Body weights and percentage adrenal and thyroid weights are recorded for 249 species of birds in 49 families, collected in Panamá during December, January, February, and March.

There was great range among individuals of many species in both adrenal and thyroid weights. However, this range was not great in 20 species.

The adrenals were larger than the thyroids in 176 species, while the reverse was true in 42 species.

When the logarithms of the adrenal weights are plotted against those of the body weight, the values of birds weighing 200 grams or less tend to lie near a straight line, while larger birds show a great divergence, a few being below the line but more being above. There were 15 species with adrenals about 0.02 per cent of the body weight or above. In eight species the adrenals were 0.01 per cent of the body weight or less.

When the logarithms of thyroid weights are plotted against those of the body weight, the general trend is a straight line, but, unlike the adrenals, there was a generally greater divergence, small birds showing as much divergence as large ones. There were 12 species with thyroids 0.015 per cent of the body weight or less. In seven species the thyroids were 0.005 per cent of the body weight or less.

Adrenals and thyroids of four species of migrants from the United States showed no difference from the same species collected in the United States.

The adrenals of the Olivaceous Cormorant were larger than those of the Double-crested Cormorant collected in Florida. The reverse was true for the thyroids. However, the thyroids of the Common Egret collected in Panamá were larger than those from the same species from Florida.

TABLE 1

ARITHMETIC MEAN BODY WEIGHTS, PERCENTAGE ADRENAL AND PERCENTAGE THYROID OF BODY WEIGHTS WITH STANDARD ERROR OF THE MEANS
(Number of individuals in parentheses)

Family and species	*Mean body weight* ± *standard error grams*	*Adrenal weight* ×100 / *Body weight* ± *standard error*	*Thyroid weight* ×100 / *Body weight* ± *standard error*
TINAMIDAE			
Crypturellus soui Little Tinamou	(3) 202 ± 13.2	(3) 0.0122 ± 0.0033 (0.0066 — 0.0154)**	(3) 0.0110 ± 0.0032 (0.0073 — 0.0164)
PODICIPEDIDAE			
Podiceps dominicus Least Grebe	(2) 105.3, 119.1	(2) 0.0133, 0.0159	(2) 0.0086, 0.0100
PHALACROCORACIDAE			
Phalacrocorax olivaceous Olivaceous Cormorant	(3) 1225 ± 64	(3) 0.0258 ± 0.0049 (0.0182 — 0.0318)	(3) 0.0063 ± 0.0011 (0.0049 — 0.0089)
ANHINGIDAE			
Anhinga anhinga Anhinga	(2) 1150, 1325	(2) 0.0176, 0.0170	0.0041
ARDEIDAE			
Casmerodius albus Common Egret	(4) 917 ± 44	(4) 0.0142 ± 0.0033 (0.0078 — 0.0219)	(4) 0.0056 ± 0.0010 (0.0029 — 0.0070)
Leucophoyx thula Snowy Egret	(6) 394 ± 24.3	(6) 0.0180 ± 0.0016 (0.0140 — 0.0240)	(6) 0.0059 ± 0.0007 (0.0037 — 0.0087)
**Bubulcus ibis* Cattle Egret	(9) 339 ± 9.6	(9) 0.0138 ± 0.0010 (0.0108 — 0.0197)	(9) 0.0073 ± 0.0004 (0.0057 — 0.0095)
Ixobrychus exilis Least Bittern	(3) 87.7 ± 3.75	(3) 0.0171 ± 0.0020 (0.0138 — 0.0188)	(2) 0.0062, 0.0096

COCHLEARIIDAE			
Cochlearius cochlearius Boat-billed Heron	(3) 570 ± 6.1	(3) 0.0185 ± 0.0024 (0.0147 — 0.0217)	(3) 0.0075 ± 0.0009 (0.0061 — 0.0085)
ANATIDAE			
Aythya affinis Lesser Scaup	(2) 675; 675	0.0082, 0.0105	(1) 0.0086
CATHARTIDAE			
Coragyps atratus Black Vulture	(1) 1940	0.0065	0.0075
ACCIPITRIDAE			
Buteo platypterus Broad-winged Hawk	(4) 367 ± 14	(4) 0.0120 ± 0.0017 (0.0087 — 0.0156)	(4) 0.0049 ± 0.0010 (0.0025 — 0.0063)
FALCONIDAE			
Micrastur ruficollis Barred Forest Falcon	(5) 190 ± 8.73	(4) 0.0322 ± 0.0019 (0.0290 — 0.0366)	(5) 0.0066 ± 0.0005 (0.0057 — 0.0082)
CRACIDAE			
Ortalis garrula Chestnut-winged Chachalaca	(4) 537 ± 40	(4) 0.0128 ± 0.0023 (0.0079 — 0.0172)	(4) 0.0085 ± 0.0016 (0.0057 — 0.0111)
PHASIANIDAE			
**Odontophorus guttatus* Spotted Wood Quail	(9) 323 ± 15	(8) 0.0094 ± 0.0012 (0.0058 — 0.0162)	(8) 0.0062 ± 0.0007 (0.0039 — 0.0089)
Coturnix coturnix Japanese Quail	(3) 113 ± 4.3	(3) 0.0136 ± 0.0030 (0.0092 — 0.0180)	(2) 0.0050; 0.0063
Gallus gallus Common Fowl	(9) 2330 ± 19	(9) 0.0073 ± 0.0009	(9) 0.0074 ± 0.0007
RALLIDAE			
Aramides cajanea Gray-necked Wood Rail	(5) 429 ± 15.8	(4) 0.0102 ± 0.0015 (0.0079 — 0.0136)	(5) 0.0077 ± 0.0008 (0.0072 — 0.0085)

* Representative of the family in the tables.
** Range.

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(Number of individuals in parentheses)

Family and species	*Mean body weight* ± *standard error grams*	*Adrenal weight* ×100 / *Body weight* ± *standard error*	*Thyroid weight* ×100 / *Body weight* ± *standard error*
**Laterallus albigularis* White-throated Crake	(6) 41.94 ± 3.40	(6) 0.0181 ± 0.0024 (0.0122 — 0.0284)	(6) 0.0108 ± 0.0014
HELIORNITHIDAE			
Heliornis fulica Sungrebe	(1) 140	0.0129	0.0114
JACANIDAE			
Jacana spinosa American Jaçana	(6) 95.87 ± 9.8	(6) 0.0096 ± 0.0005 (0.0085 — 0.0109)	(6) 0.0086 ± 0.0016 (0.0053 — 0.0148)
LARIDAE			
Larus pipixcan Franklin's Gull	(3) 270 ± 24.7	(3) 0.0183 ± 0.0046 (0.0130 — 0.0257)	(3) 0.0083 ± 0.0014 (0.0066 — 0.0104)
COLUMBIDAE			
Columba speciosa Scaled Pigeon	(3) 267 ± 15.4	(3) 0.0087 ± 0.0007 (0.0078 — 0.0098)	(3) 0.0069 ± 0.0012 (0.0049 — 0.0081)
Columba albilinea White-naped Pigeon	(3) 317 ± 7.8	(3) 0.0103 ± 0.0018 (0.0081 — 0.0131)	(3) 0.0105 ± 0.0030 (0.0071 — 0.0155)
**Columbigallina talpacoti* Ruddy Ground Dove	(8) 45.58 ± 1.82	(8) 0.0119 ± 0.0029 (0.0054 — 0.0249)	(8) 0.0064 ± 0.00065 (0.0039 — 0.0088)
Claravis pretiosa Blue Ground Dove	(4) 70.7 ± 1.97	(3) 0.0113 ± 0.0016 (0.0086 — 0.0130)	(3) 0.0092 ± 0.0007 (0.0081 — 0.0100)
Leptotila cassinii Gray-chested Dove	(3) 143 ± 14.35	(3) 0.0094 ± 0.0016 (0.0076 — 0.0120)	(3) 0.0081 ± 0.0003 (0.0076 — 0.0085)

Leptotila rufinucha Rufous-naped Dove	(3) 164 ± 7.57	(3) 0.0126 ± 0.0013 (0.0108 — 0.0142)	(3) 0.0114 ± 0.0019 (0.0087 — 0.0141)
Geotrygon montana Ruddy Quail Dove	(5) 136.3 ± 4.47	(4) 0.0087 ± 0.0023 (0.0043 — 0.0131)	(4) 0.0098 ± 0.0015 (0.0057 — 0.0117)
Geotrygon chiriquensis Rufous-breasted Quail Dove	(5) 314 ± 8.52	(5) 0.0168 ± 0.0029 (0.0107 — 0.0239)	(5) 0.0081 ± 0.0004 (0.0071 — 0.0089)
PSITTACIDAE			
**Pyrrhura hoffmanni* Sulphur-winged Parakeet	(6) 81.45 ± 2.84	(4) 0.0113 ± 0.0020 (0.0066 — 0.0148)	(5) 0.0071 ± 0.0007 (0.0058 — 0.0095)
Brotogeris jugularis Orange-chinned Parakeet	(5) 64.79 ± 2.10	(5) 0.0151 ± 0.0018 (0.0101 — 0.0189)	(4) 0.0065 ± 0.0003 (0.0060 — 0.0070)
Pinopsitta haematotis Brown-hooded Parrot	(3) 145 ± 3.91	(3) 0.0131 ± 0.0021 (0.0114 — 0.0165)	(3) 0.0050 ± 0.0005 (0.0041 — 0.0056)
CUCULIDAE			
Piaya cayana Squirrel Cuckoo	(5) 103.5 ± 5.1	(5) 0.0130 ± 0.0017 (0.0086 — 0.0170)	(5) 0.0108 ± 0.0031 (0.0037 — 0.0181)
Crotophaga major Greater Ani	(5) 162 ± 2.09	(5) 0.0101 ± 0.0010 (0.0075 — 0.0134)	(5) 0.0058 ± 0.0006 (0.0045 — 0.0072)
**Crotophaga ani* Smooth-billed Ani	(11) 100.56 ± 1.73	(10) 0.0128 ± 0.0007 (0.0051 — 0.0165)	(10) 0.0055 ± 0.0005 (0.0040 — 0.0091)
TYTONIDAE			
Tyto alba Barn Owl	1393	0.0125	0.0046
STRIGIDAE			
Otus choliba Tropical Screech Owl	(3) 124 ± 3.57	(3) 0.0168 ± 0.0023 (0.0147 — 0.0207)	(3) 0.0100 ± 0.0030 (0.0062 — 0.0147)
NYCTIBIIDAE			
Nyctibius griseus Common Potoo	(4) 191 ± 18.2	(4) 0.0102 ± 0.0020 (0.0075 — 0.0150)	(4) 0.0044 ± 0.0006 (0.0032 — 0.0055)

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(Number of individuals in parentheses)

Family and species	*Mean body weight* ± *standard error grams*	*Adrenal weight ×100* / *Body weight* ± *standard error*	*Thyroid weight ×100* / *Body weight* ± *standard error*
CAPRIMULGIDAE			
Chordeiles acutipennis Lesser Nighthawk	(3) 51.78 ± 3.14	(3) 0.0127 ± 0.0020 (0.0099 — 0.0156)	(3) 0.0131 ± 0.0008 (0.0119 — 0.0138)
**Nyctidromus albicollis* Pauraque	(7) 56.43 ± 2.76	(6) 0.0120 ± 0.0015 (0.0091 — 0.0189)	(6) 0.0077 ± 0.0011 (0.0049 — 0.0102)
TROCHILIDAE			
Glaucis hirsuta Rufous-breasted Hermit	(5) 6.19 ± 0.23	(5) 0.0123 ± 0.0012 (0.0100 — 0.0150)	(4) 0.0137 ± 0.0010 (0.0120 — 0.0157)
Phacochroa cuvierii Scaly-breasted Hummingbird	(6) 8.72 ± 0.22	(6) 0.0137 ± 0.022 (0.0111 — 0.0158)	(4) 0.0093 ± 0.0015 (0.0067 — 0.0119)
Campylopterus hemileucurus Violet Sabrewing	(6) 11.18 ± 0.46	(6) 0.0152 ± 0.0027 (0.0114 — 0.0277)	(4) 0.0181 ± 0.0076 (0.0059 — 0.0342)
**Damophila julie* Violet-bellied Hummingbird	(10) 3.05 ± 0.05	(6) 0.0151 ± 0.0018 (0.0106 — 0.0213)	(8) 0.0127 ± 0.0010 (0.0089 — 0.0177)
Amazilia edward Snowy-breasted Hummingbird	(4) 4.74 ± 0.09	(3) 0.0131 ± 0.0036 (0.0074 — 0.0172)	(4) 0.0128 ± 0.0021 (0.0082 — 0.0168)
Amazilia tzacatl Rufous-tailed Hummingbird	(8) 4.98 ± 0.0005	(8) 0.0110 ± 0.0015 (0.0064 — 0.0166)	(7) 0.0125 ± 0.0020 (0.0079 — 0.0229)
Lampornis castaneoventris White-throated Mountain-Gem	(5) 5.66 ± 0.34	(5) 0.0134 ± 0.0019 (0.0094 — 0.0173)	(3) 0.0078 ± 0.0017 (0.0080 — 0.0106)
Selasphorus scintilla Scintillant Hummingbird	(4) 2.16 ± 0.09	(4) 0.0202 ± 0.0084 (0.0109 — 0.0420)	(2) 0.0222; 0.0227

TROGONIDAE			
Trogon massena Slaty-tailed Trogon	(3) 150.3 ± 1.39	(3) 0.0099 ± 0.0007 (0.0089 — 0.0108)	(3) 0.0068 ± 0.0003 (0.0062 — 0.0078)
Trogon rufus Black-throated Trogon	(3) 52.8 ± 3.74	(3) 0.0148 ± 0.0030 (0.0122 — 0.0190)	(3) 0.0146 ± 0.0024 (0.0110 — 0.0180)
**Trogon violaceus* Violaceous Trogon	(4) 54.2 ± 1.61	(4) 0.0115 ± 0.0017 (0.0079 — 0.0147)	(4) 0.0111 ± 0.0009 (0.0096 — 0.0133)
ALCEDINIDAE			
Chloroceryle amazona Amazon Kingfisher	(6) 121.9 ± 3.82	(6) 0.0172 ± 0.0031 (0.0082 — 0.0292)	(6) 0.0074 ± 0.0011 (0.0058 — 0.0086)
**Chloroceryle americana* Green Kingfisher	(8) 37.74 ± 2.58	(6) 0.0209 ± 0.0029 (0.0141 — 0.0300)	(6) 0.0136 ± 0.0033 (0.0066 — 0.0252)
Chloroceryle aenea Pygmy Kingfisher	(3) 15.84 ± 0.59	(3) 0.0194 ± 0.0027 (0.0170 — 0.0238)	(3) 0.0108 ± 0.0012 (0.0089 — 0.0119)
MOMOTIDAE			
Momotus subrufescens Tawny-bellied Motmot	(3) 103.9 ± 3.23	(3) 0.0077 ± 0.0018 (0.0060 — 0.0107)	(3) 0.0073 ± 0.0011 (0.0058 — 0.0090)
**Momotus momota* Blue-crowned Motmot	(3) 125.9 ± 2.27	(3) 0.0141 ± 0.0020 (0.0108 — 0.0160)	(3) 0.0073 ± 0.0007 (0.0063 — 0.0082)
BUCCONIDAE			
Malacoptila panamensis White-whiskered Puffbird	(2) 41.2; 43.0	(2) 0.0160; 0.0149	(2) 0.0083; 0.0095
CAPITONIDAE			
Eubucco bourcierii Red-headed Barbet	(6) 33.6 ± 1.52	(6) 0.0187 ± 0.0024 (0.0141 — 0.0229)	(5) 0.0091 ± 0.0012 (0.0060 — 0.0125)
RAMPHASTIDAE			
**Aulacorhynchus prasinus* Emerald Toucanet	(5) 153.5 ± 3.60	(4) 0.0135 ± 0.0025 (0.0092 — 0.0171)	(5) 0.0141 ± 0.0024 (0.0092 — 0.0200)
Pteroglossus torquatus Collared Araçari	(3) 237 ± 8	(3) 0.0120 ± 0.0012 (0.0103 — 0.0138)	(3) 0.0049 ± 0.0004 (0.0044 — 0.0056)

TABLE 1

ARITHMETIC MEAN BODY WEIGHTS, PERCENTAGE ADRENAL AND PERCENTAGE THYROID OF BODY WEIGHTS WITH STANDARD ERROR OF THE MEANS
(Number of individuals in parentheses)

Family and species	*Mean body weight ± standard error grams*	*Adrenal weight ×100 / Body weight ± standard error*	*Thyroid weight ×100 / Body weight ± standard error*
Pteroglossus frantzii Fiery-billed Araçari	(3) 276 ± 4.21	(3) 0.0105 ± 0.0007 (0.0096 — 0.0116)	(3) 0.0052 ± 0.0008 (0.0038 — 0.0060)
PICIDAE			
**Piculus rubiginosus* Golden-olive Woodpecker	(4) 77.3 ± 2.81	(3) 0.0107 ± 0.0010 (0.0096 — 0.0122)	(3) 0.0043 ± 0.0004 (0.0038 — 0.0049)
Dryocopus lineatus Lineated Woodpecker	(6) 184.7 ± 4.2	(5) 0.0090 ± 0.0003 (0.0081 — 0.0098)	(5) 0.0053 ± 0.0008 (0.0038 — 0.0069)
Centurus rubricapillus Red-crowned Woodpecker	(3) 51.07 ± 2.35	(3) 0.0140 ± 0.0008 (0.0130 — 0.0152)	(3) 0.0084 ± 0.0006 (0.0074 — 0.0091)
Centurus pucherani Black-cheeked Woodpecker	(4) 56.9 ± 3.19	(3) 0.0107 ± 0.0015 (0.0082 — 0.0125)	(3) 0.0069 ± 0.0020 (0.0050 — 0.0101)
Dendrocopos villosus Hairy Woodpecker	(3) 40.7 ± 1.39	(3) 0.0114 ± 0.0021 (0.0094 — 0.0151)	(2) 0.0082; 0.0103
DENDROCOLAPTIDAE			
**Sittasomus griseicapillus* Olivaceous Woodhewer	(7) 13.92 ± 0.33	(5) 0.0135 ± 0.0031 (0.0073 — 0.0230)	(5) 0.0072 ± 0.0011 (0.0052 — 0.0100)
Glyphorynchus spirurus Wedge-billed Woodhewer	(3) 13.03 ± 1.44	(3) 0.0140 ± 0.0016 (0.0127 — 0.0166)	(3) 0.0133 ± 0.0008 (0.0120 — 0.0140)
Xiphorhynchus erythropygius Spotted Woodhewer	(5) 48.5 ± 1.67	(5) 0.0115 ± 0.0022 (0.0073 — 0.0178)	(5) 0.0067 ± 0.0022 (0.0041 — 0.0144)
Lepidocolaptes affinis Spot-crowned Woodhewer	(4) 33.62 ± 1.84	(5) 0.0119 ± 0.0015 (0.0076 — 0.0150)	(4) 0.0073 ± 0.0009 (0.0054 — 0.0087)

FURNARIIDAE			
Synallaxis albescens Pale-breasted Spinetail	(3) 13.35 ± 0.27	(3) 0.0167 ± 0.0045 (0.0093 — 0.207)	(2) 0.0175; 0.0285 (
Synallaxis brachyura Slaty Spinetail	(4) 18.14 ± 0.58	(3) 0.0164 ± 0.0042 (0.0093 — 0.0231)	(2) 0.0087; 0.0165
**Cranioleuca erythrops* Red-faced Spinetail	(7) 16.94 ± 0.21	(6) 0.0191 ± 0.0022 (0.0138 — 0.0265)	(5) 0.0148 ± 0.0027 (0.0088 — 0.0228)
Syndactyla subalaris Lineated Foliage-gleaner	(4) 31.28 ± 3.23	(4) 0.0116 ± 0.0007 (0.0102 — 0.0127)	(4) 0.0065 ± 0.0006 (0.0055 — 0.0074)
Anabacerthia striaticollis Scaly-throated Foliage-gleaner	(4) 25.0 ± 3.54	(3) 0.0151 ± 0.0038 (0.0090 — 0.0194)	(3) 0.0080 ± 0.0032 (0.0039 — 0.0130)
FORMICARIIDAE			
Cymbilaimus lineatus Fasciated Antshrike	(3) 35.85 ± 0.71	(3) 0.0086 ± 0.0008 (0.0081 — 0.0099)	(3) 0.0091 ± 0.0019 (0.0073 — 0.0122)
Thamnophilus doliatus Barred Antshrike	(6) 28.05 ± 0.52	(4) 0.0127 ± 0.0018 (0.0103 — 0.0173)	(6) 0.0085 ± 0.0012 (0.0052 — 0.0129)
Dysithamnus mentalis Plain Antvireo	(6) 14.31 ± 0.45	(4) 0.0113 ± 0.0026 (0.0053 — 0.0154)	(5) 0.0090 ± 0.0016 (0.0060 — 0.0145)
Cercomacra tyrannina Dusky Antbird	(5) 16.18 ± 0.41	(5) 0.0162 ± 0.0023 (0.0099 — 0.0276)	(6) 0.0093 ± 0.0016 (0.0058 — 0.0143)
Formicarius analis Black-faced Antthrush	(3) 61.6 ± 1.40	(3) 0.0143 ± 0.0031 (0.0095 — 0.0182)	(3) 0.0104 ± 0.0022 (0.0065 — 0.0126)
**Gymnopithys bicolor* Bicolored Antbird	(5) 28.38 ± 1.52	(5) 0.0127 ± 0.0029 (0.0058 — 0.0193)	(4) 0.0109 ± 0.0021 (0.0060 — 0.0100)
PIPRIDAE			
Pipra mentalis Red-capped Manakin	(5) 15.06 ± 0.47	(5) 0.0144 ± 0.0008 (0.0125 — 0.0165)	(4) 0.0088 ± 0.0015 (0.0056 — 0.0121)
**Manacus vitellinus* Golden-collared Manakin	(8) 19.29 ± 0.53	(6) 0.038 ± 0.0011 (0.0109 — 0.0178)	(8) 0.0086 ± 0.0006 (0.0068 — 0.0119)

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(Number of individuals in parentheses)

Family and species	*Mean body weight* ± *standard error grams*	*Adrenal weight ×100* / *Body weight* ± *standard error*	*Thyroid weight ×100* / *Body weight* ± *standard error*
COTINGIDAE			
Cotinga ridgwayi Turquoise Cotinga	(4) 57.8 ± 1.67	(4) 0.0141 ± 0.0010 (0.0098 — 0.0167)	(3) 0.0099 ± 0.0006 (0.0085 — 0.0106)
Attila spadiceus Bright-rumped Attila	(5) 40.4 ± 0.73	(5) 0.0215 ± 0.0013 (0.0129 — 0.0258)	(5) 0.0083 ± 0.0008 (0.0075 — 0.0113)
Rhytipterna holerythra Rufous Mourner	(3) 38.0 ± 0.31	(2) 0.0117, 0.0172	(3) 0.0060 ± 0.0008 (0.0044 — 0.0077)
**Tityra semifasciata* Masked Tityra	(10) 80.14 ± 0.79	(8) 0.0146 ± 0.0008 (0.0099 — 0.0239)	(10) 0.0109 ± 0.0006 (0.0055 — 0.0229)
Erator inquisitor Black-crowned Tityra	(4) 41.6 ± 1.24	(4) 0.0156 ± 0.0024 (0.0078 — 0.0247)	(4) 0.0111 ± 0.0015 (0.0077 — 0.0178)
Querula purpurata Purple-throated Fruitcrow	(5) 100.97 ± 1.37	(5) 0.0113 ± 0.0028 (0.0098 — 0.0151)	(5) 0.0078 ± 0.0007
TYRANNIDAE			
Myiodynastes maculatus Streaked Flycatcher	(6) 46.48 ± 0.52	(6) 0.0132 ± 0.0007 (0.0090 — 0.0174)	(4) 0.0102 ± 0.0010 (0.0079 — 0.0146)
Megarynchus pitangua Boat-billed Flycatcher	(3) 74.8 ± 2.93	(3) 0.0123 ± 0.0012 (0.0096 — 0.0138)	(2) 0.0105, 0.0141
Myiozetetes similis Social Flycatcher	(3) 27.1 ± 1.83	(2) 0.0068, 0.0092	(3) 0.0144 ± 0.0004 (0.0082 — 0.0208)
Myiarchus tuberculifer Dusky-capped Flycatcher	(4) 18.81 ±0.65	(3) 0.0124 ± 0.0018 (0.0102 — 0.0152)	(4) 0.0128 ± 0.0026 (0.0093 — 0.0195)

**Empidonax flaviventris* Yellow-bellied Flycatcher	(8) 10.98 ± 0.32	(7) 0.0138 ± 0.0021 (0.0073 — 0.0219)	(8) 0.0149 ± 0.0018 (0.0087 — 0.0237)
Empidonax flavescens Yellowish Flycatcher	(4) 12.26 ± 0.38	(3) 0.0151 ± 0.0037 (0.0093 — 0.0197)	(4) 0.0108 ± 0.0010 (0.0096 — 0.0126)
Mitrephanes phaeocercus Tufted Flycatcher	(3) 8.83 ± 0.24	(3) 0.0131 ± 0.0021 (0.0096 — 0.0151)	(2) 0.0039, 0.0085
Lophotriccus pileatus Scale-crested Pygmy-Tyrant	(6) 7.85 ± 0.22	(4) 0.0222 ± 0.0058 (0.0141 — 0.0350)	(5) 0.0145 ± 0.0036 (0.0069 — 0.0253)
Capsiempis flaveola Yellow Tyrannulet	(3) 7.16 ± 0.22	(3) 0.0236 ± 0.0067 (0.0135 — 0.0325)	(2) 0.0107, 0.0184
Elaenia frantzii Mountain Elaenia	(7) 20.5 ± 0.52	(6) 0.0137 ± 0.0019 (0.0102 — 0.0205)	(7) 0.0097 ± 0.0009 (0.0065 — 0.0139)
Myiopagis viridicata Greenish Elaenia	(3) 14.23 ± 0.66	(2) 0.0135, 0.0178	(3) 0.0099 ± 0.0034 (0.0043 — 0.0138)
Tyranniscus vilissimus Paltry Tyrannulet	(3) 8.75 ± 0.30	(3) 0 0089 ± 0.0026 (0.0054 — 0.0125)	(3) 0.0097 ± 0.0009 (0.0087 — 0.0112)
HIRUNDINIDAE			
**Progne chalybea* Gray-breasted Martin	(11) 39.42 ± 0.93	(10) 0.0118 ± 0.0030 (0.0070 — 0.0177)	(9) 0.0116 ± 0.0006 (0.0090 — 0.0140)
Stelgidopteryx ruficollis Rough-winged Swallow	(3) 12.06 ± 0.54	(3) 0.0206 ± 0.0050 (0.0130 — 0.0269)	(3) 0.0163 ± 0.0009 (0.0149 — 0.0173)
TROGLODYTIDAE			
Thryothorus modestus Plain Wren	(5) 19.06 ± 0.42	(5) 0.0166 ± 0.0023 (0.0129 — 0.0242)	(4) 0.0084 ± 0.0014 (0.0048 — 0.0107)
Troglodytes musculus Southern House Wren	(6) 14.67 ± 3.75	(6) 0.0194 ± 0.0013 (0.0161 — 0.0225)	(5) 0.0139 ± 0.0033 (0.0059 — 0.0230)
**Henicorhina leucophrys* Gray-breasted Wood Wren	(5) 17.64 ± 0.29	(5) 0.0147 ± 0.0019 (0.0090 — 0.0184)	(4) 0.0117 ± 0.0027 (0.0079 — 0.0186)

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(Number of individuals in parentheses)

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Cyphorhinus phaeocephalus Song Wren	(3) 27.47 ± 1.02	(3) 0.0109 ± 0.0017 (0.0082 — 0.0132)	(2) 0.0058, 0.0080
TURDIDAE			
**Turdus assimilis* White-throated Robin	(3) 64.1 ± 1.09	(3) 0.0166 ± 0.0055 (0.0143 — 0.0200)	(3) 0.0207 ± 0.0054 (0.0139 — 0.0291)
Turdus grayi Clay-colored Robin	(3) 72.3 ± 1.27	(3) 0.0139 ± 0.0014 (0.0121 — 0.0161)	(3) 0.0128 ± 0.0044 (0.0079 — 0.0198)
Hylocichla ustulata Olive-backed Thrush	(4) 31.1 ± 0.35	(4) 0.0212 ± 0.0067 (0.0148 — 0.0386)	(4) 0.0106 ± 0.0015 (0.0074 — 0.0128)
SYLVIIDAE			
Ramphocaenus rufiventris Long-billed Gnatwren	10.08	0.0231	0.0208
CYCLARHIDAE			
Cyclarhis gujanensis Rufous-browed Peppershrike	(6) 30.97 ± 0.73	(6) 0.0165 ± 0.0018 (0.0123 — 0.0220)	(5) 0.0133 ± 0.0030 (0.0079 — 0.0235)
VIREONIDAE			
**Hylophilus viridiflavus* Scrub Greenlet	(3) 12.42 ± 0.31	(3) 0.0192 ± 0.0019 (0.0163 — 0.0220)	(2) 0.0059, 0.0113
Hylophilus decurtatus Gray-headed Greenlet	(3) 9.11 ± 0.19	(2) 0.0146, 0.0158	(3) 0.0119 ± 0.0033 (0.0092 — 0.0173)
COEREBIDAE			
Chlorophanes spiza Green Honeycreeper	(3) 16.86 ± 0.26	(2) 0.0122, 0.0165	(3) 0.0151 ± 0.0057 (0.0075 — 0.0258)

Cyanerpes cyaneus Red-legged Honeycreeper	(8) 12.75 ± 0.47	(8) 0.0213 ± 0.0025 (0.0123 — 0.0286)	(7) 0.0096 ± 0.0038 (0.0059 — 0.0146)
Cyanerpes lucidus Shining Honeycreeper	(5) 11.40 ± 0.22	(4) 0.0156 ± 0.0018 (0.0134 — 0.0202)	(4) 0.0144 ± 0.0026 (0.0089 — 0.0202)
**Dacnis venusta* Scarlet-thighed Dacnis	(5) 16.02 ± 0.63	(5) 0.0148 ± 0.0027 (0.0084 — 0.0203)	(5) 0.0138 ± 0.0023 (0.0076 — 0.0196)
PARULIDAE			
Mniotilta varia Black-and-White Warbler	(3) 9.58 ± 0.19	(2) 0.0094, 0.0213	(3) 0.0092 ± 0.0025 (0.0054 — 0.0126)
Vermivora peregrina Tennessee Warbler	(5) 8.95 ± 0.22	(5) 0.0176 ± 0.0034 (0.0136 — 0.0207)	(5) 0.0101 ± 0.0017 (0.0066 — 0.0141)
Parula pitiayumi Tropical Parula	(4) 6.96 ± 0.15	(4) 0.0137 ± 0.0016 (0.0110 — 0.0166)	(2) 0.0110, 0.0155
Dendroica virens Black-throated Green Warbler	(6) 8.82 ± 0.14	(3) 0.0131 ± 0.0032 (0.0086 — 0.0163)	(3) 0.0155 ± 0.0043 (0.0112 — 0.0225)
Dendroica pensylvanica Chestnut-sided Warbler	(3) 8.84 ± 0.089	(3) 0.0173 ± 0.0038 (0.0111 — 0.0214)	(3) 0.0085 ± 0.0014 (0.0072 — 0.0109)
Wilsonia pusilla Pileolated Warbler	(5) 7.02 ± 0.177	(6) 0.0153 ± 0.0020 (0.0105 — 0.0231)	(6) 0.0161 ± 0.0037 (0.0126 — 0.0231)
**Myioborus miniatus* Slate-throated Redstart	(6) 9.01 ± 0.41	(5) 0.0148 ± 0.0019 (0.0101 — 0.0193)	(3) 0.0056 ± 0.0018 (0.0028 — 0.0075)
Myioborus torquatus Collared Redstart	(4) 10.49 ± 0.26	(4) 0.0167 ± 0.0020 (0.0135 — 0.0215)	(4) 0.0079 ± 0.0019 (0.0055 — 0.0117)
Basileuterus culicivorus Golden-crowned Warbler	(3) 10.8 ± 0.45	(2) 0.0153, 0.0241	(3) 0.0079 ± 0.0017 (0.0053 — 0.0100)
ICTERIDAE			
Zarhynchus wagleri Chestnut-headed Oropendola	♀ 110.5; 120 ♂ 200.0; 225	(4) 0.0105 ± 0.0017 (0.0092 — 0.0115)	(4) 0.0083 ± 0.0011 (0.0061 — 0.0108)

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Family and species	*Mean body weight ± standard error grams*	*Adrenal weight ×100 / Body weight ± standard error*	*Thyroid weight ×100 / Body weight ± standard error*
Psarocolius decumanus Crested Oropendula	(3) 276 ± 42.5	(3) 0.0077 ± 0.0007 (0.0068 — 0.0083)	(3) 0.0074 ± 0.0003 (0.0071 — 0.0079)
**Cacicus vitellinus* Yellow-rumped Cacique	(6) 68.77 ± 1.24	(7) 0.0115 ± 0.0007 (0.0093 — 0.0140)	(7) 0.0083 ± 0.0010 (0.0059 — 0.0111)
Cacicus microrhynchus Scarlet-rumped Cacique	(4) 58.90 ± 4.11	(4) 0.0115 ± 0.0016 (0.0089 — 0.0152)	(4) 0.0067 ± 0.0016 (0.0043 — 0.0104)
Amblycercus holosericeus Yellow-billed Cacique	(3) 75.43 ± 1.93	(3) 0.0107 ± 0.0010 (0.0095 — 0.0122)	(2) 0.0054, 0.0062
Scaphidura oryzivora Colombian Rice Grackle	2 ♀ 132.60; 149.44 2 ♂ 175.3; 200	(4) 0.0119 ± 0.0013 (0.0071 — 0.0125)	(4) 0.0073 ± 0.0015 (0.0066 — 0.0086)
THRAUPIDAE			
**Tangara icterocephala* Silver-throated Tanager	(6) 21.82 ± 0.63	(6) 0.0139 ± 0.0014 (0.0098 — 0.0181)	(5) 0.0066 ± 0.0009 (0.0048 — 0.0092)
Tangara larvata Golden-masked Tanager	(5) 19.42 ± 0.47	(5) 0.0168 ± 0.0021 (0.0110 — 0.0215)	(5) 0.0084 ± 0.0011 (0.0057 — 0.0111)
Tangara gyrola Bay-headed Tanager	(3) 22.3 ± 1.04	(3) 0.0140 ± 0.0027 (0.0106 — 0.0183)	(2) 0.0076, 0.0081
Ramphocelus dimidiatus Crimson-backed Tanager	(4) 31.28 ± 1.68	(4) 0.0131 ± 0.0030 (0.0059 — 0.0186)	(4) 0.0096 ± 0.0014 (0.0074 — 0.0127)
Piranga rubra Summer Tanager	(6) 30.22 ± 0.46	(4) 0.0121 ± 0.0023 (0.0057 — 0.0201)	(5) 0.0127 ± 0.0020 (0.0088 — 0.0219)

Piranga leucoptera White-winged Tanager	(4) 16.8 ± 0.74	(4) 0.0180 ± 0.0036 (0.0111 — 0.0234)	0.0095, 0.0095
Habia fuscicauda Dusky-tailed Ant-Tanager	(3) 39.34 ± 1.27	(3) 0.0137 ± 0.0027 (0.0104 — 0.0180)	(3) 0.0094 ± 0.0013 (0.0079 — 0.0114)
Tachyphonus rufus White-lined Tanager	(4) 34.95 ± 1.09	(4) 0.0093 ± 0.0006 (0.0081 — 0.0105)	(4) 0.0090 ± 0.0007 (0.0073 — 0.0103)
Rhodinocichla rosea Rose-breasted Thrush-Tanager	(3) 49.84 ± 1.00	(3) 0.0089 ± 0.0021 (0.0054 — 0.0116)	(3) 0.0062 ± 0.0014 (0.0051 — 0.0087)
Chlorospingus ophthalmicus Common Bush-Tanager	(6) 20.52 ± 0.75	(6) 0.0164 ± 0.0011 (0.0132 — 0.0210)	(3) 0.0081 ± 0.0027 (0.0039 — 0.0113)
FRINGILLIDAE			
Saltator maximus Buff-throated Saltator	(6) 48.2 ± 1.04	(4) 0.0128 ± 0.0054 (0.0103 — 0.0165)	(5) 0.0099 ± 0.0019 (0.0059 — 0.0145)
**Saltator albicollis* Streaked Saltator	(7) 38.96 ± 1.00	(4) 0.0116 ± 0.0019 (0.0092 — 0.0166)	(5) 0.0111 ± 0.0021 (0.0083 — 0.0180)
Pheucticus ludovicianus Rose-breasted Grosbeak	(4) 45.3 ± 0.97	(3) 0.0125 ± 0.0040 (0.0059 — 0.0162)	(3) 0.0168 ± 0.0037 (0.0105 — 0.0200)
Tiaris olivacea Yellow-faced Grassquit	(4) 8.46 ± 0.22	(4) 0.0123 ± 0.0026 (0.0117 — 0.0128)	(3) 0.0220 ± 0.0069 (0.0124 — 0.0322)
Sporophila aurita Variable Seedeater	(6) 10.71 ± 1.63	(5) 0.0096 ± 0.0016 (0.0043 — 0.0123)	(6) 0.0122 ± 0.0039 (0.0081 — 0.0158)
Oryzoborus funereus Thick-billed Seed-Finch	(4) 12.48 ± 0.81	(4) 0.0086 ± 0.0010 (0.0071 — 0.0111)	(3) 0.0089 ± 0.0005 (0.0081 — 0.0095)
Pselliophorus tibialis Yellow-thighed Finch	(3) 33.0 ± 1.51	(3) 0.0181 ± 0.0032 (0.0130 — 0.0218)	(3) 0.0081 ± 0.0007 (0.0069 — 0.0090)
Arremonops conirostris Lafresnaye's Sparrow	(6) 40.80 ± 1.00	(3) 0.0103 ± 0.0020 (0.0070 — 0.0127)	(6) 0.0082 ± 0.0007 (0.0057 — 0.0103)
Zonotrichia capensis Rufous-collared Sparrow	(4) 20.03 ± 0.88	(4) 0.0161 ± 0.0026 (0.0110 — 0.0218)	(3) 0.0139 ± 0.0028 (0.0099 — 0.0179)

SPECIES NOT SHOWN IN THE TABLES

ANATIDAE

1 *Anas discors* (Blue-winged Teal): body, 330 g.; adrenals, 0.0094%; thyroids, 0.0076%. 1 *Mareca americana* (Baldpate): body, 545 g.; adrenals, 0.0224%; thyroids, 0.0112%.

ACCIPITRIDAE

1 *Leptodon cayanensis* (Gray-headed Kite): body, 435 g.; adrenals, 0.0122%; thyroids, 0.0045%. 1 *Harpagus bidentatus* (Double-toothed Kite): body, 206 g.; adrenals, 0.0073%; thyroids, 0.0150%. 2 *Buteo magnirostris* (Large-billed Hawk): body, 295–312 g.; adrenals, 0.0131–0.0160%; thyroids, 0.0051%.

COLUMBIDAE

1 *Leptotila verreauxi* (White-tipped Dove): body, 152 g.; adrenals, 0.0091%; thyroids, 0.0112%.

PSITTACIDAE

2 *Bolborhynchus lineola* (Barred Parakeet): body, 45.2–53.2 g.; adrenals, 0.0110–0.0185%; thyroids, 0.0077–0.0112%. 1 *Pionus senilis* (White-crowned Parrot): body, 165.6 g.; adrenals, 0.0157%; thyroids, 0.0080%. 2 *Amazona autumnalis* (Red-fronted Parrot): body, 400–468 g.; adrenals, 0.0094–0.0143%; thyroids, 0.0073–0.0094%.

CUCULIDAE

1 *Coccyzus americanus* (Yellow-billed Cuckoo): body 52.4 g.; adrenals, 0.0094%; thyroids, 0.0079%. 2 *Tapera naevia* (Striped Cuckoo): body, 46.86–58.18 g.; adrenals, 0.0107–0.0196%; thyroids, 0.0080–0.0087%.

STRIGIDAE

1 *Ciccaba nigrolineata* (Black-and-White Owl): body, 500 g.; adrenals, 0.0078%; thyroids, 0.0046%. 1 *Rhinoptynx clamator* (Striped Owl): body, 385 g.; adrenals, 0.0097%; thyroids, 0.0038%.

TROCHILIDAE

2 *Phaethornis guy* (Green Hermit): body, 5.74–5.98 g.; adrenals, 0.0077–0.0124%; thyroids, 0.0094%. 2 *Phaethornis longuemareus* (Little Hermit): body, 2.71–2.77 g.; adrenals, 0.0134–0.0211%; thyroids, 0.0144–0.0166%. 2 *Anthracothorax nigricollis* (Black-throated Mango): body, 6.32–7.16 g.; adrenals, 0.0117–0.0160%; thyroids, 0.0064–0.0149%. 1 *Chlorostilbon assimilis* (Garden Emerald): body, 2.84 g.; adrenals, 0.0222%; thyroids, 0.0141%. 2 *Amazilia amabalis* (Blue-chested Hummingbird): body, 3.51–3.51 g.; adrenals, 0.0128–0.0251%; thyroids, 0.0185%. 2 *Eupherusa eximia* (Stripe-tailed Hummingbird): body, 4.29–4.50 g.; adrenals, 0.0142–0.0196%; thyroids, 0.0129–0.0191%. 2 *Elvira chionura* (White-tailed Emerald): body, 3.20–3.37 g.; adrenals, 0.0156%; thyroids, 0.0089–0.0199%. 2 *Heliothrix barroti* (Purple-crowned Fairy): body, 5.83–5.91 g.; adrenals, 0.0144–0.0146%; thyroids, 0.0164%. 1 *Philodice bryantae* (Magenta-throated Woodstar): body, 3.31 g.; adrenals, 0.0103%; thyroids, 0.0157%.

TROGONIDAE

2 *Pharomachrus mocinno* (Quetzal): body, 209–224 g.; adrenals, 0.0120–0.0125%; thyroids, 0.0071–0.0110%. 2 *Trogon strigilatus* (White-tailed Trogon): body, 62.4–63.7 g.; adrenals, 0.0159–0.0188%; thyroids, 0.0082–0.0114%. 2 *Trogon collaris* (Bar-tailed Trogon): body, 64.9–67.3 g.; adrenals, 0.0128–0.0145%; thyroids, 0.0089–0.0131%.

ALCEDINIDAE

1 *Ceryle torquata* (Ringed Kingfisher): body, 342 g.; adrenals, 0.0220%; thyroids, 0.0074%.

RAMPHASTIDAE

1 *Ramphastos swainsonii* (Chestnut-mandibled Toucan): body, 600 g.; adrenals, 0.0102%; thyroids, 0.0160%.

PICIDAE

2 *Picumnus olivaceus* (Olivaceous Piculet): body, 10.78–10.93 g.; adrenals, 0.0100–0.0187%; thyroids, 0.0069–0.0080%. 1 *Melanerpes formicivorus* (Acorn Woodpecker): body, 81 g.; adrenals, 0.0083%; thyroids, 0.0027%. 2 *Sphyrapicus varius* (Yellow-bellied Sapsucker): body, 40.7–43.4 g.; adrenals, 0.0096–0.0111%; thyroids, 0.0060–0.0070%. 2 *Venilornis fumigatus* (Smoky-brown Woodpecker): body, 29.6–31.6 g.; adrenals, 0.0186%; thyroids, 0.0122–0.0148%. 2 *Phloeoceastes guatemalensis* (Pale-billed Woodpecker): body, 227.6–271 g.; adrenals, 0.0064–0.0067%; thyroids, 0.0067–0.0118%.

DENDROCOLAPTIDAE

2 *Dendrocincla fuliginosa* (Plain-brown Woodhewer): body, 36.95–42.97 g.; adrenals, 0.0088–0.0133%; thyroids, 0.0083%. 1 *Dendrocincla homochroa* (Ruddy Woodhewer): body, 42.25 g.; adrenals, 0.0084%; thyroids, 0.0090%. 1 *Dendrocolaptes certhia* (Barred Woodhewer): body, 67.10 g.; adrenals, 0.0107%; thyroids, 0.0021%. 2 *Xiphorhynchus guttatus* (Buff-throated Woodhewer): body, 45.9–48.6 g.; adrenals, 0.0081–0.0122%; thyroids, 0.0045–0.0196%.

FURNARIIDAE

2 *Thripadectes rufobrunneus* (Streak-breasted Treehunter): body, 51.5–64.8 g.; adrenals, 0.0058–0.0151%; thyroids, 0.0080%. 2 *Xenops minutus* (Plain Xenops): body, 12.0–12.83 g.; adrenals, 0.0116–0.0172%; thyroids, 0.0080%.

FORMICARIIDAE

2 *Taraba major* (Great Antshrike): body, 65.8–66.2 g.; adrenals, 0.0092–0.0125%; thyroids, 0.0058–0.0069%. 1 *Thamnophilus punctatus* (Slaty Antshrike): body, 15.42 g.; adrenals, 0.0122%; thyroids, 0.0164%. 2 *Cercomacra nigricans* (Jet Antbird): body, 15.51–19.47 g.; adrenals, 0.0060–0.0111%; thyroids, 0.0081–0.0122%. 1 *Myrmeciza longipes* (White-bellied Antbird): body, 26.59 g.; adrenals, 0.0147%; thyroids, 0.0099%. 1 *Myrmeciza exsul* (Chestnut-backed Antbird): body, 28.80 g.; adrenals, 0.0104%; thyroids, 0.0088%.

COTINGIDAE

1 *Pachyramphus polychopterus* (White-winged Becard): body, 19.65 g.; adrenals, 0.0151%; thyroids, 0.0102%.

TYRANNIDAE

1 *Myiodynastes hemichrysus* (Golden-bellied Flycatcher): body, 43.4 g.; adrenals, 0.0092%; thyroids, 0.0097%. 2 *Myiozetetes cayanensis* (Rusty-margined Flycatcher): body, 22.64–23.73 g.; adrenals, 0.0177–0.0222%; thyroids, 0.0116%. 1 *Myiozetetes granadensis* (Gray-capped Flycatcher): body, 26.6 g.; adrenals, 0.0185%; thyroids, 0.0094%. 1 *Myiarchus ferox* (Short-crested Flycatcher): body, 31.51 g.; adrenals, 0.0071%; thyroids, 0.0052%. 1 *Contopus lugubris* (Dark Pewee): body, 20.23 g.; adrenals, 0.0116%; thyroids, 0.0138%. 1 *Myiobius atricaudus* (Black-tailed Flycatcher): body, 10.62 g.; adrenals, 0.0141%; thyroids, 0.0132%. 1 *Platyrinchus coronatus* (Golden-crowned Spadebill): body, 19.83 g.; adrenals, 0.0144%; thyroids, 0.0090%. 2 *Platyrinchus mystaceus* (White-throated Spadebill): body, 9.62–10.8 g.; adrenals, 0.0052–0.0154%; thyroids, 0.0096–0.0103%. 2 *Rhynchocyclus brevirostris* (Eye-ringed Flatbill): body, 20.54–23.33 g.; adrenals, 0.0129%; thyroids, 0.0085–0.0092%. 2 *Todirostrum cinereum* (Tody Flycatcher): body, 6.14–7.03 g.; adrenals, 0.0122%; thyroids, 0.0107–0.0220%. 1 *Elaenia frantzii:* body, 19.78 g.; adrenals, 0.0147%; thyroids, 0.0165%. 2 *Camptostoma pusillum* (Beardless Tyrannulet): body, 7.31–8.12 g.; adrenals, 0.0049–0.0096%; thyroids, 0.0084–0.0145%. 2 *Leptopogon superciliaris* (Slaty-capped Flycatcher): body, 11.08–13.77 g.; adrenals, 0.0061–0.0182%; thyroids, 0.0051–0.0070%. 1 *Mionectes olivaceus* (Olive-striped Flycatcher): body, 14.46 g.; adrenals, 0.0142%; thyroids, 0.0123%.

HIRUNDINIDAE

1 *Iridoprocne albilinea* (Mangrove Swallow): body, 12.87 g.; adrenals, 0.0178%; thyroids, 0.0200%.

CORVIDAE

1 *Cyanocorax affinis* (Black-chested Jay): body, 221.2 g.; adrenals, 0.0095%; thyroids, 0.0113%.

TROGLODYTIDAE

1 *Troglodytes ochraceus* (Ochraceous Wren): body, 18.3 g.; adrenals, 0.0243%; thyroids, 0.0067%. 1 *Henicorhina leucosticta* (White-breasted Wood-Wren): body, 18.3 g.; adrenals, 0.0243%; thyroids, 0.0067%.

TURDIDAE

2 *Turdus plebejus* (Mountain Robin): body, 70.6–76.7 g.; adrenals, 0.0083–0.0163%; thyroids, 0.0123–0.0149%.

SYLVIIDAE

1 *Polioptila plumbea* (Tropical Gnatcatcher): body, 5.90 g.; adrenals, 0.0188%; thyroids, 0.0085%.

VIREONIDAE

2 *Vireo flavifrons* (Yellow-throated Vireo): body, 15.61–17.70 g.; adrenals, 0.0183–0.0201%; thyroids, 0.0116–0.0149%. 1 *Vireo leucophrys* (Brown-capped Vireo): body, 13.17 g.; adrenals, 0.0099%; thyroids, 0.0128%. 2 *Hylophilus aurantiifrons* (Golden-fronted Greenlet): body, 9.27–10.19 g.; adrenals, 0.0189–0.0223%; thyroids, 0.0175%.

PARULIDAE

1 *Vermivora chrysoptera* (Golden-winged Warbler): body, 8.38 g.; adrenals, 0.0117%; thyroids, 0.0215%. 1 *Dendroica aestiva* (Yellow Warbler): body, 9.42 g.; adrenals, 0.0124%; thyroids, 0.0116%. 1 *Dendroica fusca* (Blackburnian Warbler): body, 9.29 g.; adrenals, 0.0165%; thyroids, 0.0133%. 1 *Seiurus motacilla* (Louisiana Waterthrush): body, 18.1 g.; adrenals, 0.0177%; thyroids, 0.0128%. 2 *Oporornis formosus* (Kentucky Warbler): body, 14.0–14.61 g.; adrenals, 0.0105–0.0143%; thyroids, 0.0084%. 2 *Oporornis philadelphia* (Mourning Warbler): body, 11.52–11.84 g.; adrenals, 0.0050–0.0190%; thyroids, 0.0090–0.0146%. 1 *Setophaga ruticilla* (American Redstart): body, 7.45 g.; adrenals, 0.0141%; thyroids, 0.0058%. 2 *Basileuterus melanogenys* (Black-cheeked Warbler): body, 11.86–13.43 g.; adrenals, 0.0143–0.0145%; thyroids, 0.0067–0.0079%. 2 *Basileuterus fulvicauda* (Buff-rumped Warbler): body, 14.32–15.50 g.; adrenals, 0.0147–0.0153%; thyroids, 0.0108–0.0110%.

ICTERIDAE

1 *Icterus spurius* (Orchard Oriole): body, 21.39 g.; adrenals, 0.0092%; thyroids, 0.0108%. 2 *Icterus mesomelas* (Yellow-tailed Oriole): body, 47.21–57.14 g.; adrenals, 0.0133–0.0138%; thyroids, 0.0055–0.0180%. 1 *Sturnella magna* (Meadowlark): body, 102.3 g.; adrenals, 0.0107%; thyroids, 0.0203%.

THRAUPIDAE

1 *Tanagra elegantissima* (Blue-hooded Euphonia): body, 14.18 g.; adrenals, 0.0162%; thyroids, 0.0092%. 1 *Tanagra laniirostris* (Thick-billed Euphonia): body, 15.60 g.; adrenals, 0.0227%; thyroids, 0.0092%. 1 *Tanagra imitans* (Spot-crowned Euphonia): body, 13.37 g.; adrenals, 0.0201%; thyroids, 0.0073%. 1 *Tangara guttata:* body, 19.0 g.; adrenals, 0.0352%; thyroids, 0.0095%. *Thraupis virens* (Blue-gray Tanager): body, 30.08–34.16 g.; adrenals, 0.0101–0.0157%; thyroids, 0.0116–0.0121%. 1 *Thraupis palmarum* (Palm Tanager): body, 35.8 g.; adrenals, 0.0163%; thyroids, 0.0095%. 2 *Ramphocelus passerinii* (Scarlet-rumped Tanager): body, 31.3–31.4 g.; adrenals, 0.0132–0.0186%; thyroids, 0.0079–0.0127%. 1 *Ramphocelus icteronotus* (Yellow-rumped Tanager): body, 34.23 g.; adrenals, 0.0059%; thyroids, 0.0074%. 2 *Piranga bidentata* (Flame-colored Tanager): body, 34.2–36.1 g.; adrenals, 0.0140–0.0146%; thyroids, 0.0045%. 1 *Habia rubica* (Red-crowned Ant-Tanager): body, 31.49 g.; adrenals, 0.0069%; thyroids, 0.0118%. 2 *Tachyphonus luctuosus* (White-shouldered Tanager): body, 14.13–15.76 g.; adrenals, 0.0098%; thyroids, 0.0190–0.0258%.

FRINGILLIDAE

1 *Saltator atriceps* (Black-headed Saltator): body, 96.74 g.; adrenals, 0.0108%; thyroids, 0.0105%. 1 *Cyanocompsa cyanoides* (Blue-black Grosbeak): body, 33.8 g.; adrenals, 0.0090%; thyroids, 0.0094%. 1 *Passerina cyanea* (Indigo Bunting): body, 13.61 g.; adrenals, 0.0163%; thyroids, 0.0086%. 1 *Sporophila minuta* (Ruddy-breasted Seedeater): body, 10.05 g.; adrenals, 0.0087%; thyroids, 0.0105%. 1 *Spinus xanthogaster* (Yellow-bellied Siskin): body, 13.12 g.; adrenals, 0.0111%; thyroids, 0.0050%. 1 *Atlapetes brunnei-nucha* (Chestnut-capped Brush-Finch): body, 45.8 g.; adrenals, 0.0111%; thyroids, 0.0070%. 2 *Atlapetes assimilis* (Gray-striped Brush-Finch): body, 38.9–43.8 g.; adrenals, 0.0132–0.0143%; thyroids, 0.0096–0.0105%.

Among all species studied few show great distinction in size of the adrenals. None are relatively as large as those of the Brown Pelican, those of the Barred Forest Falcon being the largest in this series.

Neither the size of the adrenals nor thyroids appears to bear any relation to the activity of the bird.

The variation in adrenal size in birds appears to be much greater than in mammals.

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