A STUDY OF AUTUMNAL POSTMIGRANT WEIGHTS AND VERNAL FATTENING OF NORTH AMERICAN MIGRANTS IN THE TROPICS

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Although there have been several papers dealing with vernal arrival weights and autumnal fattening of trans-Gulf migrants in the United States, virtually nothing has been published concerning these two phases of bird study in the tropics. In fact, published data on arrival weights in the U.S.A. and Bermuda actually have not dealt with postmigrants but with birds which were interrupted during flight by television towers or storms (Odum et al., 1961; Nisbet et al., 1963). Wetmore (1939) stated that migrants arriving in Venezuela were exhausted to the point of having their breast muscles reduced to mere bands. According to Voous (1957) large numbers of birds arrived on the island of Curaçao off the coast of Venezuela ". . . in such a state of exhaustion that their bodies were hardly more than an assemblage of bones and dry muscles." The statements of Wetmore and Voous are interesting but they are not quantified and probably do not represent typical postmigrants.

Likewise there are few data from the tropics concerning weights of North American migrants during spring migration. Beebe (1947) gave some weights of premigrant birds in Venezuela but so few data were presented that no conclusions could be drawn from them.

In the fall of 1963 a trip was taken to northern Panama for the purpose of obtaining data on the postmigratory weights of trans-Gulf migrants. The birds were netted in an area close to the town of Almirante which is a port on the Caribbean Sea just south of the border of Costa Rica in the province of Bocas del Toro. This area was chosen because a netting operation consisting of 100 mist nets had already been set up by the Gorgas Memorial Research Laboratory in Panama City. The netting area was located in a second growth rain forest tract, little cultivated, although extensive banana plantations were located fifteen miles to the north.

In the spring of 1964 another trip was taken to Central America to obtain data on the buildup of weights prior to migration. This trip, taken in conjunction with a U. S. Public Health Service encephalitis team, was to the Stann Creek Valley of British Honduras. The netting operation in British Honduras differed from the one in Panama by being in an area under extensive agriculture. Most of the nets were set up at the edges of citrus groves, a habitat which was selected because it was preferred by the Orchard Oriole (*Icterus spurius*), an abundant transient and winter resident. After termination of the netting operation in British Honduras, postmigrants were netted in Louisiana at Grand Isle and the Delta National Wildlife Refuge.

MATERIALS AND METHODS

Weighing of birds was accomplished on a triple beam balance. Since weighings took place in houses which were rather open and subject to wind currents, weights were rounded off to tenths. The birds were caught in Japanese mist nets and held in cages for periods varying from two to seven hours, thus insuring that their digestive tracts would be relatively empty. In Panama the banding of the Catbird (*Dumetella carolinensis*), Wood Thrush (*Hylocichla mustelina*), Swainson's Thrush (*Hylocichla ustulata*), Gray-cheeked Thrush (*Hylocichla minima*), and Veery (*Hylocichla fuscescens*) was carried out by personnel of the Gorgas Memorial Research Laboratory. Therefore, the data presented herein on the above species do not represent all birds caught in the netting operation but that portion of the catch which could be weighed.

Data on birds taken in the U.S.A. are from television tower casualties at Tall Timbers Research Station, Tallahassee, Florida, and from the netting operation in Louisiana. All fat-free weights were derived from television tower casualties by an extraction process described in detail by Rogers and Odum (1964).

RESULTS AND DISCUSSION

Fat-free weights.—Since the main purposes of this study were to estimate the amount of fat remaining in postmigrants and to follow the buildup of fat reserves in premigrants in the tropics, it was necessary first to establish fat-free weight values for the species being studied. In an analysis of a mixed sample of spring and fall birds, Rogers and Odum (1964) showed that the fat-free weights of 4 species of warblers did not depend on the amount of fat remaining in the birds. Working on the assumption that the same situation applies to other species of tower casualties at Tallahassee, the fat-free weights in Table 1 were calculated using all available spring and fall specimens of species being studied.

It should be emphasized that the specimens which were used to derive the fat-free weight means in Table 1, as well as those used by Rogers and Odum (1964), contained not less than 0.25 g fat/g non-fat dry weight. Such birds are not believed to be "stressed" from the standpoint of lacking fat "fuel." Although the spring birds had already completed long flights, they still had some migratory fat reserves. The term "migratory fat reserves" is defined for purposes of this paper as that fat stored in adipose tissues which is readily available as flight fuel. As will be pointed out later, all specimens examined in

TABLE 1

MEAN WEIGHTS, RANGES, AND STANDARD DEVIATIONS OF FAT-FREE WEIGHTS FROM TELEVISION TOWER CASUALITIES AT TALLAHASSEE, FLORIDA

Species	Number of individuals	Mean wgt. and range, g	S.D.
Hylocichla mustelina Wood Thrush	77	41.64 34.31–48.11	3.07
Hylocichla minima Gray-cheeked Thrush	25	25.68 22.68–29.36	1.85
Hylocichla fuscescens Veery	121	26.71 21.31–32.42	2.42
Hylocichla ustulata Swainson's Thrush	73	25.46 20.61–29.57	1.96
Dumetella carolinensis Catbird	68	31.80 27.15–35.86	2.23
Vireo olivaceus Red-eyed vireo	55	14.30 12.39–17.13	1.11
Protonotaria citrea Prothonotary Warbler	72	10.99 9.68–12.75	0.68
Vermivora peregrina Tennessee Warbler	12	7.46 6.75– 7.92	0.42
Dendroica pensylvanica Chestnut-sided Warbler	73	8.31 6.97– 9.06	0.68
Seiurus aurocapillus Ovenbird	18	15.98 13.89–17.82	1.06
Seiurus noveboracensis Northern Waterthrush	88	13.95 9.93–17.00	1.13
Piranga rubra Summer Tanager	22	25.07 21.56–27.88	1.60

this study had some fat even when they had obviously been forced to burn some muscle proteins or other non-fat tissue for energy, thus reducing their fat-free weights. Throughout the remainder of this paper, the term "fat-free weight" will refer to the weight minus extracted fat of birds collected from the television tower at Tallahassee. This weight is presumed to represent the mean fat-free weight of migrants which have not exhausted their stored fat or "migratory fat reserves."

Postmigrants in Panama in autumn.—Table 2 includes data from birds captured during fall migration in Panama. It is not known what percentage of these birds had just arrived, or had been in Panama for several days. The fact that most of the birds were caught at times when large numbers of individuals were flying into the nets at one time suggested that the birds were still in flocks and probably new arrivals.

TABLE 2

MEAN WEIGHTS, RANGES, AND STANDARD DEVIATIONS OF LIVING BIRDS NETTED IN PANAMA DURING FALL MIGRATION WITH ESTIMATED FAT REMAINING BASED ON FAT-FREE WEIGHTS IN TABLE 1

Species	Number of individuals	Mean wgt. and range, g	S.D.	Est. fat g
Hylocichla mustelina	24	42.62 36.9–49.1	3.19	0.98
Hylocichla minima	138	27.47 22.3–33.7	2.59	1.79
Hylocichla fuscescens	43	27.02 20.1–38.0	3.41	0.31
Hylocichla ustulata	321	27.53 20.4–37.2	2.87	2.07
Dumetella carolinensis	101	31.32 26.5–37.4	2.41	0.00
Vireo olivaceus	203	16.75 11.4–21.6	2.00	2.45
Protonotaria citrea	7	11.91 10.8–13.1	0.88	0.92
Vermivora peregrina	37	8.65 7.0– 9.1	0.55	1.19
Dendroica pensylvanica	20	8.01 6.8– 9.1	0.58	0.00
Seiurus aurocapillus	87	15.74 12.9–19.0	1.30	0.00
Seiurus noveboracensis	165	14.69 10.5–19.2	1.54	0.74
Piranga rubra	22	27.33 22.6–34.5	3.00	2.25

It is evident from the mean weights of postmigrants in Panama (Table 2) that individuals of some species had not only exhausted their migratory fat reserves but had begun to lose some fat-free weight as well. In 3 species, *Dumetella carolinensis, Dendroica pensylvanica* and *Seiurus aurocapillus,* the mean weights in Panama were actually below the mean fat-free weights for birds of those species killed in Florida. After migratory fat reserves have been exhausted, it is likely that the bulk of weight loss comes from the breast muscles. It was noted during the handling of some of the very light birds that the breast muscles seemed reduced so that the keels of the sternums protruded noticeably.

It is probable that individuals of some species other than the three mentioned previously, also had begun to lose some of their fat-free weight. For instance, the lower end of the range of weights from Panama is beneath the lower end of the range of fat-free weights in *Vireo olivaceus, Hylocichla ustulata, Hylocichla fuscescens* and *Hylocichla minima* (Table 1).

Odum, Rogers, and Hicks (1964) suggested that all fat should not be considered available to a bird for energy purposes. Three birds caught in Panama and returned frozen to the United States had weights below the lowest fat-free weight recorded for tower casualties in Florida. It should be safe to assume that these three birds had begun to use some of their fat-free weight for energy and thus should have had minimum amounts of fat. Data on these three birds, one each of the species *Hylocichla fuscescens, H. ustulata* and *Vireo olivaceus*, are presented in Table 3, along with data from some other noticeably thin birds which were returned frozen from Panama. Table 3 shows that some fat remained in all these birds. Based on Table 3 roughly 0.3 g of fat in the smaller warblers, 0.5 g in vireo-sized birds and 1.0 g in thrush-sized birds is non-storage fat and unavailable as fuel to a migrating bird except, perhaps, at expense of living tissues. The fat indices of the birds in Table 3 are well below the lowest values presented by Odum et al. (1964) who suggested that ". . . at least 0.2 g of fat per gram of nonfat is not storage."

It is important to note that the water indices of the birds in Table 3 are within the range presented by Odum et al. (1964) although, as already indicated, the fat indices are not within the range. The specimen of *Hylocichla fuscescens* in Table 3 was a recaptured bird which had four days to drink. Yet this individual did not have a higher water index than the others in Table 3. These facts bolster the contention that water is not usually limiting to migrating birds. A full discussion of the evidence for and against water as a limiting factor during migration can be found in Nisbet et al. (1963) for data to that date. Since that time 2 additional papers (Rogers and Odum, 1964 and Odum et al., 1964) have presented data which indicate that water is not usually limiting. Further evidence to this effect can be found in the data on extremely thin birds in Table 3.

Postmigrants in Louisiana.—Six of the species which were captured in Panama were caught also in Louisiana on their way north in the spring. As with the birds in Panama, it is believed that most of the birds netted in Louisiana were new arrivals. In fact, migration "waves" could be observed at Delta National Wildlife Refuge, with flocks of mixed species moving through the trees. The twittering of these birds made it possible to hear them coming before they could be seen. During the periods when large groups were on the move, Catbirds could be flushed from the ground in groups of 15 or more birds. The fact that most of the mass movements of birds in Louisiana occurred early in the afternoon strengthens the contention that most of them were new arrivals because the time would coincide with the expected arrival

TABLE 3

DATA FROM SOME UNUSUALLY LIGHT POSTMIGRANTS CAUGHT IN PANAMA WHICH WERE BELIEVED TO HAVE LOST SOME OF THEIR FAT-FREE WEIGHT AND THE RANGE OF FAT-FREE WEIGHTS FROM TALLAHASSEE, FLORIDA

Species	Range fat-free wgt.[1]	Wgt. g	Fat g	Water index[2]	Fat index[3]
Hylocichla fuscescens[4]	21.3–32.4	16.3	0.62	1.97	0.14
Hylocichla ustulata	20.6–29.6	20.4	1.06	2.21	0.18
Vireo olivaceus	12.4–17.1	11.2	0.50	2.28	0.15
Oporornis philadelphia		9.2	0.38	2.34	0.14
Oporornis formosus		10.8	0.39	2.38	0.13
Oporornis formosus		11.8	0.46	2.44	0.14
Wilsonia canadensis		6.9	0.27	1.90	0.12
Seiurus noveboracensis	9.9–17.0	14.4	0.54	2.26	0.13
Seiurus noveboracensis		13.1	0.66	2.24	0.17
Dendroica petechia		8.0	0.29	2.22	0.12
Dendroica petechia		7.5	0.33	2.26	0.15

[1] see Table 1; [2] water content divided by nonfat dry weight; [3] nonfat dry weight divided by fat weight; [4] recaptured bird.

time of nocturnal trans-Gulf migrants which had left Central America or Mexico early the previous night.

The six species which were caught both in Panama and Louisiana are compared in Table 4. In every case, the means from Panama are the lower although a *t* test shows that two sets of means do not differ statistically. The differences indicate that either the birds become fatter in Central America before flying north than before flying south and/or the southward flights to Panama involve longer or more difficult flights. It is more likely that the latter explanation is better because tower casualties from the fall at Tallahassee are among the fattest organisms known (Odum et al., 1961). Also as will be shown later, spring premigrants in British Honduras were not unusually fat although birds were leaving. Perhaps the birds caught in Panama had flown all the way from North America nonstop while those caught in Louisiana had taken off from an area farther north in Central America or Mexico. However, it is likely also that during fall migration, some birds which are in Panama did not fly nonstop from North America. Rogers (1965) found that several birds killed during a nocturnal rainstorm in Panama had enough fat to fly ranges estimated from 411 to 1179 miles. It was postulated that these individuals may have stopped farther north in Central America or Mexico.

Odum et al. (1961) noted that spring tower casualties at Tallahassee still had enough fat reserves to have continued flying inland for several hours. These fat reserves led the authors to suggest that ". . . long distance migrants accumulate more fat than is normally needed to complete any given flight."

TABLE 4

NUMBER OF INDIVIDUALS, MEAN WEIGHTS, STANDARD ERRORS OF THE MEANS, AND SIGNIFICANCE TESTS FOR DIFFERENCES BETWEEN POSTMIGRANTS FROM PANAMA IN THE FALL AND LOUISIANA IN THE SPRING

Species	Panama			Louisiana			t[1]
	No. of individuals	Mean wgt., g	S.E.	No. of individuals	Mean wgt., g	S.E.	
Hylocichla mustelina	24	42.62	0.65	52	44.83	0.66	*
Dumetella carolinensis	101	31.32	0.24	46	35.67	0.27	***
Vireo olivaceus	203	16.75	0.14	148	17.31	0.15	**
Seiurus noveboracensis	165	14.69	0.12	8	15.26	0.63	NS
Seiurus aurocapillus	87	15.74	0.14	18	16.62	0.35	**
Piranga rubra	22	27.33	0.64	30	28.15	0.58	NS

[1] 1, 2, or 3 asterisks indicate statistical differences between means at the levels of 95 per cent, 99 per cent, and 99.9 per cent respectively. Nonsignificant differences are marked NS.

This hypothesis based on spring arrivals on the Florida Gulf coast must now be reconsidered in view of numerous birds which appear to have been pushed to the limits to complete the fall migration as far as Panama. Further studies at various points in Central America are needed.

The fact that postmigrants in Panama were, on the average, leaner than those in Louisiana and considerably leaner than tower casualties at Tallahassee (Odum et al., 1961) is important for several reasons: (1) it suggests that southward migration in the fall may be more arduous than the northward flight in spring and thus provide a strong selection factor; (2) the survival of birds which have evidently catabolized muscles for energy suggests that flight-range capabilities may be greater than would be predicted on the basis of energy in fat stored in adipose tissue; (3) comparison of live weights and fat-free weights provides a means of estimating routes and distances flown by migratory birds.

The estimation of flight-range capabilities of birds has, in the past, been based upon fat reserves only (Odum et al., 1961) with no consideration given to the possibility that birds may fly some distance on the energy derived from muscle catabolism. Since the fat-free weights of individuals within a species have a range, it is not possible to say just how much fat-free weight has been used by a bird based on mean values. However, if the Veery which was caught in Panama at 20.1 g (Table 1) left North America as an "average Veery" i.e. with a fat-free weight of 25.68 g, then roughly 6.6 g of fat-free weight was lost (considering 1.0 g of the net weight was unavailable fat).

If the ash-free dry weight of long range migrants is assumed to have a value of at least 5.4 kcal/g (Odum et al., 1965) and ash-free fat-free weight is roughly 71.1 per cent water (mean of 13 individuals of three species), then

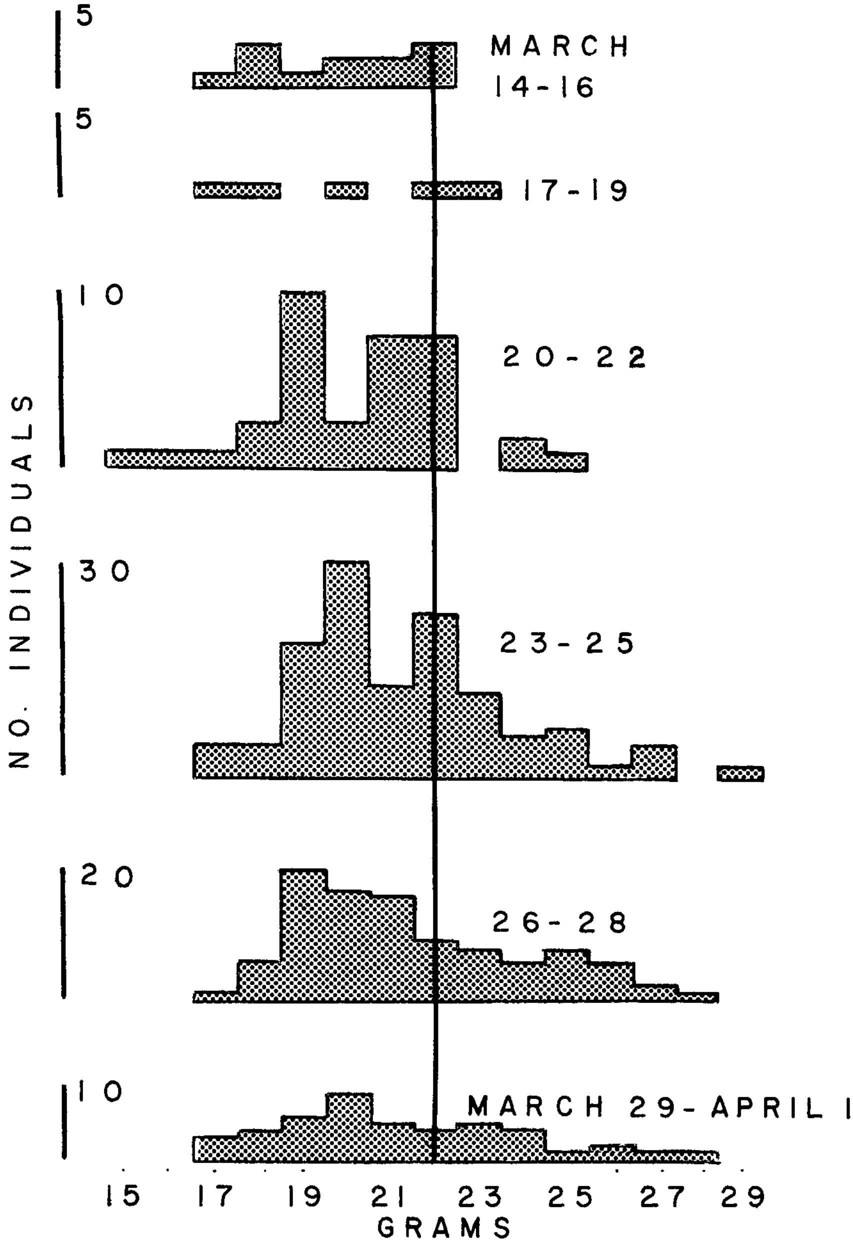

FIG. 1. Frequency diagrams of weight classes for male Orchard Orioles netted in British Honduras. A line has been drawn through the weight class which contains individuals theoretically capable of an 800 mile flight.

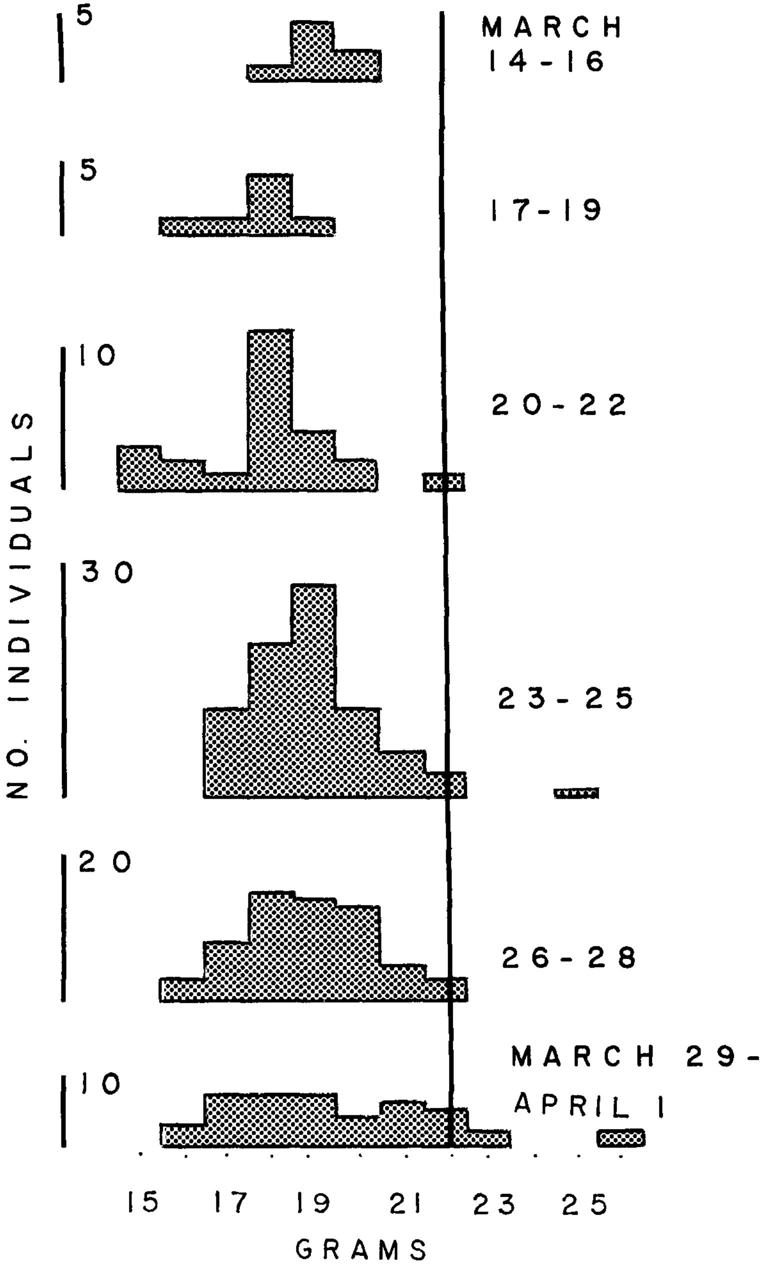

FIG. 2. Frequency diagrams of weight classes for female Orchard Orioles netted in British Honduras. A line has been drawn through the weight class which contains individuals theoretically capable of an 800 mile flight.

6.6 g of fat-free weight would yield about 10.6 kcal. Using an estimate of 0.10 kcal/g fat-free weight–hr for the energy requirements of migratory flight and a flight speeed of 30 knots (Nisbet et al., 1963), 10.6 kcal would allow an extra 4.0 hours of flying time or 138 miles.

With some birds arriving in Panama without migratory fat reserves, it is not difficult to imagine that some individuals may have been unable to make the trans-Gulf flight. It is possible also that many individuals arrive so exhausted that they do not survive. It would be of interest to know just how much basic body weight a bird can lose and still recover. There were five recaptures that showed a weight gain even though initially they weighed less than the mean fat-free weight for the respective species. These individuals are marked by asterisks in Table 5. Of these, a Catbird caught on 24 October weighed less than the lowest fat-free weight which has been recorded for that species. By 29 October it had gained 1.8 g. Therefore it is safe to assume that birds can recover weight after losing some of their fat-free weight.

Premigratory weight buildup in British Honduras.—Whereas the birds captured in Panama were necessarily recent postmigrants, those in British Honduras were a mixture of winter residents and spring transients in unknown proportions. However, a changing species composition of the catch and sudden changes in the number caught for a particular species were circumstantial evidences for an influx of spring transients during the period when nets were operated in British Honduras.

The four species which were caught in sufficient numbers to allow an analysis of weight changes with time were the Orchard Oriole, Catbird, Indigo Bunting (*Passerina cyanea*), and Yellowthroat (*Geothlypis trichas*). Figures 1 through 5 are weight distribution frequencies for these four species with males and females separated in the case of Orchard Oriole. In the other species sex was either not determinable by plumage, as in Catbirds, or females were scarce.

Using 9.0 kcal/g fat (Odum et al., 1965), the flight metabolism and speed estimates presented earlier, and assuming every individual to have a fat-free weight which is average for the species, estimates can be made concerning the number of birds capable of flying from British Honduras to any other point of known distance. The two complicating factors which must be disposed of are: (1) some fat is unavailable for energy and (2) fat-free weight can be used for energy. Since neither of these quantities has been precisely measured, they have been considered as essentially cancelling each other in the following discussion although it probably introduces a slight error toward underestimating flight-range capabilities.

If the mean fat-free weight for Orchard Orioles is assumed to be 18.14 ± 0.40 g (from 11 extracted individuals), the weight necessary to make a non-

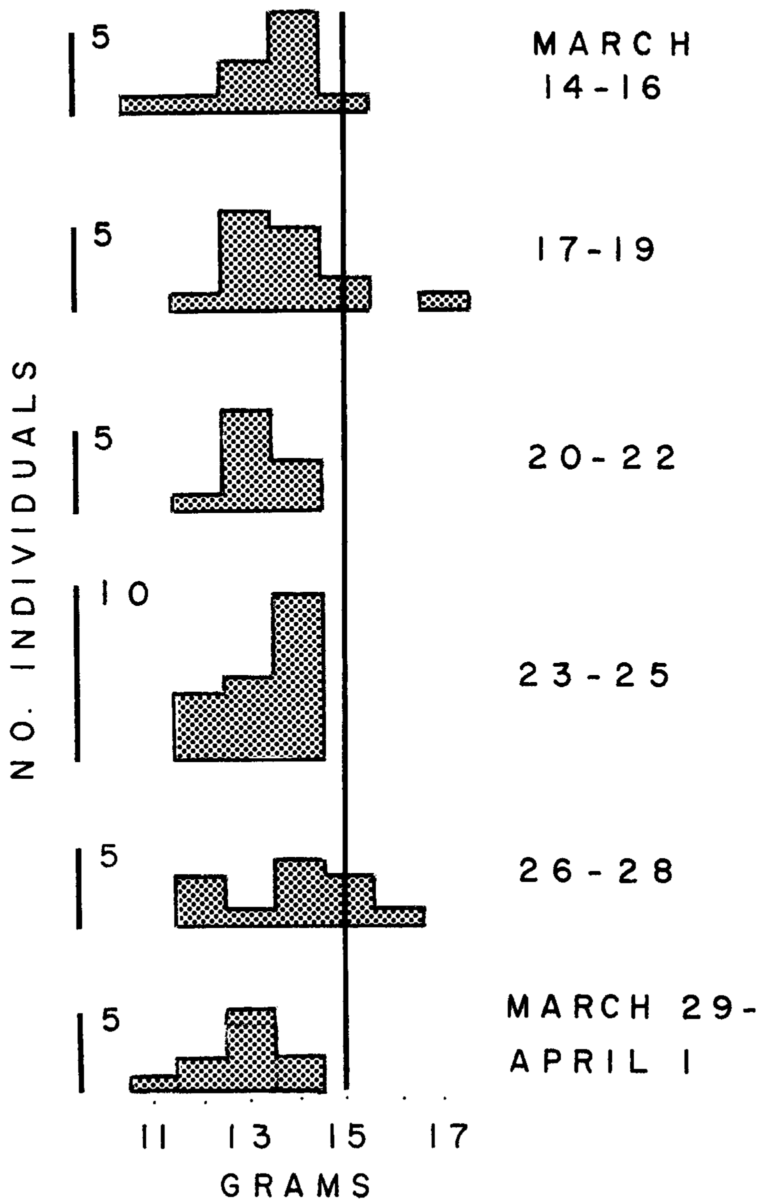

FIG. 3. Frequency diagrams of weight classes for male Indigo Buntings netted in British Honduras. A line has been drawn through the weight class which contains individuals theoretically capable of an 800 mile flight.

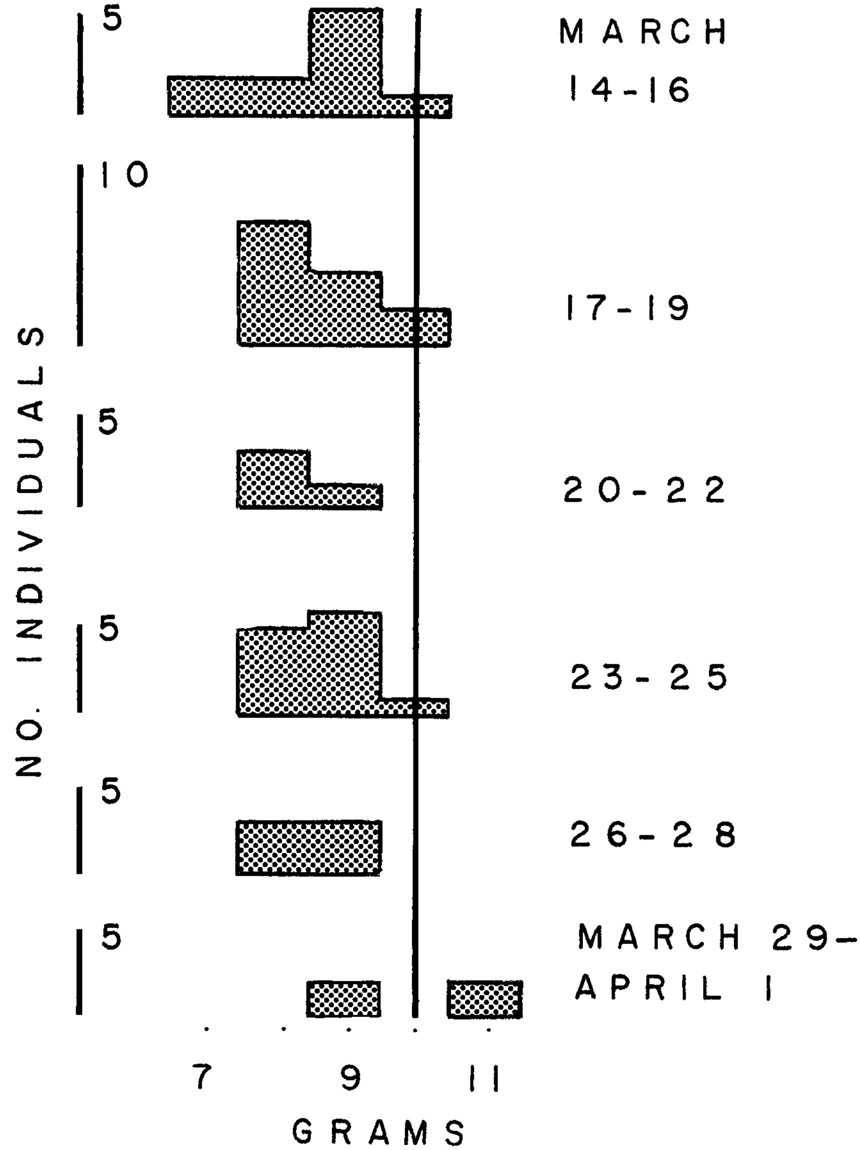

FIG. 4. Frequency diagrams of weight classes for male Yellowthroats netted in British Honduras. A line has been drawn through the weight class which contains individuals theoretically capable of an 800 mile flight.

stop flight of 800 miles from British Honduras to North America would be 22.9 g (flight energy = 0.1 kcal/g fat-free weight–hour; fat = 9.0 kcal/g; flight speed = 30 knots; fat is the only energy source; all fat is available). It can be seen from Figures 1 and 2 that Orchard Orioles in the 22 g block, and above, became more frequent as the season progressed. For instance, during the period 23–25 March, 43.8 per cent of the male Orchard Orioles appeared to be capable of 800 mile flights. The females did not show a weight buildup equal to the males with few becoming capable of 800 mile flights. It seems that many male Orchard Orioles are capable of nonstop flights from British Honduras to North America while most females are not and therefore perhaps move northward by land before attempting trans-Gulf migration; or perhaps they remain longer at Stann Creek. Figure 6 shows that a greater percentage of males than females were leaving. This is to be expected if males will arrive on the breeding grounds earlier than the females.

Using a fat-free weight of 12.12 ± 0.08 g for Indigo Buntings (mean of 88 individuals), individuals weighing 15.1 g would have a potential flight range of 800 miles. It can be seen from Figure 3 that the percentage of birds in the 15 g group and above attained a maximum of 25 per cent during the netting period 26–28 March. This indicates that at least some individuals of this species may be able to cross the Gulf from British Honduras to Louisiana.

The mean fat-free weight of 12 extracted Yellowthroats was 8.36 ± 0.12 g. Individuals of this species weighing roughly 10.5 g could be considered as having the necessary reserves to fly nonstop to North America. The weight frequencies for Yellowthroats (Fig. 4) show that birds with 800 mile flight capabilities were few even though the number of birds caught was showing a sharp decline indicating departure from Stann Creek station. These facts would indicate that this species moves north overland perhaps achieving maximum fatness farther north in Central America.

The Catbirds (Fig. 5) demonstrated neither a sharp decline in numbers caught nor a high proportion of birds capable of an 800 mile flight (39.7 g). Therefore no conclusions can be drawn about where this species has its final fattening phase. Perhaps they attained trans-Gulf capabilities from British Honduras after discontinuation of the netting operation.

It seems then, that flight-range capabilities of migrants at Stann Creek indicate that some species have a high proportion of individuals which attain the ability for long flights while other species are migrating through the area with only moderate fat reserves.

The phenomenon of weight loss in recaptured birds.—Nisbet et al. (1963) noticed that a high percentage of Blackpoll Warblers recaptured during migration showed a weight loss unless two or more days had lapsed since the previous capture. The authors cited references in which others had noticed a simi-

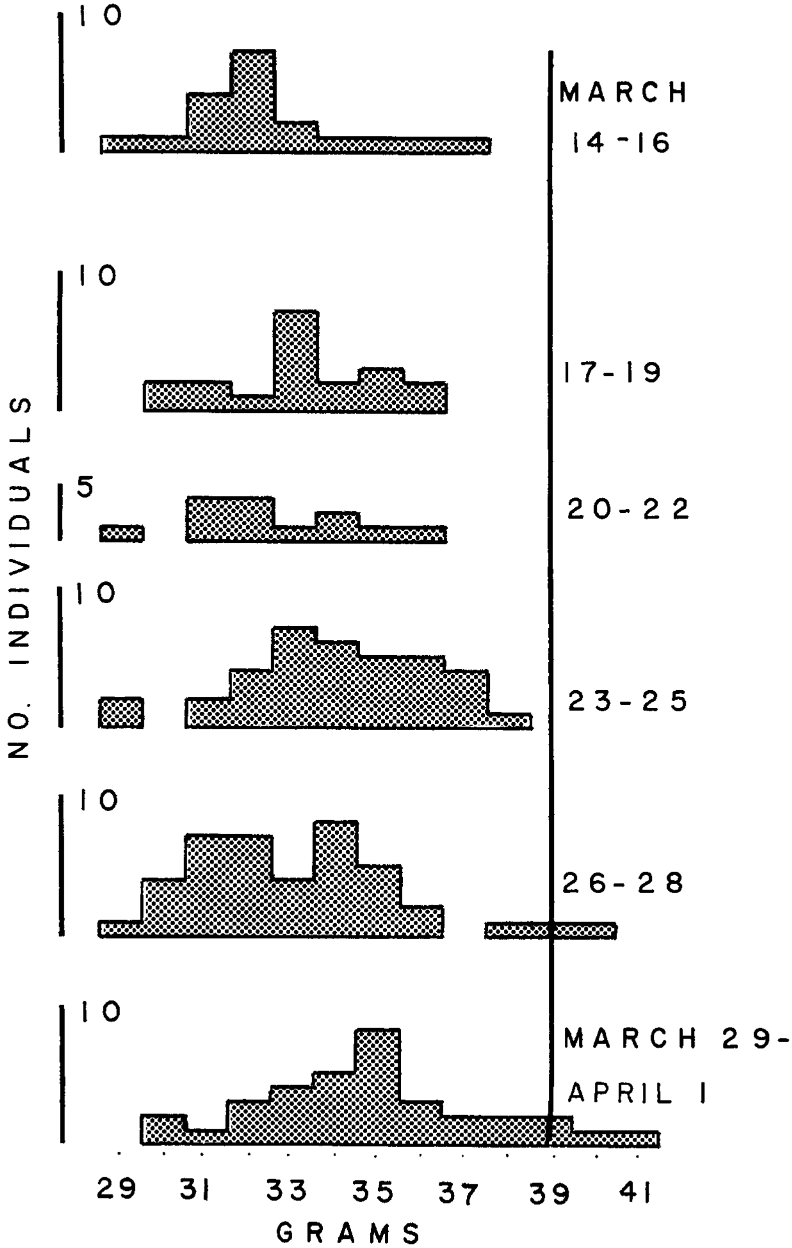

FIG. 5. Frequency diagrams of weight classes for Catbirds netted in British Honduras. A line has been drawn through the weight class which contains individuals theoretically capable of an 800 mile flight.

TABLE 5
WEIGHTS OF RECAPTURES IN PANAMA

Species	Date	Weight g	Date	Weight g	Date	Weight g	Date	Weight g	Date	Weight g
Dumetella carolinensis	10/24	26.5	10/25	25.7						
" "	10/27	32.1	10/28	29.7						
" "	10/23	28.7	10/28	26.7						
* " "	10/22	27.7	10/28	33.3						
* " "	10/24	25.5	10/29	28.3						
* " "	10/28	31.3	10/31	32.3						
" "	10/28	33.7	10/31	34.5						
" "	10/29	35.0	11/ 1	34.4						
" "	10/24	29.6	10/26	29.0						
Hylocichla ustulata	10/26	24.7	10/29	23.5						
" "	10/27	25.6	10/30	26.2						
Icteria virens	10/11	24.3	10/19	25.4						
" "	10/21	23.1	10/22	22.3						
" "	10/11	22.3	10/14	22.5						
" "	10/17	24.0	10/18	22.1						
Seiurus noveboracensis	10/13	14.4	10/21	14.6						
" "	10/16	14.6	10/21	14.6						
" "	10/10	15.2	10/12	13.9	10/25	14.8				
" "	10/13	17.3	10/14	16.3						
" "	10/13	14.3	10/14	13.6						
" "	10/13	18.0	10/14	17.1						
" "	10/13	15.5	10/17	13.7						
Dendroica petechia	10/16	8.3	10/21	8.6						
Oporornis formosus	10/12	14.6	10/22	14.3						
" "	10/14	11.3	10/15	11.6	10/16	11.3	10/18	12.1	10/31	13.2
**Piranga rubra*	10/ 7	23.8	10/23	29.9						
Seiurus aurocapillus	10/15	17.1	10/24	19.1						
Hylocichla minima	10/25	29.0	10/26	25.0						
Oporornis philadelphia	9/23	12.6	9/30	11.7						
" "	10/ 5	11.4	10/14	9.9						
" "	10/14	10.5	10/16	9.5	10/19	10.2	10/22	9.1		
" "	10/14	10.0	10/17	9.1						
**Hylocichla fuscescens*	10/ 1	25.5	10/ 4	23.6	10/10	28.1				
" "	9/30	28.7	10/ 4	16.3						
Vireo olivaceus	10/11	19.5	10/13	17.9						
" "	10/ 9	15.9	10/14	17.9	10/17	16.7				
" "	10/10	18.7	10/11	16.9						
" "	10/14	16.3	10/15	15.2						

* Individuals which were below the mean fat-free weight of television tower casualties from Tallahassee, Florida, and later showed a gain in weight.

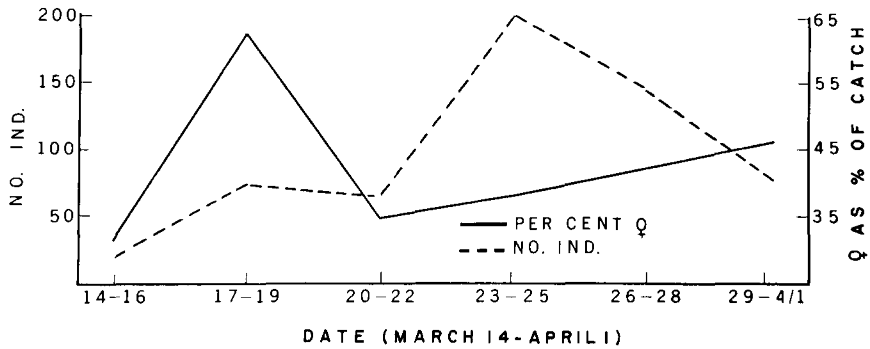

FIG. 6. Total catch of Orchard Orioles and percentage of the catch which was females. British Honduras.

lar loss in postmigrants and it was hypothesized that such weight losses might be a general phenomenon among postmigrants. Mueller (1964) has recorded similar losses in migrating Swainson's Thrushes but he believes that the losses are caused by a general trauma which is brought on by handling birds. The recapture data from Panama (Table 5) show that 14 of 15 birds which were recaptured within two days had lost weight. Table 6, which summarizes the recapture data from Panama, shows that the recaptured birds demonstrated a weight loss similar to that shown for the Blackpoll Warbler in that after two days, there was a sharp decrease in the percentage of birds which were below their initial weights when first handled. The weight losses cannot be blamed on the bleeding operation of the encephalitis team alone because only thrushes and Catbirds were bled but all species showed the weight losses.

The recapture data from British Honduras are more instructive as to the question of a cause for weight loss because many of the individuals were not postmigrants but were winter residents. It can be seen from Table 7 that 25 of 28 recaptured Orchard Orioles had lost weight even though the population as a whole was gaining weight. The two orioles which did not lose weight

TABLE 6

A SUMMARY OF RECAPTURE DATA FROM SEVERAL SPECIES OF POSTMIGRANTS IN PANAMA

Days after first capture	Number of individuals	% that lost weight
1	11	90.9
2	4	100.0
3	8	50.0
4–6	9	33.3
7–	8	37.5

TABLE 7
RECAPTURES FROM BRITISH HONDURAS

Species	Date	Weight g	Date	Weight g
Icterus spurius	3/24	19.1	4/ 1	18.1
	3/25	22.5	3/31	19.4
	3/28	25.9	3/31	23.1
	3/21	19.5	3/30	17.4
	3/24	19.6	3/30	17.6
	3/23	15.9	3/30	16.9
	3/26	22.9	3/29	19.8
	3/19	18.4	3/29	16.7
	3/28	20.6	3/29	18.6
	3/25	22.8	3/28	21.8
	3/24	27.4	3/28	22.8
	3/24	29.3	3/28	26.3
	3/24	20.3	3/28	16.6
	3/18	18.4	3/28	17.7
	3/20	19.4	3/27	18.1
	3/21	22.3	3/27	20.9
	3/18	21.5	3/26	21.7
	3/18	21.5	3/25	22.1
	3/21	19.2	3/25	16.9
	3/15	20.9	3/25	16.5
	3/19	21.7	3/24	20.1
	3/20	22.0	3/24	19.7
	3/21	19.5	3/24	17.7
	3/18	19.3	3/23	17.9
	3/20	16.4	3/23	15.9
	3/21	22.0	3/22	20.3
	3/17	17.7	3/19	16.5
Seiurus aurocapillus	3/13	19.3	3/17	17.4
	3/18	15.8	3/24	15.2
Seiurus noveboracensis	3/23	14.8	3/24	14.3
	3/24	16.1	3/30	15.0
Wilsonia citrina	3/25	9.5	3/26	9.1
	3/15	8.7	3/27	8.4
Dendroica petechia	3/22	8.1	3/26	8.2
Icteria virens	3/25	24.4	3/28	21.7
Passerina cyanea	3/20	12.7	3/28	12.4
Guiraca caerulea	3/20	24.5	3/31	23.4

just retained the weight they had in the beginning and were not caught until at least seven days after the first capture. In addition to Orchard Orioles only one recaptured Yellow Warbler (*Dendroica petechia*) of 10 recaptures of various species did not have a loss in weight. It should be emphasized that the weight losses of recaptures in British Honduras occurred in premigrant populations except for spring transients which are postmigrants. Of course, it cannot be stated with absolute certainty that all the birds in Table 7 were not spring transients and thus postmigrants of a sort but such would be highly unlikely. The recapture data from British Honduras, then, strongly indicate that weight losses are caused by handling.

SUMMARY

The autumnal arrival weights in Panama and vernal fattening in British Honduras were studied for several species of trans-Gulf migrants. Birds arriving in Panama were extremely thin and many were below the estimated fat-free weights for the species. Fat indices on some specimens which were extracted, were below any which have been reported previously in the literature. Evidence is presented that fat-free weight may have been used as an energy source in some postmigrants.

The premigratory buildup of fat reserves in Catbirds, Orchard Orioles, Indigo Buntings, and Yellowthroats in British Honduras indicated that some individuals of these species attained trans-Gulf flight capabilities at different dates while the fattening of sexes differed by date in the Orchard Oriole. The possibility that Stann Creek Valley may be a final stop in Central America for some species during spring is discussed.

Data on weight changes in recaptured birds indicated that weight losses between capture dates may have been caused by handling of the birds.

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