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HABITAT INFLUENCES ON THE WEIGHT CYCLE OF THE COLUMBIAN GROUND SQUIRREL

Stephen A. Peck
Directed Studies
Wildlife Resources

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Stephen A. Peck, College of Forestry, Wildlife, and Range Sciences, University of Idaho, Moscow, Idaho 83843

Abstract: Columbian ground squirrels (*Citellus columbianus*) were studied at three sites in the Idaho Primitive Area during the summer of 1976. These three sites varied, basically, in terms of the amount of vegetational moisture present, a factor that reportedly has a significant influence on the length of the season of activity available to the squirrels. These three habitats were studied in terms of their effects on the weight cycle, dates of estivation, and population densities. Those squirrels on drier sites were the first to enter estivation. Population densities were smaller in dry habitats as opposed to moist habitats. No firm correlation was apparent between the rates of vegetational desiccation and the rate of weight gain displayed by the squirrels at each site. The variability in squirrel weights prevented statistical discrimination between the approximate weights at estivation.

The Columbian ground squirrel is a terricolous organism which derives sustenance almost solely from the land's surface. It has evolved no means to contend with snow accumulations in winter that bury its food sources and must hibernate during this period. This dormancy lasts seven to eight months (Howell 1938). During the active season, an individual must reproduce and conduct other functions as efficiently as possible so as not to jeopardize efforts to store the large quantities of fat needed to sustain it throughout hibernation. For instance, the adult male restricts its aggressive displays to the breeding period, and no effort is spent in the establishment or maintenance of territories (Betts 1974). The genital organs of both sexes develop during dormancy, permitting the squirrel to breed shortly after emergence, thus, providing the young with the longest period possible to acquire the fat needed for the first winter (Shaw 1926). Hence, the emphasis is on energy assimilation and conservation.

Vegetation plays a vital role in the life cycle of the Columbian ground squirrel by providing a source of both energy and moisture (Shaw 1926, 1925a). Some observers believe that the decline in the moisture content of the vegetation is the stimulus that initiates dormancy (Howell 1938, Shaw 1925b). The latent condition is, thus, said to have characteristics of estivation and hibernation. The available vegetation may be the determinate of the quantity and quality of food the squirrel receives, of the amount of moisture in its diet, and even of the date in which estivation ensues.

In the Idaho Primitive Area, the Columbian ground squirrel is found in a variety of habitats ranging from lush mountain meadows, to dry slopes, to open woodlands. Are each of these environments equally capable of providing the squirrel with the energy it requires, or are some habitats more conducive to weight gain and survival than others? The aim of this investigation was to compare the weight performances of ground squirrels in different vegetational situations and relate this to the composition and abundance of the plant species present. An examination was also made of the degree of correspondence between the moisture content of the vegetation and the initial dates of estivation to discern if rapid desiccation in drier environments could compel the squirrels to enter dormancy with fewer fat reserves.

STUDY AREA

This study was conducted in Valley and Idaho Counties near the center of the Idaho Primitive Area. Three sites containing populations of Columbian ground squirrels were chosen. Site 1 was an exposed slope located approximately 3.2 km south of the University of Idaho's Research Station at Taylor Ranch. The area was characterized by bare patches of loose, sandy soil intermixed with vegetation and rock outcroppings in which ground squirrels often resided. Site 2, located 6.3 km west of Taylor Ranch along the Big Creek Ridge, was similar to the first area in species composition, but was located at a higher elevation and had a less severe slope. Site 3 was located in Cold Meadow, 22.0 km north-northwest of Taylor Ranch. The vegetation here was moister and the terrain less rugged than the previous two study areas.

For each site, Table 1 (appendix) lists the land area of the plot on which squirrels were captured, the elevation, the direction of the slope, and the percentage slope. Table 2 (appendix) provides a listing of the abundance of each plant species found at the three sites.

METHODS

The first function to be performed at each site was the livetrapping of ground squirrels. Initial capturing success was poor until adequate traps were obtained. The most successful device used was a wire box trap, 4 X 4 X 18 ins. The trigger mechanism was similar to that described in Taber (1971: 284) in Fig. 18.7. Carrots were used as bait.

Fifteen traps were used at Sites 2 and 3, while no more than nine traps were utilized at Site 1. Traps were selectively placed on runways, at burrow entrances, or on rock outcroppings. Trapping was executed at Site 1 on 14 through 16 June, 26 June, 5 through 7 July, and 21 and 22 July; at Site 2 on 22 June, 13 and 14 July, and 14 through 17 August; and at Site 3 on 28 through 30 June, 26 through 30 July, and 19 through 25 August.

After capture squirrels were weighed to the nearest gram on a Pesola spring scale and toe-clipped for identification according to the chart in Taber (1971:307) in Fig. 18.18. Sex was also noted. Individuals were then released.

The second function was to define the habitat on each of the three sites through the determination of both the plant biomass and the percentage of moisture found in each species. The analysis used was based on the Weight-Estimation Method described by Tadmor et al (1975). Vegetational analysis was conducted twice at each site: during the last week of June and first week of August at Site 1, during the second week of July and third week of August at Site 2, and during the last week of July and third week of August at Site 3.

When carrying out vegetational analysis, ten transects, 50 ft. long, were randomly selected within the boundaries of the site. A Daubenmire plot (20 X 50 cms.) was placed at ten locations along each transect, the locations being at five foot intervals. Thus, the total sampling area consisted of 10 sq. m. The wet weight of each species within the plot was then estimated. At the termination of each line, samples of species encountered within the line were collected. The weights of these samples were estimated and then measured to the nearest tenth of a gram with a Pesola spring scale. This calibration enabled linear regressin of the estimated weights to the actual weights so that the error in estimation could be corrected. The actual weights of each species obtained from the regression equation where the estimated weights served as the independent variable were then used as a basis for species composition. These plant samples were later oven-dried at 55°C for at least 48 hrs. and then weighed on an electronic top-loading balance to the nearest tenth of a gram.

RESULTS

The weights and sex of each squirrel are compiled in Table 3 (appendix) with weights being listed according to the dates they were obtained. Many squirrels were captured more than once on any given trapping period, but only the weight of the squirrel taken on the first capture is listed since repetitive capture may have upset the squirrel's feeding habits and metabolic rate, thus alterring its weight for the remainder of the trapping period.

Dates of Estivation

There was a distinct procession into dormancy between the three sites with the squirrels at Site 1 entering estivation first and the squirrels at Site 3 entering last. Manville (1959) stated that the older males are the first to enter dormancy, followed by the older females, and finally the young of the year. The results of this investigation support that contention.

On 21 and 22 of July, both adult and young squirrels were captured at Site 1. The next visit on 5 through 9 August resulted in no captured individuals, although a squirrel was observed on occasion. Apparently, all but one or two young of the year had entered dormancy.

At Site 2 both adults and young were trapped on the 13 and 14 July. The following venture on the 14 through 17 August yielded only young of the year, suggesting that the adults had already begun estivation.

On the last trip to Site 3 during 19 through 25 August, adults of both sexes and young of the year were captured. However, only five adults were obtained as compared to 27 adults on 28 through 30 June and 21 adults on 26 through 30 July. During the 26 through 30 July trapping venture at Site 3, an average of 12.2 squirrels per 15 traps was captured a day. This value was statistically different ($P<.001$) from the 3.7 squirrel per 15 traps per day average obtained on 19 through 25 August. A possible explanation for the low number of captured adults and the reduced trapping frequency is that many adults had already begun estivation. However, field observations tended to discredit this possibility. A more satisfying answer is that the ground squirrels were experiencing a feeding lethargy that, according to Pengelley (1967), sets in just prior to estivation. Thus, the bait was less desirable to them. This lethargy would be expected to prevail in adults more than in young since the latter require more time to build up the necessary fat reserves. Although the number of captured adults was greatly reduced from previous trips, the number of young on 19 through 25 August was only three less than the number on the 26 through 30 of July. Thus, it may be assumed that the adults were on the brink of estivation during the last trapping period at Site 3.

Comparison of Approximate Weights of Estivation

Given the information on approximate dates of estivation, the next task was to determine if squirrels at different sites displayed statistically different weights upon estivation. Ideally this could be accomplished by regressing the average weights derived from each trapping period with time. However, due to the relatively small number of trapping periods, regression of this nature becomes artificial, if not impossible. Therefore, linear regression was performed between the weights of individual squirrels and time. This regression was handled separately for adult females, adult males, and young of the year at each site. A 95 percent confidence interval was then constructed around each function. The regression lines and their corresponding confidence intervals are illustrated in Fig. 1 (appendix).

Adult females

At Site 1 adult females were last encountered on 21 and 22 July while no females were captured during a subsequent trapping period extending between 5 through 9 of August. Hence, adult females were assumed to have estivated during the intervening time period. Regression analysis reveals that on 22 July the adult females at Site 1 had an approximate average weight of 478 gms. with a 95 percent confidence interval lying between 359 and 597 gms. Likewise, if it is assumed estivation did not interrupt the weight cycle, on 5 August this same population of females would have displayed a mean weight of 517 gms. with a 95 percent confidence interval extending between 383 gms. and 652 gms.

A similar situation was encountered at Site 2 in that during 13 and 14 July adult squirrels were captured, whereas on a return venture during 14 through 17 August adults were absent. Dormancy apparently ensued between 14 July and 14 August. Regression indicates that adult females at this site had a mean weight of 440 gms. on 14 July with a 95 percent confidence interval lying between 326 and 555 gms. If trends are extended to 14 August a mean weight of 529 gms. with a 95 percent confidence interval between 366 and 691 gms. would have been expected.

These confidence intervals at the initiation and termination of the periods in which dormancy was believed to begin for both Sites 1 and 2 are large enough so that no significant difference between any of the mean weights can be demonstrated. None of the regressed weights for Site 1 between 22 July and 5 August are statistically different from the regressed weights for Site 2 between 14 July and 14 August. Hence, these results do not confirm statistically different weights of estivation for the adult female squirrels at Sites 1 and 2.

As previously mentioned, the adult squirrels at Site 3 were apparently experiencing a feeding lethargy during the final venture. Since this lethargy sets in just prior to estivation and the squirrels would not be expected to gain much more weight because of it, the mean weight on the last day of this final trapping period, 25 August, can be considered representative of the weight of estivation. The results of regression analysis show that on this date the adult female squirrels at this site had an approximate mean weight of 552 gms. with the 95 percent confidence interval lying between 428 and 676 gms. This mean weight, although larger, is not statistically different from those previously sited for either Site 1 or 2. Thus, the approximate weights of estivation for all three sites were not shown to vary significantly for adult females (Fig. 1a, appendix).

Adult males

No statistical differences were evident between adult males at the three sites during the approximate times of estivation. Due to small sample sizes obtained at Sites 1 and 2 along with wide individual weight variations found at all three sites, enormous confidence intervals were derived which precluded any statistical discrimination. The regression lines which describe the trends in weight gain for the adult males at all sites are illustrated in Fig. 1b (appendix), but the confidence intervals are not included due to their size.

Young of the year

Generally, no statistical variation could be demonstrated for the young of the year, either. The young at Site 1 entered estivation sometime between 22 July and 5 August. As shown in Fig. 1c (appendix), on 22 July they had a mean weight of 278 gms. with a 95 percent confidence interval extending between 169 and 386 gms. On 5 August the mean would have been 368 gms. with the 95 percent confidence interval between 216 and 521 gms.

On 14 through 17 August only young and no adults were captured at Site 2. It can be assumed that the young may have joined the adults in estivation shortly after this trapping session; hence, the mean weight for the young of the year calculated for 17 August may be considered representative of the weight of estivation. On this date the mean was approximately 255 gms. with a 95 percent confidence interval lying between 138 and 372 gms. By comparing the means and confidence intervals for Sites 1 and 2, no statistical variation is shown between the approximate weights of estivation for these young.

It was difficult to assume a definite weight or date of estivation for the young of the year at Site 3. Although the adults at this site appearred to be embarking into dormancy during the last trapping period, which extended between 19 and 25 August, the young seemed relatively active and may have remained so for one or two weeks after this time. However, it is assumed for arbitrary purposes that the mean weight calculated for 25 August is the best estimate of the weight of estivation for these young, although this may be an under-estimation of the actual value. This mean was 313 gms. with the 95 percent confidence interval between 269 and 357 gms. Now, this mean lies within the confidence intervals established at the beginning and the end of the period during which the young at Site 1 were believed to have entered estivation. It also falls into the confidence interval defined around the weight of estivation for the young at Site 2. However, when viewed from another perspective, the confidence interval constructed around the mean weight of estivation for the young at Site 3 does not include the mean weight of estivation for the squirrels at Site 2; the mean for Site 3 is statistically greater.

This confidence interval for Site 3 does encompass the projected mean weights of 92 percent of those days lying within the period in which the squirrels at Site 1 were suspected to have entered dormancy. Thus, there seems to be no statistical difference between the weights of estivation for the young at Sites 1 and 3, and there is either no statistical difference or else the young at Site 3 had a statistically greater weight of estivation than those at Site 2, depending upon which confidence interval is consulted.

Vegetational Analysis

Although moisture content in the vegetation at the time of estivation could not be clearly defined for each site due to the uncertainty associated with the exact dates of estivation, a pattern did exist in that the squirrels on the drier sites were the first to enter dormancy. Table 2 (appendix) contains the percent abundance for each of the plant species, an estimate of total plant biomass in kilograms per hectare, and an estimate of total percent moisture for each of the species in the site. From the total percent moisture, trends in desiccation for each of the sites were derived (Fig. 2, appendix).

The greatest amount of plant biomass was found at Site 1 and the least, at Site 3. On any given date, the vegetation at Site 3 proved to have the greatest percentage of moisture and that at Site 1, the least. The rate of desiccation was .28 percent per day at Site 1, .37 percent per day at Site 2, and .20 percent per day at Site 3. These rates of desiccation were correlated with the rates of weight gain for female adults, male adults, and young of the year. There was a fairly strong positive correlation for female adults ($r=.89$) and a weak negative correlation for male adults ($r=-.53$) and young of the year ($r=-.45$). Due to the small number of sites and, hence, small sample size ($n=3$) along with the contradictory r values, it can not be concluded from this study that the rate of plant desiccation influences the rate of weight gain among these ground squirrels.

Population Densities

As a measure of survival success, population densities may provide an insight into the relative habitat suitability. The population size was only determined on those dates in which young squirrels were present, in which lethargy or estivation hadn't reduced trapping success, and in which enough data was available. The Schnabel Method was most easily applied to this data. Final results indicate that Site 3 had the highest population density and Site 1, the lowest. The density at Site 1 was 25.0 squirrels per ha.; at Site 2, 43.5 squirrels per ha.; and at Site 3, 80.2 squirrels per ha.

DISCUSSION AND CONCLUSIONS

Most ecologists agree that the environment in which an organism resides can influence several aspects of that organism's life in many ways. This study examined how one environmental parameter, vegetational moisture, affected the life cycle of the Columbian ground squirrel. Certain patterns were noted. First of all, squirrels associated with drier sites were found to enter estivation sooner. Also, squirrel densities were greater in colonies located on the moistest sites.

Other patterns did not prevail. No consistent correlation was observed between the rate of weight gain and the rate of desiccation. The major thrust of this study was concerned with the comparison of weights of estivation at sites with different degrees of vegetational moisture. The data obtained and the methods employed did not reveal a significant difference between the approximate weights of estivation at the three sites.

To place this study in perspective, the sources and significance of these results require some conjecture. The fact that the squirrels on the driest site entered dormancy first, the squirrels on the intermediate site, second, and those on the moistest site, third may indeed suggest that the date of estivation is a function of available plant moisture. There is only a .167

probability that the dates of estivation and the relative moisture contents would have coincided as they did. The same probabilities apply to the relationship between the moistness of the sites and the population densities, for the drier the site, the lower the squirrel density. Perhaps vegetational moisture has an influence on the ultimate carrying capacity of an area.

Why did the data not reveal statistical differences between the average squirrel weights at the time of estivation? Perhaps those squirrels on drier sites were able to overcome the resistances offerred by their environment, such as earlier dates of dormancy, and managed to obtain approximately the same weight as squirrels in wetter habitats. However, a more plausible answer is suggested by reviewing the tables and graphs presented in the appendix. The confidence intervals that were constructed around the weight versus time functions and used for statistical comparisons of the approximate weights of estivation were rather large. This situation resulted from employing the weights of individual squirrels as a factor in regression. In some cases a low sample size contributed to the wide confidence intervals. In all cases the inherent variability in the weight of individual ground squirrels at any one time was a factor. It would have been more desirable to use the mean weight of all the squirrels obtained during each trapping session as a factor in regression instead of the individual squirrel weights, since this would have greatly reduced the variance and made the regression functions more reliable. However, as was previously mentioned, the insufficient number of trapping sessions at each site prevented this. Hence, due to a statistical malady, any ecological inferences derived from these results should be viewed dubiously.

In consolation for conclusive results, some possible techniques will be offerred that may be used to improve studies of this nature in the future. First of all the variability in the statistics should be reduced by any legitimate means possible. Mean weights obtained over short periods instead of individual weights should be used. This requires a greater commitment on the part of the researcher to conduct enough trapping sessions at each site so as to obtain an adequate sample size. However, continuous trapping at any one site should be avoided for it may impair the weight gain of the squirrels. Ideally, trapping should take place for an entire day at about seven day intervals at each study area.

This study was concerned with the manner in which habitat and time, and only these factors, influenced the weight of squirrels. Any extraneous factors should be accounted for. The age of the squirrel also affects its weight. Therefore, provisions should be arranged to compensate for the bias intoduced by age. One solution is to divide the samples into yearly age classes. However, this presents problems since many more squirrels must be captured to provide adequate sample sizes, and no reliable method is known for aging living ground squirrels. Although some have argued that the validity of the data may be marred, a condition index based on sound principles and relationships can eliminate biases in weight due to age.

This study was comparitive in nature and required alternating visitations to three geographically distinct areas throughout the course of the summer. Due to the ruggedness of the terrain, travel between sites was slow and sometimes restricted. To receive a sufficient number of trapping sessions at each area it may be advisable to station separate observers at each site. This would also be advantageous since it would allow greater spans of observation at each site, thus providing a more precise recording of the dates of estivation than were obtained in this study. Because the Columbian ground squirrel has a limited season of activity during which data can be gathered an observer must enter the field fully prepared and ready to commit all the time available to the collection of data.

APPENDIX

TABLES AND GRAPHS

Table 1. Characteristics of the study areas.

Site	Area (ha.)	Slope Aspect	Slope degree (%)	Elevation (ft.)
1	.48	south	40	5700
2	.92	south	30	6200
3	.59	no slope	--	6700

Table 2. Vegetational composition for each site in percent, the percentage of moisture present in each plant species, the total vegetational biomass (per ha.) for each site, and a total percentage of vegetational moisture derived from all the species on a site. (Note: two analysis were conducted at all sites.)

	Site 1		Site 2		Site 3	
	6/30	8/7	7/13	8/15	7/28	8/20
Achillea lanulosa	1.10[a]	..80[a]	2.73[a]	.97[a]	3.80[a]	1.16[a]
	71.2[a]	67.8[a]	71.2[a]	65.9[a]	66.3[a]	74.3[a]
Agastache urticifolia	--	--	.40	--	--	--
	--	--	80.0	--	--	--
Agropyron spicatum	5.73	4.79	1.95	10.89	--	--
	56.2	46.0	55.6	47.2	--	--
Antennaria microphylla	--	.20	--	.01	.73	2.58
	--	45.7	--	20.0	59.4	63.4
Arabis holboellii	.14	.25	--	.02	--	--
	67.3	12.8	--	42.9	--	--
Artemisia tidentata	18.09	46.28	--	--	--	--
	60.8	57.5	--	--	--	--
Balsamorhiza sagittata	49.70	19.83	24.30	17.38	--	--
	75.6	65.1	76.2	70.1	--	--
Berberis repens	1.56	2.00	.21	.50	--	--
	52.2	47.0	55.6	57.1	--	--
Calamagrostis rubescens	--	.14	--	2.75	--	--
	--	46.7	--	51.3	--	--
Chrysothamnus sp.	--	--	.27	.49	--	--
	--	--	76.0	64.1	--	--
Collinsia parviflora	.02	--	--	--	--	--
	69.7	--	--	--	--	--
Descurainia sp.	.02	--	--	--	--	--
	75.0	--	--	--	--	--

Table 2. (cont.)

	Site 1		Site 2		Site 3	
	6/30	8/7	7/13	8/15	7/28	8/20
Epilobium minutum	.04	.02	--	--	.18	.01
	52.6	--	--	--	65.6	50.0
Erigeron sp.	--	--	--	--	24.04	21.91
	--	--	--	--	72.5	69.9
Eriogonum flavum	--	--	--	--	.48	--
	--	--	--	--	62.5	--
Eriogonum umbellatum	.56	.06	2.05	2.71	--	--
	67.1	53.4	63.5	54.4	--	--
Festuca idahoensis	8.35	7.19	8.60	14.32	.65	1.65
	53.7	38.4	61.1	45.2	58.5	58.8
Fragaria virginiana	--	--	--	--	15.86	9.86
					67.8	66.2
Frasera albicaulis	.64	tr[b]	7.11	7.74	--	--
	74.4	68.9	75.6	71.1	--	--
Geum triflorum	--	--	--	--	3.39	.77
	--	--	--	--	68.4	63.3
Gilia tenerrima	--	--	--	--	.56	.61
	--	--	--	--	53.1	57.9
Hieracium albertinum	--	--	.92	.51	--	--
	--	--	30.3	69.6	--	--
Koeleria cristata	--	--	2.29	1.18	--	--
	--	--	60.3	35.3	--	--
Lithospermum ruderale	2.62	1.84	7.48	11.01	--	--
	73.6	67.7	73.1	67.3	--	--
Lomatium dissectum	.16	--	--	--	--	--
	75.9	--	--	--	--	--
Lupinus sericeus	.15	--	--	--	--	--
	77.1	--	--	--	--	--
Phacelia hastata	.11	--	--	--	--	--
	67.3	--	--	--	--	--
Phacelia linearis	.04	--	--	--	--	--
	72.8	--	--	--	--	--
Penstemon procerus	--	--	--	--	6.46	6.96
	--	--	--	--	69.0	63.7
Polygonum sawatchense	--	--	--	--	2.94	2.38
	--	--	--	--	61.2	65.4

Table 2. (cont.)

	Site 1		Site 2		Site 3	
	6/30	8/7	7/13	8/15	7/28	8/20
Polygonum sp.	--	.48	--	.10	--	--
	--	56.0	--	50.1	--	--
Potentilla diversifolia	--	--	--	--	.22	2.12
	--	--	--	--	70.9	65.6
Prunus virginiana	.13	.26	--	--	--	--
	67.1	59.0	--	--	--	--
Purshia tridentata	10.74	15.25	13.83	4.96	--	--
	57.7	57.3	61.1	54.0	--	--
Ribes aureum	--	--	10.98	--	--	--
	--	--	56.9	--	--	--
Solidago sp.	--	--	13.38	9.01	--	--
	--	--	83.6	69.0	--	--
Spiraea betulifolia	.10	.36	--	--	--	--
	46.7	48.9	--	--	--	--
Symphoricarpos albus	--	.24	.41	15.47	--	--
	--	50.6	56.0	43.7	--	--
Vaccinium sp.	--	--	--	--	8.71	4.31
	--	--	--	--	63.0	57.5
Unknown grass 1	--	--	3.07	--	--	--
	--	--	64.9	--	--	--
Unknown grass 2	--	--	--	--	7.16	6.82
	--	--	--	--	66.0	62.8
Unknown grass 3	--	--	--	--	9.29	12.52
	--	--	--	--	59.7	53.1
Unknown grass 4	--	--	--	--	12.78	21.14
	--	--	--	--	64.4	58.7
Unknown grass 5	--	--	--	--	2.74	.86
	--	--	--	--	59.8	57.0
Unknown grass 6	--	--	--	--	--	4.32
	--	--	--	--	--	54.3
Total plant biomass (kg. per ha.)	855010	529450	281080	313670	157320	129600
Total % moisture	67.44	56.92	69.35	57.31	66.85	62.19

[a]For each plant species, the top value represents the percent of the total biomass which that plant encompasses, and the bottom value is the percent moisture in the plant.

[b]tr is less than .01.

Table 3. Compilation of the sex and weights (in gms.) of the squirrels arranged according to the location and date of capture.

Site 1

		Adults			
Id	Sex	6/14-6/16	6/26	7/5-7/7	7/21-7/22
1	male	--	546	--	--
3	female	--	--	417	448
4	female	--	--	381	461
8	male	--	--	403	--
20	female	382	--	--	--
40	female	406	--	--	554
50	male	330	--	--	--
60	female	366	--	--	--
70	male	337	--	--	--
mean:		364	546	400	484
		Young of the Year			
2	female	--	--	141	264
5	male	--	--	142	--
6	male	--	--	187	--
7	female	--	--	137	--
10	male	--	--	210	--
30	female	--	--	240	--
80	male	--	--	--	277
mean:		--	--	176	271

Site 2

		Adults		
Id	Sex	6/22	7/13-7/14	8/14-8/17
1	female	371	438	--
2	male	488	--	--
3	female	368	--	--
4	female	315	--	--
5	female	458	--	--
6	female	--	421	--
7	male	--	585	--
30	female	--	387	--
40	female	--	478	--
50	male	--	521	--
60	female	--	416	--
70	female	--	446	--
80	female	--	520	--
90	male	--	566	--
100	female	--	405	--
12	male	--	388	--
mean:		400	464	--
		Young of the Year		
8	female	--	153	255
10	female	--	169	290
20	female	--	172	--
11	female	--	109	195
mean:		--	150	247

Table 3. (cont.)

Site 3

Id	Sex	Adults 6/28-6/30	7/26-7/30	8/19-8/25
1	female	476	--	--
2	male	363	468	553
3	male	353	--	--
4	female	355	--	--
5	female	399	418	--
6	female	479	484	574
7	female	438	--	--
8	female	366	456	--
10	female	488	--	--
20	male	465	568	--
30	female	412	--	--
40	female	406	504	--
50	female	312	439	--
60	male	394	--	--
70	female	529	--	--
80	male	544	--	--
100	female	395	476	--
11	female	473	468	--
12	male	455	595	--
13	female	411	526	--
14	male	323	--	--
15	female	402	--	--
16	male	410	--	--
17	female	296	--	--
18	male	526	--	--
21	male	527	673	--
22	male	528	644	--
23	female	--	429	--
25	female	--	526	--
32	female	--	498	--
34	male	--	704	--
35	female	--	403	--
41	male	--	358	--
48	female	--	539	--
51	male	--	551	--
53	female	--	--	544
55	male	--	--	502
57	male	--	--	617
mean:		427	511	558
		Young of the Year		
90	male	--	201	356
24	male	--	161	280
26	male	--	182	291
27	female	--	159	--
28	male	--	174	293
31	female	--	169	--
33	male	--	197	336
36	female	--	173	--
37	female	--	176	304
38	male	--	203	--
42	male	--	189	--
43	female	--	181	304
44	male	--	178	--

Table 3. (cont.)

Id	Sex	Young of the Year 6/28-6/30	7/26-7/30	8/19-8/25
45	female	--	215	--
46	male	--	229	--
47	male	--	206	--
52	male	--	181	293
54	female	--	--	277
56	female	--	--	307
58	male	--	--	340
61	female	--	--	280
62	male	--	--	309
63	male	--	--	273
mean:		--	187	303

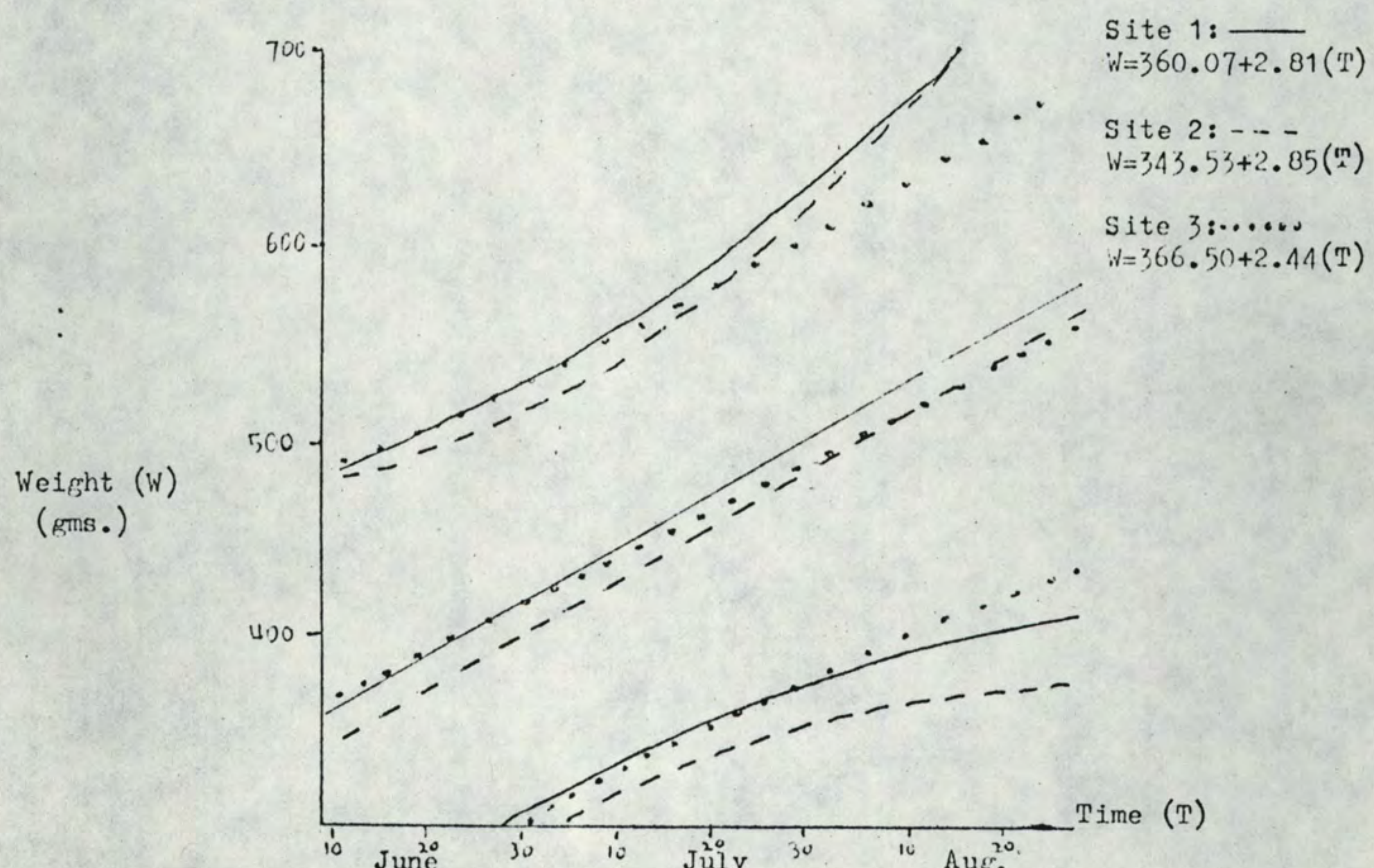

Fig. 1a. The change in weight functions obtained by linear regression and their 95% confidence intervals for the female adults at all three sites.

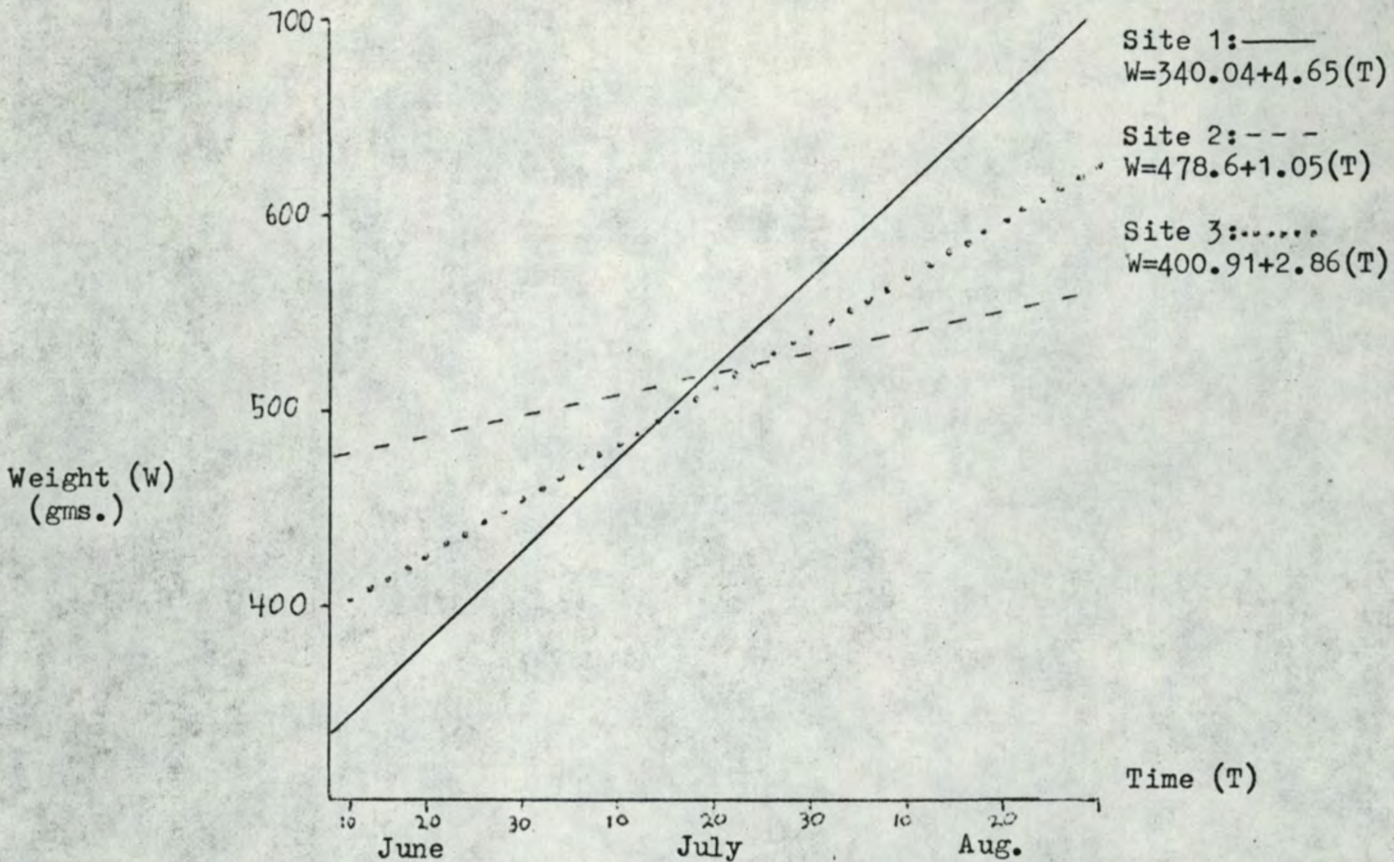

Fig. 1b. The change in weight functions obtained by linear regression and their 95% confidence intervals for the male adults at all three sites.

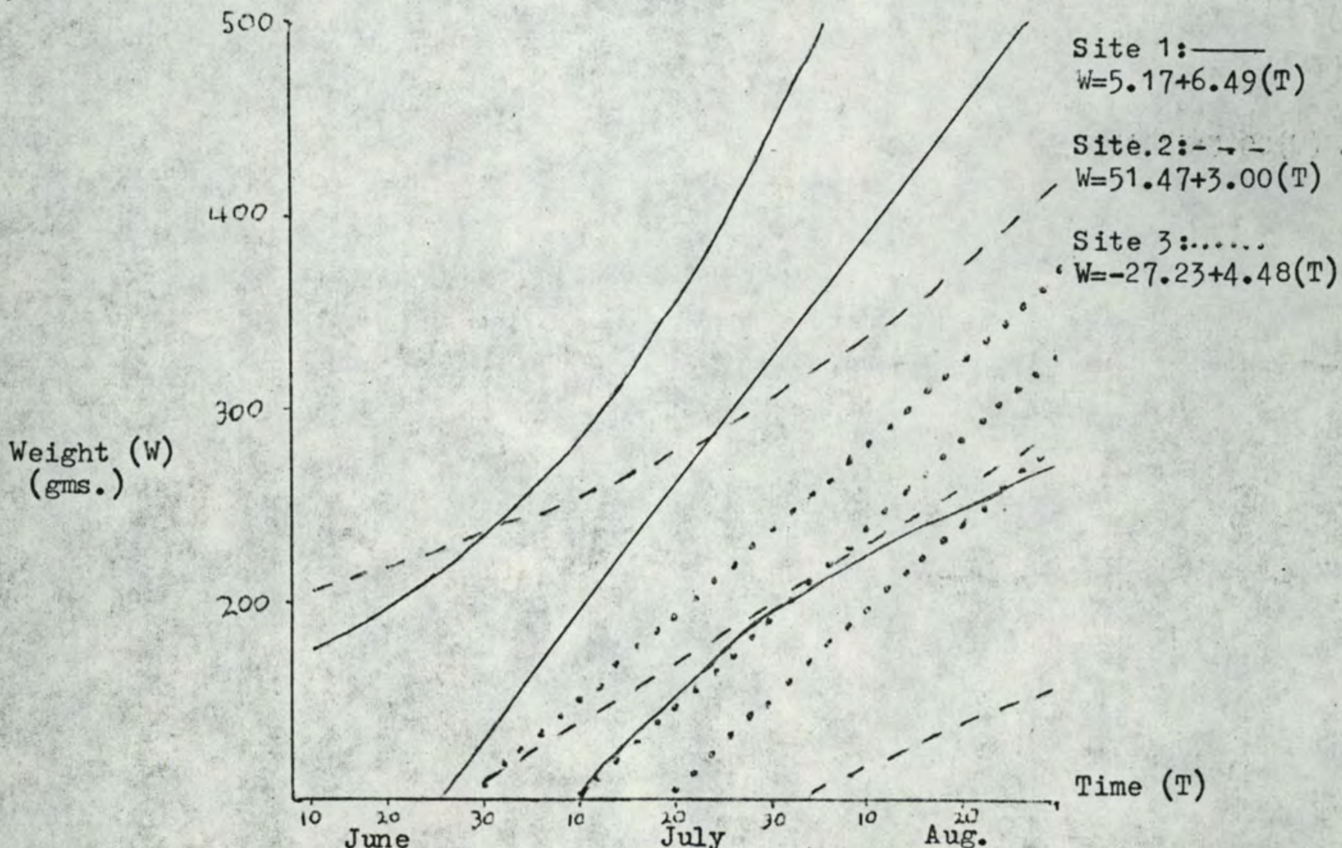

Fig. 1c. The change in weight functions obtained by linear regression and their 95% confidence intervals for the young of the year at all three sites.

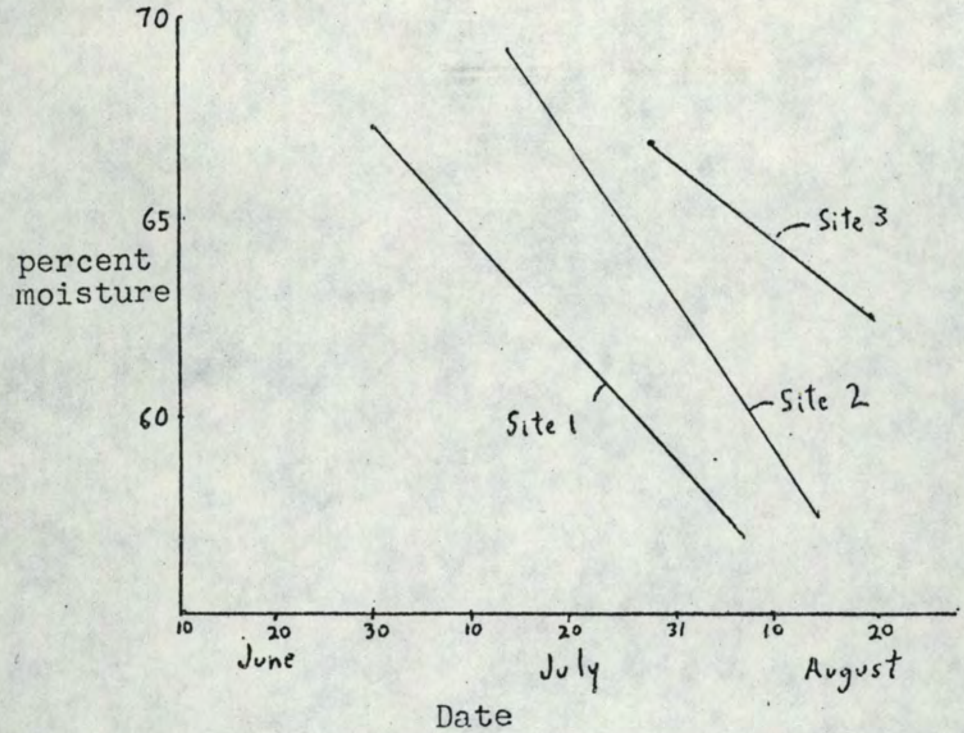

Fig. 2. Rate of vegetational moisture loss for each site.

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