T H E S I S

THE RELATION OF GRASSHOPPERS (With Special Emphasis on *Dissosteira longipennis*, Thomas) to the NATIVE RANGES OF COLORADO

Submitted by

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In partial fulfillment of the requirements

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY Galen A. Hinkle

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INTRODUCTION

The native ranges of Colorado for over half a century have produced large amounts of summer and winter forage for live-stock. During recent years, however, it has become more and more apparent to the ranchmen and those interested in better range management that the carrying capacity of the grasslands was diminishing rather rapidly. Over grazing was the consequent outcome resulting naturally in the destruction of the more palatable grass species which have gradually gone out to be replaced by less palatable forms.

When the overgrazing problem was eventually analyzed it became increasingly apparent that a combination of factors were operating to produce this overgrazed condition. Drouth proved to be an important item, accompanied by a poorly regulated grazing policy, and insect utilization, of which the principle offenders were grasshoppers.

During recent years many inquiries have been made of the Entomology Department at Colorado State College concerning problems of grasshopper utilization of the native grasses of Colorado. In response to these inquiries, an experiment was set up to determine what species of grasshoppers were responsible for the greatest amount of utilization; what grasses were the preferred hosts; the grasses that produce the most forage; the actual amount of

utilization in per cent, caused by the feeding of constant populations of grasshoppers; how grasshopper grazing compares with that of livestock; whether or not the density of grasses has any effect upon utilization; and the species of grasshoppers that commonly occur in grass formations and the numbers in which they are present.

The economic importance of this problem may be judged according to the emphasis placed upon range management by such agencies as the Colorado State College Experiment Station, the United States Forest Service, and the Soil Conservation Service. Ranchers and stockmen have indicated a strong interest in this problem, since during recent years in many Colorado counties, wheat and native grasslands, sudan, maize, and other forage producing crops have been destroyed by grasshoppers with the result that ranchers annually suffer severe loss of winter and summer feed. In 1937, it was estimated that over three million acres of native range was destroyed, by the above pest. Such losses become increasingly serious when drouth and insect utilization combine to cause a general destruction of summer and winter forage over the grass producing sections of the state.

The experiment involved two phases of study, (1) the extent of damage to native grasses caused by the feeding of the migratory grasshopper, Dissosteira longipennis, Thos., which periodically migrates into the south east part of Colorado, and (2) the extent of damage to native

grasses caused by the feeding of the native range land forms of grasshoppers. The experiment was started in December, 1936, and completed in May, 1938.

REVIEW OF LITERATURE

Review of the Publications Concerning Dissosteira longipennis, Thomas--

The original description in 1872 of Dissosteira longipennis, Thos. is credited to C. Thomas (44) as Oedipoda longipennis from Kansas 1872. C.V. Riley (38) claimed to have collected this species in Colorado in 1867.

A new genus (Dissosteira) was proposed for the reception of Oedipoda longipennis, Thos. and Gryllus carolina, Linn., in 1876 by S.H. Scudder (39), distinguishing the latter species as the genotype.

This species was found in 1875, in small numbers in the region west of Colorado Springs, Colorado, by Philip R. Uhler (45).

While on a general tour of observations to investigate rumored grasshopper ravagee in different parts of the Western States, Lawrence Bruner (4), in 1891, stated that the species causing the alarm in Colorado was "---a rather rare species, known as Dissosteira longipennis, Thos. occuring at that time over 400 square miles of territory in sufficient numbers to materially injure the grasses growing on the range of the entire region. Grains and other cultivated plots did not appear to be especially attractive to it. In fact, very little, or no injury was done by it to the cultivated crops growing within the

region infested."

While making a visit to Lincoln County in 1891 E. H. Popenoe noted that this species was sufficiently numerous to stop trains.

This species was locally harmful in Kansas, as reported by Kellogg (29), in 1892, but no serious crop destruction was threatened.

According to Bruner (9), in 1895, this species was found out on the plains away from the foothills and irrigating ditches; over a large portion of Colorado and Nebraska. He believed that hillsides furnished a suitable place for the increase of Dissosteira longipennis, Thos. and several other barren ground species.

This species was abundant in Colorado and Nebraska, where it destroyed entire fields of small grains, some corn, potatoes, and a number of garden plants, Bruner (6) again reports in 1896.

In western Kansas in Edwards County, S. J. Hunter (28) reported in 1898 that this locust was abundant in a portion of an alfalfa field of 320 acres. In the same year he also reported, that the locusts came from the west down into Colorado Springs in countless numbers on July 21.

Regarding this species in 1904, Bruner (7) wrote that it was a native of the high prairies of Western Kansas, Nebraska, Eastern Colorado, and Wyoming, but was not nearly so abundant as it was in 1898.

When H.E. Smith (42) in 1915 wrote an account of "The Grasshopper outbreak in New Mexico during the summer of 1913", he gave a complete review of the activities of the so-called long-winged migratory grasshopper of the plains in New Mexico.

He stated that the 1913 outbreak of the species extended over 400-500 square miles, that the prairie grasses, grains and garden crops within the area was in great part destroyed. Herds of cattle grazing within this infested area were forced to travel from eleven to thirteen miles for grazing facilities. Freight and passenger trains were repeatedly stopped by grasshoppers massing upon the railroad tracks, from the middle of May until the first of July.

The prairie grasses within the infested area were so completely ravaged that hardly a surface depression of the soil could be located, which was not from one-fourth to completely filled with grasshopper excrement.

Since 1915, very little has been added to our general knowledge of the species. B.R. Walton (46) wrote a brief description of it in 1916.

In 1921, C.L. Corkins (13) gave a detailed report of a rather serious infestation in El Paso, Lincoln, Crowley, and Pueblo counties, Colorado, where considerable damage was reported to have been caused by their feeding on the native range. He seemed to be of the opinion that the species was capable of extended migrations. Gillette (21)

in a similar report, stated that they were positively phototropic.

It was again mentioned by Corkins (14) in the state Entomologist's report for 1923, but it apparently was responsible for little damage that year.

The species is listed in Morgan Hebard's (24) "Orthoptera of Colorado" of 1929.

The species reinfested Lincoln County in 1934, and was reported on by Sam C. McCampbell, Extension Entomologist for Colorado, in his unpublished annual report. It was also mentioned in the forty-eighth annual report of the Colorado Agricultural Experiment Station that same year, apparently as a similar infestation to the one that occurred in 1921.

An account was given by F.A. Fenton (16) in 1936, of an infestation in Oklahoma which seemed to have assumed serious proportions. He writes of the damage to grasslands and other crops, and gives control.

In the fall of 1936, Lincoln County, Colorado was again reinfested by Dissosteira longipennis, Thos. to be reported on by McCampbell in his unpublished annual report for that year.

It was McCampbell's opinion that permanent breeding grounds of this species existed somewhere in the adjacent states south of Colorado. He further stated that these areas should be located and surveyed each year in order that the nymphs might be poisoned before they reach

maturity.

The worst infestation of Dissosteira longipennis Thos. ever to be recorded for the state occurred in 1937, in the southeastern section of Colorado.

A survey of this area by the author indicated that the damage to agriculture crops and range forage by the species was about one million five hundred thousand dollars ($1,500,000). It was necessary for many stockmen to either reduce their herds very materially or to sell out completely because of the destruction of the forage by Dissosteira longipennis, Thos.

Review of the Literature Making Direct Reference to the Effects of Grasshopper Grazing on Grasslands

It is true that Dissosteira longipennis, Thos. is the most important form attacking range grasses when it appears periodically in restricted areas, however, those grasshoppers that are yearly breeders on the native ranges of Colorado are equally important from a utilization standpoint year after year. Of these forms, very little has ever been written.

The greatest damage to grasses caused by the feeding of the native grasshoppers, D. A. Wilbur (48) suggested, in 1936, was probably due to their desire for water during dry seasons. Such damage takes the form of clipping the seed-bearing culms off near the base of the inflorescence where the plant stays green and succulent longest. Such injury, it seems, may be expected only during dry hot seasons when a high percent of injury may result from the feeding of a small number of grasshoppers.

A distinct grasshopper fauna was found populating the native grass areas of Kansas, by Woodruff (49) in 1936. In his "Grasshopper Survey for Eastern Kansas" he reports the above.

In a publication presented first to the Fourth International Conference for Anti-Locust Research, Cario, Egypt, in 1936, E. R. Buckell (11), stated that "Study of the deterioration of the range, showed quite clearly that

with Camnula pellucida, Schdd., a well preserved range was characterized by having very few grasshoppers, and that an overgrazed range was a favorite grasshopper breeding ground-----In 1921, the relationship between grasshopper abundance and overgrazing having been established, an experiment was begun to demonstrate to the stockmen that by proper range management to avoid overgrazing, not only would the original vegatation re-establish itself, but that Camnula would not continue breeding in the well kept fields."

A few unpublished notes of F.A. Morton, Assistant Entomologist for the Federal Bureau of Entomology and Plant Quarantine, support the prevailing contention that range land grasshoppers are responsible for considerable damage to native grasses. Nothing conclusive, however, has been published to date that would materially substantiate the growing feeling among farmers and ranchmen that grasshoppers are an important factor in the proper management of grazing areas.

METHODS OF STUDY

A native range type was selected west of Fort Collins for the grasshopper utilization study. In the area occurred native range species that are found throughout the eastern part or plains region of the State.

A vegetative area was selected that contained almost pure stands of blue gramma (Bouteloua gracilis), pure stands of buffalo grass (Buchloe dactyloides), and mixed stands of the above species and western wheat grass (Agropyron smithii). The area was fenced to keep out livestock. Thirty meter square quadrats were established, ten in which blue gramma was the dominant species, ten in which buffalo grass was dominant, and ten that contained a mixture of the above two species, and western wheat grass.

The composition of the vegetation on each quadrat was determined by ocular estimates. In Table 1 in the following page is given the list of species that occurred in the quadrats, and their palatability percentages. These palatability percentages are given to show the relative importance of various forage plants for cattle. Measurements were obtained of the foliage of the three principal grasses to determine the rate of growth throughout the duration of the experiment.

Table 1: List of palatability percentages of grasses, annual and perennial weeds, and shrubs, with symbols, found in the quadrats.

Scientific name	Common name	Symbol	Palatability percentages for cattle
Perennial grass			
1. Buchloe dactyloides	Buffalo grass	Bd	80
2. Bouteloua gracilis	Blue gramma	Bg	80
3. Agropyron smithii	Western wheat grass	As	60
4. Aristida longiseta	Three awn grass	Al	30
5. Hordeum nodosum	Meadow barley grass	Hn	20
6. Schedonnardus paniculatus	Texas crab grass	Sp	60
7. Muhlenbergia torreyi	Ring Muhlenbergia	Mt	0
Annual grass			
1. Festuca octoflora	Six weeks fescue	Fo	30
2. Bromus tectorum	Downy chess	Bt	20
Perennial weed			
1. Malvastrum coccineum	False mallow	Mc	10
2. Psoralea tenaiflora	Indian turnip	Pt	0
3. Iva axillaris	Poverty weed	Ia	0
4. Cogswellia sp.	Cogswellia	Co	10
5. Guara coccinea	Gaura	Gc	20
6. Helianthus pumilus	Perennial sunflower	Hp	40
7. Liatrus punctata	Blazing star	Lp	0
8. Astragalus flexuosus	Vetch	Asf	10
9. Sophora sericea	Silky sophora	Ss	0
Annual weed			
1. Lappula occidentalis	Stick weed	Lao	0
2. Plantago purchii	Indian wheat	Pp	0
3. Helianthus annus	Annual sunflower	Ha	0
4. Salsola pestifer	Russian thistle	Sal	10
Shrub			
1. Yucca glauca	Soap weed	Yg	0
2. Artemisia gnaphloides	Sage	Ag	0

Table 1 Continued:

Scientific name	Common name	Symbol	Palability percentages for cattle
2. Artemisia gnaphloides	Sage	Ag	0
3. Gutierrezia longifalia	Snake weed	Gl	0

These palatability data were obtained from the 1936 plant check list of the Department of Range and Pasture Management.

The population of grasshoppers on each quadrat was determined on June 16, by two men working slowly from the ends of the quadrats, towards the center. The average grasshopper population for the experimental area was twenty-two individuals per square meter.

Each grass quadrat was inclosed by a galvanized sixteen mesh screen cage forty-eight inches in length, thirty-two inches in width, and eighteen inches in height.

Plate A: Inclusioned Quadrats

These screen cages were for the purpose of excluding grasshoppers from six check plots, and for inclosing exact numbers of grasshoppers in the remaining quadrats. They were placed over the grass areas on June 17 and 18, according to the table on the following page.

Table 2: Table showing the number of quadrats, grasshopper species in each, number of individuals in each, instar when introduced, and dominant grass species in each.

Cage No.	Hopper Species	No. Indiv. per sq. M.	Instar when Introduced	Dominant grass species
1. Check	None	0	0	94% Buchloe dactyloides
2. "	"	"	"	80% Buchloe dactyloides & 15% Agropyron smithii
3. "	"	"	"	94% Bouteloua gracilis
4. "	"	"	"	98% Buchloe dactyloides
5. "	"	"	"	80% Bouteloua gracilis & 10% Agropyron smithii
6. "	"	"	"	91% Bouteloua gracilis
7. Inclusion quadrat	Dissosteira longipennis	40	1st	95% Buchloe dactyloides
8. "	"	20	3rd & 4th	92% Bouteloua gracilis
9. "	"	20	3rd & 4th	35% Buchloe dactyloides, 25% Bouteloua gracilis, 22% Agropyron smithii
10. "	"	20	3rd & 4th	95% Buchloe dactyloides
11. "	"	30	3rd & 4th	93% Bouteloua gracilis
12. "	"	30	3rd & 4th	53% Buchloe dactyloides, 25% Bouteloua gracilis, 15% Agropyron smithii
13. "	"	30	3rd & 4th	95% Buchloe dactyloides
14. "	"	40	1st	35% Buchloe dactyloides, 28% Bouteloua gracilis, 15% Agropyron Smithii

Table 2 Continued:

Cage No.	Hopper Species	No. Indiv. per sq. M.	Instar when Introduced	Dominant grass species
15. Inclusion quadrat	Dissosteira longipennis	40	1st	87% Bouteloua gracilis
16. "	Native rangeland species	22	1st, 2nd, 3rd	98% Buchloe dactyloides
17. "	"	"	1st, 2nd, 3rd	70% Buchloe dactyloides. 3% Bouteloua gracilis, 6% Agropyron smithii
18. "	"	"	1st, 2nd, 3rd	93% Bouteloua gracilis
19. "	"	"	1st, 2nd, 3rd	94% Buchloe dactyloides
20. "	"	"	1st, 2nd, 3rd	70% Buchloe dactyloides, 3% Bouteloua gracilis, 15% Agropyron smithii
21. "	"	"	1st, 2nd, 3rd	92% Bouteloua gracilis
22. "	"	"	1st, 2nd, 3rd	95% Buchloe dactyloides
23. "	"	"	1st, 2nd, 3rd	25% Buchloe dactyloides, 10% Bouteloua gracilis, 45% Agropyron smithii
24. "	"	"	1st, 2nd, 3rd	93% Bouteloua gracilis&& 4% Agropyron smithii
25. "	"	"	1st, 2nd, 3rd	97% Buchloe dactyloides
26. "	"	"	1st, 2nd, 3rd	65% Buchloe dactyloides, 5% Bouteloua gracilis, 15% Agropyron Smithii

Table 2 continued:

Cage No.	Hopper Species	No. Indiv. per sq. M.	Instar when Introduced	Dominant grass species
27.	Inclusion quadrat	Native range-land species	22	1st, 2nd, 3rd	90% Bouteloua gracilis
28.	"	"	"	1st, 2nd, 3rd	97% Buchloe dactyloides
29.	"	"	"	1st, 2nd, 3rd	35% Buchloe dactyloides, 45% Bouteloua gracilis, 10% Agropyron smithii
30.	"	"	"	1st, 2nd, 3rd	91% Bouteloua gracilis, 4% Agropyron smithii

As shown in Table 2, six of the quadrats were not grazed by grasshoppers. Leaf and seed stalk measurements were secured at different intervals during the growing season, and at the end of the experiment. The forage of species, was clipped at the end of the growing season, air dried and weighed. From these data, it was possible to compute the total yield of each species on an acreage basis. Species production was calculated for each plot, by dividing the average species production by the average species density to get the production for a density of one, then taking the species density times the production for the density of one. After the species production for one meter was determined, acreage production was calculated by multiplying production by the number of meters in an acre.

Table 3: A table of the dominant species of grass, plot densities, species densities, and ninety day production for the check quadrats.

Plot. No.	Plot Density	Species %	Species density	90 day production in grams
1	.13	Bd--94%	.1222	44.14 grams
		Bg-- 1%	.0013	.61 "
		As-- T (trace)	T	.25 "
		Weeds--4%	.0052	5.70 "
2	.08	Bd--80%	.064	31.5 "
		Bg-- T	T	0 "
		As--15%	.0120	43.88 "
		Weeds--4%	.0032	5.80 "
3	.09	Bd-- 0%	0	0 "
		Bg--94%	.0846	89.90 "
		As-- 0%	0	0 "
		Weeds--6%	.0054	20.70 "
4	.12	Bd--98%	.1176	52.70 "
		Bg-- 0%	0	0 "
		As-- 0%	0	0 "
		Weeds	.0024	.73 "
5	.05	Bd-- T	T	.25 "
		Bg--80%	.04	37.31 "
		As--10%	.005	22.90 "
		Weeds--9%	.0045	8.0 "
6	.10	Bd-- T	T	.25 "
		Bg--91%	.091	57.2 "
		As-- 2%	.002	1.56 "
		Weeds--6%	.006	13.15 "

	Bd.	Bg	As	Weeds
Average density	.3038	.2169	.0190	.0267
Average Production	Bd	Bg	As	Weeds
	128.34 grs	185.0 grs.	68.34 grs.	54.37 grs.

Table 4: Production table for Buffalo Grass

A	Density	of	.01	of	Buffalo	Grass	produced	37.435	pounds	per	acre
"	"	"	.02	"	"	"	"	74.870	"	"	"
"	"	"	.03	"	"	"	"	112.305	"	"	"
"	"	"	.04	"	"	"	"	149.740	"	"	"
"	"	"	.05	"	"	"	"	187.175	"	"	"
"	"	"	.06	"	"	"	"	224.610	"	"	"
"	"	"	.07	"	"	"	"	262.045	"	"	"
"	"	"	.08	"	"	"	"	299.480	"	"	"
"	"	"	.09	"	"	"	"	336.915	"	"	"
"	"	"	.10	"	"	"	"	374.350	"	"	"
"	"	"	1.00	"	"	"	"	3743.500	"	"	"

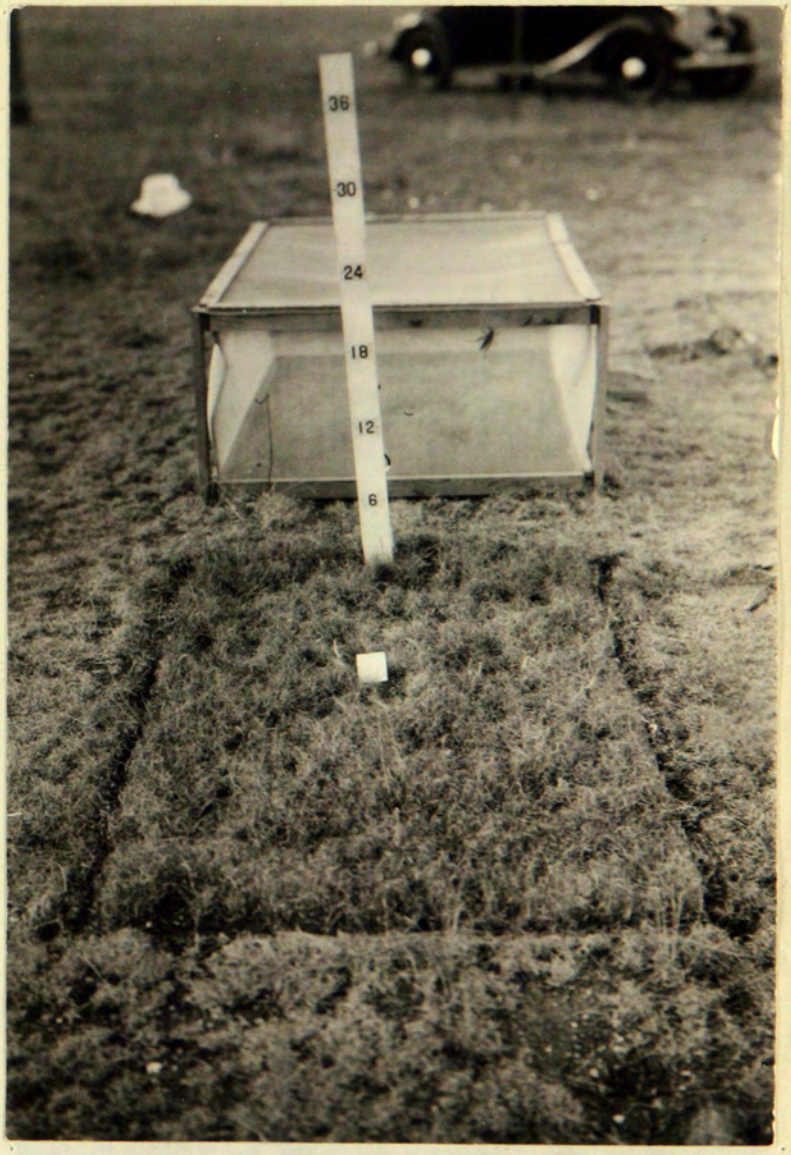
Table 5: Production table for Blue Gramma Grass

A	Density	of	.01	of	Blue	Gramma	produced	76.037	pounds	per	acre
"	"	"	.02	"	"	"	"	152.074	"	"	"
"	"	"	.03	"	"	"	"	228.111	"	"	"
"	"	"	.04	"	"	"	"	304.148	"	"	"
"	"	"	.05	"	"	"	"	380.185	"	"	"
"	"	"	.06	"	"	"	"	456.222	"	"	"
"	"	"	.07	"	"	"	"	532.259	"	"	"
"	"	"	.08	"	"	"	"	608.296	"	"	"
"	"	"	.09	"	"	"	"	684.333	"	"	"
"	"	"	.10	"	"	"	"	760.370	"	"	"
"	"	"	1.00	"	"	"	"	7603.720	"	"	"

Table 6: Production table for Western Wheat Grass

A	Density	of	.001	of	Western	wheat	produced	32.052	pounds	per	acre
"	"	"	.002	"	"	"	"	64.104	"	"	"
"	"	"	.003	"	"	"	"	96.104	"	"	"
"	"	"	.004	"	"	"	"	128.208	"	"	"
"	"	"	.005	"	"	"	"	160.260	"	"	"
"	"	"	.006	"	"	"	"	192.312	"	"	"
"	"	"	.007	"	"	"	"	224.364	"	"	"
"	"	"	.008	"	"	"	"	256.416	"	"	"
"	"	"	.009	"	"	"	"	288.468	"	"	"
"	"	"	.010	"	"	"	"	320.520	"	"	"
"	"	"	.100	"	"	"	"	3205.200	"	"	"
"	"	"	1.000	"	"	"	"	32052.000	"	"	"

Plate No. I Showing quadrat No. 1, Buffalo Grass dominant



Seasonal forage check quadrat yield.

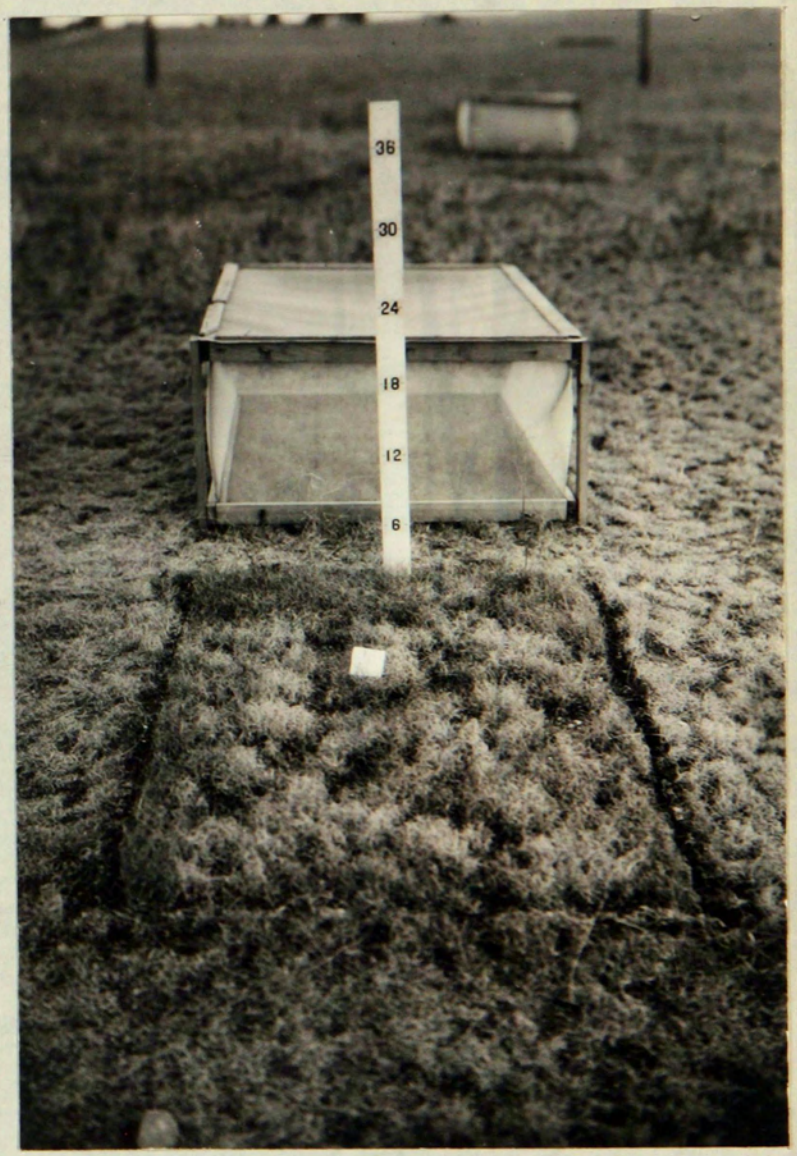
Plate No. II Showing quadrat No. 4, Buffalo grass dominant

Seasonal forage check quadrat yield

Plate No. III Showing quadrat No. 3, Blue Gramma Grass dominant

Seasonal forage check quadrat yield

Plate No. IV Showing quadrat No. 6, Blue Grama grass dominant



Seasonal forage check quadrat yield

Plate No. V Showing quadrat No. 2, Western wheat grass dominant

Seasonal forage check quadrat yield

Plate No. VI Showing quadrat No. 5, Western wheat grass dominant

Seasonal forage check quadrat yield

Using the preceeding production tables it is possible for the average individual with a little practice to estimate the density of a given range and from this calculation, approximately the number of cattle or sheep that can be satisfactorily supported by it.

The following nine plots were set up to assist in calculating the damage to range land caused by the feeding of grasshoppers of the species Dissosteira longipennis, Thos.

Table 7: Table showing the quadrat numbers, total densities, grass-species percentages, and grass species densities.

Plot No.	Total Plot Density	Grass Species %				Grass Species Density			
		Bd	Bg	As	Weeds	Bd	Bg	As	Weeds
7	.17	95	2	1	2	.1615	.0034	.0017	.0034
8	.10	0	92	1	7	0	.092	.001	.007
9	.05	35	25	22	18	.0175	.0125	.011	.009
10	.14	95	T	T	4	.133	T	T	.0056
11	.10	0	93	1	6	0	.093	.001	.006
12	.07	53	25	15	7	.0375	.0175	.0105	.0049
13	.13	95	0	0	5	.1235	0	0	.0065
14	.05	35	28	15	22	.0175	.014	.0075	.011
15	.08	3	87	3	7	.0024	.0696	.0024	.0056

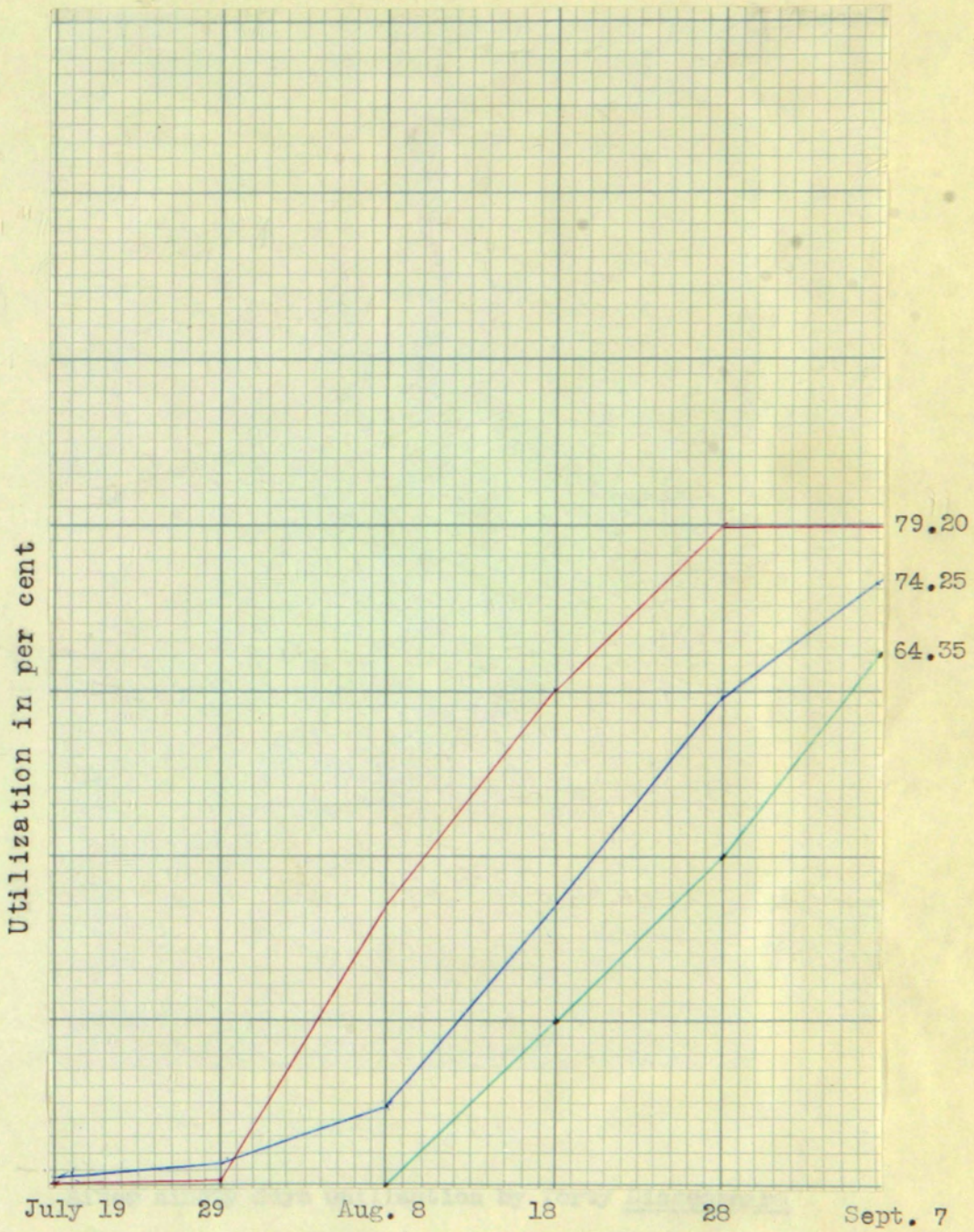
The populations in each quadrat as shown by Table 2 were maintained by replacing the dead grasshoppers with

laboratory hatched individuals. In all the cages, the nymphs were allowed to grow to maturity.

Careful estimates of the utilization by grasshoppers were made at ten day intervals of each vegetative species. These estimates were checked every twenty day period by measurements of the species.

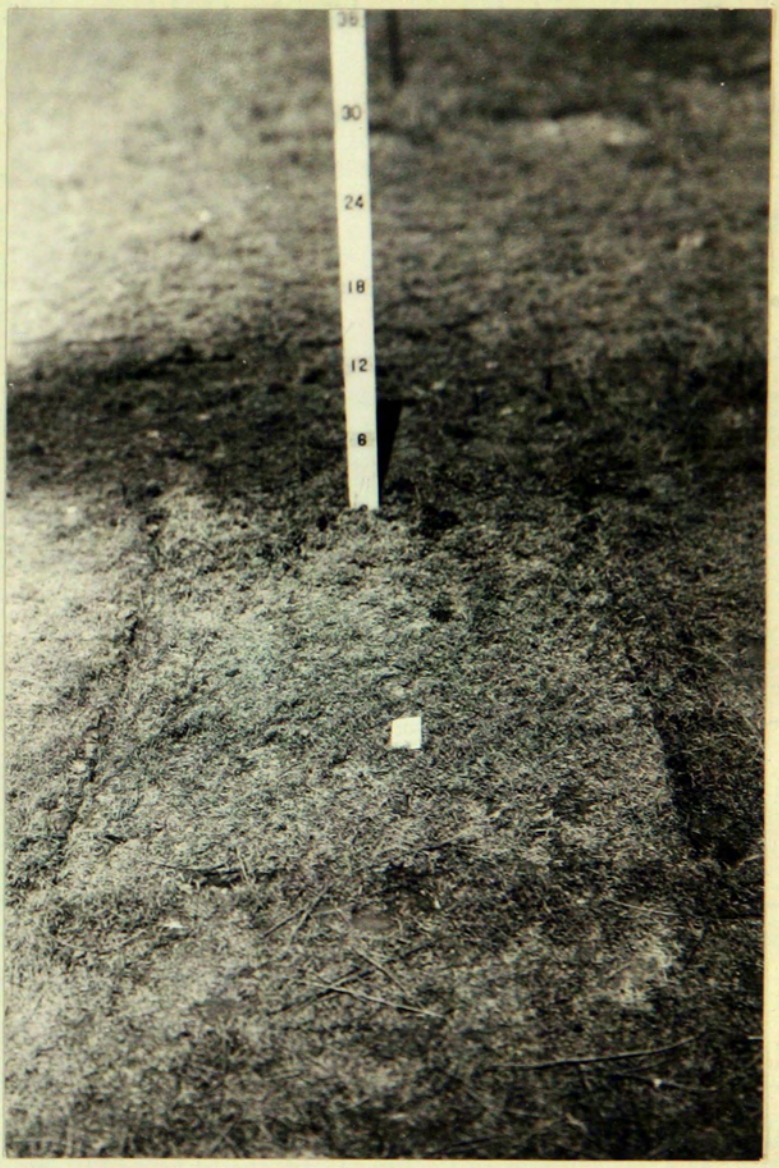
The graphs on the following pages show the utilization by species of grasses in percentages caused by the feeding of Dissosteira longipennis, Thos. It took approximately thirty days for the nymphs to graze a sufficient amount of the grasses in a majority of the plots to become noticeable, consequently, the graphs start with the first utilization estimate on July 19, and end with the last and total utilization estimate on September 7, when grazing by the adult grasshoppers had ceased. The evidence of utilization is also shown following each graph by a picture taken of the quadrat one day after the cages were removed on September 7.

Fig. 1 Showing utilization for quadrat No. 7 by forty Dissosteira longipennis, Thos.



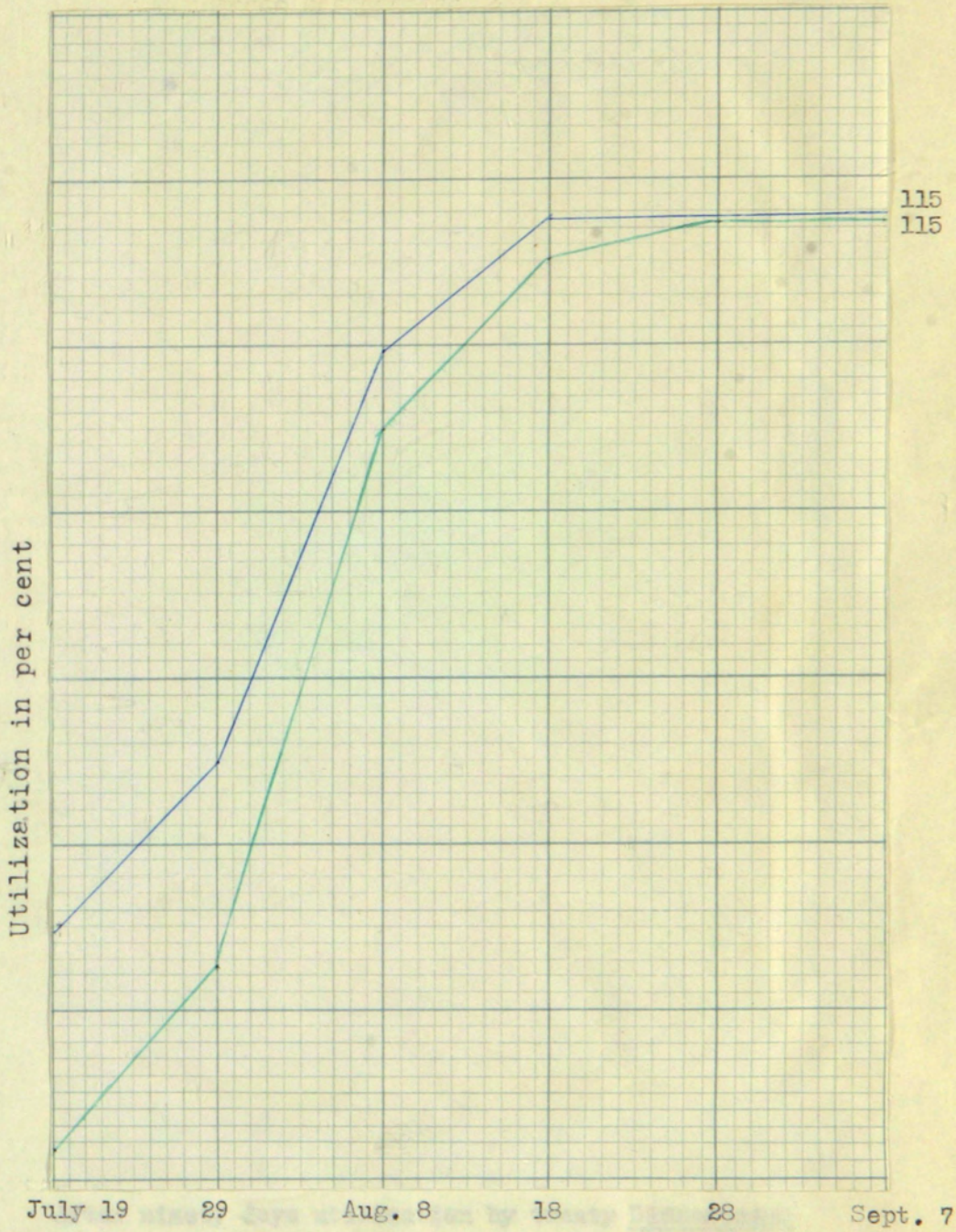
Buffalo grass ---------- Red
Blue gramma grass ------ Blue
Western wheat grass ---- Green

Plate No. VII Showing quadrat No. 7



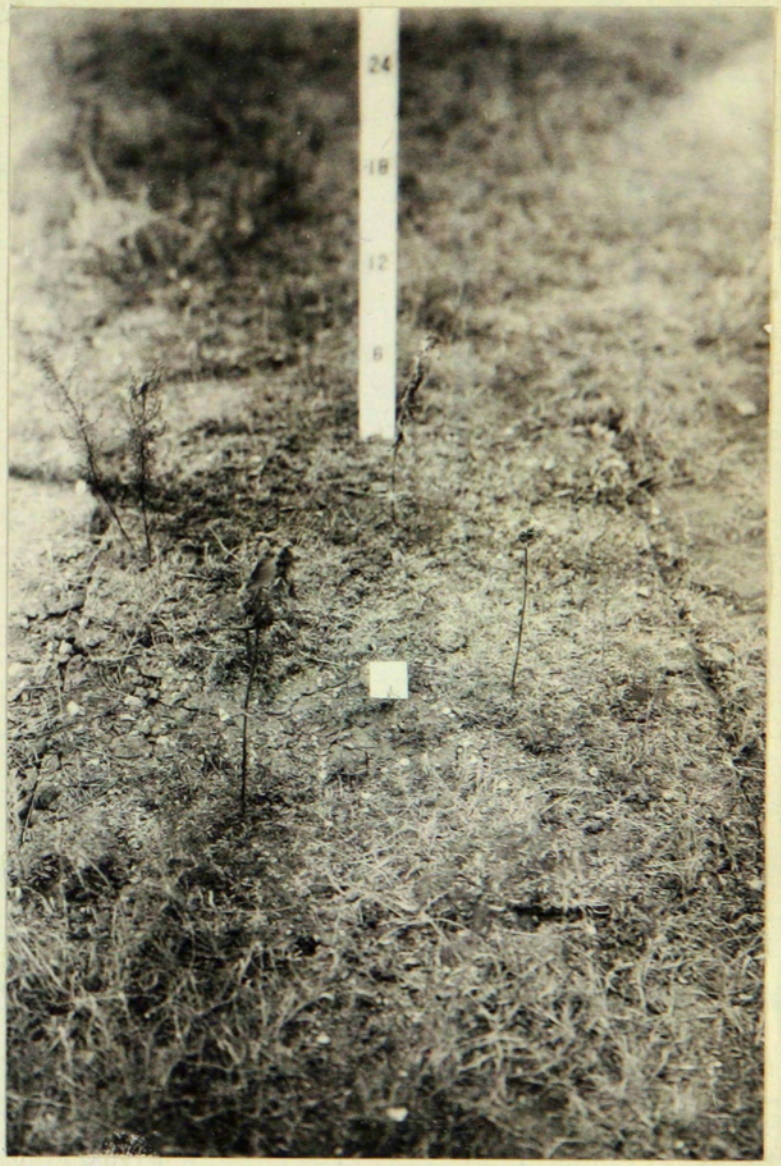
After ninety days utilization by forty Dissosteira longipennis, Thos., introduced into the cage during the first instar, and allowed to grow to maturity.

Fig. 2 Showing utilization for quadrat No. 8 by twenty *Dissosteira longipennis*, Thos.



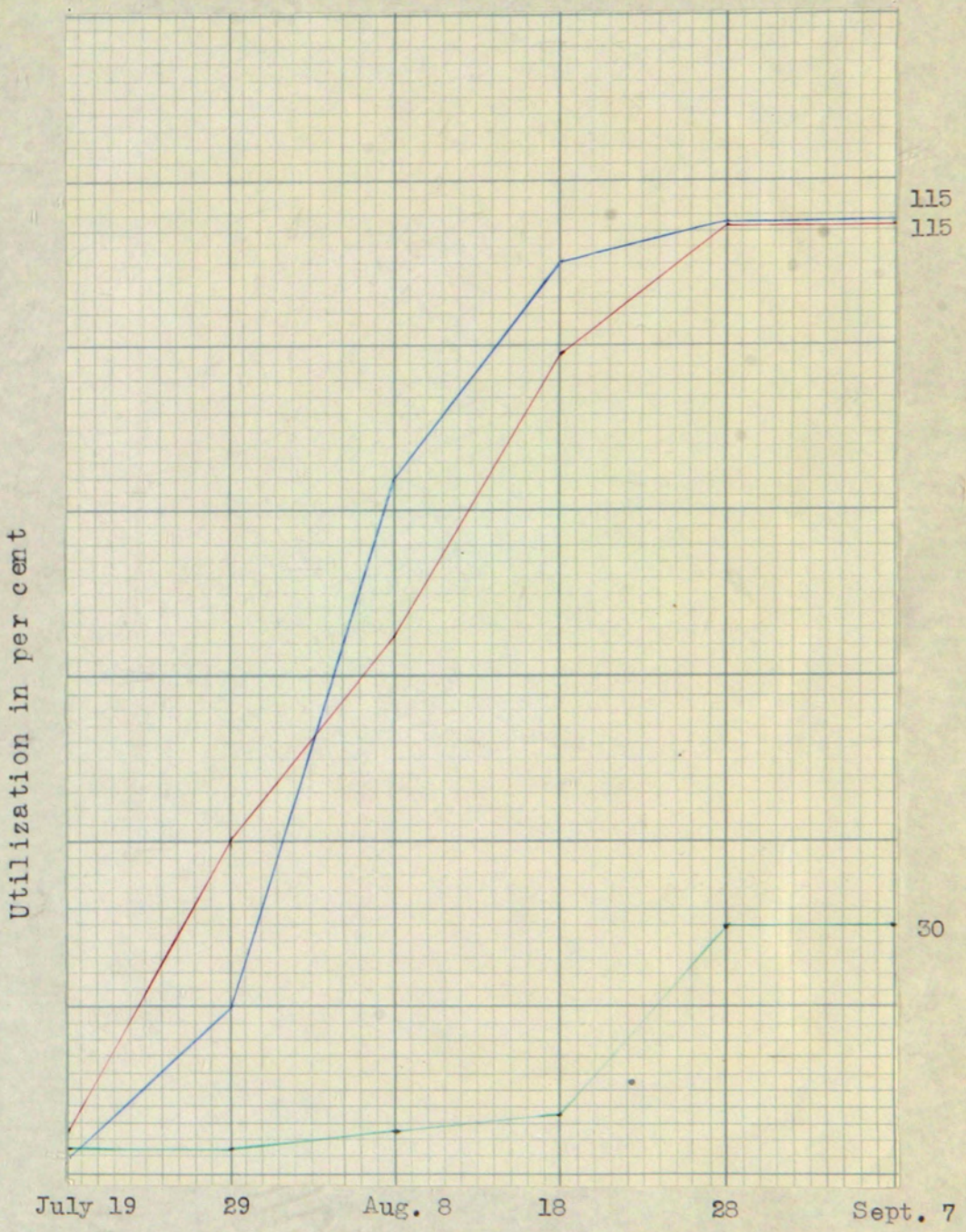
Blue gramma grass ------ Blue
Western wheat grass ---- Green

Plate No. VIII Showing quadrat No. 8



After ninety days utilization by twenty Dissosteira longipennis, Thos., introduced into the cage during the third and fourth instars, and allowed to grow to maturity.

Fig. 3 Showing utilization for quadrat No. 9 by twenty Dissosteira longipennis, Thos.



Buffalo grass ---------- Red
Blue gramma grass ------ Blue
Western wheat grass ---- Green

Plate No. IX Showing quadrat No. 9

After ninety days of utilization by twenty Dissosteira longipennis, Thos., introduced into the cage during the third and fourth instars, and allowed to grow to maturity.

Fig. 4 Showing utilization for quadrat No. 10 by twenty Dissosteira longipennis, Thos.

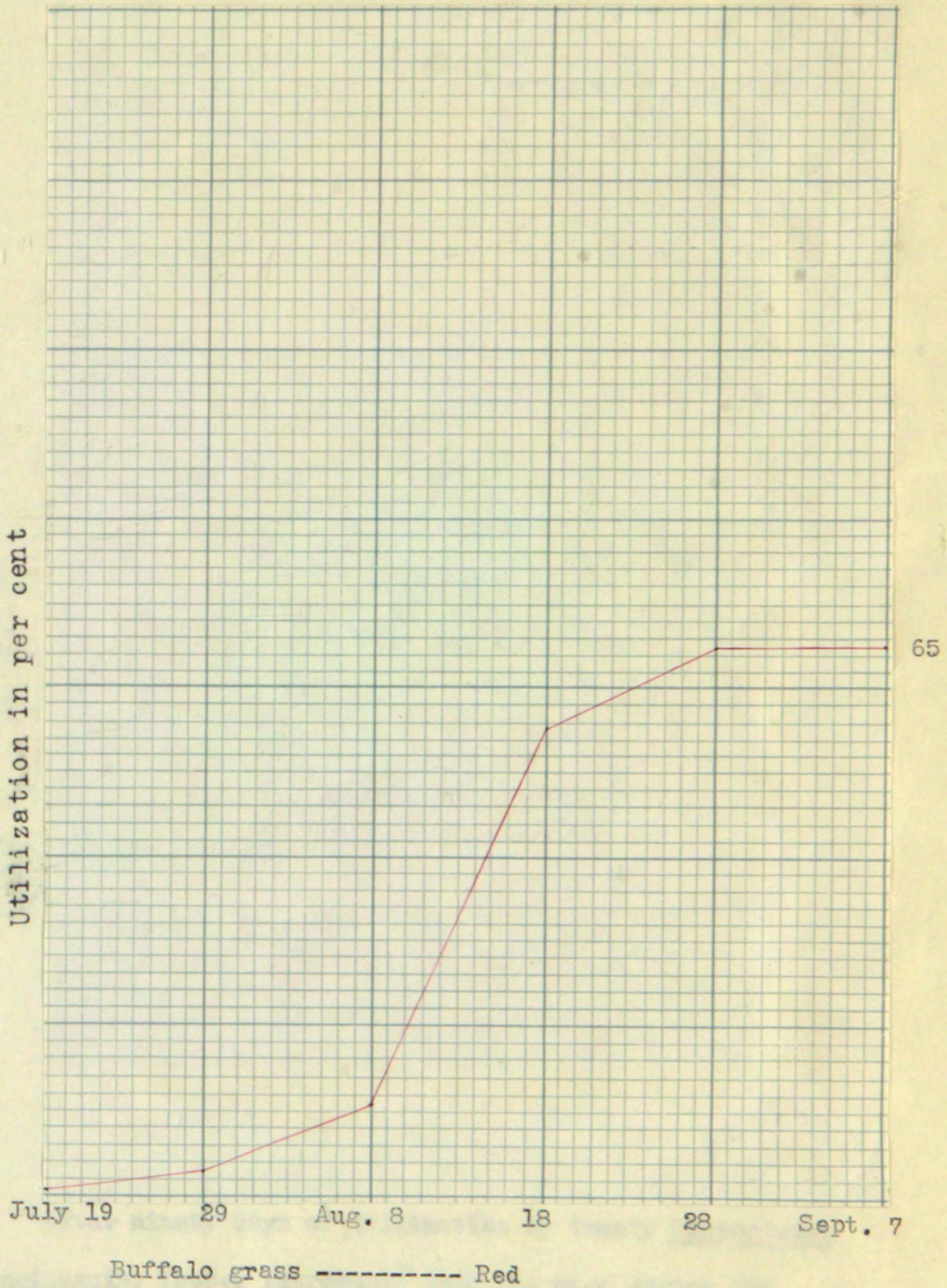


Plate No. X Showing quadrat No. 10

After ninety days of utilization by twenty Dissosteira longipennis, Thos., introduced into the cage during the third and fourth instars, and allowed to grow to maturity.

Fig. 5 Showing utilization for quadrat No. 11 by thirty Dissosteira longipennis, Thos.

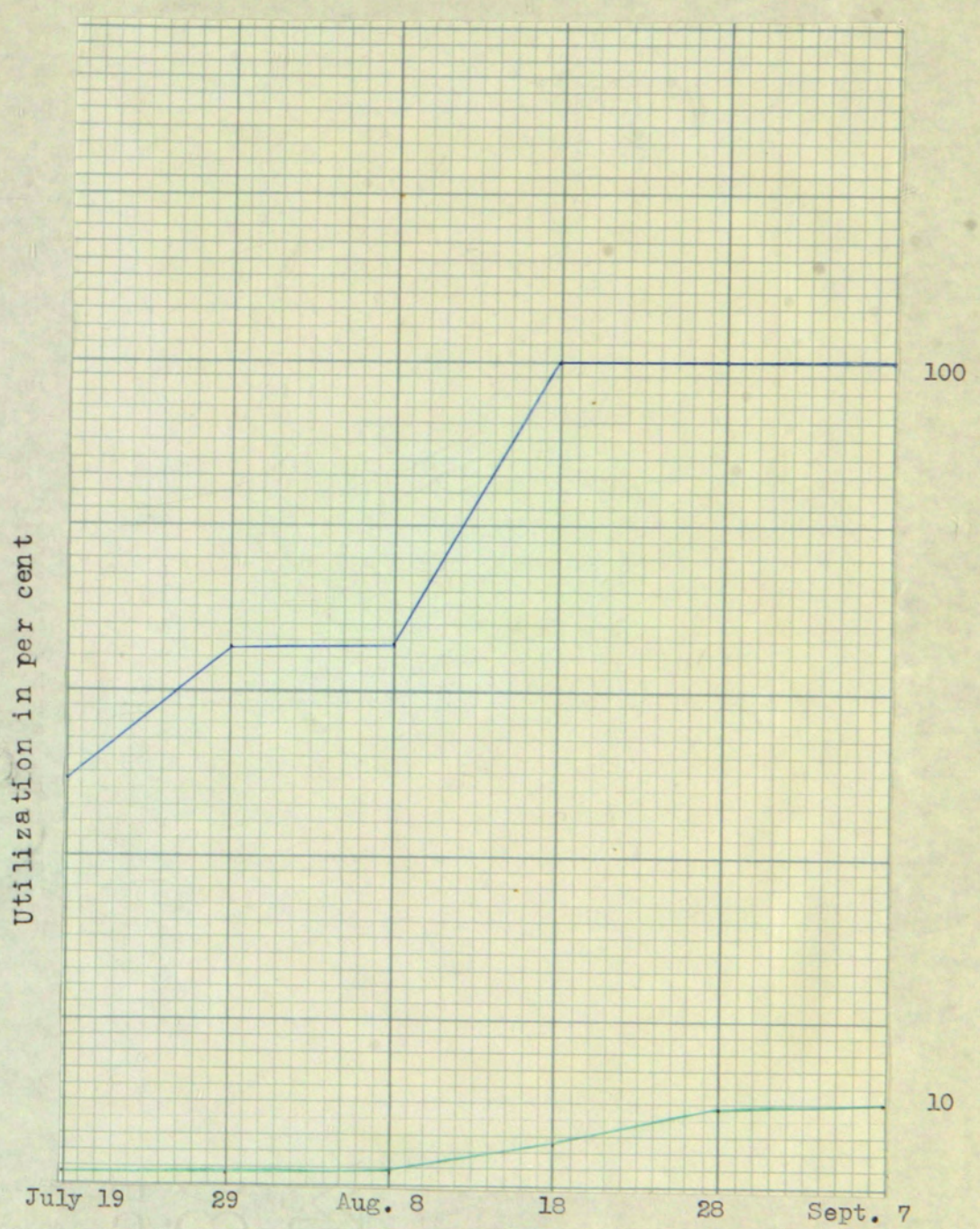
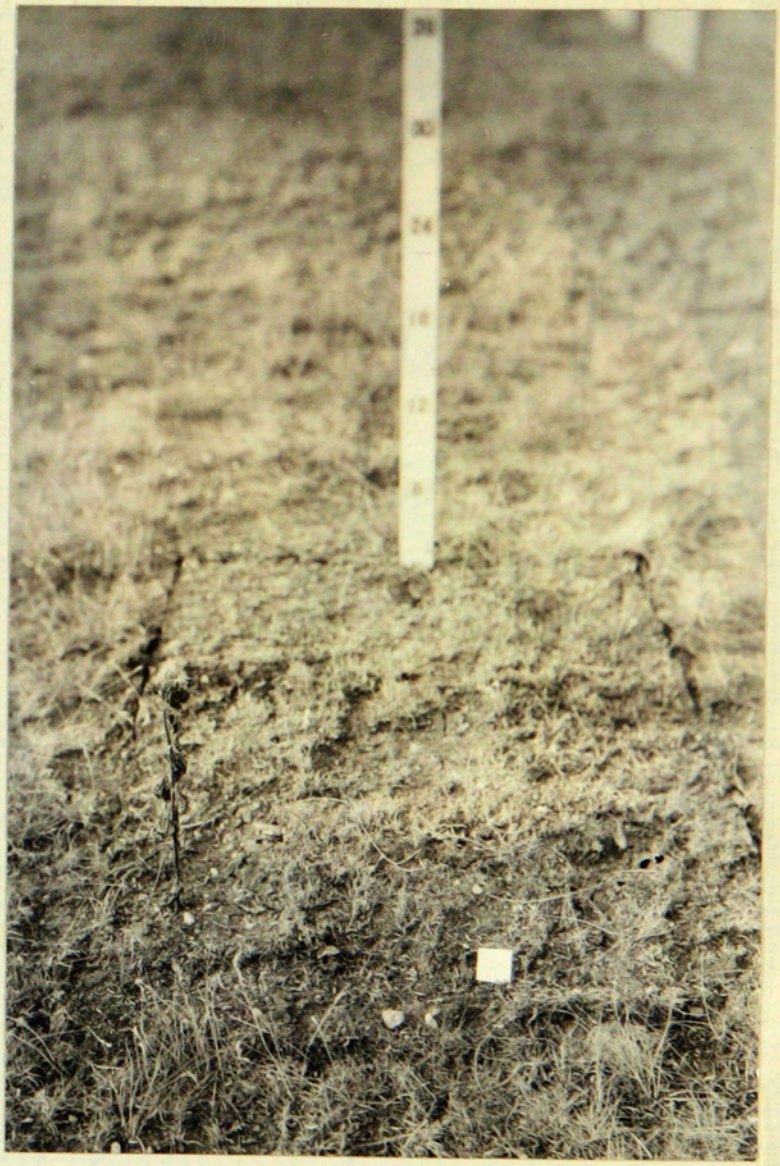


Plate No. XI Showing quadrat No. 11



After ninety days of utilization by thirty Dissosteira longipennis, Thos., introduced into the cage during the third and fourth instars, and allowed to grow to maturity.

Fig. 6 Showing utilization for quadrat No. 12 by thirty Dissosteira longipennis, Thos.

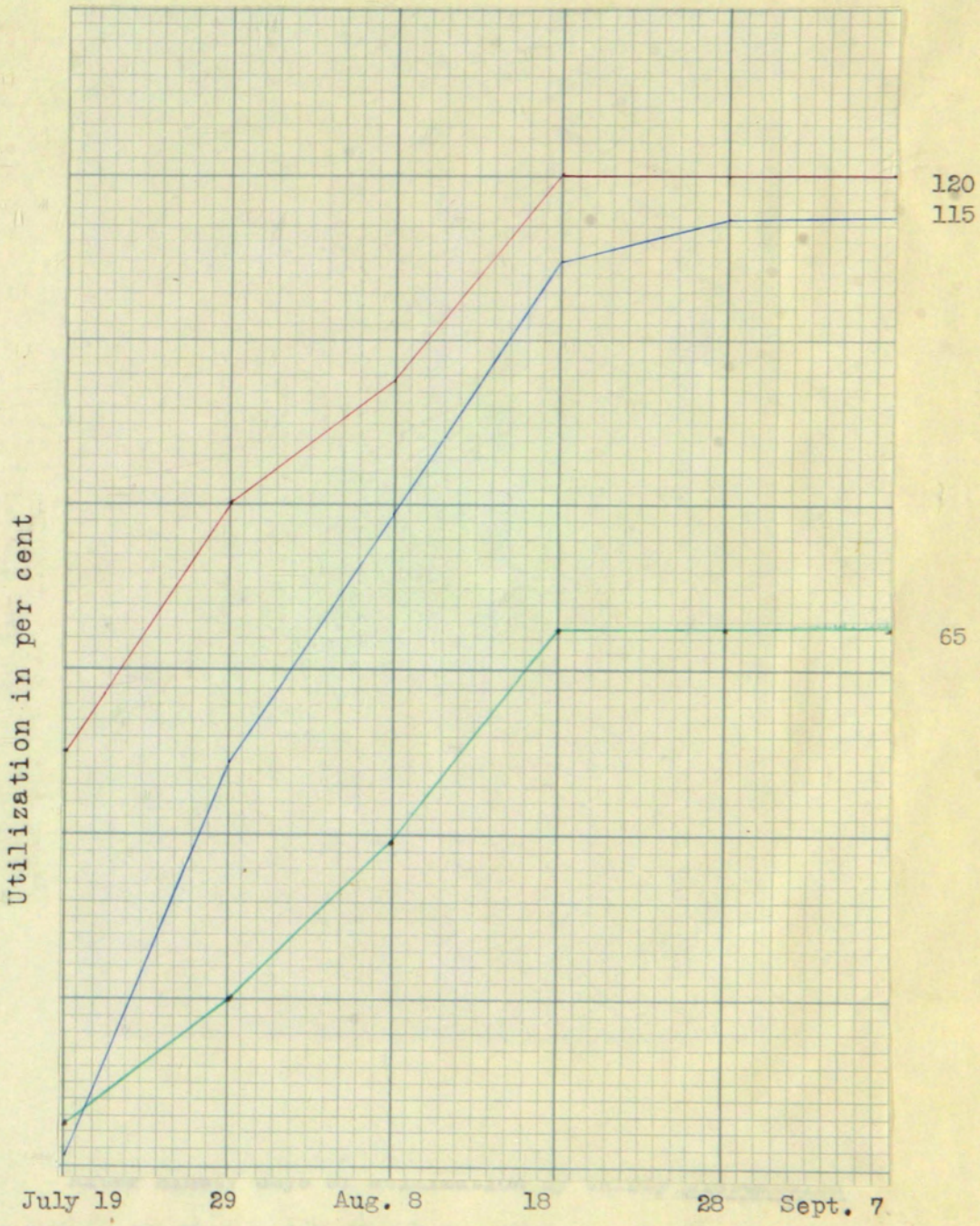
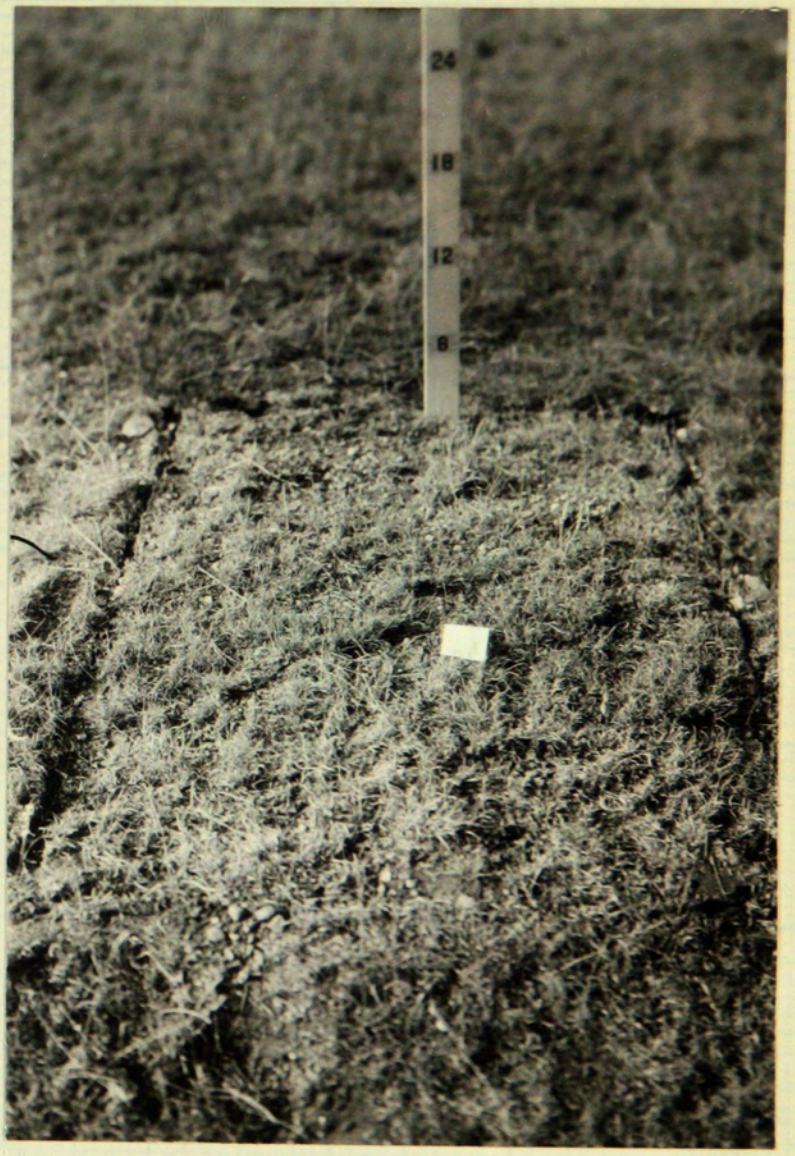


Plate No. XII SShowing quadrat No. 12



After ninety days of utilization by thirty Dissosteira longipennis, Thos., introduced into the cage during the third and fourth instars, and allowed to grow to maturity.

Fig. 7 Showing utilization for quadrat No. 13 by thirty *Dissosteira longipennis*, Thos.

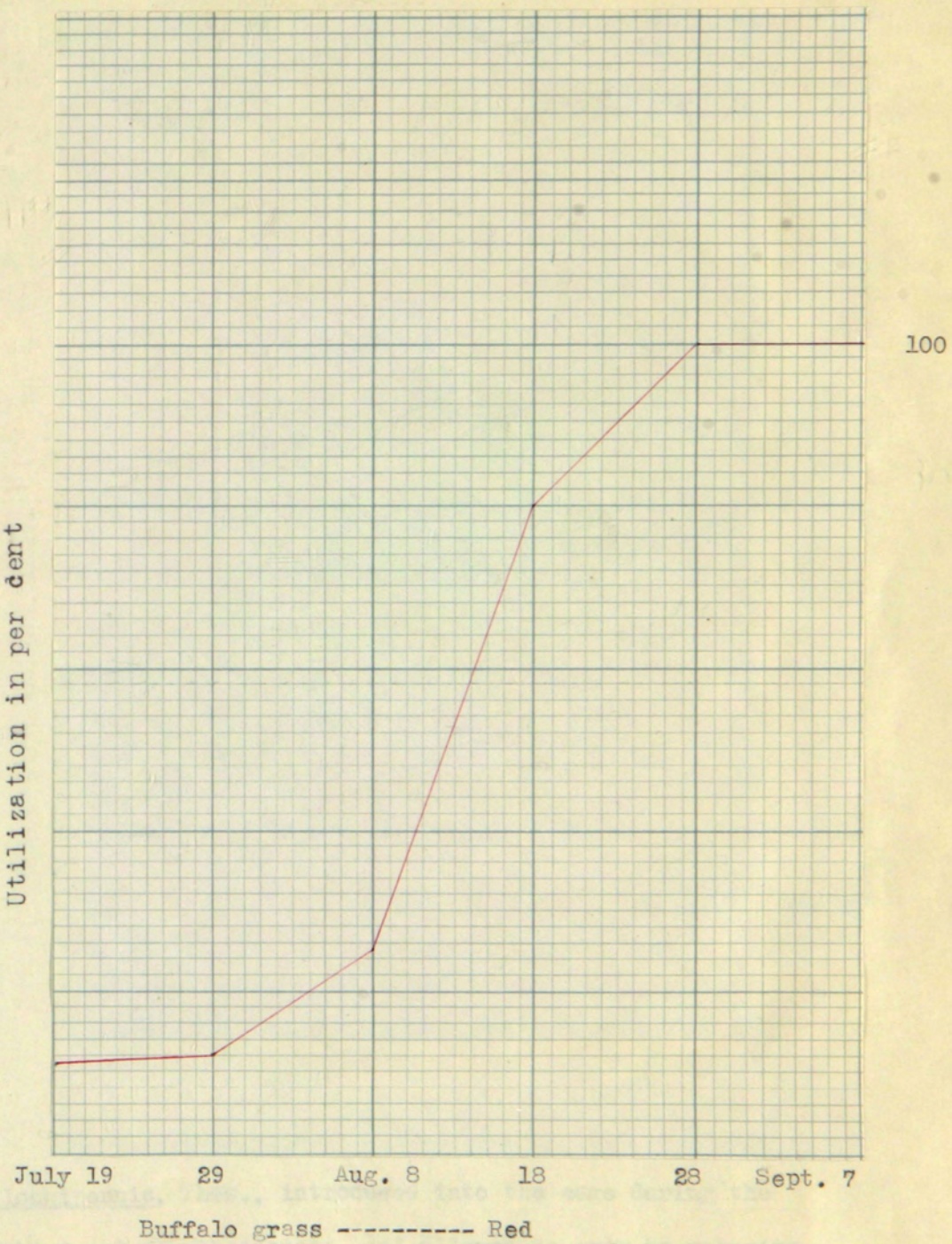


Plate No. XIII Showing quadrat No. 13

After ninety days of utilization by thirty Dissosteira longipennis, Thos., introduced into the cage during the third and fourth instars, and allowed to grow to maturity.

Fig. 8 Showing utilization for quadrat No. 14 by forty Dissosteira longipennis, Thos.

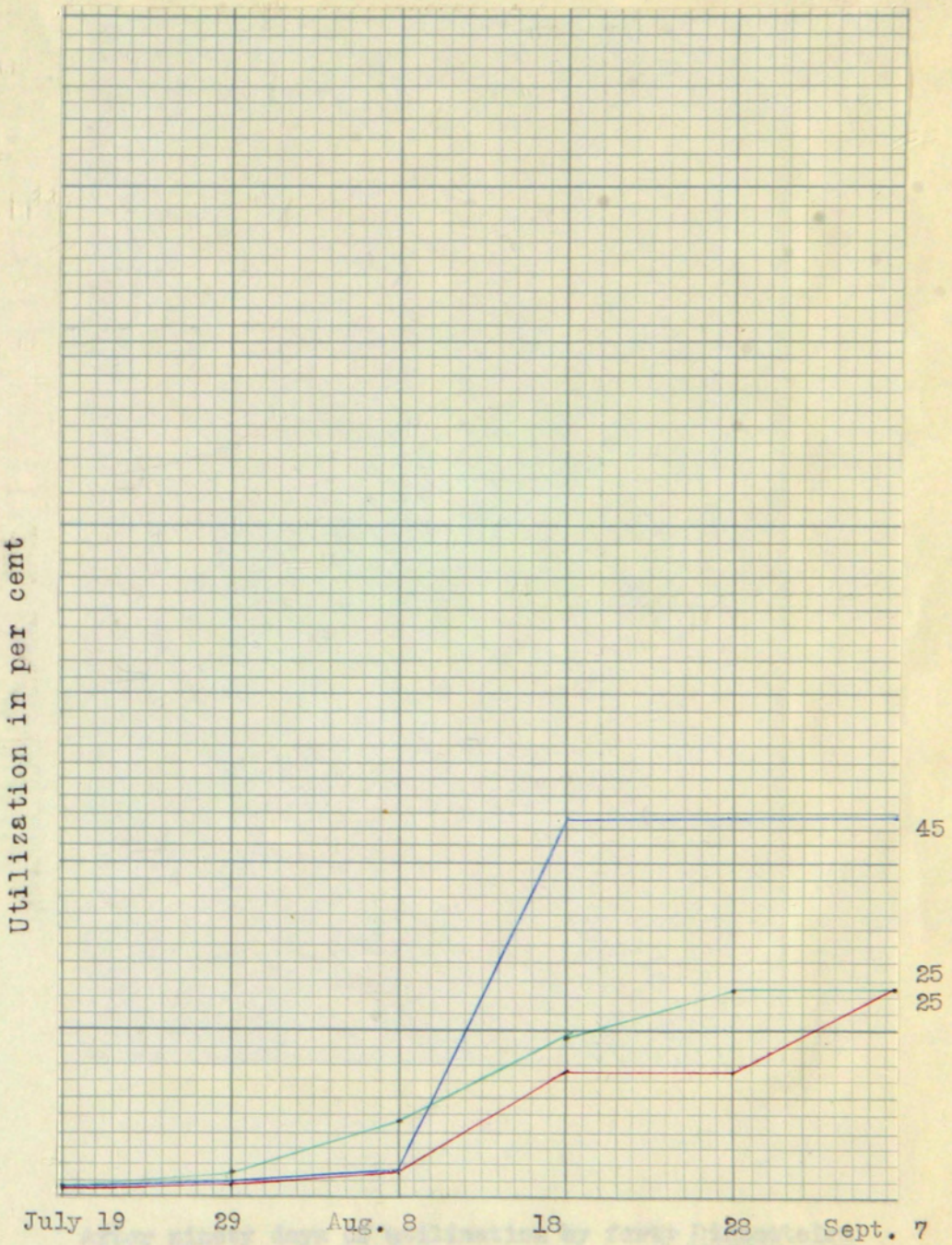
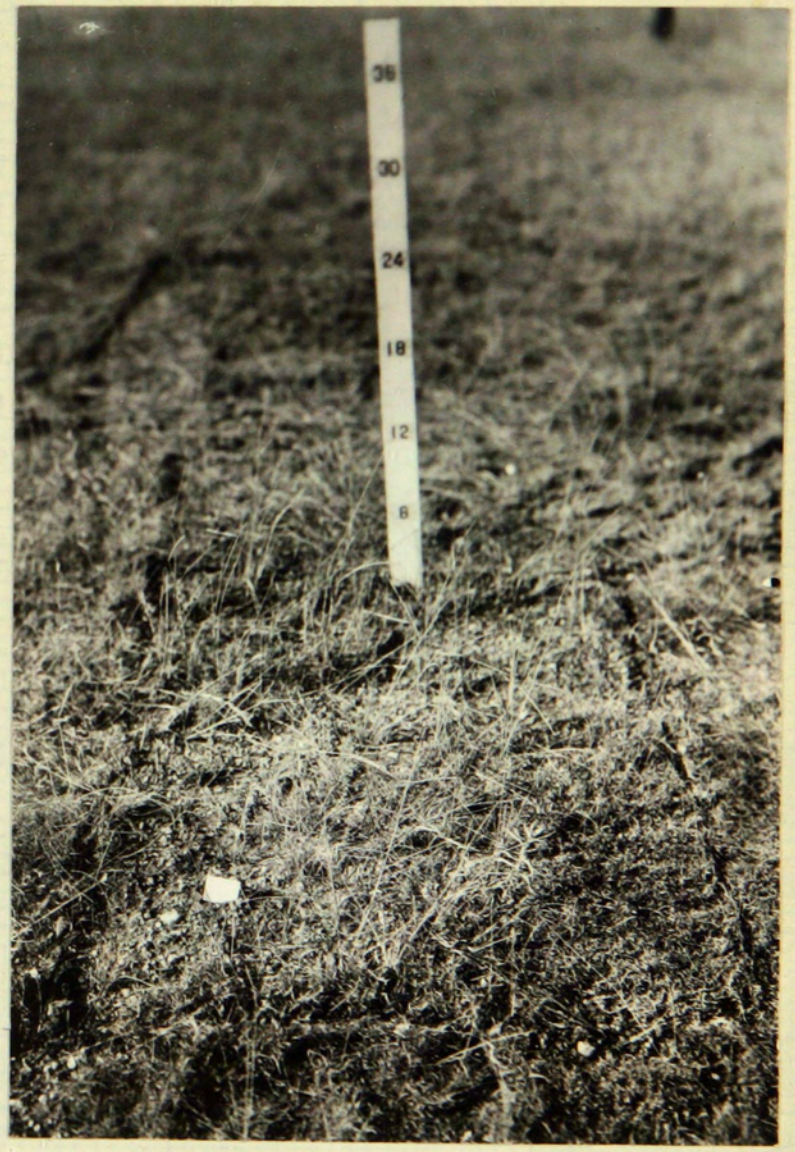
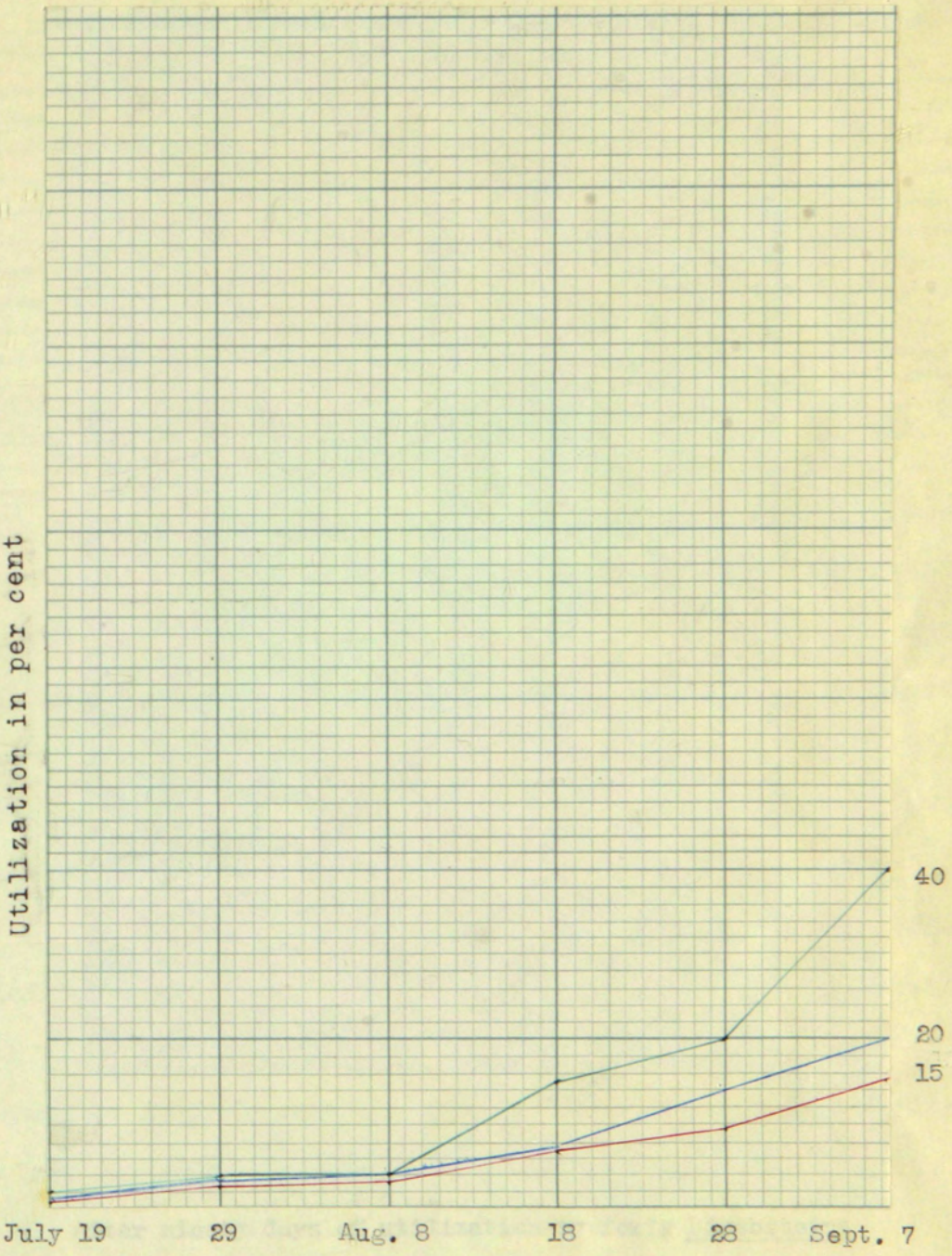


Plate No. XIV Showing quadrat No. 14



After ninety days of utilization by forty Dissosteira longipennis, Thos., introduced into the cage during the first instar, and allowed to grow to maturity.

Fig. 9 Showing utilization for quadrat No. 15 by forty *Dissosteira longipennis*, Thos.



Buffalo grass ---------- Red
Blue gramma grass ------ Blue
Western wheat grass ---- Green

Plate No. XV Showing quadrat No. 16

After ninety days of utilization by forty Dissosteira longipennis, Thos., introduced into the cage during the first instar, and allowed to grow to maturity.

Table 8: Total utilization of important native grasses by *Dissosteira longipennis*, Thos.

Quadrat No.	Buffalo Grass	Blue Gamma Grass	Western Wheat Grass
7	70.20%	74.25%	64.25%
8	0	115.	115.
9	115.	115.	30.
10	65.	65.	0
11	0	100.	10.
12	120.	115.	65.
13	100.	0	115.
14	25.	45.	25.
15	15.	20.	40.
Totals	519.30%	649.25%	464.35%
Averages	74.2 %	81.15%	58.4 %

The density of the respective plots apparently has little effect upon the amount or character of utilization. Plot No. 9 had a density of .05 next to the lowest density (.04) in all thirty of the plots, and was utilized an average of eighty-eight per cent, while plot No. 7 had the highest density of .17 with an average utilization of only 72.6 per cent.

The same situation prevailed with respect to utilization of weeds. Where the density of weeds was relatively high, the utilization, on an average, was no higher than for utilization of weeds in plots where the densities for weeds was relatively low. In fact the utilization of weeds never exceeded more than one per cent in any of the plots at any time.

The period of greatest utilization came between July 20 to August 10.

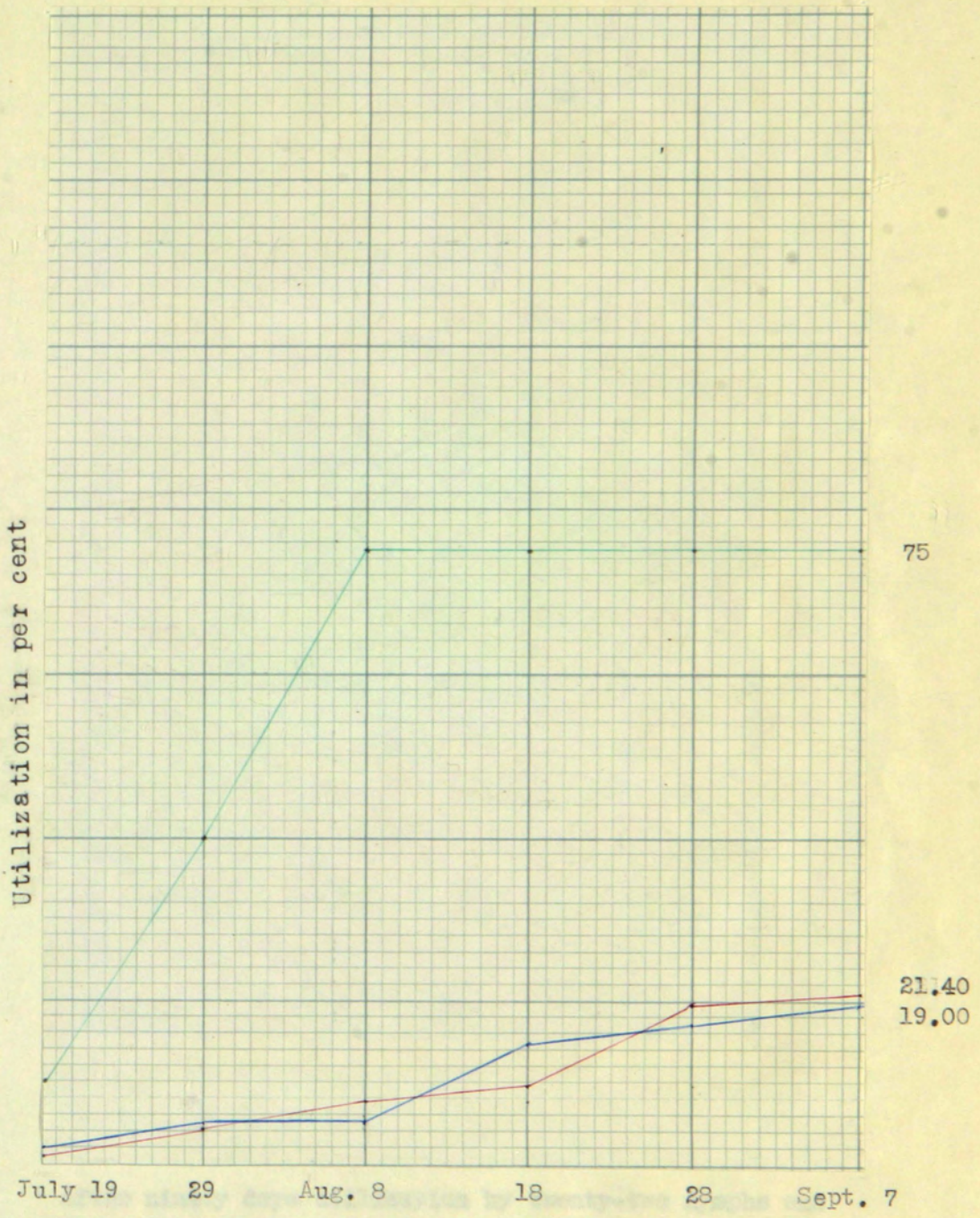
The quadrats represented in the following table were set up to assist in calculating the damage to range land caused by the feeding of grasshoppers consisting of nineteen species of the native variety.

Table 9: Table giving the plot density, percentage of species of grass and weeds, together with the grass species densities in the experiment with the native species of range land grasshoppers.

Plot No.	Total Plot Density	Grass Species %				Grass species Density			
		Bd	Bg	As	Weeds	Bd	Bg	As	Weeds
16	.11	98	T	T	T	.1078	T	T	T
17	.09	70	3	6	21	.0630	.0027	.0054	.0189
18	.11	2	93	1	4	.0022	.1023	.0022	.0044
19	.09	94	3	0	3	.0846	.0027	0	.0027
20	.04	70	3	15	12	.0280	.0012	.0020	.0048
21	.10	0	92	1	7	0	.0920	.0010	.0070
22	.09	95	0	T	4	.0855	0	T	.0036
23	.07	25	10	45	20	.0175	.0070	.0315	.0140
24	.12	T	93	4	2	T	.1116	.0048	.0024
25	.11	97	0	0	3	.0067	0	0	.0033
26	.07	65	5	15	15	.0455	.0035	.0105	.0105
27	.13	0	90	2	3	0	.1170	.0026	.0104
28	.12	97	0	0	3	.1064	0	0	.0036
29	.09	35	45	10	10	.0315	.0405	.0090	.0090
30	.10	0	91	4	5	0	.0910	.0040	.0050

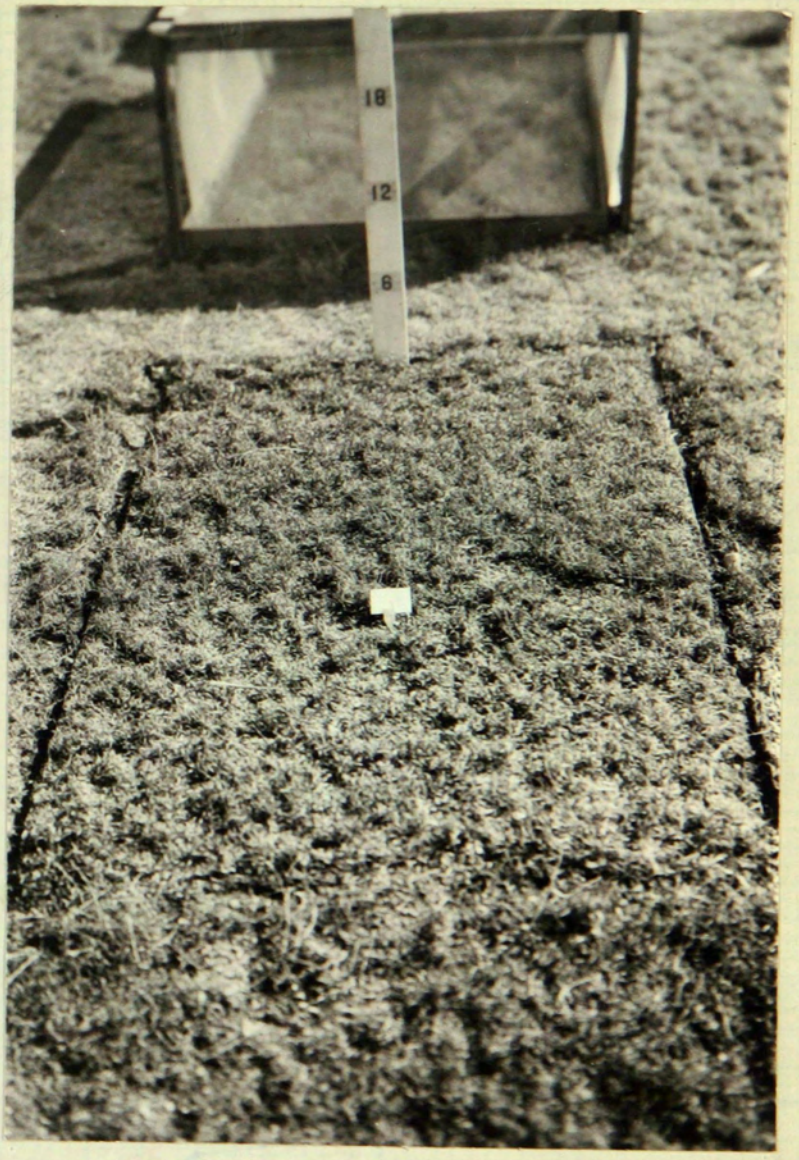
In these fifteen quadrats, the population was kept at twenty-two individuals which was the general average outside the quadrats; consequently, for the duration of the experiment, this number was maintained in the quadrats. They were introduced in the second and third instars and allowed to grow to maturity. The following charts show the utilization graphically; each graph is accompanied by a picture with the explanation following the last picture of the entire group.

Fig. 10 Showing utilization for quadrat No. 16 by twenty-two nymphs of native range land forms.



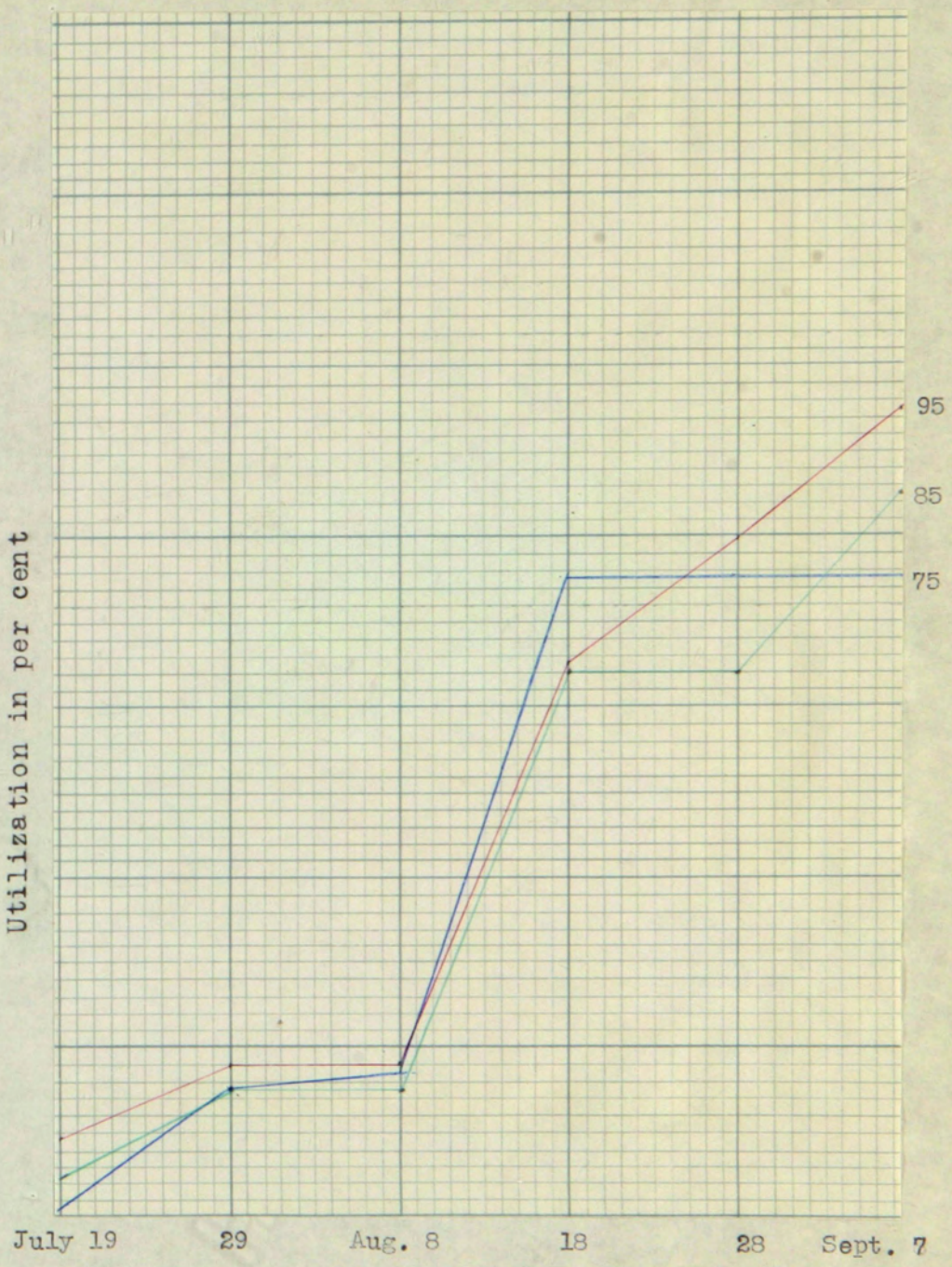
Buffalo grass ---------- Red
Blue gramma grass ------ Blue
Western wheat grass ---- Green

Plate No. XVI Showing quadrat No 16



After ninety days utilization by twenty-two nymphs and adults, introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 11 Showing utilization for quadrat No. 17 by twenty-two nymphs of native range land forms.



Buffalo grass ---------- Red
Blue gramma grass ------ Blue
Western wheat grass ---- Green

Plate No. XVII Showing quadrat No. 17

After ninety days utilization by twenty-two nymphs and adults, introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 12 Showing utilization for quadrat No. 18 by twenty-two nymphs of native range land forms.

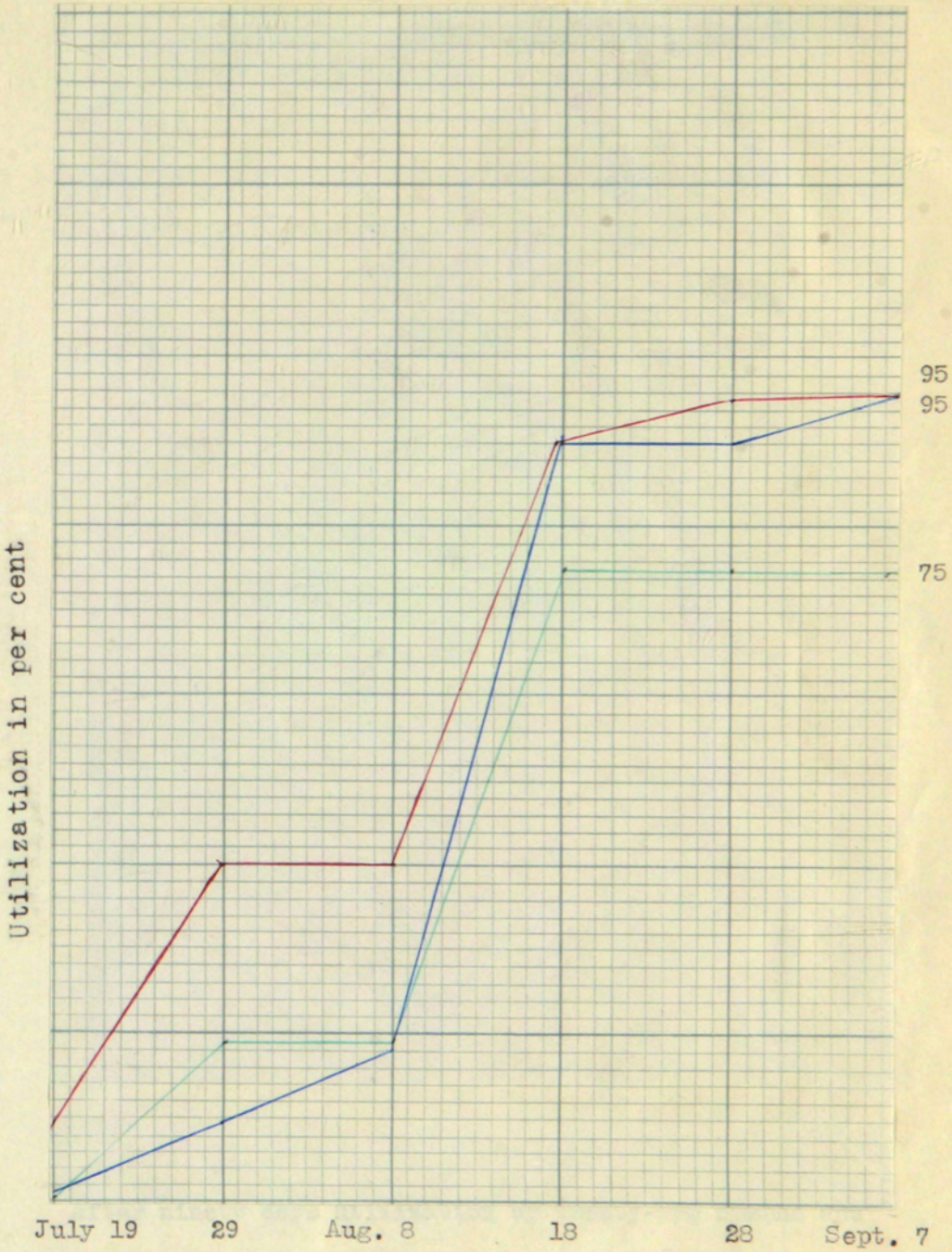


Plate No. XVIII Showing quadrat No. 18

After ninety days utilization by twenty-two nymphs and adults, introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 13 Showing utilization for quadrat No. 19 by twenty-two nymphs of native range land forms.

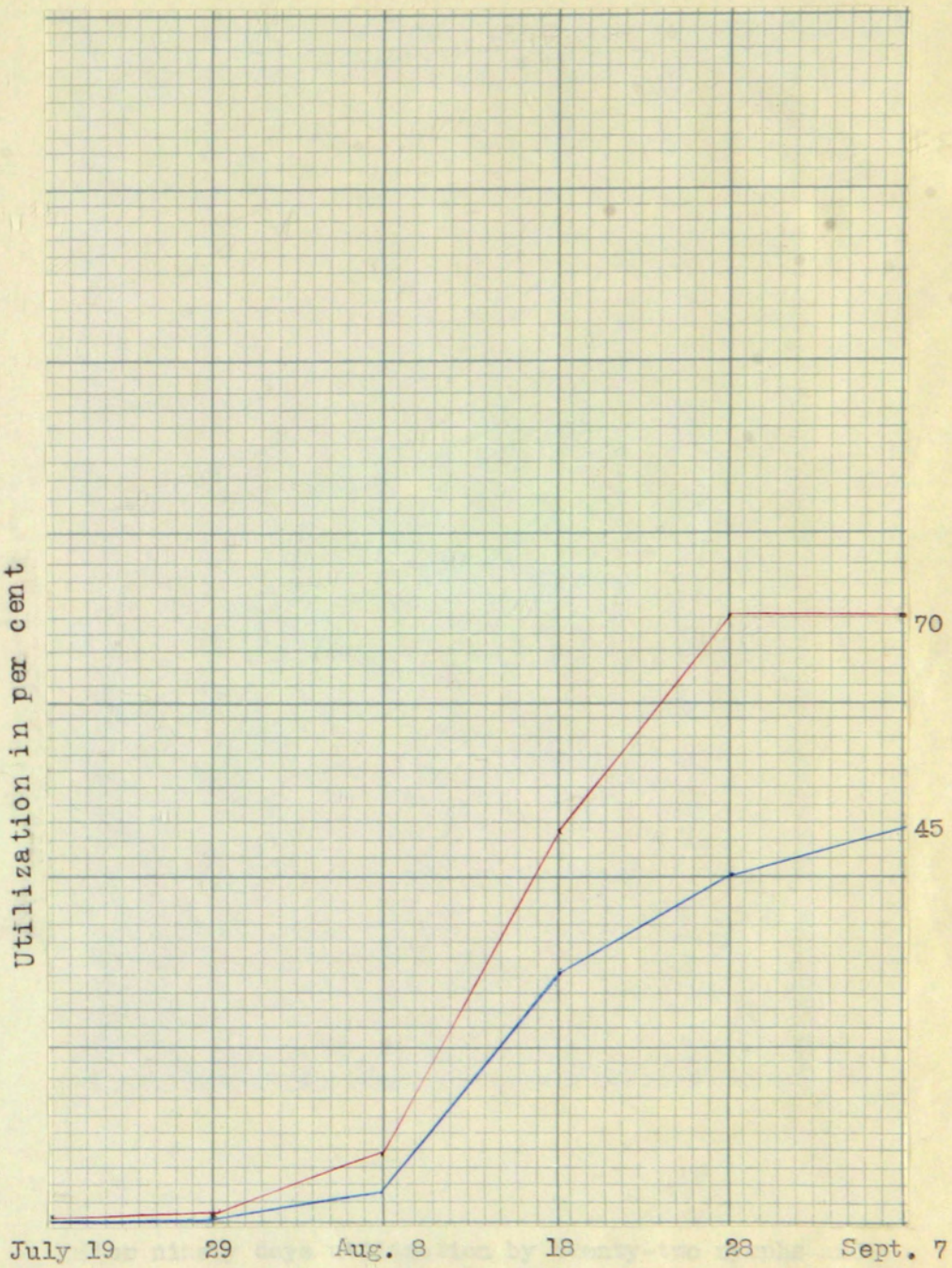
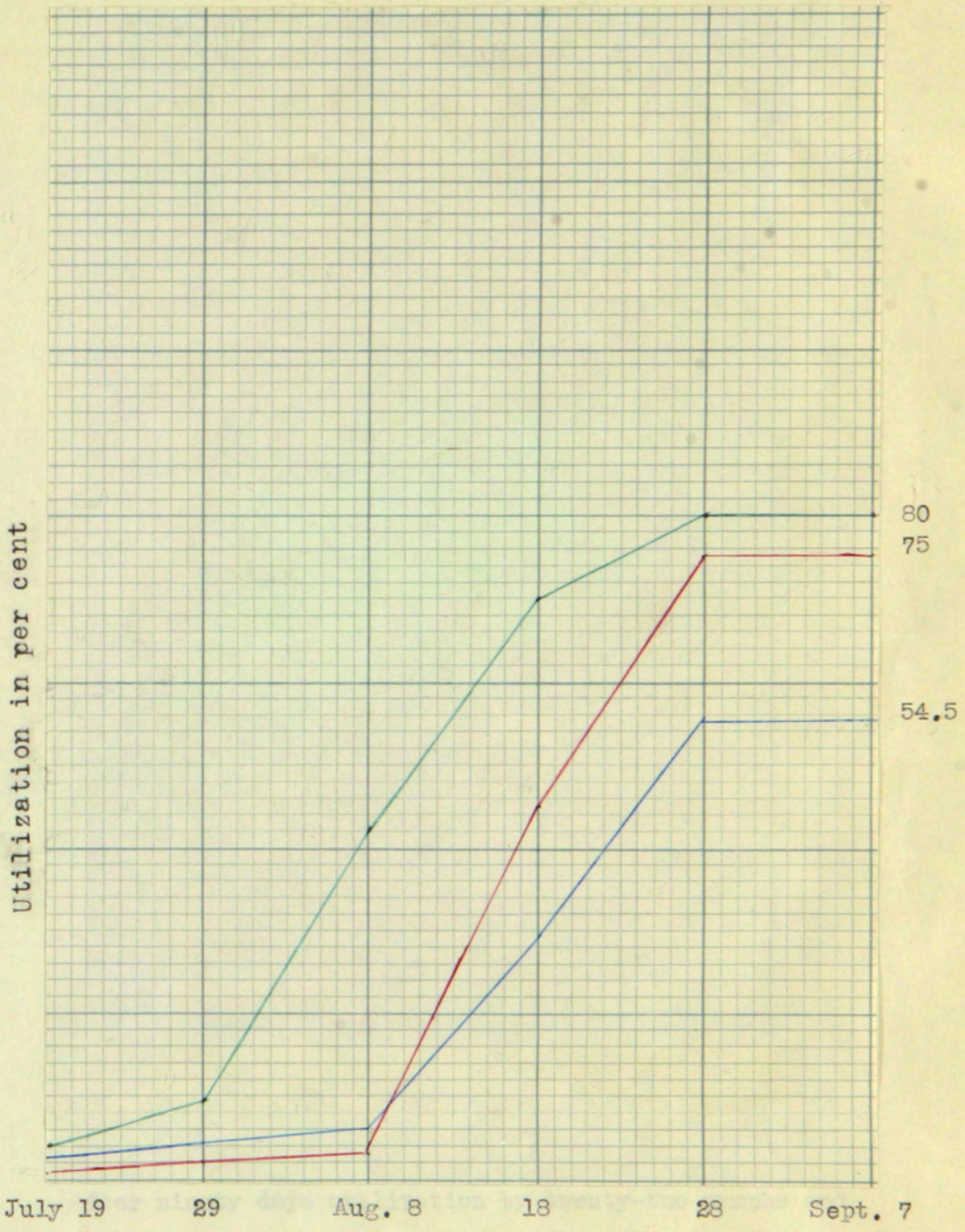


Plate No. XIX Showing quadrat No. 19

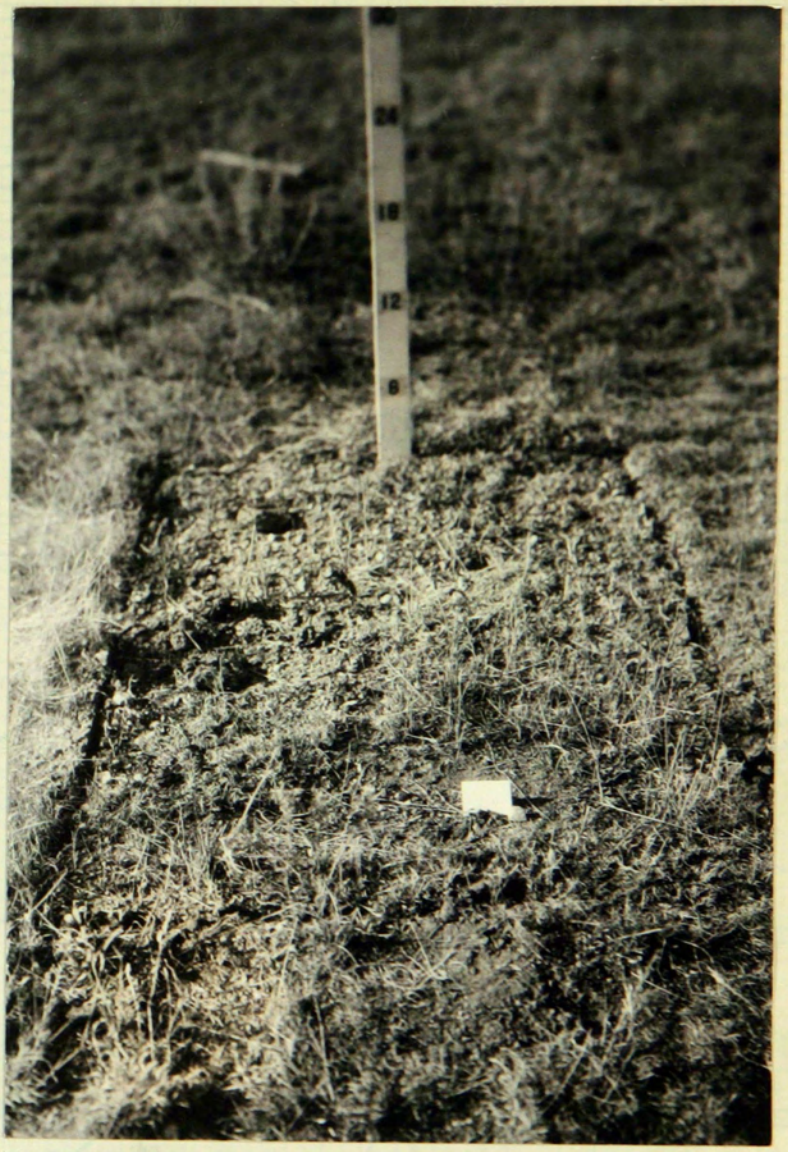
After ninety days utilization by twenty-two nymphs and adults, introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 14 Showing utilization for quadrat No. 20 by twenty-two nymphs of native range land forms.



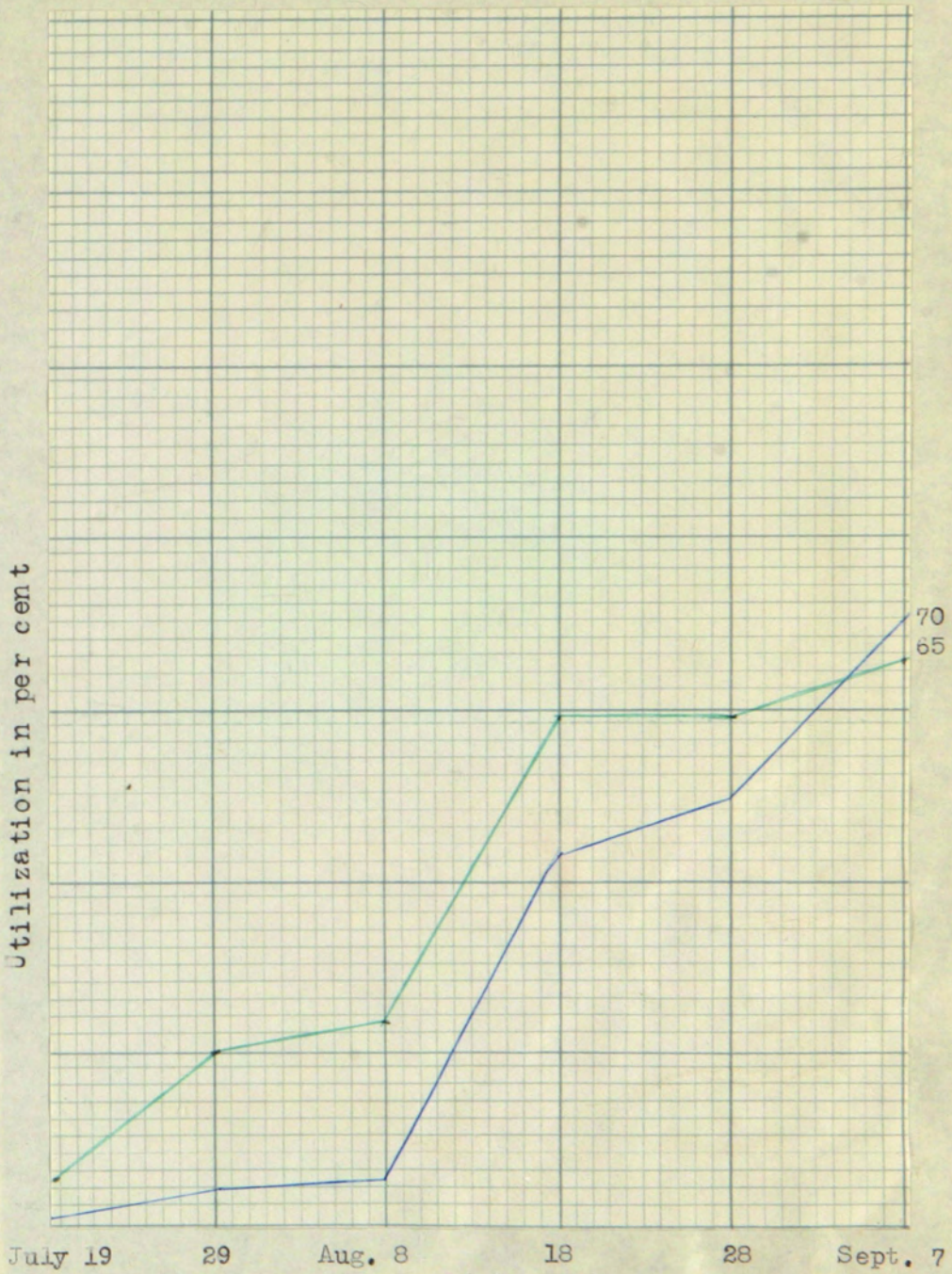
Buffalo grass ---------- Red
Blue gramma grass ------ Blue
Western wheat grass ---- Green

Plate No. XX Showing quadrat No. 20



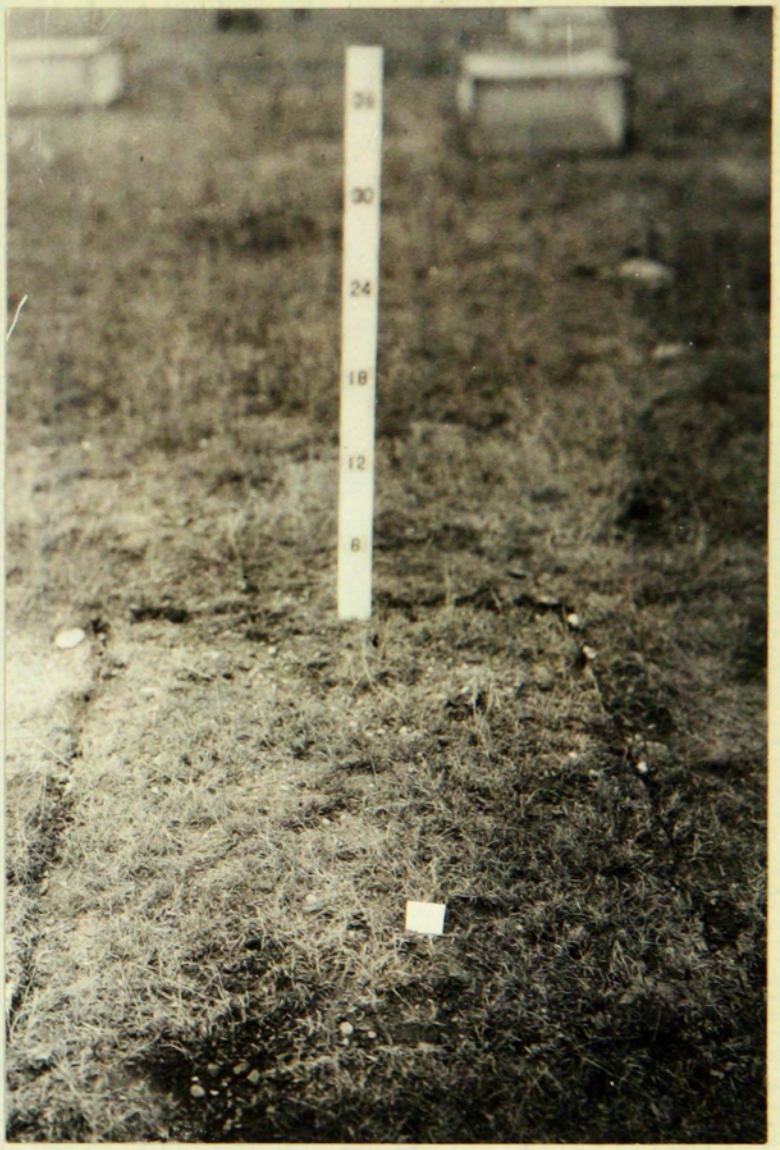
After ninety days utilization by twenty-two nymphs and adults introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 15 Showing utilization for quadrat No. 21 by twenty-two nymphs of native range land forms.



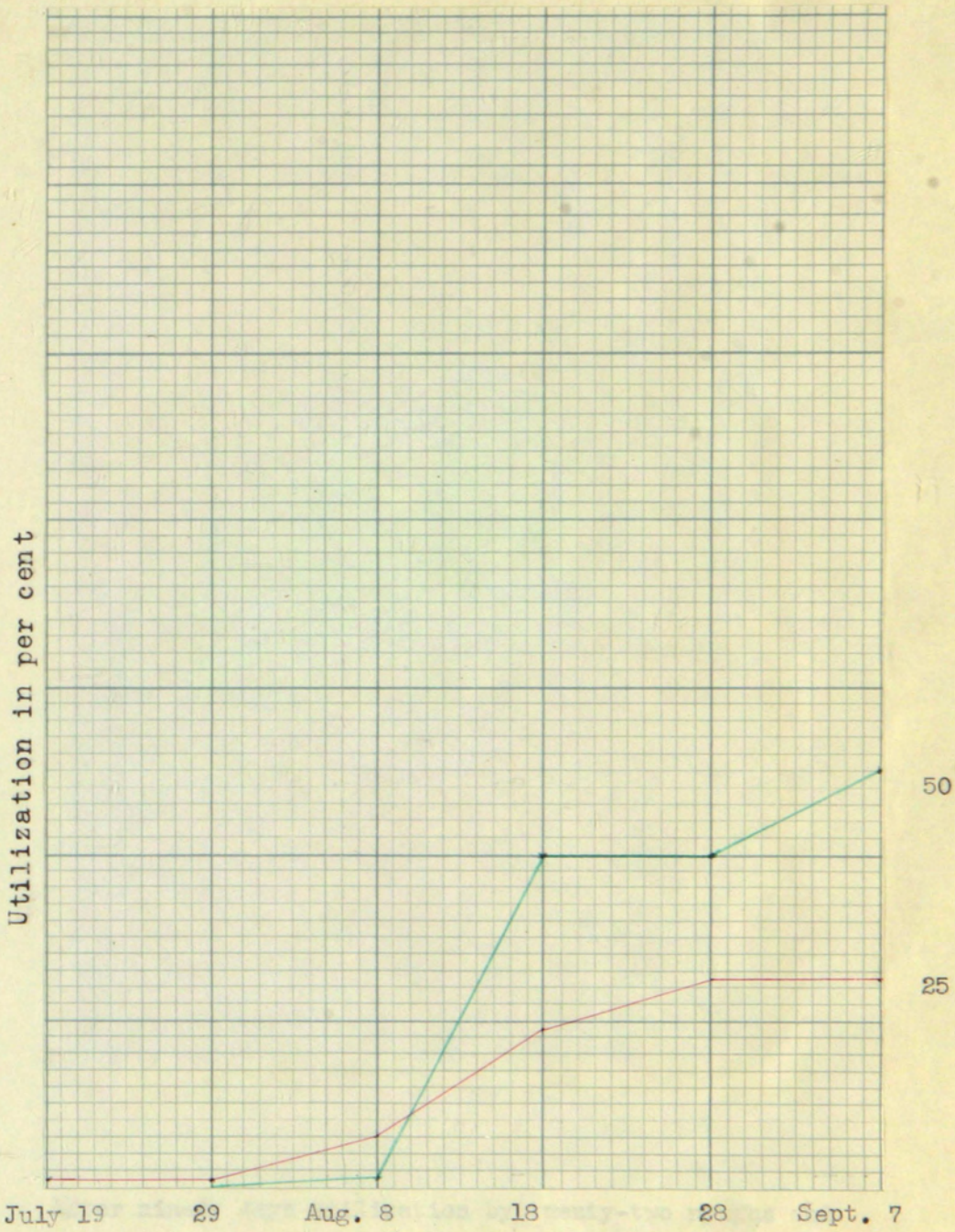
Blue gramma grass ------ Blue
Western wheat grass ---- Green

Plate No. XXI Showing quadrat No. 21



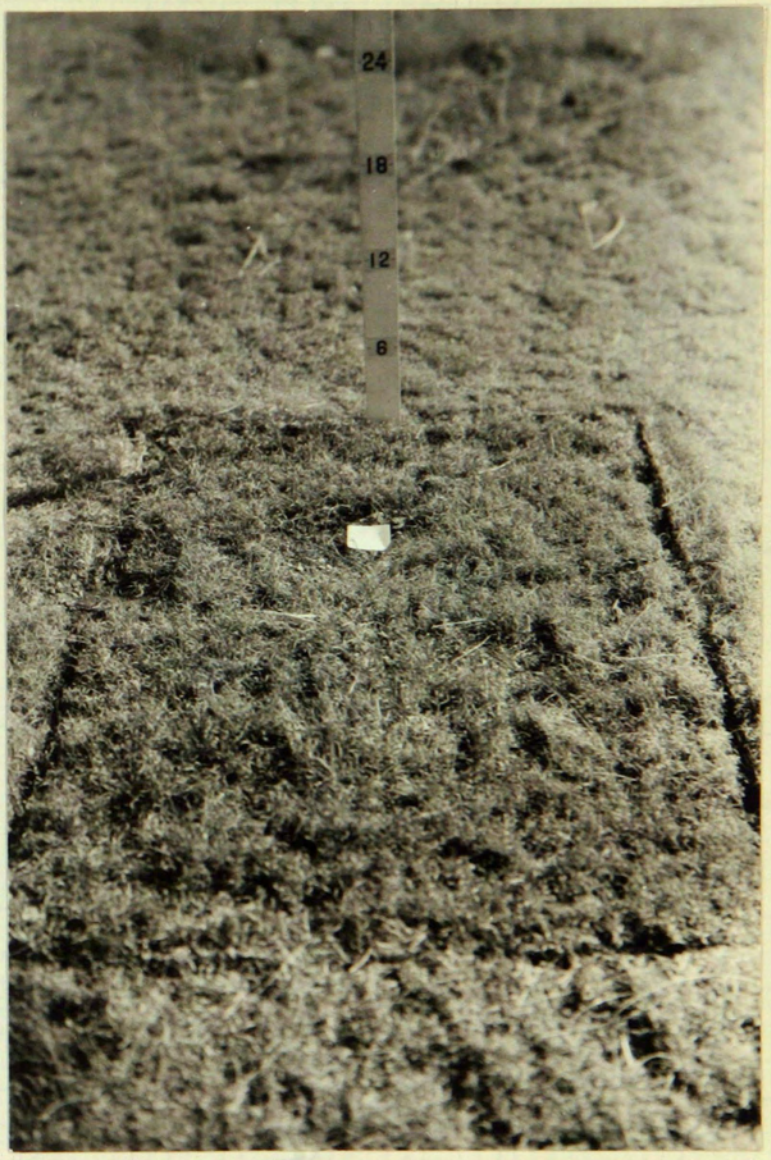
After ninety days utilization by twenty-two nymphs and adults introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 16 Showing utilization for quadrat No. 22 by twenty-two nymphs of native range land forms.



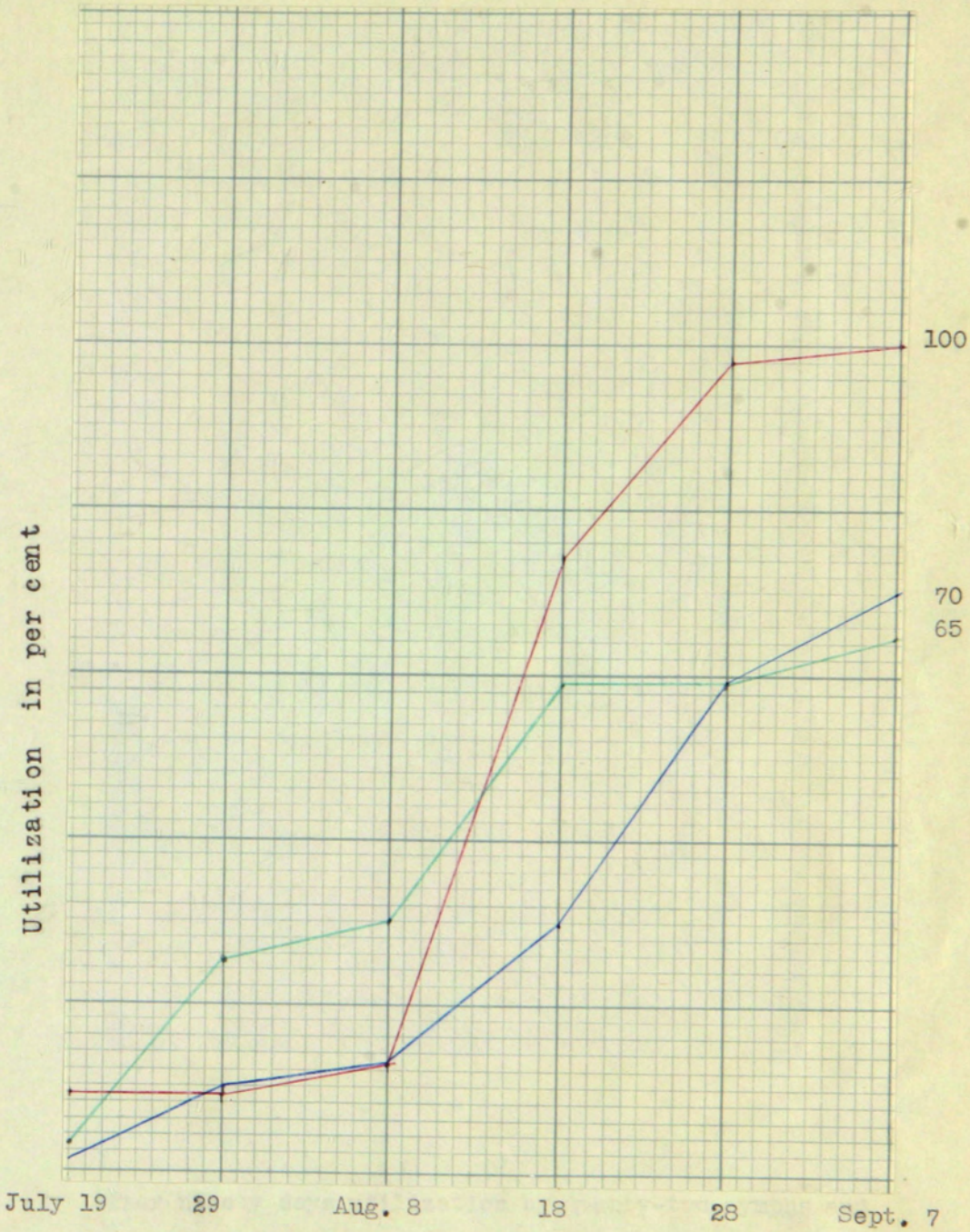
Buffalo grass ---------- Red
Western wheat grass ---- Green

Plate No. XXII Showing quadrat No. 22



After ninety days utilization by twenty-two nymphs and adults introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 17 Showing utilization for quadrat No. 23 by twenty-two nymphs of native range land forms.



Buffalo grass ---------- Red
Blue gramma grass ------ Blue
Western wheat grass ---- Green

Plate No. XXIII Showing quadrat No. 23

After ninety days utilization by twenty-two nymphs and adults, introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 18 Showing utilization for quadrat No. 24 by twenty-two nymphs of native range land forms.

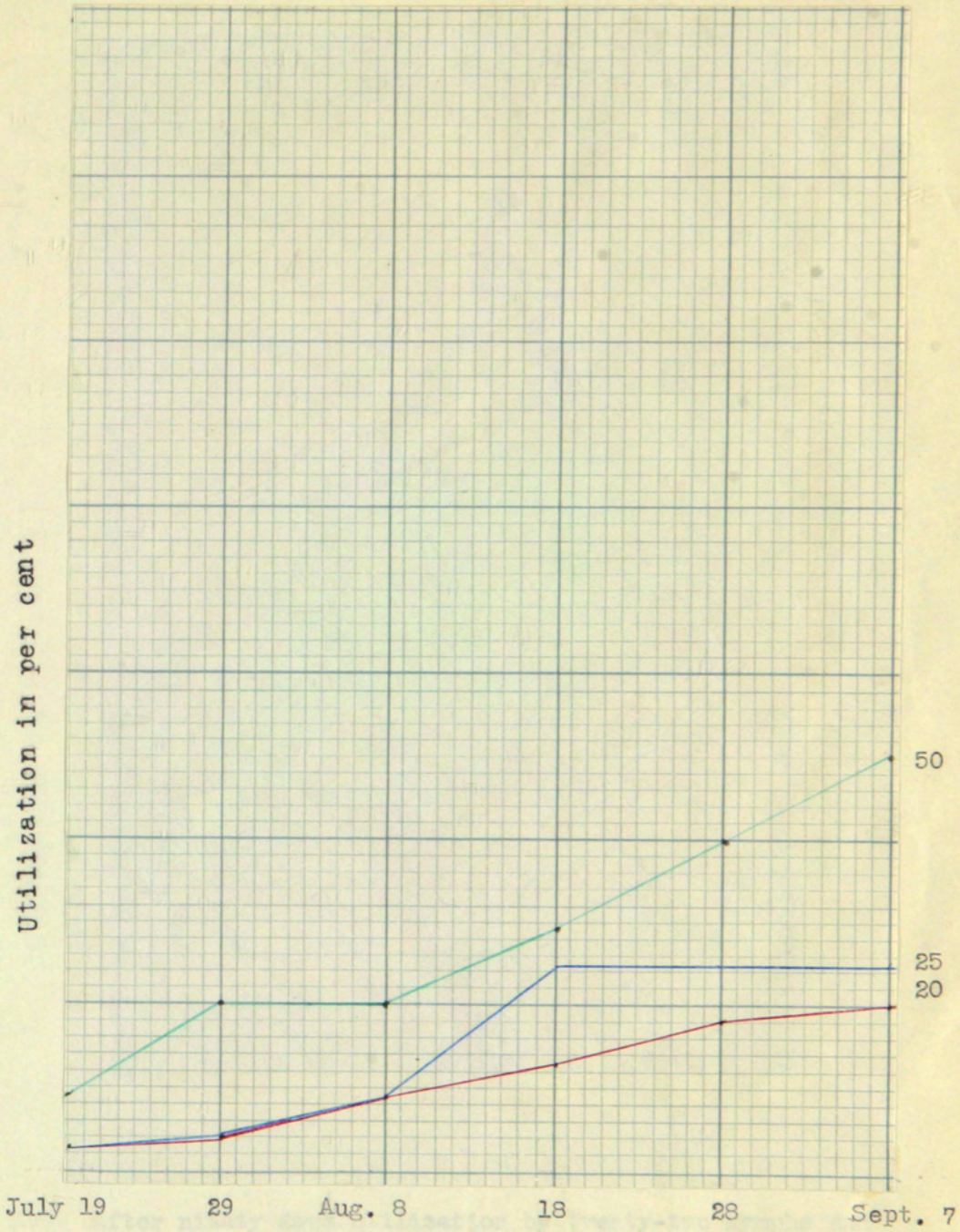


Plate No. XXIV Showing quadrat No. 24

After ninety days utilization by twenty-two nymphs and adults, introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 19 Showing utilization for quadrat No. 25 by twenty-two nymphs of native range land forms.

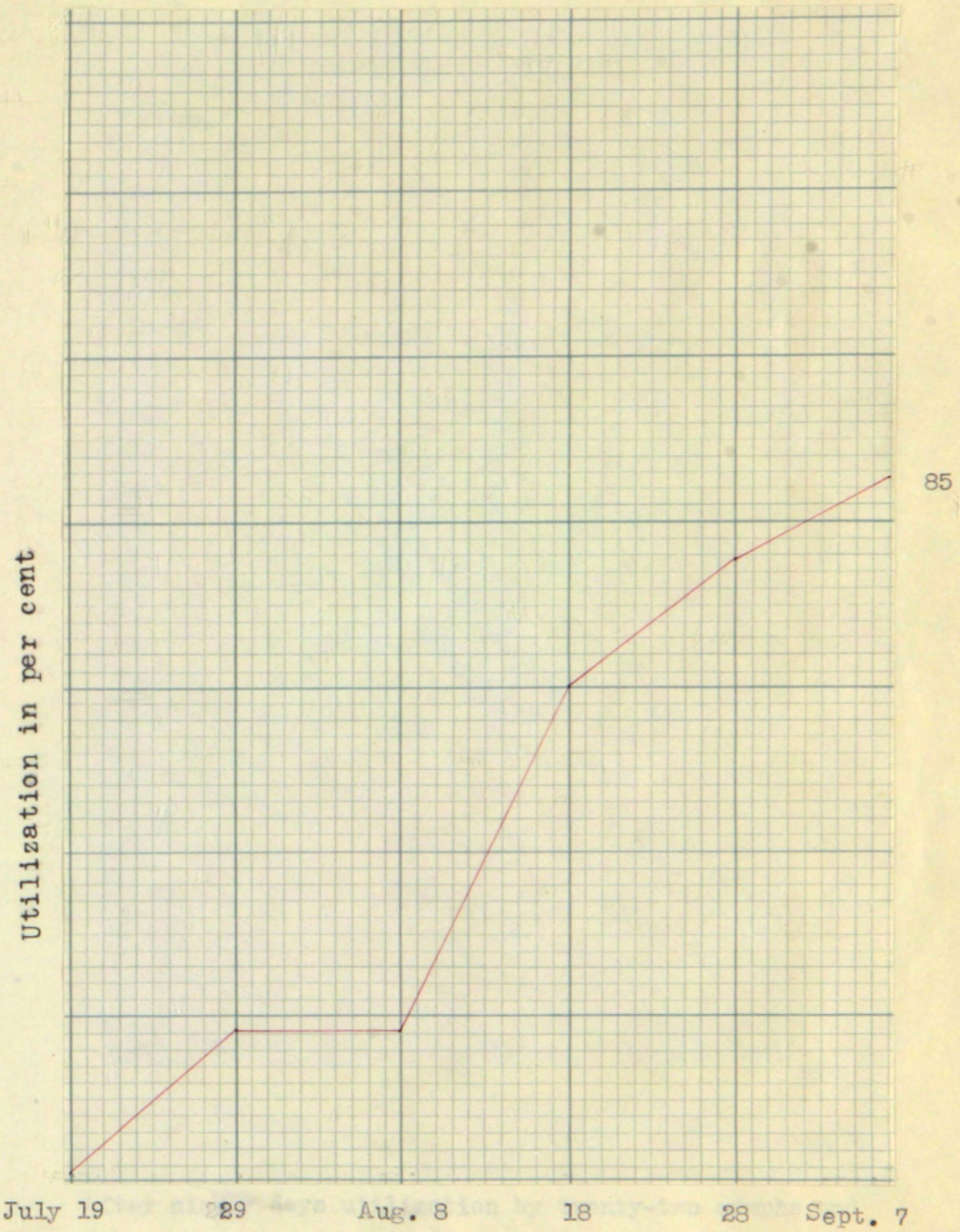
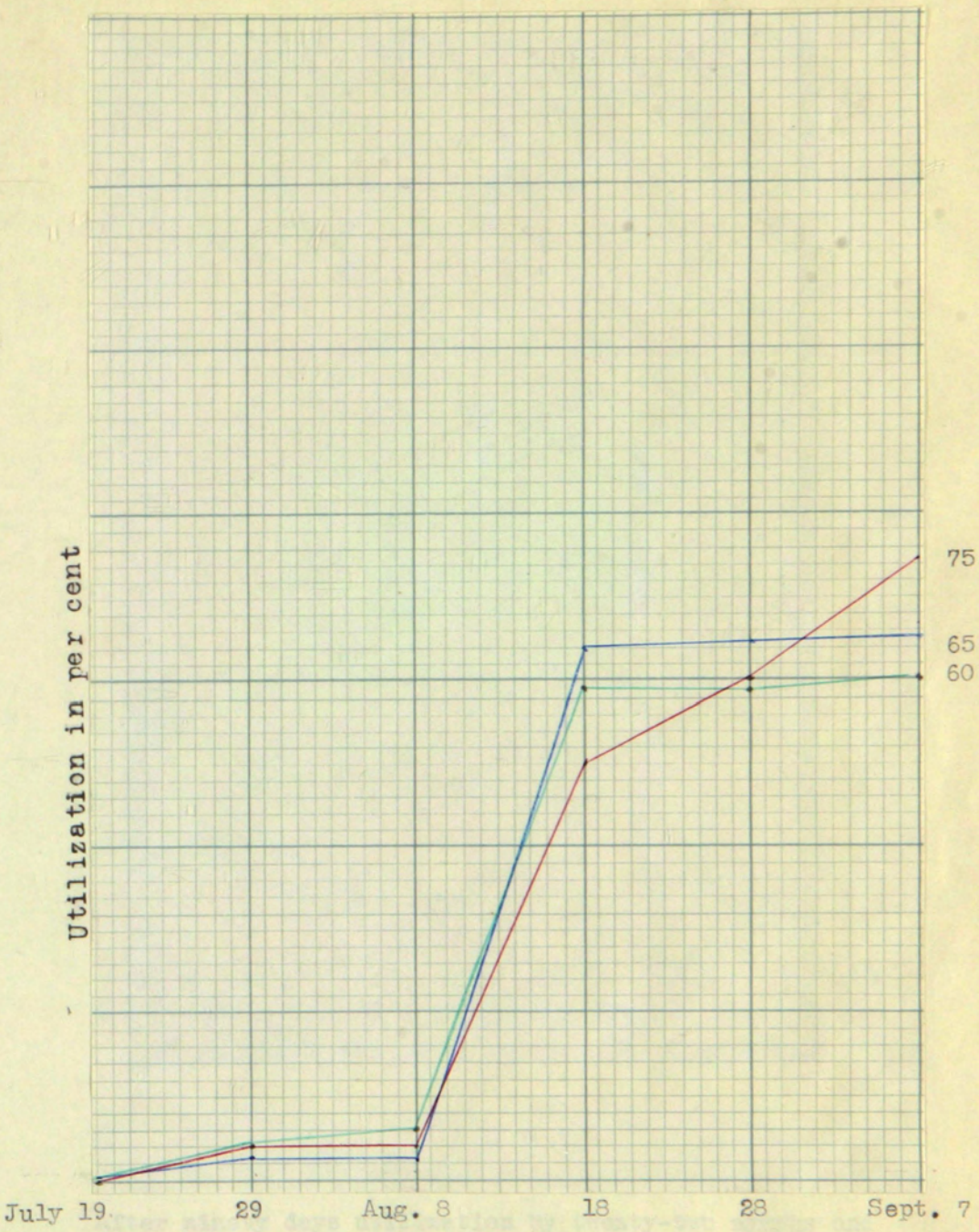


Plate No. XXV Showing quadrat No. 25

After ninety days utilization by twenty-two nymphs and adults, introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 20 Showing utilization for quadrat No. 26 by twenty-two nymphs of native range land forms.

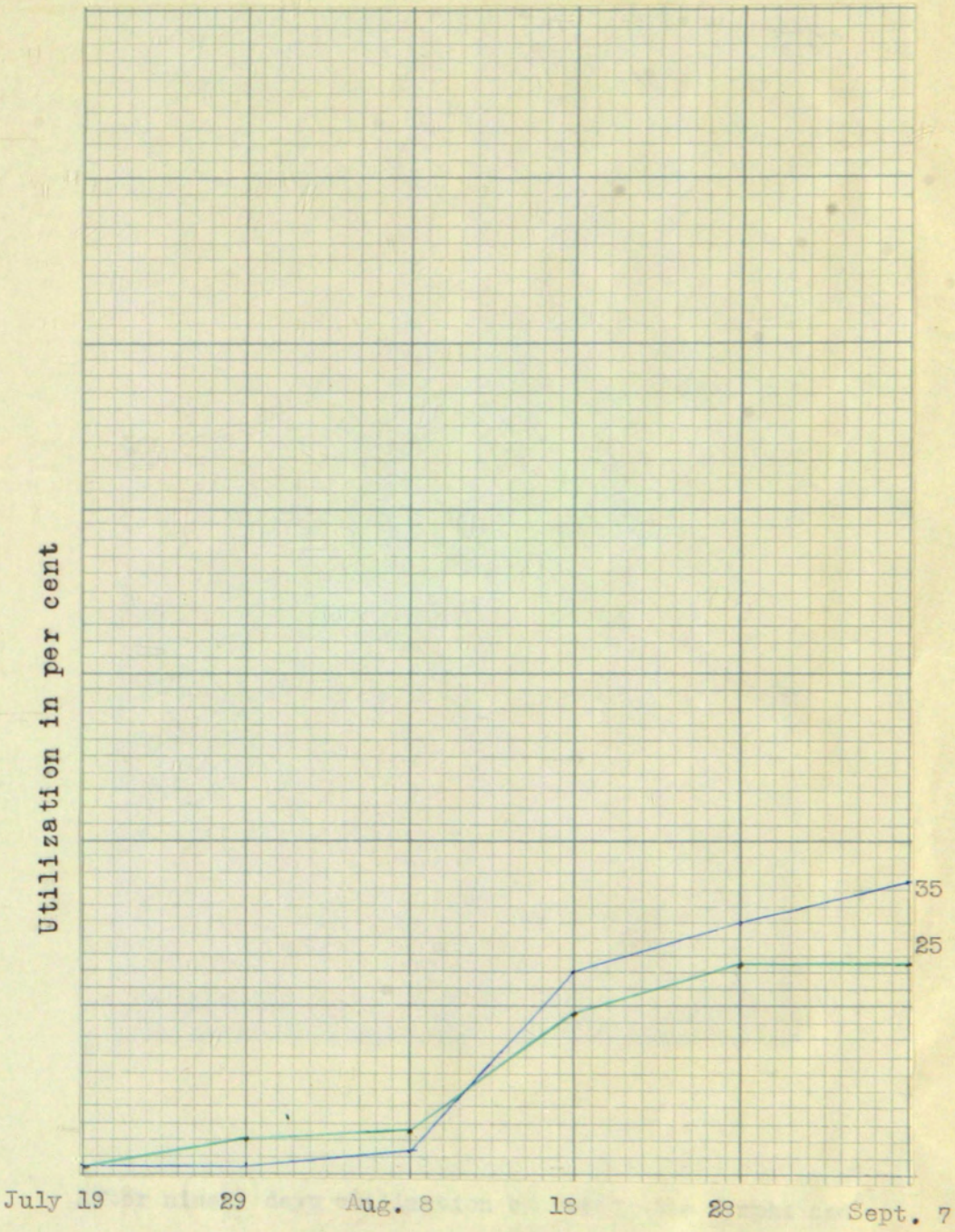


Buffalo grass ---------- Red
Blue gramma grass ------ Blue
Western wheat grass ---- Green

Plate No. XXVI Showing quadrat No. 26

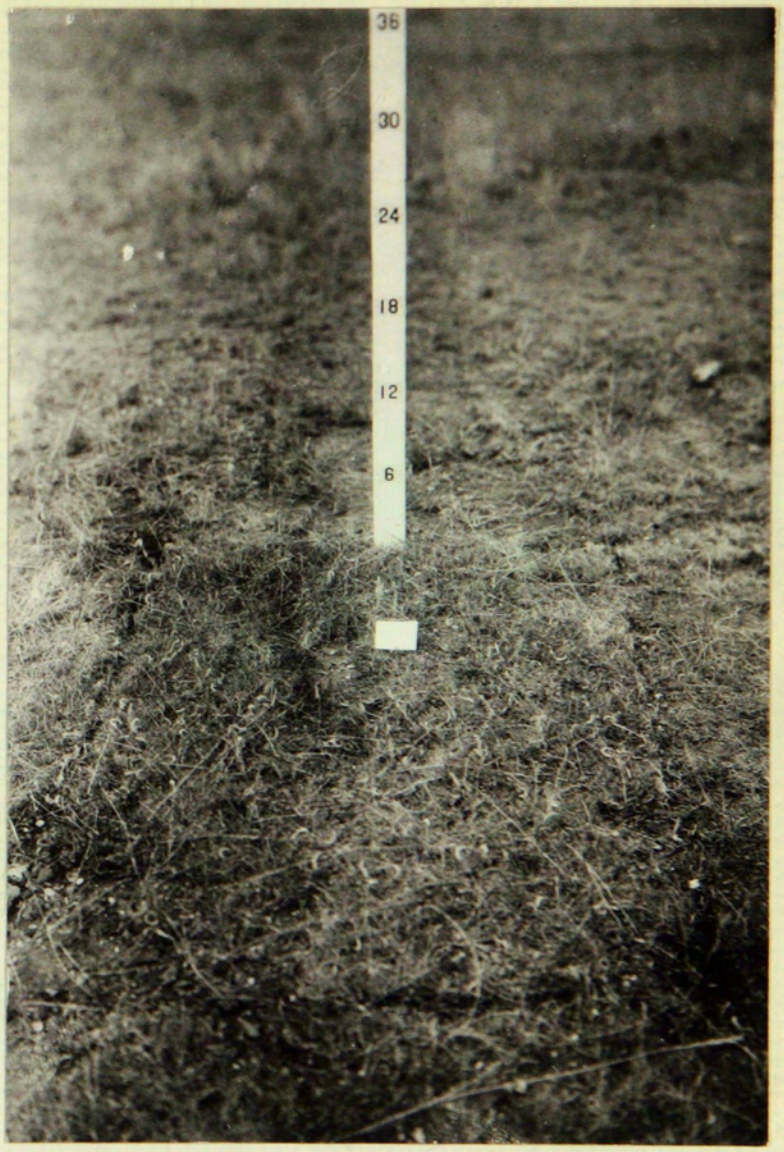
After ninety days utilization by twenty-two nymphs and adults, introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 21 Showing utilization for quadrat No. 27 by twenty-two nymphs of native range land forms.



Blue gramma grass ------ Blue
Western wheat grass ---- Green

Plate No. XXVII Showing quadrat No. 27



After ninety days utilization by twenty-two nymphs and adults, introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 22 Showing utilization for quadrat No. 28 by twenty-two nymphs of native range land forms.

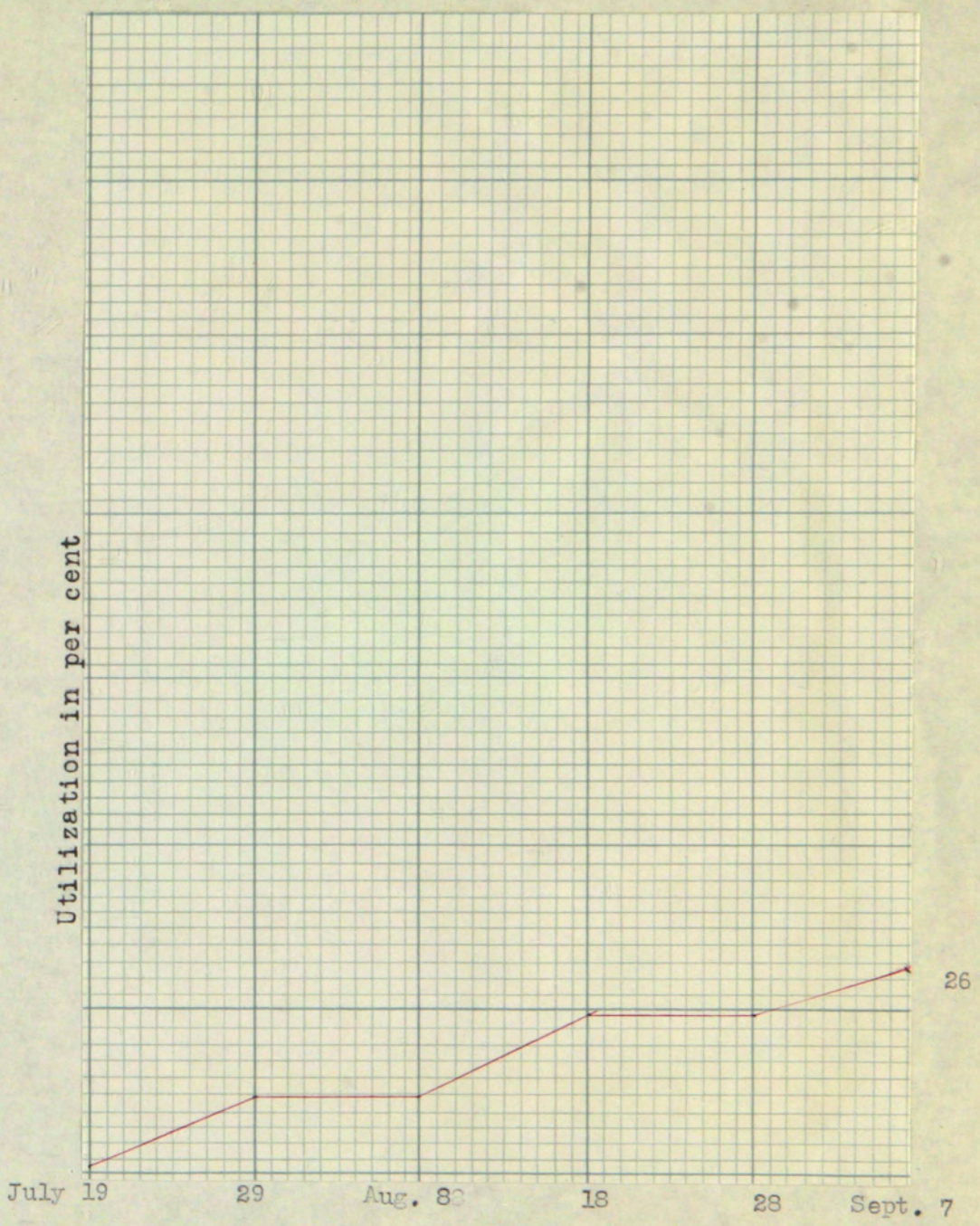


Plate No. XXVIII Showing quadrat No. 28

After ninety days utilization by twenty-two nymphs and adults, introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 23 Showing utilization for quadrat No. 29 by twenty-two nymphs of native range land forms.

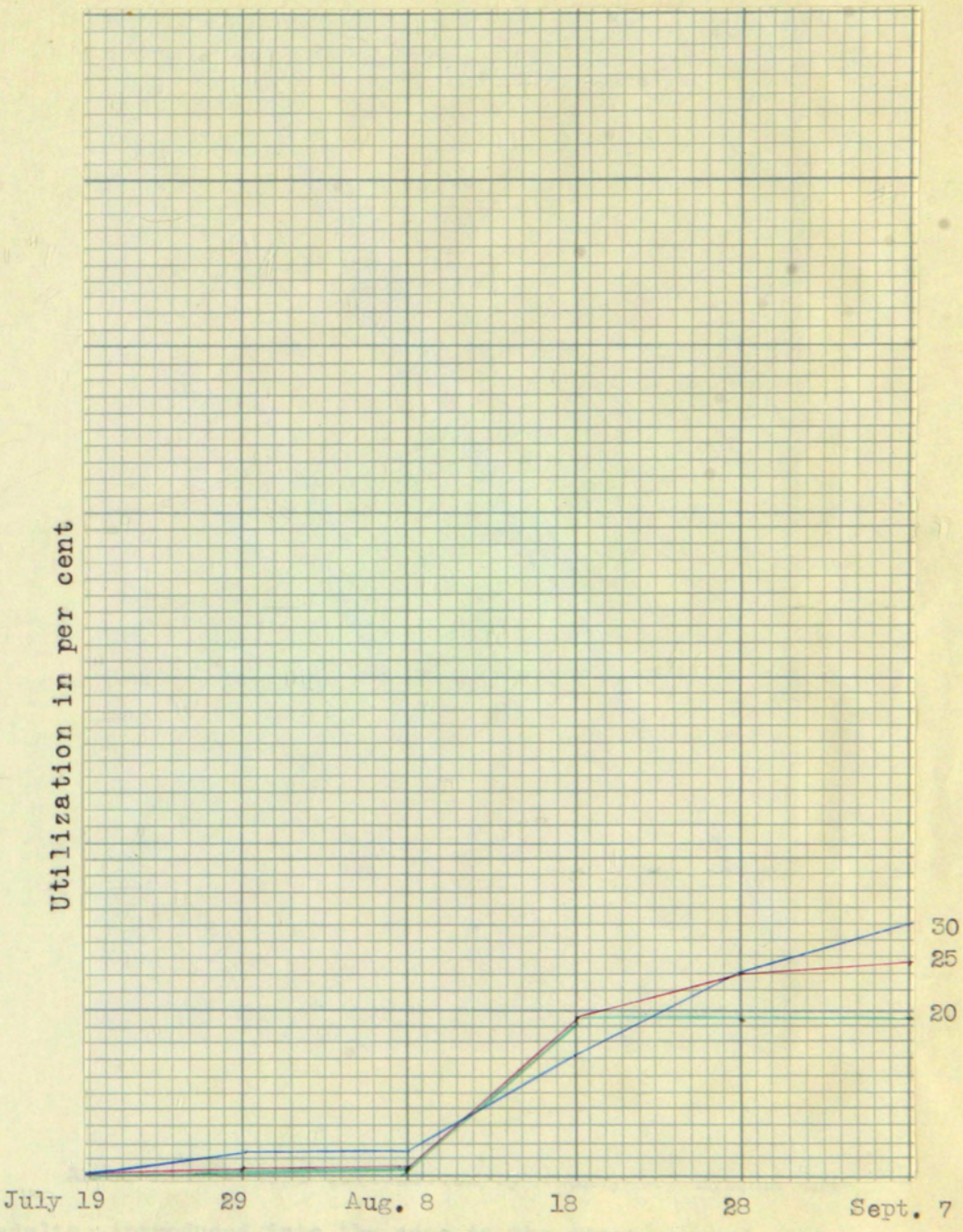
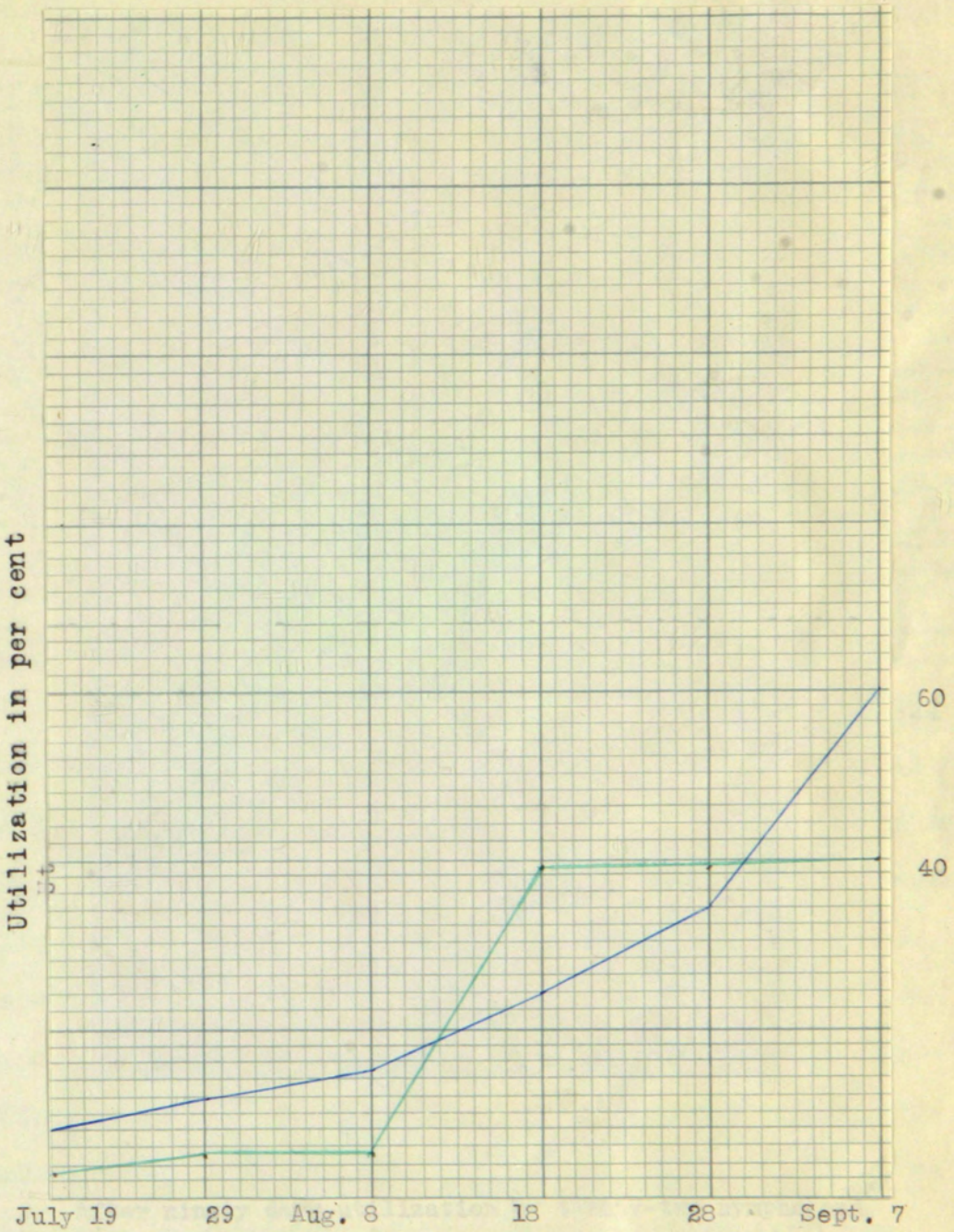


Plate No. XXIX Showing quadrat No. 29

After ninety days utilization by twenty-two nymphs and adults, introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Fig. 24 Showing utilization for quadrat No. 30 by twenty-two nymphs of native range land forms.



Blue gramma grass ------ Blue
Western wheat grass ---- Green

Plate No. XXX Showing quadrat No. 30

After ninety days utilization by twenty-two nymphs and adults, introduced into the cage in the first, second, and third instars, and allowed to grow to maturity.

Table 10: Total utilization of important native grasses by native range-land species.

Quadrat Number	Buffalo Grass	Blue Gramma Grass	Western Wheat Grass
16	21.4%	19%	75%
17	95	75	85
18	95	95	75
19	70	45	0
20	75	75	80
21	0	70	85
22	25	0	50
23	100	70	65
24	20	25	50
25	85	0	0
26	75	65	60
27	0	35	25
28	26	0	0
29	25	30	20
30	0	60	40
Totals	712.4%	664.0%	690.0%
Averages	59.4%	55.3%	57.5%

Discussion of data for quadrats sixteen to thirty.

In each one of these quadrats, there were introduced on June 16, twenty-two native range land grasshoppers in the first, second, and third instars. These nymphs were allowed to feed and develop until September 7. The populations in these plots were maintained thruout the summer equal to the number per square meter in the adjoining area immediately surrounding the entire experimental plot. The number outside fluctuated somewhat but the average approximated twenty-two grasshoppers per square meter for the ninety day period.

The period of greatest utilization for approximately all of this group of plots as shown by the individual curves was from August 8 to August 28, or twenty days

during the middle of August. Heavy utilization occurred after the hoppers had reached the fifth instar, and continued for an average of thirty days following maturity.

Mature grasshoppers were collected early in July, and by July 15, in two-hundred sweeps collecting 109 individuals, only twelve were immature. It is evident, therefore, that the native range land forms do their heaviest grazing after maturity.

The grasshoppers in these plots showed little inclination to feed on the weeds. Where they did feed on weeds, they managed, somehow, to locate those species most platable to livestock and these were often clipped off at the base of the plant and never touched again. In none of the quadrats did the utilization of weeds exceed one per cent.

The seed bearing culms of the grasses were quite often clipped off at the rachis* or at the base of the culm, and in those plots where utilization was high for leaves the utilization for seed bearing culms was without exception as high as, or higher than the total utilization for the plot. Utilization always started with the seed stalks, and later progressed to the leaves.

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*rachis--axis of infloresence

POPULATION FLUCTUATIONS

During the summer months, June, July, and August, population trends were calculated on the basis of occular estimates and periodic sweepings. As the utilization estimates of the plots were made at intervals of ten day periods, an estimate of the approximate population of grasshoppers per square meter was made outside the screened plots at the same time. During the same period, June, July, and August--a total of 1200 sweeps were made on six separate occasions during the three months, or every two weeks. The catch from these sweeps was dipped in alcohol and allowed to dry out, labeled with date, number of sweeps, and number of individuals taken, then placed in a separate screen cage, and thus preserved until in September, when the species were identified, by the author, and confirmed, by Fred Morton, of the U.S. Bureau of Entomology and Plant Quarantine. In the manner described above, the data were obtained for the population fluctuations for the various species of grasshoppers as shown in table 11.

The following table will illustrate the population trends and species fluctuations thruout the summer.

Table 11: Showing population trends and species fluctuations.

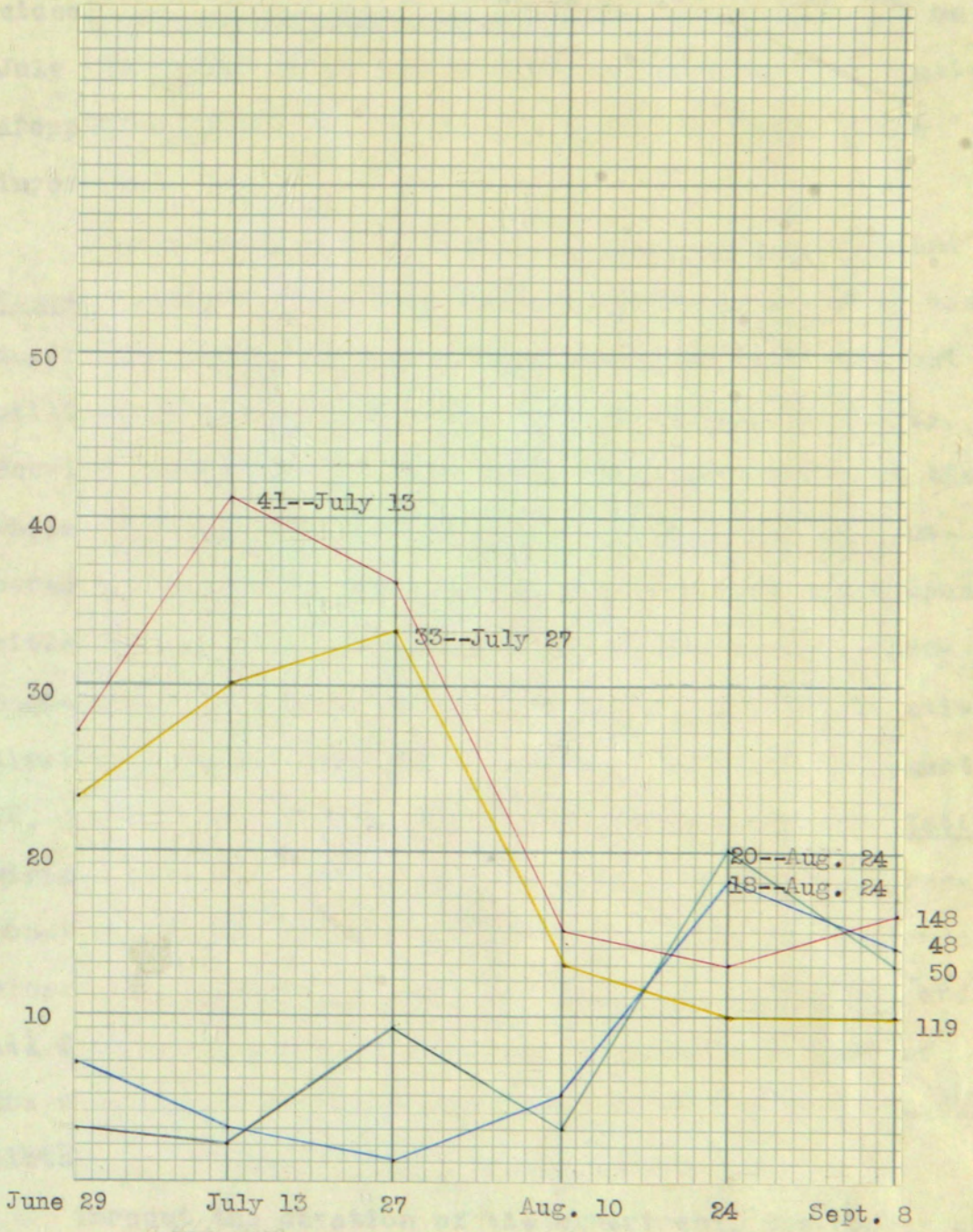
Species	Sweeps	Number of individuals on:						
		June 29	July 13	July 27	Aug.10	Aug.24	Sept.8	Total
Alocura elliotti	200	27	41	36	15	13	16	148
Brachystola manga	200	5	1	0	1	3	2	12
Melanoplus femur-rubrum	200	2	0	5	0	1	2	10
Mepanoplus packardi	200	3	2	9	3	20	13	50
Hesperotettix viridis	200	7	3	1	5	18	14	48
Ageneotettix deorum	200	23	30	33	13	10	10	119
Amphitornus coloradus	200	2	0	1	2	1	0	6
Melanplous mexicanus	200	0	8	3	0	4	3	18
Encoptolophus costalis	200	3	0	0	1	2	1	7
Timerotropis latifasciata	200	0	0	0	1	8	7	16
Melanoplus bivittattus	200	0	0	0	4	6	7	17
Melanoplus occidentlais	200	0	4	2	0	1	8	15
Dactylotum pictum	200	0	1	0	0	1	0	2
Philbostroma 4-maculata	200	0	2	4	10	1	1	18
Metator pardalinus	200	0	8	8	1	2	0	19
Aleopus turnbuli	200	0	0	0	3	2	0	5
Trachyrachis kiowa-kiowa	200	0	3	1	2	0	0	6
Cordillacris crenulata	200	0	0	1	0	0	0	1
Herllophitus hirtipes	200	1	0	0	0	0	0	1

Table 12: A list of the species of range land grasshoppers encountered during the experiment in order of their occurrence in per cent.

1.	Aulocura elliotti	26.6 %
2.	Ageneotettix deorum	22.9 %
3.	Melanoplus packardi	9.6 %
4.	Hesperotettix viridis	9.2 %
5.	Metator pardalinus	3.6 %
6.	Phlibostroma 4-maculatum	3.4 %
7.	Melanoplus mexicanus	3.4 %
8.	Melanoplus bivitattus	3.2 %
9.	Trimerotropis latifasciata	3.0 %
10.	Melanoplus occidentalis	2.7 %
11.	Brachystola magna	2.3 %
12.	Melanoplus femur-rubrum	1.9 %
13.	Encoptolophus costalis	1.3 %
14.	Trachyrhachis kiowa-kiowa	1.1 %
15.	Amphitornus coloradus	1.1 %
16.	Aeoloplus turnbulli	.96%
17.	Dactylotum pictum	.38%
18.	Herolophitus hirtipes	.19%
19.	Cordillacris crenulata	.19%

Total number of grasshoppers collected -----518

Fig. 25 Population curve for the four dominant species of range land grasshoppers



Aulocura elliotti---------- Red
Hesperotettix viridis ----- Blue
Melanoplus packardi ------- Green
Ageneotettix deorum ------- Yellow

According to the population chart, Aulocura elliotti occurred in greatest numbers on July 13, and was followed closely be Ageneotettix deorum which reached its peak on July 27. After July, the populations of these two species dropped until their occurrence appeared to be of minor importance.

During the month of August, Melanoplus packardi and Hesperotettix viridis were the leading species and it was during the period of August 8 to August 28 that greatest utilization occurred in plots numbers sixteen to thirty. Bearing this information in mind, it becomes apparent that while Aulocura elliotti and Ageneotettix deorum out numbered the other two forms two-to-one they were not responsible for the greatest damage to the range grasses. Consequently, it is safe to say that since the greatest utilization occurred during the period of August 8 to August 28, during which time Melanoplus packardi and Hesperotettix viridis were dominant in numbers these two forms are responsible for the highest per cent of utilization followed closely by Aulocura elliotti and Ageneotettix deorum, and all four species are responsible for practically all of the utilization of the grasses present on the experimental plots.

Thruout the duration of the experiment, the number of individuals in the cages approximated an average of twenty-two. As the smaller earlier hatching forms reached their peaks of increase and started to diminish in numbers the slower hatching forms came in to predominate so that at

no period during the summer did the population in the surrounding pasture fall below eighteen per square meter, nor go above twenty-seven per square meter.

For Dissosteira longipennis, Thos., however, the populations were constant in all the cages desiginated for that species.

A comparison of the utilization of the two forms of grasshoppers, the migratory form and the native range land forms reveals a few interesting facts.

Table 13: Comparison of utilization of the two forms of grasshoppers, the migratory form, and the native range land forms.

Grasshoppers	Population	Utilization per cent			
		Buffalo grass	Blue gramma	Western Weede wheat	
Migratory species (*Dissosteira longipennis*, Thos.)	30 per square meter	74.2%	81.15%	58.4%	1.0%
Native species	22 per square meter	59.4%	55.3%	57.0%	.5%

The marked difference in utilization by the two forms may be accounted for, at least in part, on the basis of difference in size and numbers. The average migratory grasshopper is approximately twice the size of the average range land form. The numbers per cage of migratory species was thirty per square meter, while the smaller range land forms was twenty-two per square meter.

MORTALITY

The decrease or increase in numbers of species populations is extremely difficult to account for; in fact it is impossible to make such explanation in this paper. According to the collections taken thruout the summer the peaks of populations for the four leading, or important species is shown graphically by the chart on a preceding page. The remaining species occurred in such small numbers as to give basis for the classification "unimportant". These "unimportant" species have been listed, but should not be considered as basis for alarm, considering the data presented here. The population fluctuations were due primarily to the sudden decrease in numbers of some species, due to mortality, but it is impossible to account for this mortality here.

ECOLOGICAL DATA

During the course of the experiment, notes were taken on some of the ecological habits of the various species.

Types of vegetation infested

In general, it was found that those species that were strong fliers were found congregating in bare areas, seldom alighting on grass or weeds, while the weak fliers remained in tall or thick vegetation from which they apparently received some protection.

Choice of food plants

Of the twenty forms of grasshoppers studied, the choice of food plants was Buffalo grass, Blue gramma grass, and Western wheat grass. In the cages, after the grasses had been completely eaten off, a few species attacked the more palatable forms of weeds, but apparently were unable to subsist on them, and soon died. The utilization of weeds in general was so small, that it was impossible to calculate a preference. It is altogether unlikely that there are any species that occur commonly in the range land areas of this section of the state that can be considered to be beneficial.

Temperature and activity

Greatest activity of the grasshoppers was noted between air temperatures of seventy degrees and eightly degrees Fahrenheit. Below sixty degrees Fahrenheit, feeding ceased entirely, and above ninety degrees Fahrenheit,

the grasshoppers began seeking higher elevations, by flying twenty to thirty feet above the ground, or climbing fence posts or weeds and grass culms.

ANALYSIS OF RESULTS

The data collected during the course of this experiment are analyzed on the basis of results found in the field and laboratory. It is not necessary to apply statistical methods to the analysis of these data in order to understand the significance of the information found herein.

A. Period of greatest growth of grasses

The grasses in the experimental plots made the greatest growth from July 19 to August 18.

B. Period of greatest utilization of grasses and weeds

The native range land species of grasshoppers utilized the grasses the heaviest from August 8 to August 28.

The migratory grasshoppers grazed the grasses the heaviest from July 20 to August 10.

C. Effect of density of grasses on utilization

Apparently, the density of the grasses had little effect on the utilization of the grasses, in experimental cages.

D. Grasses preferred by grasshoppers

The native range land species prefer the grasses in the following order--Buffalo grass, Western wheat grass, and Blue gramma grass. The migratory grasshoppers prefer the grasses in the following order--Blue gramma grass, Buffalo grass, and Western wheat grass.

E. List of common range land forms of grasshoppers in order of occurrence

1. Aulocura elliotti
2. Ageneotettix deorum
3. Melanplous packardi
4. Hesperotettix viridis
5. Metator pardalinus
6. Phlibostroma 4-maculatum
7. Melanoplus mexicanus
8. Melanpolus bivitattus
9. Trimerotropis latifasciata
10. Melanoplus occidentalis
11. Brachystola magna
12. Melanoplus femur-rubrum
13. Encoptolophus costalis
14. Trachyrhachis kiowa-kiowa
15. Amphitornus colorodus
16. Aeoloplus turnbulli
17. Dactylotum pictum
18. Herolophitus hirtipes
19. Cordillacris crenulata

F. Grasshoppers responsible for greatest damage

1. Dissosteira longipennis
2. Melanoplus packardi
3. Hesperotettix viridis
4. Aulocura elliotti
5. Ageneotettix deorum

G. Production of grasses according to density per acre

The grasses produce forage on the basis of density and species. Western wheat grass will produce more forage per acre than an equal density of gramma and buffalo, but is seldom utilized as heavily by livestock or insects. Of the two species, Buffalo and Blue gramma, the latter will produce more per acre of an equal density than the former. In order of production they are--

1. Western wheat grass
2. Blue gramma grass
3. Buffalo grass.

H. Utilization of grasses per acre of varying numbers of grasshoppers per square meter or square yard in per cent

1. Of Dissosteira longipennis, Thos.

If the migratory species occur in numbers approximating thirty per square meter, or twenty-seven to the square yard on a range of average density, they are capable of utilizing 71.25 per cent of the available forage produced over a period of ninety days.

2. Of common range land forms

When the native range land forms occur in numbers approximating twenty-two to the square meter, or nineteen to the square yard, on a range of average density, they are capable of utilizing fifty-seven per cent of the available forage produced over a per-

iod of ninety days.

I. Utilization of grasses by cows vs. grasshoppers

Nelson, head of the Department of Range and Pasture management, states that it requires five acres of the native range to support one cow, consequently, if grasshoppers are present in a pasture, in populations equal to nineteen to the square yard, the carrying capacity will be reduced by fifty-seven per cent, which means that the number of acres required to support on the cow will be increased a little over two times, or from five to over ten acres.

Considering the situation from another angle--let us assume that a pasture has an average density of seven-tenths for all the species of grass, Buffalo equals three-tenths, Blue gramma, three-tenths, and Western wheat, one-tenth. Turning to the production tables, it is found that Buffalo, of such a density, will produce 1123 pounds per acre, Blue gramma, 2281.116 pounds per acre, and wheat grass will produce 3205.20 pounds per acre, making a total production of 6609.316 pounds per acre, and over a pasture of ten acres, 66099.160 pounds would be produced. Consequently, since cattle consume forty pounds of succulent forage per day, the pasture in question will support ten head of cattle for 165 days. But if in this same pasture, there were present thirty Dissosteira longipennis, Thos. to the square

meter, they will reduce the carrying capacity of the pasture by seventy-five per cent, or from 165 days, to forty-one days.

In the case of the native grasshoppers, if there are twenty-two present, to the square meter, the carrying capacity will be reduced by fifty-seven per cent, or to ninety-four days.

J. This experiment shows the trends

The information found in this thesis shows what is happening to native grasses, by way of insect utilization. An experiment covering a period of from three to five years will be necessary to establish this information, which shows the trends, as facts.

CONCLUSION

A. Utilization, for average number of grasshopper per acre on a range of average density:

If native range land grasshoppers are uniformly present over an area in numbers equal to nineteen to the square yard, or twenty-two to the square meter, over a period of ninety days, they are capable of destroying fifty-seven per cent of the palatable species of grasses present on the range.

If there are present, twenty-seven migratory grasshoppers to the square yard, or thirty to the square meter, they are capable of destroying seventy-one per cent of the palatable species of grasses present on ranges approximating average density.

B. Period of greatest utilization:

For native grasshoppers, from August 8 to August 28.

For migratory species, from July 20 to August 10.

C. Preferred host of range grasshoppers:

The native species prefer in the order named--

1. Buffalo grass
2. Western wheat grass
3. Blue gramma grass

Migratory grasshoppers prefer in the order named

1. Blue gramma grass
2. Buffalo grass
3. Western wheat grass

D. Species of grasshoppers responsible for greatest

utilization:

1. Dissosteira longipennis, Thos.
2. Melanoplus packardi
3. Hesperotettix viridis
4. Aulocara elliotti
5. Agenecotettix deorum

E. Utilization of weeds:

Utilization of weeds, in the experimental plots, by grasshoppers never exceeded one per cent in any case and was only a trace in many of the quadrats.

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ABSTRACT

The Relation of Grasshoppers (with special emphasis on Dissosteira longipennis, Thos.) to the Native Ranges of Colorado.

INTRODUCTION

The extent to which grasshoppers utilize the grasses of the native pasture areas in the state is a problem of relatively recent origin. The literature reviewed, showed that a very small amount of information is available on the subject, and that the information thus referred to is not conclusive.

The experiment was carried on in the Colorado State College experimental pasture west of Fort Collins, for a period of ninety days, from June 21 to September 7, to show what damage constant populations of grasshoppers were capable of doing to grasses in experimental plots.

EXPERIMENTAL METHODS

The data are divided into two phases, one dealing with constant populations in varying stages of development of the migratory grasshopper Dissosteira longipennis, Thos., and the other dealing with constant populations of native range land forms, in similar stages of development.

Within one large enclosure, thirty meter square quadrats were laid off, ten of which were pure Buffalo grass, ten pure Blue gramma grass, and ten of mixed grasses --Buffalo, Blue gramma, and Western wheat grass.

Each plot was then charted, a list of the species of all the weeds and grasses with the densities of each made, followed by the total density of each quadrat, species measurements taken, and then, the grasshopper populations determined for each. In this way, it was calculated that twenty-two individuals per square meter was the average population, for that section of the pasture.

In each utilization quadrat, the original populations were maintained throughout the experiment, and estimates were made every ten day period of the utilization in each. When the experiment was completed, the cages were removed, the utilization calculated and compared to the clippings obtained from the check plots. In this manner, it was possible to calculate the production of various densities as compared to the check plots, and by subtracting the amount of vegetation left from the amount, that should have been present as determined by comparison to the checks, it was possible to calculate the amount of forage that had actually been utilized on all of the utilization plots.

RESULTS OF THE EXPERIMENT

The utilization on the nine quadrats, containing Dissosteira longipennis, Thos., and the fifteen quadrats containing native species can be shown in table form as illustrated by Table 1.

Table 1: Comparison of utilization by average populations of Dissosteira longipennis, Thos., (thirty) and average populations of native range land species (twenty-two).

Grasshoppers	Grass utilization in per cent			
	Buffalo Grass	Blue gramma	Western Wheat	Average
Dissosteira longipennis	74.2%	81.15%	58.4%	71%
Native Species	59.4%	55.3%	57.0%	57%

The species of grasshoppers responsible for the greatest amount of utilization appear in Table 2, in the order of their importance. Five species were found to be most destructive.

Table 2: A list of grasshopper species in order of importance responsible for the greatest amount of utilization.

1. Dissosteira longipennis
2. Melanoplus packardi
3. Hesperotettix viridis
4. Aulocura elliotti
5. Ageneotettix deorum

In the experimental quadrats, the grasses made the

greatest growth from July 19 to August 18. It was necessary to know the period of maximum forage growth to compare with the period of maximum utilization by the grasshoppers.

The grasses in the cages, continued to grow for approximately thirty days after growth had ceased outside the quadrats. The reason for this was undoubtedly the shading caused by the screen, which reduced the light and transpiration within the cages.

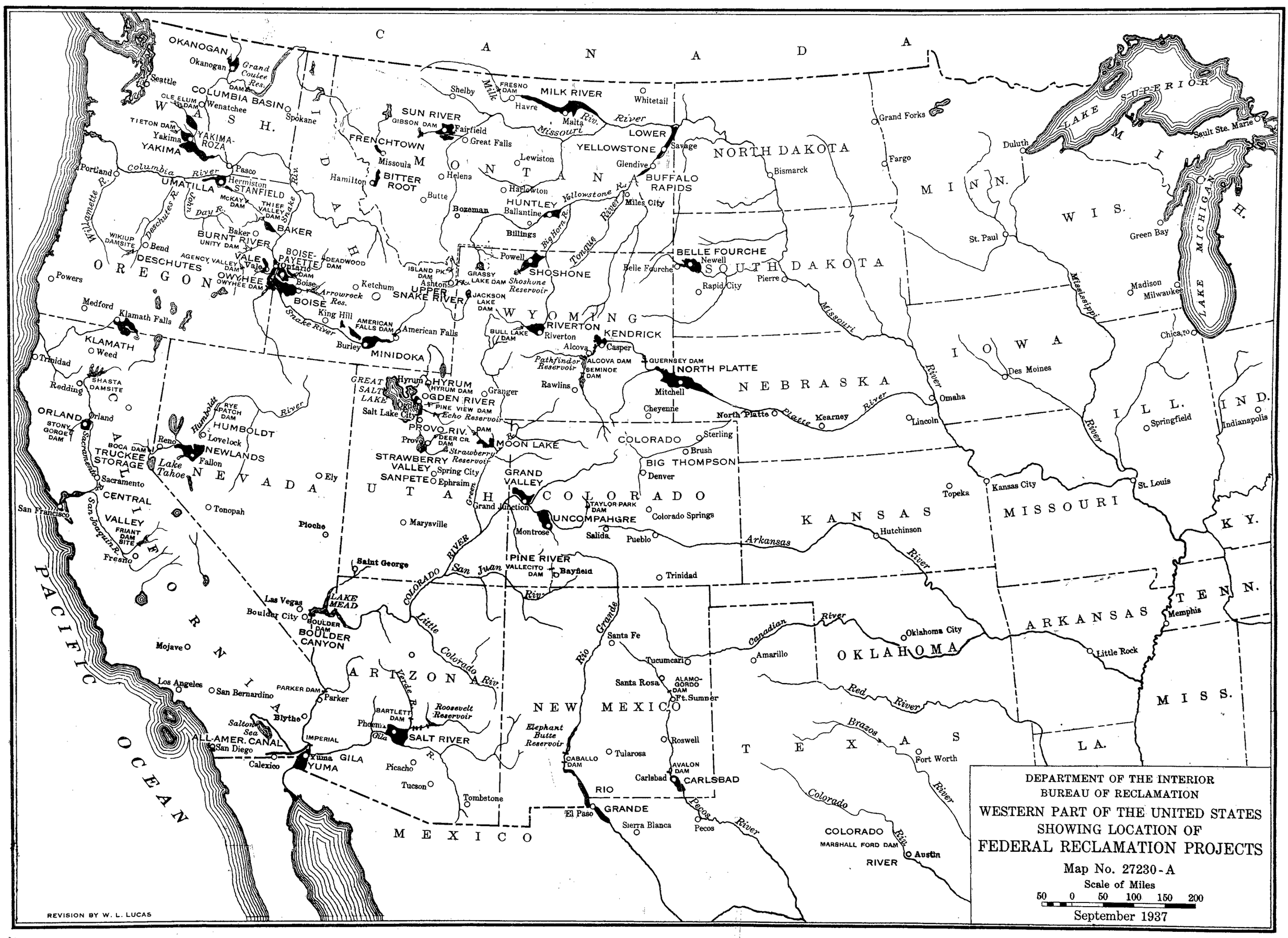
For the migratory species, the greatest utilization of grasses occurred from July 20 to August 10, and for the native species, from August 8 to August 28.

SIGNIFICANCE OF THE RESULTS

The results obtained from this experiment are significant in that they indicate what happens to our better range forage grasses when heavily utilized by different forms of grasshoppers. However, it is the consensus of opinion that investigations should be extended for a period of from three to five years to substantiate the results secured in this experiment.

This is to certify that Galen A. Hinkle has demonstrated a reading knowledge of scientific French, in fulfillment of one of the requirements for the master's degree.

Sarah I. Kettle
Head of Department of
Modern Languages



DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

WESTERN PART OF THE UNITED STATES SHOWING LOCATION OF FEDERAL RECLAMATION PROJECTS

Map No. 27230-A

Scale of Miles

50 0 50 100 150 200

September 1937