CHAPTER III.

PLANT GROWTH.

Germination of Seeds.—Figures 56, 57, 58, on a former page, illustrate the parts of a kernel of corn and its mode of growth. For the account of the structure of the seed consult a former paragraph on this subject. It will be seen that the grain of corn, as is true of all the grasses, remains stationary where planted, at the base of the ascending axis.

"For germination to take place, moisture, oxygen and a suitable temperature are necessary. Under these conditions the seed swells, oxygen is absorbed, a part of the carbonaceous ingredients is oxidized, heat is developed, and carbon dioxide is evolved. During these changes the solid ingredients of the seed gradually become soluble; the starch and fat are converted into sugar; the albuminoids are converted into amides."— (*Warington's Chemistry of the Farm.*)

In the Temperate Zones, the seeds of grasses germinate quickly at a rather low temperature, though there is considerable difference in this particular. Some germinate a little above the freezing point, while every farmer knows that Indian corn, sorghum and millet start slowly, unless the weather be quite warm, and that the seeds will decay if kept wet and cold.

Old or light seeds often sprout quickly, but produce weak plants.

Though the seeds of grasses be secured when quite young, in the milk, a short time after flowering, when the endosperm is very small and the seeds shrivel as they dry, yet, if the embryo be formed and the seed well cured in a dry place, it will germinate. Dry seeds will endure much cold; wet or green seeds will endure but little.

Grass seeds may be covered deeper in a sandy soil than in clay, deeper in a rather dry soil than in a wet one.

The seeds of grasses are quite small, and should seldom be covered more than the eighth or fourth of an inch deep. The only need of a covering is to keep the seeds moist, and in some cases to prevent birds or other small animals from eating them. If planted deep, the supply of oxygen is liable to be insufficient, or if it be present, the seed is likely to become exhausted or much weakened in thrusting its young stem and leaves to the surface, where it may reach the light and begin to make a permanent growth of green leaves. All experiments are so much modified by the weather and condition of the soil, that to give definite rules is difficult.

The Function of Green Leaves.—Leaves not unfrequently absorb water in a liquid state as well as in the form of vapor, yet the roots absorb most of the water for plant growth. That leaves sometimes absorb water is most easily tested by observing the revival of cut flowers or plants when placed in a moist, tin box.

"The paramount function of the leaf is the absorption and assimilation of carbon, as such does not exist in the atmosphere, unless, indeed, as an impurity in air of towns, and a very prejudicial one to plants." (*Masters*). The carbon of plants comes from carbon dioxide, and is decomposed through the agency of chlorophyll under the influence of light.

Plants can endure darkness for a short time, but if long continued the chlorophyll disappears and the leaves fade, and finally perish, as may be seen in warm weather where a board is placed on the grass for some time.

Unless the air is saturated with moisture, which is not commonly the case for long periods, the leaves evaporate large quantities of water. The surplus passes off, leaving the condensed assimilated matter for building up the plant. In a growing season, while everything is thrifty, a grass-plant contains 70 to 80 per cent or more of water.

The Plant is a Factory.—"All the labour of the plant by which out of air, water, and a pinch of divers salts scattered in the soil, it builds up leaf and stem and roots, and puts together material for seed or bud or bulb, is wrought and wrought only by the green cells, which give greenness to leaf and branch or stem. We may say of the plant, that the green cells of the green leaves are the blood thereof. As the food which an animal takes remains a mere burden until it is transmuted into blood, so the material which the roots bring to the plant is mere dead food till the cunning toil of a chlorophyll-holding cell has passed into it the quickening sunbeam. Take away from a plant even so much as a single green leaf, and you rob it of so much of its very life blood." (*Masters*, quoted from *Gardener's Chronicle*).

A living plant is a machine or a factory, which, under the influence of light and heat, transforms raw materials into organic matter, suitable for enlarging the plant or enabling it to grow. In nearly all cases, some portions of a plant are dying while others are growing, and to some extent, one part is independent of other portions. This enables a plant to change its place of growth, to feed on its own stock of nourishment, or to recuperate when injured. The formation and enlargement of new cells constitute growth. To be ready for absorption by plants, matter must be in a liquid or gaseous condition. To a great extent a plant takes what it likes best, or is capable of controlling the quantity of any substance absorbed.

Of the materials assimilated, a part goes at once to form cell walls, cork, mucilage, etc., and can never be changed by the plant into matter for constructing other parts of the plant, while other portions of assimilated material take the form of starch, oil, inulin, and are likely to be again changed and transferred once or more times to other portions of the plant.

Only a very small part of the most fertile soil is in condition to be used for plant food. Some soils may contain a large amount of materials which the plants cannot take, or do not need. A fertile soil is capable of retaining plant food, while sandy soils, owing to their excellent natural drainage, are not fertile unless frequently supplied with manure.

Two different kinds of plants growing in the same field will usually be found to contain certain substances in different proportion. Some are essential, others not; some in large quantity, others in small quantity, yet, strange as it may seem, by the chemical composition of a plant, we cannot always tell what manures will benefit it most.

Composition of Plants.—The combustible part of plants is made up of five chemical elements—carbon, oxygen, hydrogen, nitrogen and sulphur; without these no plant is ever produced. The carbon, hydrogen and oxygen form the cellulose, lignose, pectin, starch, sugar, fat and vegetable acids. The same elements united with nitrogen form the amides and alkaloids; and further united with sulphur the still more important albuminoids.

The incombustible ash always contains five elements—potassium, magnesium, calcium, iron and phosphorus, besides sulphur. Iron is present in only very small quantity. Besides these, an ash will generally contain sodium, silicon and chlorine, sometimes manganese, and perhaps minute quantities of other elements.

The earlier chemists spoke of the combustible portions of plants as "organic," and the incombustible portions as "inorganic." This distinction is no longer considered accurate.

Excepting oxygen, these elements are taken from compounds, such as water, carbon dioxide and the substances combined as shown in the following:

Nitrates. Sulphates. Carbonates. Phosphates. Silicates. Chlorides.	OF	Ammonia. Potash. Lime. Iron. Soda. Magnesia.

COMPOSITION OF A CROP OF MEADOW GRASS.

Water			8,378 lbs.
Carbon	1315	Combustible matter	2,613 lbs.
Hydrogen	144		
Nitrogen	49		
Oxygen and Sulphur	1105		
Potash	56.3	Ash	209 lbs.
Soda	11.9		
Lime	28.1		
Magnesia	10.1		
Oxide of Iron	.9		
Phosphoric Acid	12.7		
Sulphuric Acid	10.8		
Chlorine	16.2		
Silica	57.5		
Sand, &c	4.5		
Total crop			11,200 lbs.

From the soil plants obtain, by means of their roots, all their ash constituents, all their sulphur, and nearly the whole of their nitrogen and water. From the atmosphere they obtain, through their leaves, the whole, or nearly the whole, of their carbon, with probably small quantities of nitrogen and water. The amount and composition of the ash of succulent plants, as meadow grass and clover, is greatly influenced by the character of the soil and the manure applied.

For most of the above paragraph the writer is indebted to the *Chemistry of the Farm*, by R. Warington.

Meadow hay contains a much larger proportion of potash and lime than is found in the ripened grain of the cereals.

The Chemical Composition of American Grasses.*—In submitting grasses to chemical analysis, with a view of judging of their nutritive value, it is usual to determine the amount present of water, ash, fat or oil, fiber and nitrogen. From the latter the amount of albuminoids to which it is equivalent is readily calculated by multiplying by a factor which represents the per

*Taken by permission from the Agricultural Grasses, by the United State Department of Agriculture, 1884, Clifford Richardson, Assistant Chemist.

cent of nitrogen present in the average albuminoid, and by subtracting the sum of all these constituents from one hundred, the percentage of undetermined matter is obtained, and as it of course contains no nitrogen, and consists of the extractive principles of the plant, it is described as 'Nitrogen free extract.' It includes all the carbo-hydrates, such a sugar, starch, and gum, together with certain other allied substances, with which we are less intimately acquainted, but which have a certain nutritive value.

Although it has been customary to state as albuminoids the equivalent of the nitrogen found, this is rarely entirely correct, as a portion is generally present in a less highly elaborated form of a smaller nutritive value. This portion is described as non-albuminoid nitrogen, and in analysis of the present day the amount is always given as an additional source of information, although our knowledge of its exact value to the animal is rather uncertain.

The wide variations in fiber and albuminoids must be regarded as being entirely due to physiological causes, which are difficult to explain. *Digitaria sanguinale,* for instance, which in one specimen contains the extreme amount of albuminoids and a small amount of fiber has in another only half as much albumen and one and three-quarter times as much fiber. We learn then, that species are not in themselves at all fixed in their composition, there being as large variations among specimens of the same as between specimens of different species.

Analysis of Phleum pratense (Timothy) from various localities.

FULL BLOOM.

LOCALITY.	Ash.	Fat.	Nitrogen Free Extract.	Crude Fiber.	Albuminoids.	Total Nitrogen.	Non-Albuminoids Nitrogen.	Per Cent. of Total Nitrogen as Non-Albuminoids.
Department Garden, 1881	7.16	4.47	50.03	27.35	10.99	1.75	.51	29.1
Department Garden, 1880	5.66	3.58	58.93	21.93	9.90	1.58	.38	24.0
Maryland	4.93	4.22	52.83	30.43	7.69	1.23	.15	12.2
New Hampshire	4.57	4.20	57.16	28.28	5.79	.93	.10	10.8
Indiana	7.05	2.18	52.99	32.26	5.52	.88	.00	.0

Analyses of Dactylis glomerata (orchard grass) from various localities.

FULL BLOOM.

LOCALITY.	Ash.	Fat.	Nitrogen Free Extract.	Crude Fiber.	Albuminoids.	Total Nitrogen.	Non-Albuminoids Nitrogen.	Per Cent. of Total Nitrogen as Non-Albuminoids.
North Carolina	7.42	3.56	56.03	23.08	9.91	1.58	.30	19.0
District of Columbia	8.07	3.24	53.76	25.40	9.53	1.53	.16	10.5
Maine	8.02	3.39	54.80	26.05	8.74	1.40	.36	25.7
District of Columbia	6.00	3.62	57.34	24.42	8.62	1.38	.42	30.4
Pennsylvania	6.33	2.66	54.99	27.51	8.56	1.37	.51	37.2
New Hampshire	8.44	3.49	54.75	24.91	8.41	1.35	.42	30.9

The different sections furnish very different qualities of grasses, and for the reason that those from the north were almost entirely from cultivated soil, while those from the other sections were many or most of them wild species from old sod. The improvement brought about by cultivation is marked, and the difference between a ton of wild western and eastern cultivated hay is apparent.

In comparison with German grasses our best do not equal in amount of albuminoids, those classed by Wolff as *fair*, but they are far superior in having a much smaller percentage of fiber, and consequently a large amount of digestible carbohydrates. In the grasses of both countries the fiber increases with regularity as the nitrogenous constituents decrease, and of the latter the non-albuminoid portion is relatively greatly the poorer the quality of the grass.

Analyses have been made of series illustrating the changes in composition of several species from the appearance of the blade to the maturity of the seed.

With a few exceptions the specimens were personally collected in the grounds of the Department. They all grew in the summer of 1880 except the few series illustrative of the first year's growth of certain species. The specimens were cut close to the roots, weighed and dried rapidly in a current of air at 60° C.

DESCRIPTION.	When Cut.	Height in Centimeters.	Dry Substance. Ash.	Fat.	Nitrogen Free Extract.	Crude Fiber.	Albuminoids.	Total Nitrogen.	Non-albuminoid Nitrogen.	Per Cent. of Nitrogen Non-Albuminoid.	Fresh Substance. Water.	Ash.	Fat.	Nitrogen Free Extract.	Crude Fiber.	Albuminoids.
I.—Agrostis vulgaris.																
DEPARTMENT GROUNDS.																
Good soil:																
Panicle not out	June 1	42	8.19	3.77	53.88	20.97	13.19	2.11	.82	38.9	67.8	2.64	1.21	17.35	6.75	4.25
Panicle out; closed	June 1	58	7.34	4.05	54.13	20.87	13.61	2.18	.80	36.7	68.1	2.34	1.29	17.27	6.66	4.34
In early bloom	June 19	48	7.55	3.62	54 46	21.64	12.73	2.04	.54	26.4	70.1	2.25	1.08	16.29	6.47	3.81
In full bloom	June 23	45	7.27	2.87	56.82	22.02	11.02	1.76	.53	30.1	61.4	2.80	1.11	21.94	8.50	4.25
Seed in the milk	July 1	43	6.60	3.51	60.02	19.43	10.44	1.67	.36	21.6	53.3	3.08	1.64	28.03	9.07	4.88
Seed hard	July 1	47	6.74	4.25	58.88	20.66	9.47	1.52	.18	11.8	51.5	3.27	2.06	28.56	10.02	4.59
Seed mature	July 9	55	5.30	2.74	61.32	21.75	8.89	1.42	.09	6.3	57.0	2.28	1.18	26.37	9.35	3.82
Poorer soil:																
Panicle spreading	June 16	43	8.41	3.88	57.41	20.49	9.81	1.57	.28	17.8	68.2	2.67	1.23	18.26	6.52	3.12
Early blooming	June 18	53	5.84	5.30	58.49	20.44	9.95	1.59	.32	20.1	58.8	2.41	2.18	24.10	8.41	4.10
II.—Phleum pratense.																
DEPARTMENT GROUNDS.																
Good soil:																
Spike invisible	June 1	42	8.68	4.56	54.31	19.91	12.54	2.01	1.70	35.0	70.7	2.54	1.34	15.92	5.83	3.67
Spike visible	June 1	62	6.41	3.40	47.26	21.03	11.90	1.86	.55	29.5	71.9	1.80	.96	16.09	5.91	3.34
Before bloom	June 23	45	9.82	3.63	54.19	22.03	10.33	1.65	.36	21.8	67.5	3.19	1.18	17.61	7.16	3.36
In early bloom	June 23	60	6.04	3.85	57.21	22.70	10.20	1.63	.30	18.4	64.9	2.12	1.35	20.08	7.97	3.58
In full bloom	June 18	58	5.66	3.58	58.93	21.93	9.90	1.58	.38	24.0	67.2	1.86	1.17	19.33	7.19	3.25
Early seed	June 18	52	10.53	3.40	51.07	22.90	12.10	1.93	.51	26.4	77.8	2.34	.76	11.34	5.08	2.68
Poorer soil:																
In bloom	June 4	60	6.56	3.95	57.48	23.53	8.48	1.36	.30	22.0	63.4	2.40	1.45	21.04	8.61	3.10
In full bloom	July 1	70	5.64	2.98	61.08	22.84	7.46	1.19	.36	30.3	71.9	1.58	.84	17.16	6.42	2.10

DESCRIPTION.	Dry Substance.										Fresh Substance.					
	When Cut.	Height in Centimeters.	Ash.	Fat.	Nitrogen Free Extract.	Crude Fiber.	Albuminoids.	Total Nitrogen.	Non-albuminoid Nitrogen.	Per Cent. of Nitrogen Non-Albuminoid.	Water.	Ash.	Fat.	Nitrogen Free Extract.	Crude Fiber.	Albuminoids.
II.—Phleum pratense—Con.																
DEPARTMENT GARDEN.																
First year's growth:																
Head out	June 19	49	8.58	6.10	47.22	23.95	14.15	2.26	.39	17.3	78.56	1.84	1.31	10.12	5.14	3.03
In bloom	June 26	76	7.16	4.47	50.03	27.35	10.99	1.75	.51	29.1	66.75	2.38	1.49	16.64	9.09	3.65
After bloom	July 3	65	6.52	4.69	51.79	28.26	8.74	1.40	.25	17.9	56.63	2.83	2.03	22.46	12.26	3.79
" "	July 10	75	5.63	3.72	55.39	27.08	8.18	1.27	.15	11.3	58.86	2.31	1.53	22.79	11.14	3.37
INDIANA.																
Head not out	June 8	-----	7.94	1.97	49.93	29.19	10.97	1.75	.18	10.3	70.00	2.38	.59	14.98	8.76	3.26
Before bloom	June 15	-----	7.64	2.27	52.64	29.65	7.80	1.25	.28	22.4	67.50	2.48	.74	17.11	9.64	2.53
In bloom	June 26	-----	7.05	2.18	52.99	32.26	5.52	.88	.00	.00	64.50	2.50	.78	18.81	11.45	1.96
After bloom	July 6	-----	6.63	2.55	53.93	31.32	5.57	.89	.03	3.3	56.30	2.90	1.11	23.57	13.69	2.43
Early seed	July 16	-----	5.95	3.74	60.77	24.70	4.84	.78	.00	.00	53.00	2.80	1.76	28.56	11.61	2.27
NEW HAMPSHIRE.																
Spike invisible	------	-----	5.19	4.60	57.09	23.46	7.66	1.55	.30	19.4	------	------	------	------	------	------
Spike visible	------	-----	4.73	4.22	56.10	25.34	9.61	1.54	.45	29.2	------	------	------	------	------	------
In bloom	------	-----	4.57	4.20	57.16	28.28	5.79	.93	.10	10.8	------	------	------	------	------	------
After bloom	------	-----	3.88	3.23	58.72	28.92	5.25	.84	.15	17.9	------	------	------	------	------	------
Early seed	------	-----	3.2	2.7	62.5	26.03	5.41	.87	.18	20.7	------	------	------	------	------	------
III.—Dactylis glomerata.																
DEPARTMENT GARDEN.																
Panicles not out	April 23	35	10.29	4.12	50.86	18.76	15.97	2.49	1.01	40.6	78.8	2.18	.87	10.78	3.98	3.39
Panicles closed	May 4	55	8.26	3.13	55.04	23.18	10.39	1.63	*.00	0.0	79.3	1.71	.64	11.40	4.80	2.15
In full bloom	May 13	87	8.07	3.24	53.76	25.40	9.53	1.53	.16	10.5	77.3	1.83	.74	12.20	5.77	2.16
After bloom	June 1	125	9.01	2.83	52.65	27.26	8.25	1.32	.33	25.0	73.5	2.39	.75	13.95	7.22	2.19
Later growth:																
In bloom	June 18	80	8.64	3.98	50.20	24.67	12.51	1.99	.77	38.7	66.9	2.86	1.32	16.62	8.16	4.14
Late bloom	June 23	75	6.00	3.62	57.34	24.42	8.62	1.38	.42	30.4	60.2	2.39	1.44	22.82	9.72	3.43
Seed nearly ripe	July 1	75	6.73	3.34	57.54	25.09	7.30	1.16	.45	38.8	62.3	2.54	1.26	21.69	9.46	2.75

DEPARTMENT GARDEN.																
First year's growth:																
Head not out	June 12	28	11.50	6.89	48.06	20.63	12.92	2.07	.15	7.3	79.50	2.36	1.41	9.85	4.23	2.65
Green	July 15	.....	10.52	6.86	46.95	21.64	14.03	2.25	.39	17.3	72.30	2.91	1.90	13.00	6.00	3.89
Yellow	July 15	.....	10.14	5.95	52.37	22.44	9.10	1.46	.18	12.3	74.60	2.58	1.51	13.30	5.70	2.31
....	Oct. 25	.....	10.95	6.50	47.98	21.24	13.33	2.14	.54	25.2	68.70	3.43	2.03	15.02	6.65	4.17
IV.—ALOPECURUS PRATENSIS.																
Head just appearing	April 19	.....	9.21	4.69	52.16	18.21	15.73	2.52	.66	38.2	77.1	2.11	1.08	11.94	4.17	3.60
Before bloom	April 19	.....	7.90	4.46	51.66	22.40	13.58	2.17	.53	40.9	76.7	1.84	1.04	12.03	5.22	3.17
In bloom	May 1	.....	7.75	3.36	54.30	23.78	10.81	1.73	.00	0.0	60.0	3.10	1.34	21.73	9.51	4.32
After bloom	May 12	.....	8.17	3.50	54.35	25.36	8.62	1.38	.07	5.0	66.6	2.73	1.17	18.15	8.47	2.88
V.—POA PRATENSIS.																
DEPARTMENT GARDEN.																
Set No. 1 grown on good soil:																
Panicle just visible	April 23	20	8.07	4.88	48.74	18.43	19.88	3.18	.48	15.1	76.70	1.88	1.14	11.34	4.30	4.64
Panicle spreading	May 1	30	5.51	4.07	51.32	22.83	16.21	2.68	.30	11.2	70.80	1.61	1.19	14.99	6.67	4.74
In full bloom	May 21	70	8.30	3.90	51.43	23.76	12.61	2.01	.02	1.0	71.90	2.33	1.10	14.45	6.68	3.54
In seed	June 5	70	6.38	4.25	52.54	24.34	12.49	2.00	.37	18.5	55.90	2.81	1.87	23.17	10.74	5.51
Set No. 2, grown on poor soil:																
Panicle closed	April 27	.....	6.61	3.92	55.32	21.92	12.23	1.96	.12	6.1	.....	.....	.....	.....	.....	.....
In full bloom	May 8	65	7.02	2.85	56.85	25.46	7.82	1.28	.10	7.8	69.00	2.18	.88	17.62	7.90	2.42
Set No. 3 grown on poor soil; wayside:																
After bloom; brown	June 1	65	7.23	3.92	56.12	23.85	8.88	1.42	.25	17.6	55.40	3.22	1.75	25.03	10.64	3.96
In full bloom	May 19	78	7.73	3.41	55.32	23.10	10.44	1.67	.14	8.4	66.20	2.62	1.15	18.69	7.81	3.53
In seed; brown	June 8	75	6.21	3.51	58.58	24.34	7.36	1.18	.15	12.7	54.60	2.81	1.59	26.61	11.05	3.34
QUINCY, ILL.																
Set No. 4:																
Before bloom	May 10	.....	8.42	4.99	45.34	21.87	19.38	3.10	.63	20.3	.....	.....	.....	.....	.....	.....
In bloom	May 17	.....	7.82	3.77	48.39	24.93	15.09	2.41	.51	21.1	.....	.....	.....	.....	.....	.....
After bloom	May 27	.....	9.07	3.30	52.51	22.75	12.37	1.97	.35	17.8	.....	.....	.....	.....	.....	.....
VI.—POA COMPRESSA.																
Poor soil:																
Panicle not out	June 1	14	7.75	5.29	58.08	18.19	10.69	1.71	*.10	5.8	67.90	2.49	1.70	18.64	5.84	3.43
Panicle well out	June 1	28	6.81	4.41	55.18	21.30	12.30	1.97	.52	26.4	68.70	2.13	1.38	17.27	6.67	3.85
In bloom	June 17	30	6.08	4.52	58.18	18.53	12.69	2.03	.45	22.2	70.70	1.78	1.32	17.05	5.43	3.72
After bloom	June 23	30	5.1[illegible]	3.85	63.89	18.13	8.97	1.43	.35	24.5	51.80	2.47	1.86	30.79	8.75	4.33

8

DESCRIPTION.	Dry Substance.										Fresh Substance.					
	When Cut.	Height in Centimeters.	Ash.	Fat.	Nitrogen Free Extract.	Crude Fiber.	Albuminoids.	Total Nitrogen.	Non-albuminoid Nitrogen.	Per Cent. of Nitrogen Non-Albuminoid.	Water.	Ash.	Fat.	Nitrogen Free Extract.	Crude Fiber.	Albuminoids.
VII.—Holcus lanatus.																
Very young	April 2	......	9.98	4.53	54.48	18.64	12.37	1.98	.21	10.6	82.3	1.77	.80	9.64	3.30	2.19
Late bloom	May 25	72	8.23	3.89	55.52	25.01	7.35	1.30	.60	46.2	50.6	4.07	1.92	27.43	12.35	3.63
VIII.—Arrhenatherum avenaceum.																
In full bloom	May 25	85	7.93	4.03	54.93	24.33	8.78	1.41	.15	10.6	62.3	2.99	1.52	20.71	9.17	3.31
After bloom	June 4	60	7.88	4.19	51.76	21.51	14.66	2.35	.96	40.9	74.4	2.02	1.07	13.25	5.51	3.75
IX.—Anthoxanthum odoratum.																
Very young	May 1	15	6.39	4.27	61.58	17.17	10.59	1.70	.06	3.5	76.9	1.47	.99	14.22	3.97	2.45
In full bloom	May 1	40	7.09	3.36	59.45	20.63	9.47	1.52	.15	9.9	78.8	1.50	.71	12.62	4.37	2.00
After bloom	June 19	45	7.27	4.86	53.40	21.17	13.30	2.13	.51	23.9	69.9	2.20	1.46	16.07	6.37	4.00
After blooming	July 19	55	5.79	4.08	58.02	25.00	7.11	1.14	.35	30.7	53.4	2.70	1.90	27.04	11.65	3.31
X.—Lolium perenne.																
Head invisible	May 1	35	8.66	3.58	57.70	18.39	11.67	1.87	.28	15.0	78.6	1.85	.76	12.35	3.94	2.50
" "	May 4	28	9.48	4.34	55.08	18.00	13.10	2.09	.39	18.7	82.4	1.67	.76	9.69	3.17	2.31
Head well out	May 4	30	7.96	3.64	56.75	20.55	11.10	1.78	.33	18.5	74.0	2.07	.94	14.71	5.34	2.89
Before bloom	May 12	55	8.40	3.75	54.93	23.93	8.99	1.43	.09	6.3	76.4	1.98	.89	12.96	5.65	2.12
After bloom	June 1	52	7.50	2.64	56.84	25.42	7.60	1.21	......	......	63.1	2.77	.97	20.97	9.38	2.81
XI.—Bromus unioloides.																
Panicle not out	April 23	35	10.65	5.03	48.73	18,54	17.05	2.73	1.06	38.8	80.60	2.07	.97	9.45	3.60	3.31
Panicle closed	May 4	64	8.95	3.44	51.03	22.22	14.33	2.31	.55	23.8	75.40	2.20	.85	12.55	5.47	3.53
In full bloom	May 13	76	9.26	3.96	51.46	22.69	12.63	2.02	.34	16.8	79.40	1.91	.82	10.60	4.67	2.60
After bloom	June 1	76	6.68	2.37	54.79	25.33	10.83	1.74	.35	20.0	67.50	2.17	.77	17.80	8.23	3.52
In seed; brown	June 1	85	8.55	2.10	59.71	19.85	9.79	1.57	.33	21.0	64.70	3.02	.74	21.08	7.01	3.45

The preceding analyses furnish the data from which is derived the general conclusion that as a grass grows older its content of water decreases, ash decreases, fat decreases, albuminoids decrease, carbo-hydrates increase, crude fiber increases, non-albuminoids decrease till bloom or slightly after, when it is at its lowest, and then increases again during the formation of the seed.

There are exceptions to these rules, but for the large majority of species, under ordinary conditions of environment they hold good.

There are almost no exceptions to the fact, that water decreases in the maturer specimens; that is to say the plant gradually dries up and becomes less succulent. The ash is very dependent on locality and surroundings.

The albuminoids decrease in amount with great regularity, the few cases where an increase appears being owing to the fact, that the specimens were probably grown under varying conditions.

Although largely a matter of opinion, it would seem from the foregoing results that the time of bloom or very little later is the time for cutting grasses to be cured as hay. The amount of water has diminished relatively, and there is a proportionately larger amount of nutriment, in the material cut, and the weight of the latter will be at its highest point, economically considered. Later on, the amount of fiber becomes too prominent, the stalk grows hard, arid, and indigestible, and the albuminoids decrease, while the dry seeds are readily detached from their glumes and lost with their store of nitrogen.

For different species, however, different times are undoubtedly suitable, and experience must be added to our chemical knowledge to enable a rational decision to be arrived at.

This work was inaugurated by Dr. Peter Collier, as chemist to this Department, and the laboratory work for the first year was in the hands of Henry B. Parsons, Mr. Charles Wellington, and myself. The remainder of the work has been under my own supervision, and has been almost entirely carried out by Mr. Miles Fuller and myself."

From the foregoing statements, we conclude that grasses of the better grazing districts, when grown in a dry season, make the best feed, but usually less in quantity. Grasses grown in sunny weather are better than those grown in cloudy weather or in the shade. Woodland pastures are proverbially lacking in "heart" or nourishment. Grasses grown on marshes or wet land are not so nutritious as those grown on dry land. Grasses grown on rich loam or clay, in fine condition, are more nutritious than those grown on poor, thin soil.

Further statements in regard to the chemistry of **plant growth** will be found in the chapter on red clover.

CHAPTER IV.

CLASSIFYING, NAMING, DESCRIBING, COLLECTING, STUDYING.

Plant Affinity.—In the plant kingdom there are certain genera so closely related to each other that the botanist calls them *families* or *natural orders*. The plants of a family resemble each other in many respects.

"That which really determines affinity is correspondence in structure. It may be said that those plants are most nearly related which correspond in the greatest number of points, and those the most distantly in which we find the fewest points of correspondence. The organs of vegetation are of very different degrees of value in determining resemblance of structure. All constant characters of whatever nature, require to be taken into account in classifying plants according to their natural affinities. Whatever points of structure are variable in the same species, or in species nearly allied to each other, are unessential and should