be compared with those obtained with wire, it is necessary to consider the length of line used. The entire length of the wire or cord was not used in all the ascensions, and the differences between the heights given and the length of wire should not be understood to imply that the angular heights were low. Altitudes approximating 1 mile were reached on July 20, 22, 23, and August 1, 1896, and none of these ascensions occupied over six hours. The ascension of July 20 was managed by three men, although the average strain upon the wire was from 80 to 100 pounds, and the maximum, 125 pounds, or nearly 2 pounds for each square foot of kite surface. On July 23 two ascensions of 2,600 and 5,000 feet, respectively, were accomplished between 1 p. m. and 7 p. m., the usual stops at each 500 meters being included in this time.

In the following tables appear some details of two of our highest ascensions which serve to show the method of conducting the ascensions. Observations are made almost every minute, but it was considered unnecessary to include every observation. Stops were made every 300 or 500 meters, or oftener, from 3 to 5 minutes usually, and kites were attached whenever the angle of the wire at the reel was 5° or more lower than that of the instrument. The dimensions of the kites used are as follows:

Designation of Eddy kite.	Length of sticks.		Total weight of kite.	Approximate area.
	Vertical stick.	Cross stick.		
	Inches.	*Inches.*	*Pounds.*	*Sq. ft.*
4-foot	48	48	0.7	7.5
5-foot	60	60	0.9	11.5
6-foot	72	72	1.6	16.5
7-foot	84	84	2.0	22.0
9-foot	108	108	3.7	35.5

Ascension of July 20, 1896.

Time.	Line out.	Pull on line.	Angle of recording instrument.	Corrected maximum altitude of instrument above hill.	Remarks.
	Meters.	*Pounds.*	°	*Meters.*	
9.15 a. m.	0	....	....	0	Instrument left ground supported by one 6-foot and one 9-foot Eddy kite.
9.25-30 a. m.	300	....	47.0-50.0	233	
9.37-40 a. m.	620	....	48.5	456	6-foot Eddy kite attached.
10.29-38 a. m.	900	....	42.7-48.5	660	Upper kites entered base of strato-cumulus cloud; electricity faint; kites occasionally hidden by clouds.
10.43-47 a. m.	1,200	50-125	41.3-46.2	851	
10.51-54 a. m.	1,500	60-85	35.1-37.5	895	
11.02-04 a. m.	2,000	....	36.6-38.0	1,208	
11.13-14 a. m.	2,500	....	38.4-39.2	1,550	
11.26-29 a. m.	3,000	....	31.1-34.2	1,654	Electricity strong.
11.39-51 a. m.	3,430	....	....	....	Kites hidden by clouds.
0.14-19 p. m.	3,030	110	37.7-36.4	1,817	
1.08-10 p. m.	2,000	125	35.3-33.8	1,134	
1.42-50 p. m.	1,400	110	32.7-34.2	769	Kites below clouds.
2.20-23 p. m.	900	....	31.8-34.9	504	
2.34-38 p. m.	610	95	30.0-31.3	311	
2.49-51 p. m.	300	....	34.9-37.2	177	
3.03 p. m.	0	....	....	0	On ground.

Ascension of August 1, 1896.

Time.	Line out.	Pull on line.	Angle of recording instrument.	Corrected maximum altitude of instrument above hill.	Remarks.
2.19 p. m.	0	....	....	0	Left ground; instrument supported by two Eddy kites, one 6-foot and one 9-foot.
2.34-39 p. m.	500	....	25.0-47.0	358	9-foot Eddy kite attached.
2.50-51 p. m.	1,000	100	28.0-30.5	497	
3.02-07 p. m.	1,500	....	45.2-51.5	1,152	Electricity faint; 6-foot Eddy kite attached.
3.20-23 p. m.	2,000	130	30.0-33.3	1,076	
3.50-59 p. m.	2,500	....	33.5-36.5	1,459	6-foot Eddy kite attached.
4.08-18 p. m.	3,000	....	31.0-34.9	1,682	4-foot Eddy kite attached.
4.22-52 p. m.	3,420	100	30.0-37.5	2,043	
5.18-20 p. m.	2,500	....	35.0-35.5	1,425	
5.51-53 p. m.	1,500	....	43.0-44.5	1,030	
6.07-09 p. m.	1,000	....	42.5-44.6	688	
6.26-28 p. m.	500	....	43.9-43.3	340	
6.39 p. m.	0	....	....	0	On ground.

Remarks.—On July 20, the weather was cloudy, the wind from the south and southwest, the mean velocity increasing from 19 miles an hour at 9 a. m., to 33 miles an hour at 3 p. m. Rain began at 3.50 p. m. Maximum temperature of day 74°, minimum 59°.

On August 1, the weather was clear, wind variable before 1 p. m. and very light; the mean velocity at 2 p. m. was 16 miles, and at 6 p. m. 20 miles, varying between 11 and 26 miles an hour during the ascension. The direction from 2 p. m. to 6 p. m. was west and southwest. Maximum temperature 73°, minimum 52°.

The instrumental records of humidity, temperature, and wind velocity are very valuable and interesting. The records at different levels give approximate sections of the upper air, and the changes occurring at different levels can be determined very easily. The directions assumed by the different kites of the tandem also indicate the direction of the wind prevailing at the level of these kites, which in many instances is different from that at the earth's surface. The differences on days when the sea breeze prevails are specially marked, and on one occasion two kites less than 200 feet apart were flying in opposite directions, the lower being sustained by the easterly sea breeze, while the upper was supported by the westerly wind prevailing above the sea breeze. The height and the thickness of the low stratus clouds are easily measured by the tandem line, especially in many instances where the clouds are too uniform to be observed with theodolites. On July 20 the humidity rose from 70 to 100 per cent when the instrument entered the strato-cumulus cloud at 2,070 feet, and afterward at a height of 5,000 feet it fell to 68 per cent or lower, as the dryness was so great that the ink evaporated from the recording pens, showing that the air became very dry above the moist current of air supporting the cloud. The vertical decrease of temperature with elevation is found to be greatest immediately preceding and during cold waves and least before and during warm waves. At elevations between 1,000 and 2,000 feet the wind velocity is about 25 per cent higher than at the summit of Blue Hill.

The results, in detail, of the kite experiments, are being prepared for publication in the Annals of Harvard College Observatory, and the present sketch is intended only to show, to a limited extent, the possibilities of this method of exploring the upper air. It will be seen that the altitudes already reached have been limited in every case by the amount of line employed. With additional length of line and improved apparatus already arranged for and in process of construction, it is safe to predict that altitudes at least twice as great as those already attained will be accomplished.

A HIGH KITE ASCENSION AT BLUE HILL.

By Prof. S. P. FERGUSSON (dated October 9, 1896).

On October 8 the Blue Hill meteorograph was sent up to a height of 9,375 feet above sea level, or 8,740 feet above the summit of Blue Hill, and remained higher than a mile above the hill for three hours. Nine kites, with a total area of about 170 square feet, were used to lift the instrument and the 3 miles of wire; the ascent was completed in about twelve hours, although between 11 a. m. and 1 p. m. the line was drawn down to a height of about 600 feet to remove a defective kite. The ascent from this point was completed in less than ten hours. The record is one of the best we have obtained so far. (The original record is reproduced in fac simile on Chart No. VI.) The altitude scale is much too wide and the correction to the barograph readings at altitudes above 1,600 meters is considerable. The height above given was obtained from angular altitudes observed with a surveyor's transit at the windlass, and has been checked by readings of the barograph. The corrections to the barograph were determined by placing the instrument under an air-pump and

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noting the fall of pressure necessary to raise the pen to the highest point recorded. The time at which the instrument entered the cloud, at 1.58 p. m., is shown by the rise in humidity at that hour, and the time the instrument passed above the clouds is shown by the rapid fall of the humidity between 3 and 4 p. m. As the kites were drawn down, the cloud was again entered, at about 5.30 p. m.; the instrument was left at this height until 8 p. m. The time at which the weather cleared is shown by a decided fall in humidity at 7 p. m. The temperature at the highest point was about 20.2° F., or about 26° lower than the temperature at the observatory. The average strain on the line for several hours, when at the highest elevation, was between 60 and 100 pounds, but after 6 p. m. it became less, and for the entire ascent was between 30 and 55 pounds. A hand windlass was used for winding in the line. Three men—Messrs. Clayton, Sweetland, and myself—did the whole of the work without assistance.

PHENOLOGY.

A general summary of the literature of phenology showing somewhat fully the results already obtained by the study of a great mass of observations was submitted by the Editor in a report of June 30, 1891, but this seems to have formed a volume too bulky for publication. Subsequently a report was made by Prof. L. H. Bailey, of the College of Agriculture in Cornell University, on the general subject of phenology. As the publication of the latter report has been delayed it is thought best to present, through the medium of the MONTHLY WEATHER REVIEW, the following portion which suggests useful work for voluntary observers. It is hoped that the present brief instructions will suffice to stimulate the interest in this subject which would seem to have flagged somewhat in America during the past twenty-five years. As the conservative botanists still retain the use of the Latin language and the reckoning of longitudes from Ferro, 18° 07′ west of Greenwich, the Editor has not ventured to alter these matters.—C. A.

INSTRUCTIONS FOR TAKING PHENOLOGICAL OBSERVATIONS.

By Prof. L. H. BAILEY.

Phenological observations are of two general types, although there is no invariable difference between them; those which record simply the external features of the passing life of plants and animals, and those which attempt to discover or construct some vital connection between life events and climatal environment. The one is concerned chiefly with mere observations, the other with experiment and the philosophy of life courses. While the recording of life-dates may serve either purpose, it must be left to the trained scientist to make the comparisons in the deeper studies of the mutual relationships of climate and periodical phenomena. At the present time I wish simply to indicate the practical methods to be pursued in the taking of notes that shall have permanent value.

Of first importance is the purpose which the observer has in mind. This purpose should be restricted to a definite line of inquiry, and its theme, if it be phenological, should be climate rather than natural history. Let him take one or more of the following subjects:

1. To determine the general oncoming of spring.
2. To determine the fitful or variable features of spring.
3. To determine the epoch of the full activity of the advancing season.
4. To determine the active physiological epoch of the year.
5. To determine the maturation of the season.
6. To determine the oncoming of the decline of fall.
7. To determine the approach of winter.
8. To determine the features of the winter epoch.
9. To determine the fleeting or fugitive epochs of the year.

It is evident that any miscellaneous series of observations will satisfy none of these purposes, unless, possibly, the last. Such plants must be selected as will give unequivocal periods, and which are convenient for observation year by year. The observer must feel that records are valuable in proportion to the number of years over which they extend. Except in determining fugitive epochs (No. 9), observations of a single season alone have little value. Hoffmann's five tests of phenological observations are as follows:[1]

1. As broad a distribution as possible of the given species selected for observation.
2. Ease and certainty of identifying the definite phases which are to be observed.
3. The utility of the observations as regards biological questions, such as the vegetative periods, time of ripening, etc.
4. Representation of the entire period of vegetation.
5. Consideration of those species which are found in almost all published observations, and especially of those whose development is not influenced by momentary or accidental circumstances, as is the dandelion.

Generally speaking, the events which determine the epochs 1, 3, 4, 5, and 6 should be observed upon a definite and well chosen set of plants of limited number, and it is important that the dates should generally represent the average epoch, and not the very first bloom or leaf upon some individual early plant. In recording the leafing of plants, the date chosen should be that upon which the leaves are seen to be spread open or expanded so that the upper surface is visible, and not the mere bursting or unrolling of the bud. Hoffman's "Scheme for phenological observations" is essentially that proposed by Linnæus:

a. Upper surface of the leaf first visible or spread open.
b. First blossom open.
c. First fruit ripe.
d. All leaves, or more than half of them, colored.

One should also be careful to select a typical or average plant for observation, and one which is not unduly exposed either to heat or cold, moisture or dryness. The observer should be careful to state if the plant is in wild or cultivated grounds. Most authorities discourage the taking of dates from the same individual plant year after year, although this is one of the most accurate means of determining variations in local climate; but it may not represent the average of a wide range. The safest plan is to take notes upon two or three typical individuals and then to average the observations. The leafing period of some diœcious plants differs between the two sexes. Britton has found,[2] for instance, that "the female in diœcious plants appears to hold its foliage longer than the male." This was "very strongly marked in *Ailanthus glandulosus*, *Acer saccharinum* and *Acer rubrum*,[3] and *Salix alba* and *Salix discolor*, but not in *Populus*." Woods[4] observed, however, that in the cottonwood "the female tree generally drops its leaves first and leafs out last." The observer should also consider that his observations of blooming and leafing correct or check each other, and that, therefore, both epochs should be recorded in the same specimens, so far as possible. Observations should be made every day.

In publishing phenological observations which are taken at a single station, the species of plants should be arranged according to the dates of the events, beginning with the earliest, and not alphabetically. That is, it is generally best to devote the first column to dates, the second to names of the plants, and the third to the events.

The proper method of securing phenological records is to put the matter in the hands of a single person or office for

[1] Hermann Hoffmann, Phanologische Beobachtungen aus den Jahren, 1879-1882, p. 141.
[2] Bull. Torr. Bot. Club, vi. 211.
[3] The maples are not strictly diœcious, but polygamo-diœcious.
[4] A. F. Woods, Bull. 11, Nebr. Exp. Sta.

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