

ART. XXXV.—*Indian Summer*; by JOSEPH E. WILLET, Prof. of Natural Philosophy and Chemistry in Mercer University, Georgia.

A PERIOD of several weeks in Autumn, characterized by smoky atmosphere, equable temperature and cloudless sky, has been known in America as Indian Summer. Several hints as to the cause of this phenomena have been thrown out, but no one of them seems to have been accepted as a sufficient explanation of the facts. The following views have been entertained by the writer for several years, and are presented for the purpose of attracting attention to the subject, with the hope that materials may be collected by observers, the discussion of which may lead to a true theory of Indian Summer.

First, as to the facts.

1. Indian Summer is not confined to North America, but occurs in both hemispheres.

It is so well known in the United States, that no reference need be made to its occurrence here. It is remarkable, however, that it extends on this continent, to very high latitudes.

Sir John Richardson passed the winter of 1848-9 at Fort Confidence, on Great Bear Lake, lat. $66^{\circ} 54'$ N. He remarks,* "with regard to the progress of the seasons, the 'Indian Summer,' as it is called, brought us three weeks of fine weather after our arrival in September."

Kaemtz, in his discussion of the height of the barometer in different seasons, says,† "In the autumn, on the contrary, when the air comes from the south, the south winds predominate; they pour upon the south of Europe the water with which they are charged, and reach us perfectly dry; hence the beautiful weather, that sometimes prevails in the middle of autumn, and which is known in France under the name of *St. Martin's Summer*; in Germany it is called *the summer of old men*; and in North America, *the Indian Summer*."

Dr. Livingstone, in his *Travels and Researches in South Africa*, page 537, when he had arrived at Gonye, lat. $16^{\circ} 38' 50''$ S., says: "Aug. 22. This is the end of winter. * * * * The whole scenery is lovely, though the atmosphere is murky in consequence of the continuance of the smoky tinge of winter. This peculiar tinge of the atmosphere was observed every winter at Kolobeng," (lat. $24^{\circ} 30'$ S.) "but it was not so observable in Londa as in the south, though I had always considered that it was owing to the extensive burnings of the grass, in which hundreds of miles of pasturage are annually consumed. As the

* Richardson's Arctic Expedition in search of Sir John Franklin, p. 297.

† Complete Course of Meteorology, by L. F. Kaemtz, London, 1845, p. 283.

quantity burned in the north is very much greater than in the south, and the smoky tinge of winter was not observed, some other explanation than these burnings must be sought for. I have sometimes imagined that the lowering of the temperature in winter rendered the vapor in the upper current of air visible and imparted this hazy appearance."

Lieut. J. M. Gilliss, in his very interesting work on Chili,* says, "All through March, and the larger half of April, unexceptionably fine weather lasts, though the atmosphere is less transparent by day than during the other seasons, and copious dews at night show its increasing relative humidity. About the close of the former month, or in the first half of the latter, there are usually from ten to fifteen days when it assumes that peculiar appearance between smoke and dry fog which is so notable as the "Indian Summer" of North America. During its continuance there is scarcely any wind; and, as the temperature after noon rises to summer heat, with its fresh southerly breeze, the air is more enervating than at the latter season. Here the resemblance between the two hemispheres ceases. Unlike the North American "Indian Summer," of which, its continuity once broken, there is no return until the following year, the Chilian "verano de San Juan,"† is often interrupted by a renewal of the periodic winds with greater force, or by clouds; and after a day or two, there succeeds another interval, when the air is tranquil and smoky."

In these extracts, we have evidence of Indian Summer in North America, Europe, Africa and South America.

2. Moreover, the indications are, that Indian Summer is a phenomenon of the temperate zone.

I have seen no allusions to it in the writings of travelers in arctic and tropical regions.

As we have seen above, it is distinctly marked in the United States, in Middle Europe, at Santiago in Chili, lat. $33^{\circ} 26' 26''$ S., and at Kolobeng in South Africa, lat. $24^{\circ} 30' S.$, all within the temperate zone. Sir John Richardson, however, noticed it at lat. $66^{\circ} 54' N.$, just beyond the Arctic Circle, and Dr. Livingstone observed it at Gonye, lat. $16^{\circ} 38' 50'' S.$, about 7° within the torrid zone. The former can scarcely be regarded as an exceptional case, as the observation was made just beyond the Arctic Circle. The latter point is clearly within the torrid zone, but the remarks of Dr. Livingstone show its greater predominance in the temperate. He says "it was observed *every winter* at Kolobeng, (lat. $24^{\circ} 30' S.$) but it was *not so observable* in Londa" (in which Gonye is situated) "as in the South," and

* The U. S. Naval Astronomical Expedition to the Southern Hemisphere, vol. i. Chile, page 90.

† St. John's Summer.

that too, notwithstanding, the quantity (of grass) burned in the north (toward the equator) is very much greater than in the south" (toward the Antarctic). If the burnings of the grass were the cause of the smoky atmosphere, then the smokiness should have been more apparent toward the equator; whereas the reverse was so strikingly true, that he abandons his previous notions of a connection, between these burnings and the smokiness, of the nature of cause and effect.

3. The season when it appears and the period of continuance of Indian Summer seem, from the above, to be slightly different in different countries.

In North America, it occurs in September, October, or November in different years. It is sometimes confined to one well-defined period of two or three weeks, as at Fort Confidence, in Sept., and Oct., 1848. But more commonly it is extended through one-half or more of the autumn; presenting a series of smoky days, followed by a period of variable weather, to be restored again in full force for a short time, running thus interruptedly through two months or more. Kaemtz describes its season in middle Europe as "the middle of autumn," but says nothing of its duration.

In the southern hemisphere, Dr. Livingstone recorded his single remark of smoky weather on August 22d, which, with the reversed seasons of that hemisphere, corresponds with our February, but goes on to say, that this peculiar tinge of the atmosphere was observed every *winter* at Kolobeng. This would locate the South African Indian Summer in June, July and August, corresponding to our December, January and February, which period is two or three months later than our Indian Summer. Lieut. Gilliss describes the Chilian Indian Summer as extending "through the close of March and the first half of April," which corresponds with our September and October. From his further description above and from the collection of his register below, the season appears to be more marked and decided than with us.

4. Another point worthy of remark, is that there are individual days of smoky weather, distributed through the whole year and undistinguishable from Indian Summer, in any particular except the time of duration. Were they prolonged for a week or two, we should have Indian Summer in nearly every month of the year, and the phenomenon would cease to be regarded as peculiarly autumnal.

At this place, lat. 33° 37' N., I have noticed for several years, smoky days in every month, excepting about one month in winter and one in summer. The register by Lieut. A. W. Whipple, U. S. A., of Psychrometric and Climatological observations,* on

* Report of Explorations and Surveys for a Railroad Route from the Mississippi River to the Pacific Ocean. Senate. Vol. iv, appendix H.

his survey across the western plains from Ft. Smith, Ark., to San Pedro, Cal., presents the same fact. During the several months mentioned below, the whole period of the survey, observations of "smoky," "smoky atmosphere" and "very smoky" are recorded on the following number of days.

1853.	No. of days	1854.	No. of days
Aug.	3	Jan.	1
Sept.	6	Feb.	1
Oct.	10	March	1
Nov.	5		
Dec.	3		

The register of Lieut. J. M. Gilliss at Santiago in Chili is still more conclusive; for no month, observed during the years 1850-1-2, is without "slightly smoky," "smoky" or "very smoky" days. The number of such days in each month will appear in the following table, which has been collected from the Meteorological Observations, vol. vi.

	1850.	1851.	1852.
Jan.	6	9	23
Feb.	7	8	24
March,	21	15	26
April,	18	6	16
May,	5	7	10
June,	4	4	4
July,	5	1	9
Aug.	3	4	9
Sept.	4	3	6
Oct.	2	3	
Nov.	2	2	
Dec.	2	6	

Of like character with these individual smoky days may be the "dry fog" described by Kaemtz, *Meteorology*, pp. 469-71, as "common in north and west Germany as well as in Holland" and in other parts of Europe. That of 1783 had remarkable intensity and "presented the following phenomena:—its thickness was such, that in some places objects at the distance of five kilometers (3 miles) could not be distinguished; they sometimes appeared blue or else surrounded with vapor. The sun appeared red, and without brilliancy, and could be gazed at in the middle of the day; at its rising and setting, it disappeared in the haze." The fog appeared on different days in different parts of Europe and Asia—at Copenhagen, May 29th; in France and Italy, from the 16th to the 18th of June; in Norway, June 22d; in Switzerland, June 23d; at Stockholm, June 24th; at Moscow, June 25th; toward the end of June in Syria; and the 1st of July in the Altai. In 1834, Kaemtz noticed others in May, July and August; the one of May seemed to be transferred from place to

place by violent N. E. winds. In these countries (Germany and Holland) the dry fog is coincident with the burning of peat; when the air is dry, the smoke remains suspended in the atmosphere and may be carried away by the winds. The wind always blows from the direction of the peat bogs, when dry fog is manifested; and fogs have frequently been seen coming distinctly from the peat bogs." "The very thick dry fog of 1834 came partly from the combustion of peat, and partly from the fires for which this year was noted." "To the same cause, probably, may be attributed the particular aspect of the air in autumn. In the fine days, when the air is very dry, the air is less transparent; distant objects are not seen distinctly, they appear surrounded by a slight fog." "Can the dry fog of 1783, which was diffused over a great portion of Europe, be attributed to the same cause?" Popular superstition in Europe attributes to this "dry fog" "the disease of smut in corn, and diseases in vegetables generally," and "the predominance of the north winds which then prevail, and they say that it drives away rain and storms, and is a cause of cold."

The above description of "dry fog" accords very well with the appearance of many occasional smoky days in this country, which, if they occurred in autumn, would be styled Indian Summer. Relying upon the description alone, I am inclined to class them together. Kaemtz, also, in the description above, of "the particular aspect of the air in autumn," seems to allude to the German Indian Summer, and thus connects together the phenomena of dry fog and Indian Summer.

So much for the facts, let us now turn to the theory of Indian Summer.

Any theory, to be complete, must equally apply to these occasional smoky days, which are distributed throughout the year; for these present exactly the same characteristics, and are noted by observers, as Lieut. Whipple and Lieut. Gilliss, in precisely the same terms, as the groups of autumnal days, commonly called Indian Summer.

Without alluding to previous theories on the subject, I suggest the following:

1. The smokiness is produced by real smoke, proceeding from the ordinary fires employed in preparing food, etc., or from extraordinary fires in the burning of grass, brushwood, etc. This is an evident and a sufficient cause, and it is unphilosophical to seek for others, until this is shown to be inadequate to the given effect.

Moreover, Kaemtz, as above, plainly ascribes the smokiness of "dry fogs" to the smoke from peat bogs. What is more to the point, Prof. Henry, in allusion to "dry fogs," remarks;*

* Patent Office Report. Agriculture. 1858, pp. 458-9.

"The nature of these fogs is now pretty well understood, and more refined observations, particularly with the microscope, have served to dissipate the mystery in which they were formerly enshrouded. When a portion of the air in which the fog exists is filtered, as it were, through water, and the substance which is retained, is examined by the microscope, it is found to consist of minute fragments, in some cases, of burnt plants, and in others of the ashes of volcanoes." "Samples of substances which have been collected from rain water and examined microscopically by Prof. Schaeffer, of Washington, at the request of the Smithsonian Institution, have been found to consist of portions of plants, which must have come from a great distance, since the species to which they belong are not found in abundance in the localities at which the specimens were obtained. It is highly probable that a portion of the smoke or fog-cloud produced by the burning of one of our western prairies is carried entirely across the eastern portion of the continent to the ocean." In reference to Indian Summer, Prof. Henry remarks, "Though the first announcement of the proposition by some of our earlier meteorologists, that the peculiar condition of the atmosphere known as Indian Summer might be produced by the burning of the prairies, was not thought worthy of any comment, yet the advance of science in revealing the facts I have stated, renders this hypothesis by no means unworthy of attention."

Although these extraordinary fires may furnish the smoke for extraordinary manifestations of smokiness as in "dry fog" or unusually dense Indian Summer, yet I think too little importance has been attached to the smoke from ordinary fires. Immense volumes of smoke ascend daily from these, and it is not improbable that the majority of smoky days derive their smokiness from these ordinary sources.

2. Atmospheric currents, subsiding from higher to lower regions, would produce smokiness by depressing the smoke, and by coming under greater pressure would become relatively dry, and would thus produce relative dryness and equableness of temperature during their continuance.

Every meteorologist has, doubtless desired an indicator or vane for descending currents. Can any be devised more sensitive than smoke? The direction of horizontal currents is constantly determined by the swaying wreaths of smoke from chimneys. If the rising columns of smoke remain suspended in the lower atmosphere and hang like a smoky veil over the whole landscape, why may not the phenomenon be referred to descending currents of air? Why not follow the indications of the vane? If the smoke bends toward the north, east, south, or west, we attribute it to a wind from the opposite quarter. If it

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bends toward the earth, why not attribute it to a current from above? Mainly from the fact, that we are less familiar with descending currents, and that from the want of an indicator, we know less of their habitudes.

3. This subsiding of atmospheric currents may occur at any time, when circumstances favor; but it will be most apparent, when a conjunction of circumstances render them continuous through a series of days, as in the autumn.

Hence smoky days may occur in every month of the year, and a succession of them is called Indian Summer—near the autumnal equinox, when the violent disturbing elements of summer heat and winter cold are at a minimum. The vernal equinox would seem to be equally favorable with the autumnal; but, in the former case, a hemisphere cooled by the winter's cold and heating up under the advancing warmth of the season may be less favorable to a stable equilibrium of the atmosphere, than the same hemisphere heated by summer and cooling by radiation during the autumn.

4. Descending currents of air are supposed to occur most in the temperate zones, and Indian Summer seems to be a phenomenon of the same zone.

Kaemtz seems to think that the trade winds return toward the poles as an upper current and settle to the earth about lat. 30° and thence flow as a surface current toward the poles, returning to the equator by some route not well indicated. American meteorologists* think that the atmosphere of a hemisphere is divided into three systems, with upper and lower currents, and with belts of rains or of calms where the systems meet. But all agree as to the descent of the upper currents, whether from the equator or from the poles, to a greater or less extent, over the temperate zone and these may, when other circumstances favor, depress the smoke and produce Indian Summer.

In the above discussion, I have attempted to show that Indian Summer, the occasional smoky days distributed throughout the year, and probably dry fog are similar if not identical phenomena, and attributable to the same cause; that the smokiness is due to ordinary smoke derived from the ordinary or extraordinary fires of a country; that the smoke is held suspended in the lower portions of the atmosphere by descending currents of air; and, finally, that the phenomena seem to prevail most in autumn and in the temperate zones, and the descending currents originate in the subsidence toward the earth of the upper currents from the equator or from the poles.

In conclusion, it is proper to say, that, by examination of the

* See an able paper on the subject by Prof. Henry, Patent Office Report. Agriculture, pp. 471-7. Also Maury's Physical Geography of the Sea. Also a paper by W. Farrel, this Journal, II, xxxi, No. 91.

only complete register, that of Lieut. Gilliss, in my possession, I have not been able to connect the views here presented with the indications of the barometer. This was hardly to be hoped for, from a single register, at one locality.

Indian Summer prevails over a large extent of territory, and its laws must be evolved by the discussion of many registers kept at places distributed over the whole territory. Smokiness is rarely recorded by observers among the phases of the sky, and hence previous registers throw little light upon the subject. Should the attention of observers, hereafter, be directed to this phase, the mass of observations thus obtained may show whether the phenomena are simultaneous or consecutive over a large extent of country; whether the barometer rises or falls, &c.; and may elicit some law favorable or unfavorable to the views above suggested; but which will remove the mystery, which has so long hung around the subject of Indian Summer.

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