of plants. These summaries are so systematically arranged that they must prove of the greatest help to plant physiologists.

ALLIED to the foregoing is Dr. F. J. Alway's paper, "Studies on the Relation of the Nonavailable Water of the Soil to the Hygroscopic Coefficient" (Research Bull. No. 3, Agr'l. Expt. Station of Nebraska).

AMONG the recent pathological papers are: M. T. Cook's Report of the Pathologist for the year 1912 (N. J. Expt. Station) enumerating especially the diseases of the year; Ethel Field's Fungous Diseases Liable to be Disseminated in Shipments of Sugar Cane (Circular 126; Bureau of Plant Industry, U. S. Dept. Agric.); Adeline Ames's New Wood-Destroying Fungus (*Bot. Gaz.*, May, 1913); P. J. O'Gara's Studies on the Water Core of Apples (*Phytopathology,* April, 1913), and Organization and Methods of Control of Plant Diseases (Wash. State Hort. Assn., 1913).

HERE may be mentioned H. R. Cox's paper, "Controlling Canada Thistles" (Farmer's Bulletin 545, U. S. Dept. Agr.), containing a good deal as to the biology of these weeds, as well as practical suggestions as to how they may be eradicated.

HERE too should be noted O. F. Cook's "Wild Wheat in Palestine" (Bull. 274, Bureau of Plant Industry, U. S. Dept. Agric.), describing "a new type of wheat growing in a wild state" in Palestine. Though this paper "does not attempt to reach a final decision on the question whether the wild wheat of Palestine is the true ancestor or prototype of the domesticated varieties of wheat," it does serve to bring out "several additional facts regarding the character and habits of the plants."

THE NEW VOLUME OF THE SYLLOGE FUNGORUM

QUITE recently the twenty-second volume of this work reached American subscribers. It is a continuation of the "Supplementum Universale" of the twenty-first volume, and includes the descriptions of added species of fungi to the end of the year 1910. Like the volume immediately preceding, it is the joint work of P. A. Saccardo and Alex. Trotter. It is devoted to the Ascomyceteae (pp. 1–822) and Deuteromyceteae (pp. 823–1505). A Repertorium of 24 pages, an Alphabetical Index of species (69 pages), and an Index of Genera (13 pages) close the volume.

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SPECIAL ARTICLES

THE SOLAR SPECTRUM AND THE EARTH'S CRUST

PROFESSOR ROWLAND'S list of the elements whose lines appear in the solar spectrum has long been a classic work of reference among astronomers, and Dr. F. W. Clarke's summary of the chemical composition of the earth's crust occupies a similar position among geologists. Each list has been thoroughly discussed, by various writers, from the standpoint of the science to which it belongs; but little attention seems to have been called to the striking resemblances between the two.

In the annexed table are given (1) Rowland's list of the elements whose dark lines appear in the integrated spectrum of the sun, arranged in the order of the combined intensity of the lines of each element, as quoted in Abbot's "The Sun," p. 91 (1911); (2) a similar list of the elements, arranged in the order of the intensity of their bright lines in the spectrum of the solar atmosphere, as photographed at the total eclipse of 1905 by S. A. Mitchell[1]; (3) Clarke's table of the percentage composition of the outer ten miles of the earth's substance, including the lithosphere, hydrosphere and atmosphere,[2] and (4) the average composition of ninety-nine stony meteorites, as derived by G. P. Merrill from published analyses.[3]

[1] *Astrophysical Journal,* 38, 407–495, and 39, 166–177, 1913–14.

[2] As given by him in Bulletin 491 of the U. S. Geological Survey, pp. 27–33, with additional data from papers in the *Proceedings of the American Philosophical Society,* Vol. 51, p. 220, 1912, and the *Journal of the Washington Academy of Sciences,* Vol. 4, pp. 59–62, 1914.

[3] Quoted by Clarke on p. 39 of the work first cited.

Solar Spectrum, Dark Lines (Howland)		Chromosphere, Bright Lines (Mitchell)	Earth's Crust, Outer 10 Miles (Clarke)		Stony Meteorites (Merrill)	
1	**Ca**	Fe	**O**	49.85%	O	35.75%
2	**Fe**	Ti	**Si**	26.03	Fe	24.52
3	**H**	H	**AL**	7.28	Si	18.20
4	**Na**	Cr	**Fe**	4.12	Mg	13.80
5	**Ni**	Ca	**Ca**	3.18	S	1.85
6	**Mg**	V	**Na**	2.33	Al	1.45
7	**Co**	Sc	**K**	2.33	Ca	1.25
8	**Si**	Zr	**Mg**	2.11	Ni+Co	1.32
9	**Al**	C	**H**	0.97	Na	0.70
10	**Ti**	Mn	**Ti**	0.41	Cr	0.34
11	**Cr**	Mg	**Cl**	0.20	K	0.27
12	**Sr**	Ni	**C**	0.19	P	0.11
13	**Mn**	Ce	**P**	0.10		
14	**V**	Nd	**S**	0.10		
15	**Ba**	He	**F**	0.10		
16	**C**	Co	**Ba**	0.09		
17	**Sc**	Y	**Mn**	0.08		
18	**Y**	Sr	**Sr**	0.03		
19	**Zr**	Ba	**Cr**	0.025		
20	**Mo**	La	**Ni+Co**	0.018		
21	**La**	Sa	**V**	0.015		
22	**Nb**	Al	**Zr**	0.013		
23	**Pd**	Er	**Cu**	0.010		
24	**Nd**	Gd	**Zn**	0.004		
25	**Cu**	Na	**Li**	0.004		
26	**Zn**	Si	**Pb**	0.002		
27	**Cd**	Eu	**Br**	0.0006		
28	**Ce**	Zn	**As**	0.0004		
29	**Gl**	Dy	**Cd**	0.00002		
30	**Ge**	Cu	Allowance for all other elements 0.38			
31	**Rh**	Pr				
32	**Ag**	Nh				
33	**Sn**					
34	**Pb**					
35	**Er**					
36	**K**					

All these lists are doubtless incomplete at the lower end. Later researches have shown that oxygen, gallium, ruthenium and all the rare earths given in Mitchell's list, should be added to Rowland's table, raising the number of elements represented to forty-five. The presence of nitrogen is also indicated by the appearance of the cyanogen bands, but not by its own lines. Photographs showing fainter lines would probably considerably extend the list of elements recognizable in the flash-spectrum. The list of elements in the earth's crust is certainly very incomplete below those which form 0.01 per cent. of the total. If carried out to the limit it should of course include all the elements, and it is not yet known what positions some of them, such as the rare earths, would occupy in a complete scheme. The list for the stony meteorites is probably far from exhaustive, and it is not safe to draw conclusions from the failure of some elements to appear in it. It may be added that, according to Farringdon,[4] the average percentage of nickel in meteoric irons is about 7.5, and that of cobalt about one tenth as much, while that of copper averages about 0.02. It would therefore seem reasonable to suppose that the amounts of "Ni + Co" given in the table should be divided between the two metals in about this ratio.

Upon comparing the lists of Rowland and Clarke, we meet at once the fact—one of the commonplaces of astrophysics—that the non-metallic elements, with the exception of carbon and silicon, are scarcely if at all represented in the solar spectrum. The only one whose lines appear is oxygen—which is from 20 to 100 times more abundant in accessible materials than all the others put together (excepting C and Si, as above). If we simply accept this fact (which is still without adequate explanation), and exclude these non-metallic elements from the comparison, the similarity between the order of the remaining elements in the two lists is remarkable.

Of the eight metallic elements (including carbon and silicon under this head for the moment) which are most abundant in the earth's crust, six are among the eight whose lines are strongest in the solar spectrum, and one of the other two comes ninth in the solar list. Of the next eight metallic elements in the terrestrial list, seven are found among the second group of eight in the solar list, and the other one (Ni) is among the first eight. That is, fifteen of the sixteen leading metallic elements are common to the two lists, and there is a general similarity in their relative order in the two.

Beyond this point comparison becomes hardly practicable, as the terrestrial list is probably incomplete. Four of the next eight elements in Rowland's list are rare earths, for which there are as yet no sufficient analytical

[4] Publications of the Field Columbian Museum, Geological Series, Vol. 3, No. 5, p. 110.

data. It is clear, however, that the elements whose lines are faint in the sun are, in general, present in but very small proportions in the earth's crust.

It is very remarkable that the correspondence of the two lists is so close, in view of the radical differences in the methods of investigation, and the great differences in the relative intensities of the lines in stellar spectra of different types. Even in the bright-line spectrum of the solar atmosphere, the similarity is by no means as pronounced.

Out of the first sixteen elements in either list, only one, barium, has an atomic weight exceeding 100, and but one other, strontium, one greater than 60. The significance of this fact has frequently been discussed by geologists or by astronomers.[5] In both cases it has been suggested that the heavier elements lie for the most part deep within the body, and out of reach; but Clarke gives good reasons for believing that, even in the earth's interior, the lighter elements are more abundant than the heavier. This suggests that the faintness or absence of the lines of the heavier metals in the solar spectrum may be due largely to the small proportions in which they occur, and some confirmation of this is found in the fact that, of the elements of atomic weight greater than 180, only lead, which is the most abundant in the earth's crust, appears at all in the sun. But the rarity of these elements can not be the whole explanation of their absence from the solar spectrum, for although no lines of Os, Ir or Pt occur in it, the stronger lines of the equally rare elements Ru, Rh and Pd (whose atomic weights are about half as great) appear distinctly, though faintly.

The element which is most disproportionately conspicuous in the sun, in comparison with its terrestrial abundance, is cobalt. Nickel too is relatively high on the solar list. This may be partly explained by the great number of lines in the spectra of these elements, which gives them undue weight in a spectroscopic count. It is also worthy of notice that, if 25 per cent. of meteoric iron were added to a sample of the earth's crust, and the composition of the resulting mixture considered, iron would occupy the first place among the metallic elements, nickel the eighth, and cobalt the eleventh, and the discordance with the solar list would disappear. Of the elements abundant in the earth, and relatively less conspicuous in the sun, silicon apparently approaches the typical non-metallic elements in its behavior, while aluminium has only four lines in the observable region, and is thus handicapped by the spectroscopic method of detection.

The principal differences in the order of the metallic elements in the two lists are therefore easily explicable, with one conspicuous exception. Potassium, which is one of the principal constituents of the earth's crust, and is fairly abundant in meteorites, shows as the merest trace, if at all, in the solar spectrum, although many strong lines, both of the principal and the subordinate series, lie in the observed region. Their absence, in spite of the presence of conspicuous lines of elements which are far less abundant in terrestrial materials, is remarkable, and would seem to demand some special explanation. It is of interest in this connection that potassium, alone among the more common elements, is slightly radio-active. If this indicates that its atoms are relatively unstable, they might break down under solar conditions; but this is a highly speculative consideration. The lines of the more strongly radio-active elements do not appear at all in the solar spectrum; but this may be accounted for by their extreme rarity (on earth, at least) and their high atomic weights. It should however be mentioned that lithium, which is next to potassium in abundance among the alkali metals, and occurs in sensible proportions in the earth's crust, but, so far as is known, is not radio-active, is also practically absent from the solar spectrum—though Adams[6] points out that a very faint line, greatly strengthened in sun-spots, at wave-length 6708.08 may represent the strongest line in the lithium spectrum.

[5] Compare Clarke, *op. cit.*, p. 33, and Abbot, "The Sun," pp. 92–94, 253–254.

[6] *Astrophysical Journal*, Vol. 30, p. 92, 1909.

In spite of these exceptions, the agreement of the solar and terrestrial lists is such as to confirm very strongly Rowland's opinion that, if the earth's crust should be raised to the temperature of the sun's atmosphere, it would give a very similar absorption spectrum. A moderate admixture of meteoric material would make the similarity even closer.

In conclusion, the writer desires to express his very hearty thanks to Dr. Clarke, for valuable information on the geochemical side of the problem, and for the suggestion that the comparison here made (which has been given in the writer's lectures for several years) may contain enough that is unfamiliar to justify its publication.

Henry Norris Russell
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May 5, 1914

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION K—PHYSIOLOGY AND EXPERIMENTAL MEDICINE

At 4:30 o'clock on the afternoon of Friday, January 2, 1914, Section K met at the Atlanta Medical College, Atlanta, Georgia, with Vice-president Theodore Hough in the chair. The address of the retiring Vice-president, Dr. John J. R. Macleod, entitled, "The Physiological Instruction of Medical Students," was read by title owing to the lateness of the hour.

The Section then began the symposium on the subject of pellagra. The first speaker, Dr. J. W. Babcock, superintendent of the State Hospital for the Insane, at Columbia, S. C., spoke on the "Medico-Legal Relations of Pellagra." Dr. Babcock has not sent to the secretary an abstract of his remarks.

Captain J. F. Siler, of the U. S. Army Medical Corps, Dr. P. E. Garrison, U. S. N., and Dr. W. J. MacNeal, assistant director of laboratories, New York Post-Graduate Medical School, presented a paper read by Dr. MacNeal entitled, "Further Studies of the Thompson-McFadden Commission on the Etiology of Pellagra." An abstract follows.

"The Entomological Aspects of the Pellagra Investigation of the Thompson-McFadden Commission" was presented by Mr. A. H. Jennings, of the Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.

Report of the Thompson-McFadden Pellagra Commission:

Information concerning the age and sex, occupations, location of domicile, general dietary habits and concerning the existence of pellagra was obtained upon about five thousand persons by a house-to-house canvass of six cotton-mill villages. A similar study was carried out in one rural district of four square miles in which several cases of pellagra had occurred. Many other communities were studied in less detail. There was no definite relation observed between the occurrence of pellagra and the use of any particular foods. New cases developed for the most part in the immediate vicinity of old cases or after close association with them. In districts completely equipped with water carriage systems of sewage disposal, we found pellagrins who had acquired the disease before moving to these districts. Cases apparently originating in these sewered districts were extremely rare and their origin there somewhat doubtful.

These observations strongly suggest that unsanitary methods of sewage disposal have an important relationship to the spread of pellagra. If these indications can be confirmed in other places, we feel that the proper correction of these conditions by the installation of water carriage systems of sewage disposal will go far toward restricting the spread of the disease.

The exact mode of transmission of pellagra is still uncertain and we strongly urge the continued study of food contamination, of insects as transmitting agents and of close personal association as possible factors in its spread.

Summary of Two Years' Study of Insects in Relation to Pellagra: Allan H. Jennings.

The results of a study by the writer and W. V. King, in cooperation with the Thompson-McFadden Pellagra Commission in Spartanburg county, S. C., are here summarized, the observations and conclusions referring to conditions in that region except where otherwise stated.

Infectiousness of the disease and its transmissibility by blood-sucking insects were assumed, purely as a necessary basis for our work.

A high percentage of female cases, especially among home-frequenting individuals and among children of both sexes is a marked characteristic of the disease, a transmitter which is active by day being thereby indicated.

The characteristics of the insects studied justify