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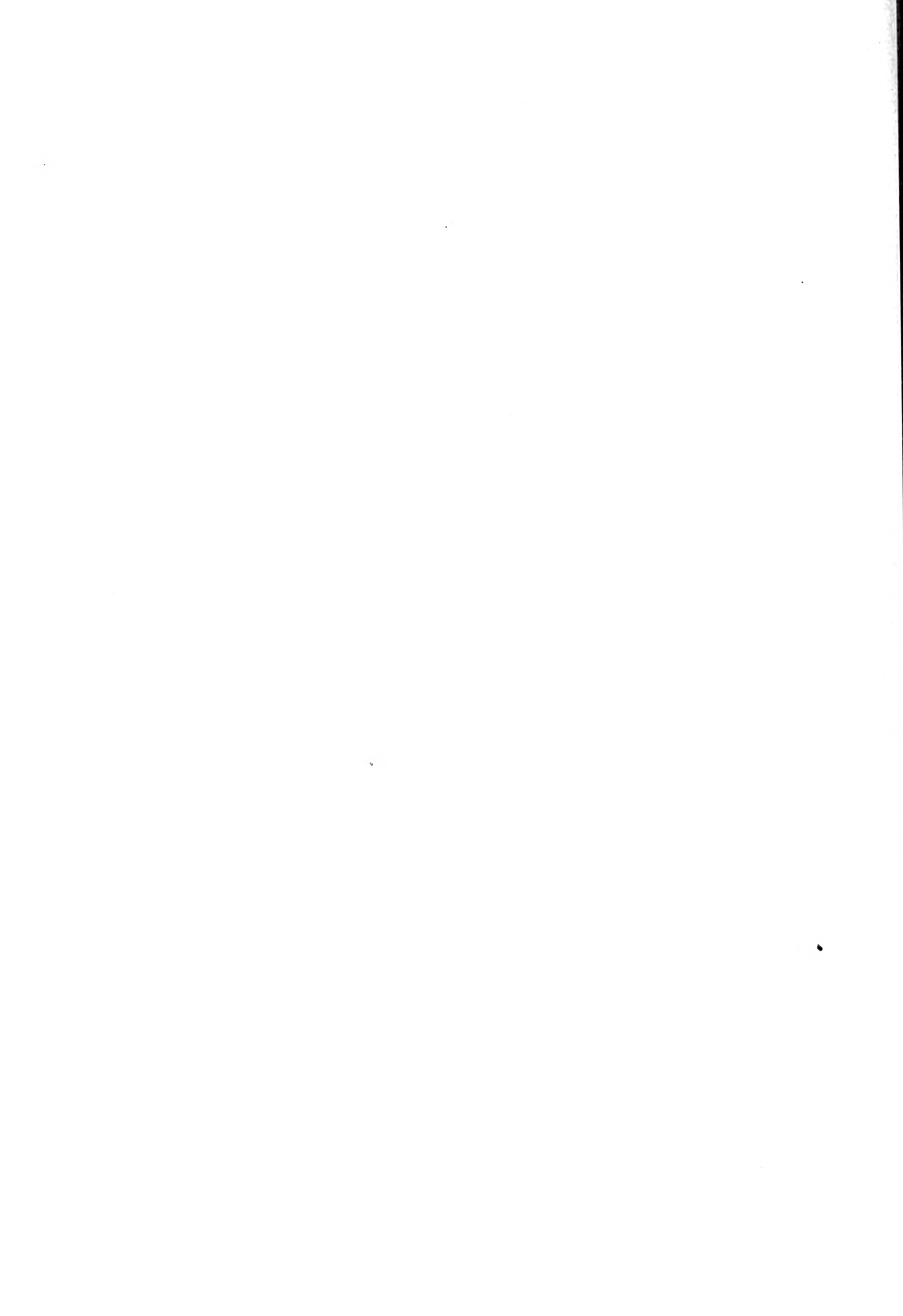
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JOURNAL

OF THE

Elisha Mitchell Scientific Society.

ON THE DETERMINATION OF AVAILABLE PHOSPHORIC ACID IN FERTILIZERS CONTAINING COTTON SEED MEAL.

BY F. B. DANCY, A. B.

The term *available* phosphoric acid is used to denote the difference between the *total* phosphoric acid in a fertilizer and the *insoluble*. The *total* phosphoric acid is the entire amount of phosphoric acid, of whatever kind, that the fertilizer contains. The *insoluble* phosphoric acid is, as generally accepted, that phosphoric acid which is left after two grams of the fertilizer, ground to pass a sieve of approximately twenty meshes to the linear inch, have had the *soluble* phosphoric acid extracted with cold water and then been digested for thirty minutes, with agitation every five minutes, at 65° C., with one hundred cubic centimeters of a strictly neutral solution of ammonium citrate of a specific gravity of 1.09, immediately after which digestion they have been thoroughly washed with cold water.

The *available*, then, being the difference between the *total* and the *insoluble*, it follows that *insolubles* being equal, the *available* varies exactly and directly as the *total*; and *totals* being equal, the *available* varies exactly, though inversely, as the *insoluble*.

The *total* is a definite and fixed quantity, and there should, therefore, be no material variation in its determination between the work of accurate analysts. Not so with the others. The

soluble, insoluble, reverted, and available are not fixed and definite quantities. They are dependent on so many conditions of time, temperature, degree of fineness, quality and quantity of solvent, agitation, etc., that it is no matter of wonder that even skillful manipulators vary in their determination. They are the results of methods, and will vary according to the method or the manner of executing the details of the method. But, as has been remarked and as its name implies, the *total* is *all* the phosphoric acid in the material under examination, of whatever kind and in whatever shape or form. It is not what is gotten by a method, but *what there is there*, and any method, therefore, that fails to reach any part or kind of it is not a method for *total* phosphoric acid. It is sometimes said that discrimination is impracticable, and that all fertilizers should be treated equally and alike. The position is untenable. It might as well be urged that in order not to discriminate the plain soda-lime method for the determination of nitrogen should be used on all fertilizers, those containing nitrates as well as those containing organic nitrogen alone, when every one knows that it is inadequate in the presence of nitrates. So a *total* method which is adequate for some kinds of fertilizers, but not for others, cannot be applied to all on the above ground or any other ground, without manifest injustice to those fertilizers for which the method is inadequate.

The Association of Official Agricultural Chemists in their official methods (Bulletin 24, United States Department of Agriculture) give three alternate methods of determining *total* phosphoric acid. There is no distinction made between them, no indication that either is better adapted than the other for any particular class of fertilizers. The presumption is, that they are given as interchangeable and equally allowable for all classes of fertilizers, at the pleasure or option of the operator. It is the purpose of this article to show that one of them, at least, is entirely inadequate for fertilizers that contain cotton seed meal, and that any chemist who uses this method on such fertilizers is in almost certain danger of doing these fertilizers a great injustice.

The method referred to is the second of the three given, namely: "Solution in thirty c. c. of concentrated nitric acid with a small quantity of hydrochloric acid." The writer has not extended his investigation, except imperfectly, to the other two methods. It is only with this one, as applied to cotton seed fertilizers, that this article has to do.

Cotton seed fertilizers are comparatively unknown in the North. It seems, therefore, that the Southern members of the A. O. A. C. must not have been very wide-awake to the interests of a class of fertilizer manufacturers peculiar to their own section of country when they failed to have attached to this method, at the time when it was adopted by their Association as one of three alternate methods, the limitation "not applicable to fertilizers containing cotton seed meal."

Cotton seed meal is readily and entirely soluble in either "nitric acid with a small quantity of hydrochloric acid" or in nitric acid alone. *But such a solution does not give up its phosphoric acid to molybdic solution.* It would appear that certain nitro-organic compounds are formed which prevent the phosphoric acid in the solution from being yielded up to the molybdic precipitant. Whether this is effected by in some way rendering the menstruum a solvent for the phospho-molybdate of ammonia that ought to be formed, or, by holding the phosphoric acid in check, serves thus to prevent such a combination, is not clear. But the fact remains. The attention of the writer was first forcibly directed to it when a sample of cotton seed meal was submitted to him for a determination of the *available* phosphoric acid it contained. A nitric acid solution of two grams of it was made (using also a little hydrochloric acid), the solution being perfect, and a total phosphoric acid percentage of 0.51 found. A duplicate made in the same way yielded 0.54 per cent. Being convinced that there was much more phosphoric acid in the meal than this, and recalling that a short time previously a gentleman had remarked that a friend of his had found materially more phosphoric acid in the ash of cotton seed meal than by acid solution, two grams of the meal were ignited to perfect ash, the ash

dissolved in acid, and a percentage of 3.24 of *total* phosphoric acid found; a duplicate in the same manner yielded 3.20, though in this case the incineration was not quite so perfect, a little char being left. The true per cent. of *total* phosphoric acid in the meal then was 3.24. A solution of two grams made by hydrochloric acid with chlorate of potash also failed by something more than half of getting the full amount. This yielded 1.45 per cent. Next two grams of the meal were taken, washed with cold water in exactly the same manner as when extracting the *soluble* phosphoric acid from an ordinary fertilizer, then digested with citrate solution and again washed exactly as is done in the determination of *insoluble* phosphoric acid. The residue was ignited and the phosphoric acid determined. It was found to be 0.24 per cent. So not only did a cotton seed meal which showed only half a per cent. of *total* phosphoric acid to a nitric acid solution contain in reality three and a quarter per cent., but three per cent. of this three and a quarter per cent. was *available* by the methods of analysis.

A cotton seed meal fertilizer may easily contain one-third cotton seed meal, and, if the meal had the composition of that examined above, would owe one per cent. of its *available* phosphoric acid to the meal. If, therefore, such a fertilizer were to be analyzed by the nitric acid method, it would theoretically show a shortage of nearly one per cent. of *available* phosphoric acid (0.90 exactly). While none of the experiments herein given exhibit as great a disparity as this, some approximate it, and it is believed that a disparity fully equal to this is quite possible. Whether the entire disparity is always due to the retention of the phosphoric acid of the meal alone, or whether in some cases the meal, while holding some of the phosphoric acid of the phosphate in check, gives up more of its own, or whether, in other cases, the phosphoric acid of the phosphate in precipitating carries more of the meal's phosphoric acid down with it than would otherwise go and thus lessens the disparity, is not clear. I am inclined to think that new and fresh meal will exhibit this peculiarity in a greater degree than old meal, though of that I

cannot speak definitely. However that may be, there seems to be not much doubt that the disparity will be greater or less according to various conditions not well understood, and may vary from a third or a half of a per cent. to even as much as one per cent.

Six fertilizers containing cotton seed meal were chosen. They were not laboratory mixtures, but *bona fide* commercial fertilizers on sale in North Carolina. They will be distinguished as 56, 76, 77, 78, 110 and 57. In each the phosphoric acid was determined by dissolving two grams in nitric acid plus a little hydrochloric acid with protracted heating. This is designated in the table below as "acid solution." Then in each the phosphoric acid was determined by incinerating two grams and dissolving the ash in nitric acid. This is designated in the table as "incineration." Following are the results:

Total Phos. Acid....	56	76	77	78	110	57
Incineration.....	10.04	9.77	9.16	9.93	10.07	9.97
Acid Solution.....	9.49	9.13	8.66	9.25	9.56	9.95
Difference.....	.55	.64	.50	.68	.51	.02

No. 57 was an old cotton seed meal fertilizer that had been carried over from last season. The meal had completely changed color to a dark brown, so that to the eye the fertilizer would never have been judged to be a cotton seed fertilizer. In this one alone was there no difference in the results of the two methods.

It is believed that the disparity in all these cases is probably not so great as it should be; that is to say, that the incineration method as here used probably does not give the full content of phosphoric acid, for this reason. The inferiority of the solvent power of nitric acid for phosphates to that of hydrochloric acid is well recognized. I believe that this inferiority is greater when the phosphate has been ignited. To test this an acid phosphate

was chosen, of which two grams were dissolved in nitric acid and hydrochloric acid, and the total phosphoric acid found to be 14.56 per cent. Another two grams were then ignited for about the same length of time that it requires to incinerate two grams of a cotton seed meal fertilizer to complete ash, and then dissolved in nitric acid. The determinations were parallel, so that each received the same amount of heating with acid, which was protracted. In the case of the ignited phosphate, undissolved portions were plainly manifest to the eye, and the percentage found was only 13.62. The undissolved portions were filtered out and readily yielded to hydrochloric acid, giving fulsome precipitate of phosphoric acid. Next, another two grams were ignited and dissolved in hydrochloric acid, when the full content of phosphoric acid was readily yielded. Hence, it is concluded that had hydrochloric acid been used to dissolve the six incinerated fertilizers employed in the above experiments, higher percentages would in all probability have been found. Fusion would have furnished an absolutely certain means of arriving at the undoubted maximum content of phosphoric acid, but time was limited and simple incineration was resorted to on account of expedition; and solution in nitric acid instead of hydrochloric acid was employed after incineration because, as the results were to be compared, it was advisable to employ the same solvent power in each case.

In addition to the six experiments described above attention is called to the following: Two samples of cotton seed fertilizers were procured in which another chemist had made determinations of *total* phosphoric by the nitric acid method. His *totals* were 9.13 and 9.33. I found by incineration and solution in hydrochloric acid 9.85 and 10.13, a difference of 0.72 per cent. and 0.80 per cent. respectively. Taking his own determinations of *insoluble*, the *available* by his analysis was 0.72 per cent. short in the first instance (7.40 per cent. when it should have been 8.12 per cent.), and 0.80 per cent. short in the second instance (7.50 when it should have been 8.30 per cent.). The disparity here is excessive, but the fault is not due to the chemist but to the

method. Being one of the alternate methods of the A. O. A. C., he had no reason to doubt its adequacy.

Having looked at one side of the determination of *available* phosphoric acid in fertilizers containing cotton seed meal, let us turn to the other, namely, the determination of *insoluble*. As almost the entire content of phosphoric acid in the meal has been shown to be available, it might be anticipated that there would be likely not to be much difference in the determination of *insoluble* whether the citrate-extracted residue is first incinerated or dissolved directly in acid. Such was found by experimentation to be the fact. In fact, in every case but one (and this was the same fertilizer that was the exception to the *total* rule, namely, the old one brought from the previous season) a slightly higher *insoluble* was found by dissolving in acid directly than after incineration.

The details of the two methods of determining the *insoluble* were these: After filtering from the citrate and thoroughly washing, the filter and contents were in the first instance incinerated and the ash dissolved in nitric acid (designated in the table below as "incineration"), and in the second instance the filter and contents were introduced directly into flasks and completely dissolved with nitric acid and a little hydrochloric acid (the "acid solution" of the table below). The samples used were the same as those used in the total experiments, with the exception of 110, which was not used.

Insoluble Phosphoric Acid...	56	76	77	78	57
Incineration	0.84	1.80	0.86	0.87	1.59
Acid Solution	1.00	1.91	1.28	1.05	1.42
Difference.....	.16	.11	.42	.18	.....

Whether the excess of *insoluble* by direct acid solution was due to mechanical loss in the incineration by the other method (which in these instances is not at all apprehended, though it is believed that care is necessary to with certainty guard against

such loss), or whether, as is much more likely, it was due to imperfect solution of the ignited phosphate by nitric acid (a danger already pointed out), is not positively shown. But it should be remarked that in the case of 77, which is the case of greatest disparity, the undissolved portions were manifest to the eye, and it is the writer's conviction that had hydrochloric acid been used instead of nitric, there would have been no material difference in the results of the two methods, either in these particular determinations, or in any other determinations. It is regarded as certain, therefore, that there will be found no material difference in the *insoluble* by which ever way determined. This being true, the *available* will vary directly and exactly as the *total*; and, therefore, by just so much as a *total* is short on account of the inadequacy of the nitric acid method when used on cotton seed meal fertilizers, by just so much will the *available* be short.

Now a few words as to what method *is* adequate and a very few experimental determinations on this point, and the subject will for the present be laid aside. It is a matter of regret to the writer that the time was not at his disposal for more extended experimentation on the subject. Nevertheless he is none the less convinced, on account of the limited number of experiments here presented, of the truth of the point urged.

In order to compare the *total* as made by several different methods sample 110 was chosen. This sample was sent by a fertilizer company, who took a fair sample of a large lot of goods at their factory, thoroughly mixed the sample and sent one-half to the writer and one-half to a chemist in another State. The *total* was determined first by fusing two grams of the fertilizer with a mixture of equal parts of carbonate of soda and nitrate of potash, as giving with certainty the maximum content, and furnishing a standard for comparison. It was then determined by incineration and solution in hydrochloric acid, by incineration and solution in nitric acid, by solution direct in hydrochloric acid with chlorate potash, and lastly, by solution direct in nitric acid and a little hydrochloric acid. Following are the results:

Fusion,	10.14 per cent.
Incineration and solution in HCl,	10.09 "
" " " HNO ₃ ,	10.07 "
Solution direct in HCl. + KClO ₃ ,	10.11 "
" " HNO ₃ + little HCl,	9.56 "

From the above it seems that in this case all the methods save the nitric acid method were adequate, but it is not apprehended that this will hold good in all cases. For, while here incineration and solution in nitric acid sufficed, there is certainly the danger of imperfect solution already referred to; and while here also solution in hydrochloric acid with potassium chlorate sufficed, it has already been shown that this method failed to extract, from the meal alone, more than half its content of phosphoric acid. Fusion is, of course, always adequate, but too time-consuming, if any other adequate method less so is at hand. It seems probable that incineration and solution in hydrochloric acid furnishes all that could be desired.

It is in point to add that in this case the writer reported to the manufacturers a *total* of 10.11 per cent., this being an average of the first four determinations. The *insoluble* found by incineration and solution in hydrochloric acid was 1.47, making an *available* of 8.64. It is not known what method the chemist used to which the other half of this sample was sent, but his *total* was 9.72, his *insoluble* 1.50 and his *available*, therefore, 8.22. Note that the two *insolubles* are practically the same, and that, therefore, his *available* is less than the writer's by practically the same amount that the writer's *total* is greater than his.

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THE DISTRIBUTION OF BORACIC ACID AMONG PLANTS.

BY J. S. CALLISON.

Attention was first drawn to the possibility of boracic acid occurring as a normal constituent in certain plants by its discovery in normal California wine.

Baumert* first drew attention to this in 1885, and his results were confirmed by Rising† and Crampton.‡

These observations were extended to other vines by Baumert,§ Soltsein|| and Ripper.¶

It was shown by Baumert and Ripper, especially, to be almost invariably present in wines of all countries, in the stalks, and even in the wild vine (Soltsein). As Crampton says, "There can no longer be any question, therefore, in view of this mass of evidence, that boracic acid is a normal and frequently occurring constituent of the grape plant." He then asks the question, if boracic is so universal a constituent of the grape plant, why not of other plants as well? In answering this question he examined certain plants, as the peach, water-melon, apple, sugar-beet and sugar-cane. Thinking this distribution of boracic acid to be a question of decided importance, I have extended the examination, to many other ashes than those mentioned by Crampton, coming from other classes of plants than fruits, though including also some of the fruits.

The results of my work have confirmed the conclusions that boracic acid is very widely distributed in the vegetable kingdom,

*Landw. Versuchstat. **33**, 39-88.

†Report of Sixth Viticultural Convention, 1888.

‡Amer. Chem. Journal, Vol. II, 227.

§Zeitschrift für Naturwissenschaften, 1887, and Ber. d. deutsch. Chem. Ges. **21**, 3290.

||Pharmaceutische Zeitung **33**, No. 42, p. 312.

¶Weinbau und Weinhandel: Organ des deutschen Weinbauvereins, No. 36, 1888.

and that there seems to be a power of selection on the part of the plants, some having no affinity for and not taking up the boracic acid, though growing on the same soil from which other plants absorb it. We are forced to the belief that it is contained in the soil and that the plants draw it from that source, yet in no case could I detect its presence in the soil, and in no well water examined could I get a test for it. It is easily possible that other waters might contain it. It would be of great interest to extend this examination of natural waters so as to see whether the boracic acid in the soil is in a soluble form or not. It may be present in a form soluble in plant solvents and insoluble in natural waters. Of course it is possible, also, that it is present in such great dilution that the amount of water evaporated failed to give the qualitative tests. My examination of different fertilizing materials revealed the fact that several of the commonest contained boracic acid in appreciable amounts, and hence, by this means, it is being constantly added to soil under cultivation.

Of course stable manure, coming from grain and straw, restores to the soil the boracic acid contained in these.

A further important fact brought out by this research is that every sample of caustic alkali examined contained boracic acid. These samples were from the best known manufacturers, and were marked chemically pure. As these alkalies, especially potassium hydroxide, are used in most of the methods for determining boracic acid, it is manifestly of great importance to secure them free from it as an impurity. I think it possible that the boracic acid in these samples, or at least in some of them, may have come from the glaze of vessels used in their manufacture or from the bottles containing them.

The method of testing was that used by Meisell for the detection of boracic acid in milk.* About one gram of the ash was treated with strong hydrochloric acid and boiled a few minutes to insure solution. It was then filtered from the unburnt carbon, insoluble silica, etc. The filtrate was evaporated to dryness

*Konig's Nahrungsmittel, **2**, 250.

on a sand-bath and the heat continued until the excess of acid was driven off and the residue assumed a white appearance. This was then moistened with very dilute hydrochloric acid (1:100), a few drops of tincture of turmeric were added, and the entire mass dried down on a water-bath. The appearance of the cherry-red or cinnabar-red color was taken as an evidence of boracic acid. The residue was then used for the flame tests. This was made by placing a part of it upon a strip of platinum, moistening with alcohol and igniting. The green flame flashes, best observed by blowing out and relighting the alcohol, were regarded as confirmatory of the turmeric tests. The flame test is, however, not so delicate as the latter, as has also been observed by Crampton.

The relative and absolute delicacy of these tests was also approximately determined. The flame reaction was still clear with .01 gm. of boracic acid, but could not be gotten with .001 gm. This latter amount gave the color reaction, but .0001 gm. failed to give it.

These figures apply, of course, only to boracic acid treated under like circumstances to the ash. 10 cc. of a solution of boracic acid of known strength was evaporated in a small porcelain dish and the residue manipulated exactly as in Meisell's test.

The porcelain dishes used in this research, and other apparatus where the presence of boracic acid might be suspected, were carefully tested and shown free from anything that could conflict with the tests.

The appended table gives the substances examined and the results of the tests. In many cases the tests were carefully repeated to insure accuracy. The specimens were chosen so as to represent as many different classes of plants as possible. In the case of caustic alkalis the evaporation and testing were done in platinum vessels.

The experiments with various chemicals, pure and commercial, were begun with the idea of seeing whether those which might have come from some plant source, contained this substance so generally present in the plants themselves. The caustic

alkalies were examined with a view to their use in the quantitative determination of boracic acid. Some other chemicals, as ferric oxide, were examined to see if they would in any way interfere with the test when present.

The table which follows will need no further explanation. I wish to express my obligations to Dr. F. P. Venable for his guidance and supervision of my work in this research.

Fruits.

No.	Common Name.	Botanical Name.	Flame Reaction.	Color Reaction.
1	Fig, green	Ficus Carica	Yes (faint)	Yes
2	leaves		No	No
3	branches		Yes	Yes
4	Persimmon, green	Diospyros Virginiana	Yes (faint)	Yes
5	leaves		No	No
6	Pear, branches	Pyrus Communis	Yes (faint)	Yes
7	leaves		Yes	Yes
8	Apple, pulp	Malus	Yes (faint)	Yes
	seed		Yes (faint)	Yes (faint)
9	Peach, branches	Prunus Communis	Yes (faint)	Yes
10	leaves		Yes	Yes
11	Honey Locust, pods	Gleditschia triacanthos	Yes	Yes
12	Lemon, pulp	Citrus Limonum	No	Yes
13	rind		Yes	Yes
14	Orange, pulp	Citrus Aurantium	Yes	Yes
15	rind		Yes (faint)	Yes
16	seed		No	Yes
17	Banana	Musa Sapientum	No	Yes
18	Dates, dried		Yes (faint)	Yes (faint)
19	seed		Yes (faint)	Yes (faint)
20	Cherry, branches	Prunus Ceracus	No	No
21	leaves		Yes (very faint)	Yes (faint)
22	Cocoanut, shell	Coco Nucifera	No	Yes (faint)
23	Raspberry, leaves	Rubus Strigosus	No	Yes
24	Blackberry, stalk	Rubus Villosus	No	Yes
25	leaves		No	Yes
26	Strawberry, leaves	Fragaria Vesca	Yes	Yes
27	Grape, Concord			
	leaves	Vitis Labrusca	Yes	Yes
28	stalk		Yes	Yes
29	Wild, leaves	Vitis Cordifolia	No	Yes
30	stalk		No	Yes

Vegetables and Grains.

31	Pea	Pisum Arvense	Yes	Yes
32	Beet, root	Beta Vulgaris	Yes	Yes
33	leaves		Yes	Yes
34	Salsify, root	Fragopogon Porrifolium	Yes (very faint)	Yes (faint)
35	leaves		Yes	Yes
36	Celery	Apium Graveolens	Yes	Yes
37	Wheat, grain	Triticum Vulgare	Yes (faint)	Yes
38	green stalk		Yes	Yes
39	Oats, grain	Avena Sativa	No	Yes (faint)
40	green stalk		Yes	Yes
41	Corn, grain	Zea Mays	No	No
42	cob		No	Yes (very faint)
43	stalk		No	No
44	blades		No	No
45	Maple, branches	Acer Rubrum	Yes	Yes
46	leaves		Yes	Yes
47	Willow, branches	Salix Nigra	Yes	Yes
48	Mulberry, wood	Morus rubra	Yes	Yes (faint)
49	bark		No	No
50	Walnut, branches	Juglans Nigra	Yes	Yes
51	Sumach, berries	Rhus copallina	Yes	Yes
52	branches		Yes	Yes
53	Pine, long leaf, branches	Pinus Australis	Yes	Yes
54	leaves		Yes (faint)	Yes
55	short leaf branches	Pinus Mitis	Yes	Yes
56	leaves		Yes	Yes
57	Dogwood, branches	Cornus Florida	Yes (faint)	Yes
58	Cedar, branches	Juniperus Virginiana	Yes	Yes
59	leaves		Yes	Yes
60	Oak, branches	Quercus alba	Yes (faint)	Yes
61	leaves		Yes	Yes
62	acorn		Yes (faint)	Yes
63	Sycamore, branches	Plantanus Occidentalia	Yes	Yes
64	Elm, branches	Ulmus	Yes	Yes
65	Black How, branches	Viburnum Prunifolium	Yes	Yes
66	fruit		Yes	Yes

67	Hickory, branches	Carpa	Yes	Yes
68	nut		Yes (faint)	Yes (faint)
69	Magnolia, branches	Magnolia Grandiflora	Yes	Yes
70	leaves		Yes	Yes
71	Holly, branches	Ilex Opaca	Yes	Yes
72	leaves		Yes	Yes
73	berries		Yes	Yes
74	Paulonia, buds	Paulonia imperialis	Yes	Yes
75	pod		Yes	Yes
76	Osage Orange	Maclura Aurantiaca	Yes (faint)	Yes

Miscellaneous Plants.

77	Tobacco, stalk	Nicotiana Tabacum	Yes	Yes
78	leaves		Yes	Yes
79	Cotton, lint	Gossypium herbaceum	Yes (very faint)	Yes (very faint)
80	seed		Yes (very faint)	Yes
81	stalk		Yes	Yes
82	Azalea Indica, leaves	Azalea Indica	No	Yes (faint)
83	root		No	No
84	Chrysanthemum, stalk	Chrysanthemum Pompone	No	Yes (faint)
85	flower		No	Yes (faint)
123	Rose, branches		Yes	Yes
86	Bamboo	Smilax Rotundifolium	Yes	Yes
87	Sorrel	Oxalis Stricta	Yes	Yes
88	Lucerne	Medicago Sativa	Yes	Yes
89	Clover, red	Trifolium Pratense	Yes	Yes
90	white	Trifolium Repens	Yes	Yes
91	Orchard Grass	Dactylis Glomerata	Yes (faint)	Yes
92	Blue Grass	Poa Compressa	Yes	Yes

Soils, Waters and Fertilizers.

No.	Common Name.	Remarks.	Flame Reaction.	Color Reaction.
93	Alluvial	2 kilos taken	No	No
94	Sandy, rich	" "	No	No
95	Sandy, poor	" "	No	No
96	Red Clay		No	No
97	Well Water, No. 1	48 liters taken	No	No
98	No. 2	56 " "	No	No

99	Water from small stream	36 litres taken	No	No
100	Bone and Peruvian Guano		Yes	Yes
101	Peruvian Guano		Yes (faint)	Yes
102	Bone Ash		No	No
103	Sodium Nitrate	Crude	No	No
104	Muriate of Potash	From Stassfurt	Yes	Yes
124	Kainite	For Fertilizers	No	Yes
125	Kelp		Yes	Yes

Chemicals.

105	Potassium Nitrate	C. P.	No	No
106	Potassium Carbonate	C. P.	No	No
107	Potassium Chlorate	C. P.	No	No
108	Potassium Carbonate	Commercial	Yes	Yes
109	Potassium Phosphate	C. P.	No	No
110	Sodium Nitrate	C. P.	No	No
111	Sodium Carbonate	C. P.	No	No
112	Calcium Carbonate	C. P.	No	No
113	Ferric Oxide		No	No
114	Concentrated Lye	Commercial	No	Yes (faint)
115	Potassium Carbonate	Pearlash	No	No
116	Potassium Hydroxide	C. P., Trommsdorf	Yes	Yes
117	"	" by alcohol, Marquart	No	Yes
118	"	" by baryta, Schuchardt	No	Yes
119	"	" " Eimer & Amend	No	Yes
120	"	" C. P., free from Al_2O_3 , SiO_2 and SO_3 , Eimer & Amend	No	Yes
121	Sodium Hydroxide	C. P.	Very faint	Yes
122	"	"	No	Yes (very faint)
126	Ammonium	"	No	No

ON THE OCCURRENCE OF BORACIC ACID AS AN IMPURITY IN CAUSTIC ALKALIES.

BY F. P. VENABLE AND J. S. CALLISON.

In the course of a research upon the distribution of boracic acid in the ashes of plants, it was decided to make some quantitative estimations of the boracic acid present. The reagents to be used were first themselves tested for boracic acid, and, much to our surprise, no sample of the caustic alkalies could be procured free from it. Specimens coming from some of the most noted manufacturers, Schuchardt, Marquart, and Trommsdorff, purified by alcohol or by baryta, were found to contain boracic acid, and sometimes in decidedly appreciable amounts. No quantitative determination has been made, but, judging from the known delicacy of the qualitative tests, the amount must have often exceeded 0.1 per cent., and was probably much greater.

As the caustic alkalies, especially potassium hydroxide, are frequently used in the methods for the quantitative determinations of boracic acid,* this presence of it as an impurity may be a serious source of error. The knowledge of it is important on other grounds as well.

*See, for instance, Morse & Burton, Amer. Chem. Jour. X, 154. Ztschr. and Chem. **25**, 202.

THE DETERMINATION OF CRUDE FIBER.

BY W. A. WITHERS.

This was begun to ascertain, if possible, some of the causes of the discrepancy in results obtained by different chemists for crude fiber. The samples were Timothy hay and cotton seed meal. They were not extracted with ether previous to treatment with alkali and acid, as is customary in ordinary analyses. Except when so stated, the solutions used were $1\frac{1}{4}$ per cent. H_2SO_4 , and $1\frac{1}{4}$ per cent. Na_2O solutions, the time of boiling 30 minutes, and the results in per cent. calculated on the dry sample.

The following questions were considered :

1. Amount of Na_2O neutralized.

By titration before and after treatment, an average of 5 different determinations gave an equivalent of .114 grams Na_2O neutralized by Timothy hay for every gram of substance taken, showing that only a very small portion of the Na_2O added enters into chemical combination, and part of this is in the saponification of the fat which would usually be extracted with ether.

2. Sulphuric acid neutralized.

Residues from Timothy hay, after treatment with Na_2O solution, were taken. It was found that for each gram of substance originally taken, .01 gram of H_2SO_4 was neutralized, showing that the H_2SO_4 does not enter into chemical combination at all.

3. Effect of different strengths of Na_2O solution.

This was tested on Timothy hay with the following results :

Time of treatment	45 minutes.		$1\frac{1}{2}$ hours.	
Na_2O (grams) used per gram of } substance	2.34	1.27	1.27	1.00
Residues	33.67	35.26	33.34	35.06
	33.28	35.36	33.70	35.30
	...	...	33.88	...
Average	33.48	35.31	33.64	35.18
Difference due to different strengths } of Na_2O solution	1.83		1.54	

This shows that the stronger the solution, or the more of the same solution used, the smaller is the per cent. of fiber.

4. Effect of time in treatment with Na_2O solution.

In the filtration a simple asbestos filter was used. After boiling the substance for 30 minutes with the alkali, the residue was detached from the filter as completely as possible, and subjected to another similar treatment with a new portion of the reagent. This method avoids very largely errors of analysis that would be shown had different samples been taken and treated for different lengths of time. Duplicate determinations A and B were made:

TREATMENTS WITH ALKALI.	TIMOTHY HAY.				COTTON SEED MEAL.			
	A.		B.		A.		B.	
	Res.	Dis.	Res.	Dis.	Res.	Dis.	Res.	Dis.
1.	36.96	63.04	36.21	63.79	4.46	95.54	4.66	95.34
2.	33.49	3.47	32.79	3.42	3.95	.51	4.14	.52
3.	31.85	1.64	31.17	1.62	3.26	.69	3.47	.67
4.	30.53	1.22	29.82	1.35	2.99	.27	3.09	.38
5.	29.74	.79	29.03	.79	With H_2SO_4 .			
6.	28.78	.96	28.34	.69	2.39	.60	2.41	.68

These treatments represent about 50 minutes contact with the alkali, being about 10 minutes to raise to boiling, 30 minutes boiling, 5 minutes standing, and 5 minutes filtering. The first treatment required from 10 to 15 minutes in filtering, thus making the contact longer. In the case of Timothy hay, therefore, this difference is about .07 per cent. of fiber per minute, and of cotton seed meal .01 per cent.

5. Effect of time in treatment with H_2SO_4 solution.

The residue after treatment with alkali was treated in the same way as above. Timothy hay was used.

From Na ₂ O									
treatment with	34.70	65.30	33.92	66.08	28.78	71.22	28.34	71.66	
acid	1. 29.10	5.60	28.33	5.59	25.59	3.19	25.38	2.96	
	2. 28.20	.90	27.60	.73	24.79	.80	24.73	.65	
	3. 27.81	.39	27.25	.35	23.91	.88	24.08	.65	
	4. 27.32	.49	26.78	.47					

The time of contact with acid was about 40 minutes, which makes a difference of nearly .02 per cent. of fiber for every minute of treatment with acid.

Ladd (5th N. Y. Ex. Sta. Rep.) has shown that the degree of heat employed causes a difference in results. The above work shows that differences are also due to amount and to the concentration of the different reagents used, and to the time of contact. To secure agreement in results, uniformity in all these conditions must be attained.

Granting this can be done with different workers, the question of accuracy of results confronts us. Without going into a review of the work of different chemists bearing on this point, I should like to call attention to the above tables under 4 and 5. One of two conclusions must be drawn from this work, viz.: 1st, That if half an hour's treatment with each alkali and acid is sufficient to give the per cent. of crude fiber, then crude fiber is soluble in both alkali and acid, and that to a somewhat considerable extent; or, 2d, that if crude fiber is not soluble in these reagents, then 6 treatments with alkali, and 3 subsequent treatments with acid, are not sufficient to separate it. From either of these conclusions it is evident that the method lacks accuracy, and is at best only a rapid method of rough approximation to the truth.

6. Ash in the residue.

Six samples were taken for this:

2	treated	with	alkali	45	minutes	and	acid	1	hour.
2	"	"	"	1½	hours	"	"	½	"
2	"	"	"	"	"	"	"	1	"

In no case was any ash found in the residue.

7. Nitrogen in the residue.

The albuminoid equivalent of this was found to vary from 4 per cent. to 5 per cent. with one treatment with alkali. The acid subsequent treatment did not remove any more, but subsequent treatments with alkali left no nitrogen.

CHEMICAL LABORATORY,
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SOME MODIFICATIONS OF THE METHOD FOR DETERMINING CRUDE FIBER.

BY W. A. WITHERS.

With the method now in use for determining crude fiber (*vide* Bul. 19, 1888, U. S. Dept. of Ag.) there is little trouble in the manipulation, except in cases of feeding-stuffs, in which the percentage of albuminoids is rather large. In all such cases, however, the albuminoids precipitated by the treatment with H_2SO_4 seriously impede the filtration, rendering it very slow, and from this longer contact causes a part of the crude fiber to be dissolved.

This difficulty can be obviated by treating the substance with the Na_2O solution before rather than after the treatment with H_2SO_4 solution.

To test this modification, I compared it with the ordinary method, on samples of Timothy hay and cotton seed meal. In both cases clear filtrates were secured by the modification in from 15 to 30 minutes, while with the ordinary method the filtration with the hay required about the same time; but the cotton seed meal from 18 to 24 hours, and then the filtrate was not clear. With Timothy hay the two methods gave practically the same results. With cotton seed meal the ordinary method gave 2.68 per cent. and 2.91 per cent., an average of 2.80 per cent., while the modification gave, with five determinations, 3.63 per cent., 3.58 per cent., 3.69 per cent., 3.49 per cent.,

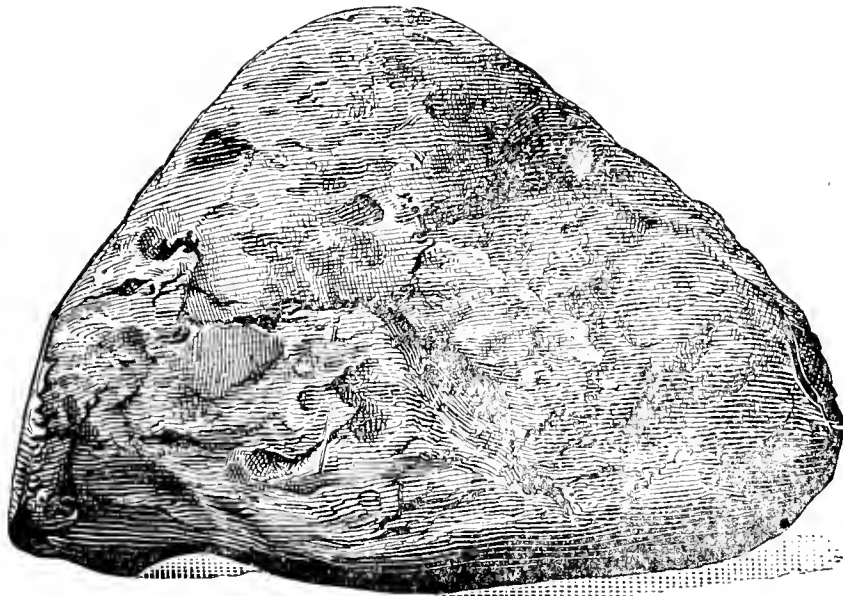
3.44 per cent., an average of 3.57 per cent. The determinations in hay show the modification gives reliable results. In the case of cotton seed meal, however, we see that 77 per cent. crude fiber is dissolved by the ordinary method, on account of the longer contact produced by the slow filtration, being more than 20 per cent. of the whole amount.

For accuracy and, therefore, agreement of results, as well as time-saving, this modification seems to recommend itself.

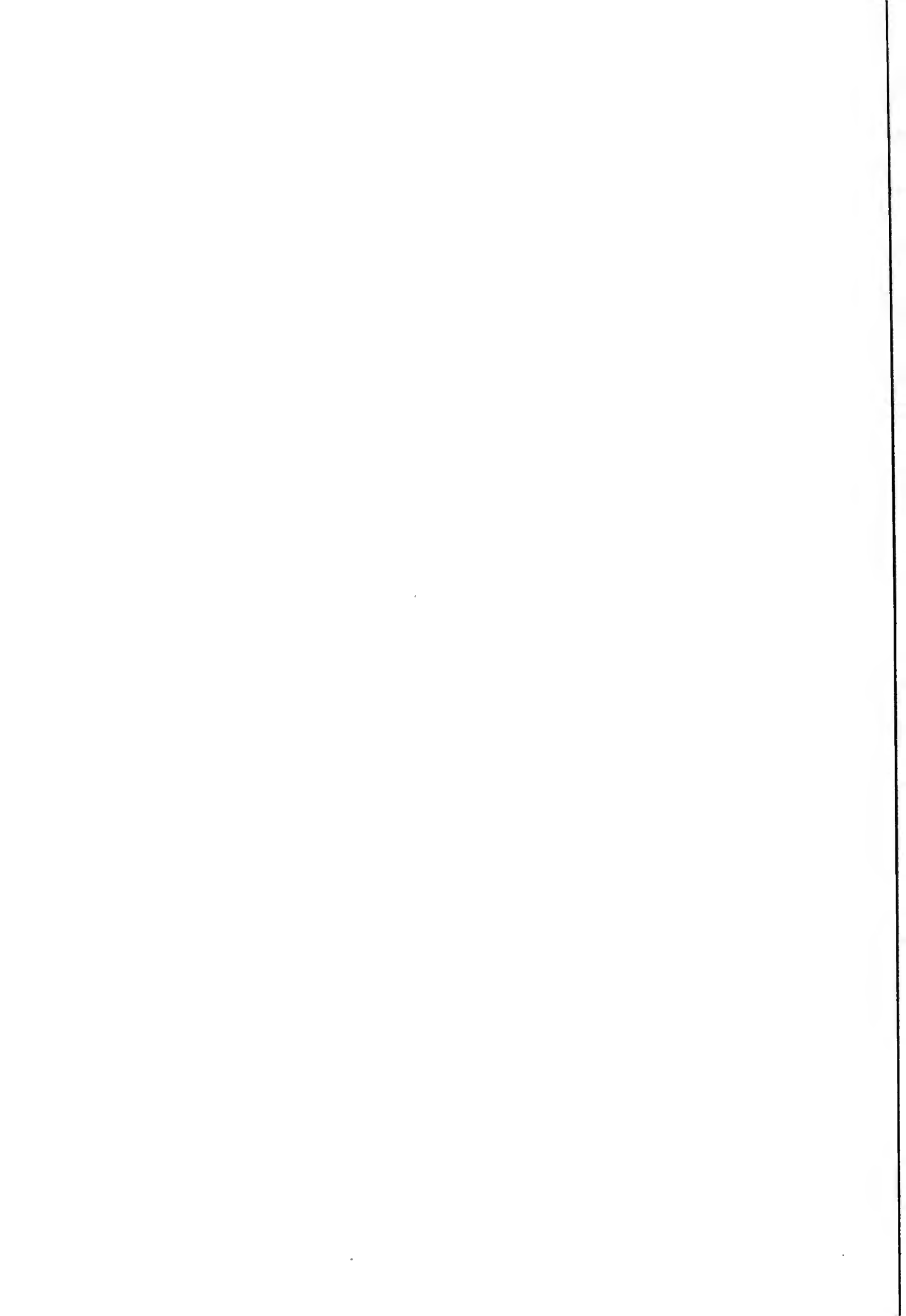
Rapid Filter.—The asbestos filter gives good results if covered with a layer of glass wool. Care should be taken, however, not to add too much liquid at a time, as this may cause the glass wool to become displaced. The coarse asbestos gives the best results.

Ladd (N. Y. Ex. Sta. Rep., 1887, p. 378) finds that when the asbestos filter was returned with the residue a larger per cent. of fiber was found, and the two reasons given are that it prevents so thorough contact with the reagents, and that it necessitated lowering of the temperature to prevent bumping. When, however, the substance is first treated with alkali there is no tendency to bump in the acid treatment, and consequently no need of lowering the temperature. As to how much the first mentioned cause will affect the results, I have not tested.

Prevention of Frothing in Boiling.—This can be done by directing a moderate blast of air into the flask through a small glass tube (1.5 mm. diam.). The constant level of the liquid can be maintained by adding boiling water from time to time, or by a reflux condenser.



LINVILLE METEORITE.



[FROM THE AMERICAN JOURNAL OF SCIENCE, VOL. XXXVI, OCTOBER, 1888.]

ART XXIX.

ON THREE NEW MASSES OF METEORIC IRON.

BY GEORGE F. KUNZ.

I. Meteoric Iron from Linville Mountain, Burke County, North Carolina.

A mass of meteoric iron* was found on Linville Mountain, Burke county, N. C. (long. $81^{\circ} 35'$ W. of Greenwich, lat. $35^{\circ} 40'$ N.), about the year 1882. It was handed to a country blacksmith in the vicinity, who sold it to a tourist miner, and by him it was sold to Mr. Norman Spang, of Etna, Pa., who, not being a collector of meteorites, has kindly allowed it to come into my possession.

This meteorite weighs 428 grams; the original weight was 442 grams ($15\frac{1}{2}$ ounces), the remainder having been used for analysis and for etching; it is $2\frac{3}{5}$ inches (65 mm.) long, $1\frac{2}{5}$ inches (35 mm.) high, and $2\frac{1}{2}$ inches (38 mm.) wide. One side is rather rough, and the other pitted with very shallow pittings. Traces of the black crust of magnetic oxide of iron are still visible, and although the mass is not rusted, yet small drops of chloride of iron have collected in the deep clefts; in one of these was also found a spider's egg-case, suggesting that the iron is either a recent fall, or had been found on the surface of the ground.

In cutting a piece from the lower side, the blacksmith has destroyed a good deal of the surface as well as the crust, on account of the toughness of the iron. The iron admits of a very high polish, yielding a rich nickel color, which, under the glass and by reflected light, shows an apparent net-work of two distinct bodies.

*Exhibited at the New York Academy of Sciences, Dec. 5th, 1887.

When bromine water or diluted nitric acid is applied to a polished surface of the iron, it blackens and does not show the Widmanstätten figures. If this black deposit is washed off, an orientated sheen appears, which resembles that of the Green county iron, described by Blake,* and the iron in the Port Orford, Oregon, meteorite, as figured by Brezina and Cohen in "Die Structur und Zusammensetzung der Meteoreisen, etc."† Almost the entire surface has, under the glass, the appearance of a mesh-work of which the irregularly rounded centers have been eaten out. At a few places on both sides of a crack is a small piece of troilite 3 mm. by 1½ mm., through which are scattered small patches of meteoric iron that after etching exhibit beautiful octahedral markings so delicate as to be invisible to the naked eye, and somewhat like those of the Tazewell, Claiborne county, meteorite, though not more than one-tenth the thickness.

The following analysis was kindly furnished by Mr. J. Edward Whitfield, of the United States Geological Survey, through the courtesy of Prof. F. W. Clarke:

	Linville, Whitfield.	Tazewell,‡ Smith.	Bear Creek,§ Smith.
Iron	84.56	83.02	83.89
Nickel	14.95	14.62	14.06
Cobalt.....	0.33	0.50	0.83
Copper	0.0	0.06	trace
Sulphur.....	0.12	0.08	.....
Carbon	trace	.....	.....
Phosphorus	"	0.19	0.21
Magnesium.....	.....	0.24	.....
Silica	none	0.84	.....
	99.96	99.57	98.12

Dr. F. A. Genth has kindly furnished the following analysis:

Iron	85.83
Cobalt.....	0.73
Nickel	13.44
	100.00

*Amer. Journal Sci., III, Vol. xxxi, p. 41.

†Stuttgart, 1876, Lieferung I, Tafel VI.

‡Original Researches, 1884, p. 439.

§Amer. Journal Sci., II, Vol. xix, p. 153.

It most closely resembles the Tazewell, Claiborne, and Bear Creek, Col., meteorites in composition. I herewith take pleasure in thanking Mr. Norman Spang for his kindness in allowing me to secure the iron and for the facts of its discovery; also, Mr. J. Edward Whitfield and Prof. F. W. Clarke for the analysis.

II. On the Meteoric Stone from Ferguson, Haywood County, North Carolina.

Mr. W. A. Harrison, of Ferguson, North Carolina, says that about six o'clock, on the evening of July 18, 1889, he noticed a remarkable noise west of him, and that fifteen minutes later he saw something strike the earth, which, on examination, proved to be a meteoric stone, so hot that he could scarcely hold it in his hand five minutes after it fell. Two-thirds of its bulk was buried in the earth when found. This stone was sent to the writer, and was unfortunately lost in New York City during the month of December.

The stone was slightly oblong, covered with a deep, black crust, which had been broken at one end, showing a great chondritic structure with occasional specks of iron. Its weight was about eight ounces, and it very closely resembled the meteoric stone from Moes, Transylvania. It remained in the writer's possession so short a time that it was not properly investigated; but still the mere mention of a fall, which had been so carefully observed, is thought to be well worthy of publication.

III. Meteoric Iron from Bridgewater, Burke County, North Carolina.

The Bridgewater, Burke county, meteorite was found by a negro plowman, two miles from Bridgewater Station, in the western part of Burke county, near the McDowell county line in North Carolina. Latitude, $35^{\circ} 41'$; longitude, $81^{\circ} 45'$ W. of Greenwich. The negro thought that it must be either gold or silver, and took it to some railroad laborers, who broke it in two pieces, one of which weighed ten-and-a-half, and the other eighteen-and-a-half pounds, together 30 pounds, equal to 13.63

kilos. The iron measures 22.5 x 15 x 10 cm. (9 x 6 x 4 inches).

Traces of black crust very much oxidized are still visible on the surface. The iron is highly octahedral in structure, and the mass was readily broken by the laborers who found it. Between the cleavage plates schreibersite is visible.

On etching a polished surface of this iron with dilute nitric acid, the characteristic Widmanstätten figures were shown. The iron belongs to the caillite group, and resembles those of the Cabin Creek and Glorietta Mountain in structure.

The specific gravity of a fragment was found to be 6.617. The following analysis was kindly furnished by Prof. F. P. Venable, of the University of North Carolina :

Fe.....	88.90
Ni.....	9.94
Co.....	.76
P.....	.35
Cl.....	.02
	<hr/>
	99.97

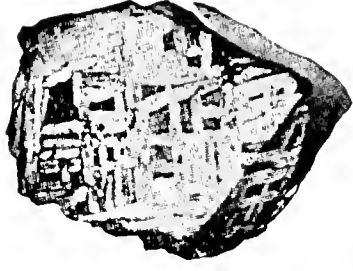
The nickel is the mean of two determinations, 9.74 and 10.14, on different parts of the sample.

The cobalt also of two determinations, .85 and .67.

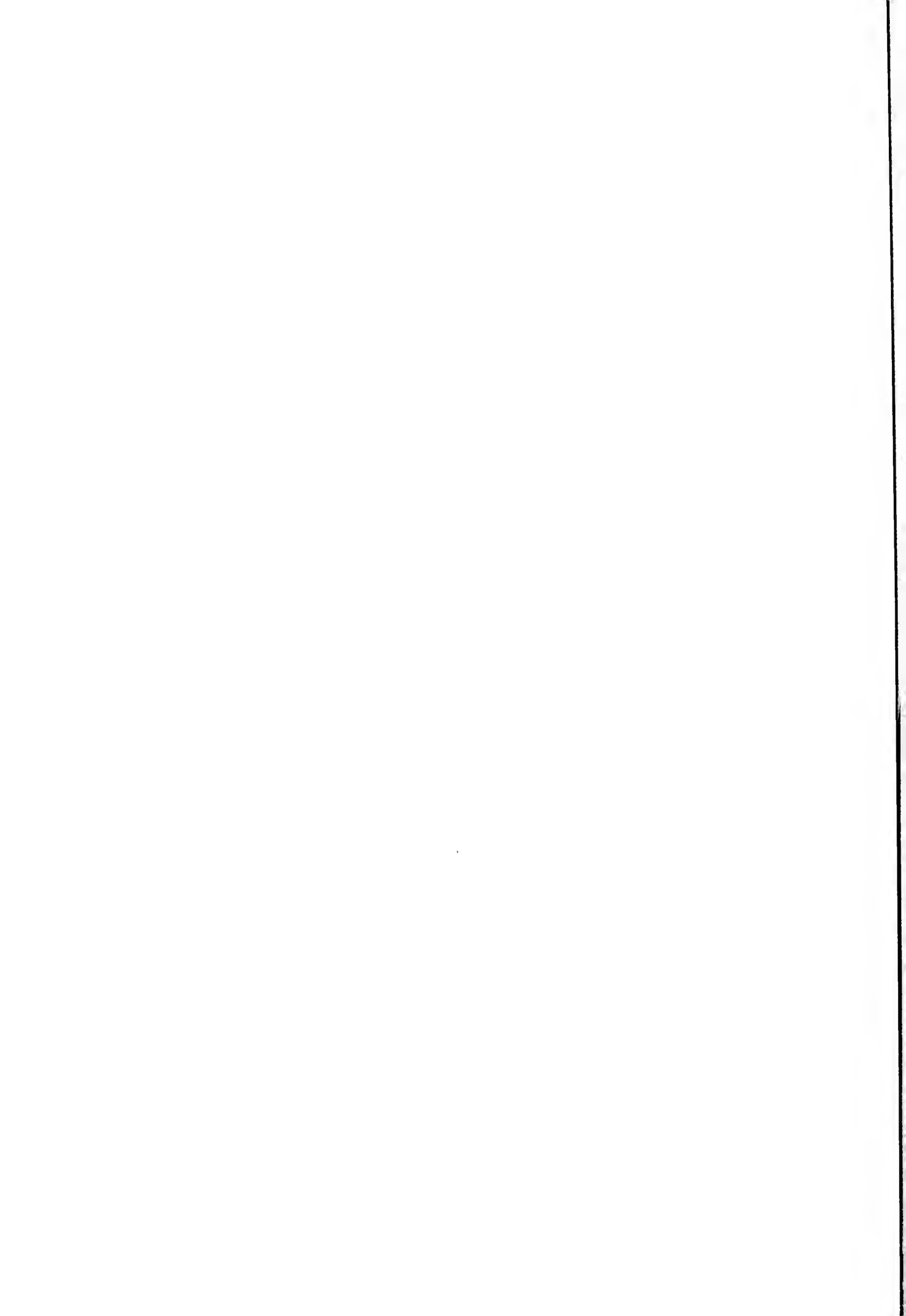
The iron is the mean of four determinations, some of which were not very closely agreeing, as the crust could not be entirely removed from the samples taken.

The phosphorus and chlorine are single determinations.

The author takes great pleasure in thanking Mr. T. K. Bruner for his courtesy in obtaining the information and the iron for him, and in thanking Professor F. P. Venable for furnishing the analysis.



BRIDGEWATER METEORITE.



TWO NEW METEORIC IRONS.

BY F. P. VENABLE.

I. FROM ROCKINGHAM COUNTY, N. C.

This mass was reported to have fallen about the year 1846, near the old "Mansion House," Deep Springs Farm, in Rockingham county, N. C. One of the old negro servants related to Mr. Lindsay, the present owner of the farm, that "the rock fell on a clear morning, and struck the ground about a hundred yards back of the garden. It frightened every one very much. Colonel Jas. Scales, the proprietor at that time, and Mr. Dillard took a man and went to the spot, dug in about four or five feet and got it out." It lay about the house as a curiosity for several years, when it ceased to be of any more interest, and was thrown aside. After Mr. T. B. Lindsay bought the farm he kept the meteoric mass for several years upon his porch. In the fall of 1889 he presented it to the State Museum. The indentation in the earth, where it is reported to have struck, is still pointed out.

The weight of the mass was 11.5 kilos. It had somewhat the outline of a rhomboid, measuring 270 x 210 mm., and having a thickness varying from 10 to 70 mm. It is coated with oxidation products to a depth, in places, of several millimetres. These give the whole mass a dull, reddish brown color. The surface is irregularly pitted with broad shallow pits. It is somewhat concave on one side. On being polished and etched it gave faintly the Widmanstätten figures. It belongs to the class of sweating meteorites, beads of deliquesced ferric chloride appearing on the surface. This lawrencite, so-called, is evidently unevenly distributed through the mass. Analyses from different portions gave different amounts of chlorine. In one boring it was noticed that the metal near the surface (within 2^{cm.}) gave a decided percentage of chlorine, while that coming from the deeper part of the drill hole (3—5 cm. from surface) gave no appreciable amount.

The analysis gave :

Fe.....	87.01
P.....	.04
SiO ₂.....	.53
Cl.....	.39
Ni.....	11.69
Co.....	.79
	100.45

II. FROM HENRY COUNTY, VA.

This meteoric iron was found by Nathaniel Murphy, in Henry county, Va., about four miles from the Pittsylvania county line, and one-half mile north of the dividing line between North Carolina and Virginia, near to Smith River. Murphy found the stone in a ploughed field in the latter part of the spring of 1889. He gave it to Colonel J. Turner Morehead, of Leaksville, N. C. Together with Colonel Morehead he searched over the farm, but could find nothing similar to this piece. Colonel Morehead sent the mass to Dr. H. B. Battle, of Raleigh, N. C. It weighed 1.7 kilos, and the detached pieces, mainly crust, weighed 0.22 kilos. This crust broke off along certain lines by a sort of cleavage, and the main mass is permeated with cracks, not irregular and zigzag, but as distinct and regular, almost, as if it were a piece of crystallized gypsum. This cleavage is in two directions. The laminae vary in thickness, but many are about $\frac{1}{2}$ mm. The color of the surface is dark bluish black, mixed with much red-rust coming from the lawrencite. Parts of the soil apparently still cling to the mass. It measured 60 x 70 x 75 mm., taking the greatest lengths in the three directions. Here and there scales or spots of bright silvery sheen were to be seen. It contains a good deal of ferric chloride, and is rapidly crumbling. On polishing one of the faces, the Widmanstätten figures (coarse) came out very plainly, no etching being necessary.

The analysis resulted as follows :

Fe.....	90.54
Cl.....	.35
SiO ₂.....	.04
P.....	.13
Co.....	.94
Ni.....	7.70
	99.70

A LIST AND DESCRIPTION OF THE METEORITES OF NORTH CAROLINA.

BY F. P. VENABLE.

So far as can be learned, twenty-three meteorites have been reported as found in North Carolina. Facts with regard to these have been collected under many disadvantages and with great difficulty. A complete list of references in scientific literature has proved an impossibility; still a great many such references are given. It is also impracticable now to trace all of the possessors of portions of these meteorites. They have been divided often into many pieces, and widely scattered. Only occasional clues to their whereabouts can be gotten at the present time. One fact is made apparent, and that is, that nearly all have passed out of the State, not even fragments being preserved here.

It will be noticed that, with the exception of one from Nash county, all of the reported meteorites have come from Western North Carolina. That many of these came to the light at all has been due to the intelligent energy of General T. L. Clingman, to whom the State owes so much already for bringing to notice her minerals and other possessions.

It has been thought best to include in this list all reported falls and finds. In the case of all proved to be non-meteoritic, or about which doubt exists, note is made under the proper heading. If these doubtful ones be eliminated, as well as those not belonging properly to the State, the number is reduced to about twenty. There is doubt, however, whether the number should be as great even as this, as there is cause for thinking the Madison county, and, perhaps, some of the Buncombe county finds may belong to the same fall. Still the number is large when we bear in mind the comparatively small number of recorded meteorites for the whole earth. Huntington in his catalogue (1887) places the number at 424.

I must express my acknowledgments to Mr. S. C. H. Bailey, of New York, for most valuable assistance rendered in this compilation.

1.

ALEXANDER METEORITE.

Locality—Cedar Creek, Alexander county.

Not analyzed.

This iron, weighing about fifty-six grams, was given by General T. L. Clingman to Mr. S. C. H. Bailey, of New York, about the year 1875. It has not been analyzed, nor have I been able to learn more of its origin. The piece, Mr. Bailey writes, is evidently a fragment from a larger mass, and is sufficiently characteristic to be distinguishable from any other iron, though it more nearly resembles the Sarepta (Russia) iron.

Literature—

Possessor—Bailey (56 grams).

2.

ASHE METEORITE.

Locality—Ashe county.

Analyst—Shepard (?)

The only reference that can be found to this mass is the following, coming from the American Journal of Science :

“A fragment of meteoric stone from Ashe county, N. C., examined at the same time, was found to contain a marked quantity of this principle (chlorine), the presence of which, however, was accounted for by the fragment having been in contact with a bag of salt as it was carried home by the person who found it.”

It is possible that this is the same as the Grayson county, Virginia, meteorite.

Literature—Am. Jr. Sc., 1st Ser. XLVIII, p. 169; Rep. Am. Met., p. 34; Buchner, p. 168.

Possessor—Unknown.

3.

ASHEVILLE METEORITE.

Locality—Asheville, Buncombe county.

Analyst—Shepard.

This meteorite was presented by Dr. J. F. E. Hardy to Dr. C. U. Shepard for examination. It weighed between nine and ten ounces, and had been detached from a rounded mass nearly as large as a man's head, which mass was found loose in the soil about five or six miles west of Asheville, on the farm of a Mr. Baird, near the south-western base of an elevation of land five hundred feet high. Dr. Hardy was of opinion that other masses existed at the same place.

The specimen had a distinctly crystalline structure, approaching a flattened octahedron. The surface had a dissected or pitted appearance, occasioned by the removal of portions of the external laminae during its separation from the original mass. The cavities were perfectly geometrical in shape, being rhomboidal, tetrahedral, or in the figure of four-sided pyramids. Sections of the external laminae loosened broke up easily into regular octahedra and tetrahedra very exact in form. Some of the plates separated into leaves nearly as thin as mica, and delicately sticated in every direction.

The specific gravity of different pieces varied from 6.5 to 7.5, and even as high as 8.

ANALYSIS.

	I.	II.
Iron	96.5	94.5
Nickel	2.6	5.
Silicon .....	.5	0.3
Chlorine.....	.2	
Chromium } Sulphur } Cobalt } Arsenic }	in traces.	
	99.8	99.8

Analysis I is taken from Am. Jr. Sc., Vol. XXXVI, p. 81. Analysis II is also credited to Shepard, and is taken from Clark's List, p. 55. It seems to be an analysis of the original lump, from which the smaller fragment described above was taken.

Literature—Am. Jr. Sc., 1st xxxvi, p. 81; Clark, p. 55; Rep. Am. M., 1848, p. 24; Buchner, p. 163; Partsch, p. 116; Jahresber, 1847-48, p. 1309; Huntington, p. 60; Smithsonian Report, p. 261; Min. and Min. Loc., p. 14.

Present Possessors—Amherst, 276 grams; Göttingen, 1.50; Shep. Cab. in National Museum, 2.95; London, 114.9; Vienna, 271; Berlin, 13.66; Paris (Nat. Hist.), 72; and in private collections: Gregory, 2; Siemascho (St. Petersburg).

4.

BLACK MOUNTAIN METEORITE.

Locality—Black Mountain, Buncombe county.

Analyst—Shepard.

The Black Mountain meteorite was found at the head of the Swannanoa River, near the base of Black Mountain, towards the eastern side of Buncombe county. It was given by Dr. Hardy to Colonel Nicholson, of South Carolina. By the latter it was given to Dr. Barratt, of the same State, and from him it was secured by Dr. Shepard. It seems to have been picked up about 1839. The fragment weighed twenty-one ounces, and was evidently a portion of a larger mass. Its texture was highly crystalline, having all the laminae (which were usually thick) arranged conformably to the octahedral faces of a single individual. There was evidence of the existence of very minute veins of magnetic iron pyrites. The mass contained several rounded and irregular nodules of graphitic matter, with which again were found large pieces of iron pyrites.

Specific gravity, 7.261.

Iron	96.04
Nickel	2.52
Cobalt ..	traces.
Insoluble matter, sulphur and loss ..	1.44
	<hr/>
	100.00

Literature—Am. Jr. Sc., 2d Ser. iv, p. 82; Rep. Am. M., p. 28; Jahresber, 1847-48, p. 1310; Buchner, p. 180; Clark, p. 34; Huntington, p. 56; Kerr Appendix, p. 56; Min. and Min. Loc., p. 14.

Present Possessors—Amherst, 243 grams; Yale, 15; London, 71.5; Vienna, 45; Paris (Nat. Hist.), 5; Dorpat, 19; Neville (now Calcutta), 29; and in private collections: Baumhauer, 44; Siemascho.

5.

HOMINY CREEK METEORITE.

Locality—Hominy Creek, Buncombe county. *Analysts*—Shepard and Clark.

The Hominy Creek meteorite, sometimes referred to simply as Buncombe county meteorite, was secured for Dr. Shepard by Hon. T. L. Clingman. The original discoverer was a Mr. Clarke, and the date of the discovery seems to have been 1845. It was found in a field near the base of Mount Pisgah, some ten miles west of Asheville. Another much larger piece was reported to have been found in the same field. The mass weighed twenty-seven pounds. It was rather flat on one side, while its other sides were irregular, with cavities and various inequalities. Externally, it bore resemblance to a cinder from a blacksmith's fire. It measured eleven inches in length by seven in breadth, and was four in thickness at the thicker end, while at the other extremity it is not above two and a half. On the lower edge it thinned down to about one inch. Its surface was rather jagged than pitted with regular depressions. In color it was various shades of brown to black, and somewhat variegated with an ash-colored earthy matter, derived undoubtedly from having served for a considerable time as a support for fuel in the fire-place of a farmer's kitchen. Upon the under side there adhered over a few inches a crust of an earthy, black amygdaloid nature, scarcely distinguishable, unless freshly broken, from the iron itself, and in one spot a few grains of a dull, yellowish gray olivine were noticed. Etched surfaces, excepting where the structure is highly vascular, exhibit the most delicate Widmanstätten figures. Specific gravity, 7.32.

SHEPARD.		CLARK.	
Iron.....	98.19	Fe.....	93.225
Chromium and Cobalt.....	traces.	Ni. } .....	.236
Nickel.....	0.23	Co. { .....	.099
Carbonaceous, insoluble } matter and loss..... }	1.58	Ca. }	?
		Sn. } .....	.501
		Mn.....	?
		Si.....	?
		Mg.....	?
		P.....	?
		S.....	.543
		Graphite }	4.765
		Schreibersite }	
	100.00		

The yellowish olivine grains consisted of silicic acid, lime, magnesia and ferric oxide.

This is placed among the pseudo-meteorites in the British Museum, and does not seem to be recognized as a meteorite by other authorities.

Literature—Am. Jr. Sci., 2d Ser. iv, p. 79; Rep. Am. M., p. 25; Jahresher, 1847-'48, p. 1310; Buchner, p. 175; Clark, 22; Min. and Min. Loc., p. 14; Kerr Appendix, p. 56.

Present Possessors—Yale, British Museum.

6.

LINVILLE METEORITE.

Locality—Linville Mountain, Burke county.

Analyst—Whitfield.

A mass of meteoric iron was found on Linville Mountain, Burke county, about the year 1882. It was handed to a country blacksmith in the vicinity, and, passing through several hands, finally came into the possession of Geo. F. Kunz, Esq., of New York.

The original weight was 442 grams. It was $2\frac{2}{5}$ inches long, $1\frac{2}{5}$ inches high, and $2\frac{1}{2}$ inches wide. One side was rather rough, and the other pitted with very shallow pittings. Traces of the black crust of magnetic oxide of iron were still visible. The mass was not rusted, and small drops of chloride of iron were noticed in the deep clefts, and in one of them was found a spider's egg-case, suggesting either that the iron was a recent fall, or that it had been found on the surface of the ground.

On being polished it gave a rich nickel color, and showed an apparent net-work of two distinct bodies. The Widmanstätten figures were not given on etching. The analyses gave:

Iron	84.56
Nickel	14.95
Cobalt	0.33
Sulphur	0.12
Carbon	trace.
Phosphorus	trace.
	<hr/>
	99.96

Literature—Am. Jour. Sc., 3d Ser. xxxvi, p. 275.

Present Possessor—Geo. F. Kunz, Esq.

7.

BRIDGEWATER METEORITE.

Locality—Bridgewater, Burke county.

Analyst—Venable.

This meteorite was described by Kunz. It was found by a negro two miles from Bridgewater Station, in the western part of Burke county, near the McDowell county line. It was broken by some laborers into two pieces, one weighing ten and a half and the other eighteen and a half pounds. The original lump, therefore, weighed thirty pounds or 13.63 kilos. The iron measures 22.5 x 15 x 10 cm.

Traces of black crust, very much oxidized, are still visible on the surface. The iron is highly octahedral in structure. Between the cleavage plates schreibersite is visible. Widmanstätten figures gotten on etching.

ANALYSIS.

Iron.....	88.90
Nickel.....	9.94
Cobalt.....	.76
Phosphorus.....	.35
Chlorine.....	.02
	<hr/>
	99.97

Literature—Trans. N. Y. Acad. Sci., Jan., 1890; Mitchell Soc., Vol. VII, p. 29.

8.

CABARRUS METEORITE.

Locality—Post Farm, Cabarrus county.

Analyst—Shepard.

The fall of this meteorite was described by J. H. Gibbon, Esq., of the United States Branch Mint at Charlotte. On October 31, 1849, at 3 P. M., a sudden explosion, followed at short intervals by two other reports, and by a rumbling in the air to the east and south, was heard in Charlotte. Five days later news was brought of the fall of a meteoric mass on the farm of a Mr. Hiram Post in Cabarrus county, some twenty-five miles distant. This stone weighed nineteen and a half pounds, was bluish and gritty in appearance, of irregular form, eight

inches long, six broad and four thick, bearing marks in spots of recent fracture, but otherwise black, as if it had been exposed to heat and smoke, the black color being relieved where the crust had been broken, and a little of the clayey soil in which it was buried in its descent still adhered to it. Lustrous metallic points appeared through the ground color. Mr. Post had heard the explosion and heard the stone strike about three hundred yards off with a dull, heavy jar of the ground. The stone had splintered a pine log lying on the ground. It was buried under some ten inches of soil.

It is further described in the Huntington Catalogue as a "stone—dark gray with light grains and thickly sprinkled with iron. Fragment showing dull black crust" (referring to the fragment in the Harvard collection).

The specific gravity was 3.60—3.66.

Nickeliferous iron (with chrome)..	6.320
Iron sulphide.....	3.807
Silica	56.186
Ferrous oxide.....	18.108
Magnesia.....	10.406
Alumina.....	1.707
Lime, soda, potash and loss	3.394

Literature—Am. Jour. Sci., 2d Ser., ix, p. 143; x, p. 127; Buchner, p. 79; Kerr Appendix, p. 56; Huntington, p. 69; Smithsonian Rep., p. 263; Min. and Min. Loc., p. 16.

Present Possessors—Amherst (mass larger than two fists); Harvard, 168 grams; National Museum (Shep. Cab.), 343.6; London, 385.5; Vienna, 138; Berlin, 133; Göttingen, 33; Paris, 42; Dorpat, 29; Dresden, 7; Bologna, 3; Yale, 2.31; Calcutta, 52; Gregory, 152; Baumhauer, 51; Siemascho.

9.

CALDWELL METEORITE.

Locality—Caldwell county.

Analyst—Venable.

A small piece of iron was found among the specimens for the State Museum, labeled, in Dr. Kerr's handwriting (roughly, on an old piece of paper), "Meteoric iron from Caldwell county." The reference in his note-book said it was received from a Col. Scilly. It has proved impossible to learn anything further

about it. It was probably set aside by Dr. Kerr for examination, but the coming on of his final illness prevented it. The piece is about the size of a silver dollar, is still fairly bright; has evidently been hammered out thin and weighs five grams. It gave no figures on etching and a qualitative analysis revealed iron as the only metal present. It is probably of terrestrial origin.

Present Possessor—N. C. State Museum.

10.

CASWELL METEORITE.

Locality—Caswell county.

This stone fell at 2 P. M. on 30th January, 1810. It was described by Bishop Madison (of Williamsburg, Virginia) as resembling other meteoric stones, especially the one which fell at Weston, Connecticut, in 1807. It was not only attracted by the magnet, but was itself magnetic.

Whether the stone is still preserved anywhere and who possesses it is as little known as anything further with regard to its characteristics.

Literature—Gilb. Ann., 41, 1812, 449; Chladin, 291; Buchner, 27; Kerr App., 56; Min. and Min. Loc., p. 13.

11.

DAVIDSON METEORITE.

Locality—Lick Creek, Davidson county. *Analysts*—Smith and Mackintosh.

This was found on July 19, 1879, by Mr. Gray W. Harris on his land near Lick Creek, Davidson county. It was somewhat pear-shaped and weighed $2\frac{3}{4}$ pounds. Its outward color is dark brown, not rusty. The original crust was almost entirely hammered off by the finder, but a little remaining showed a peculiar slaty lamellar structure and readily broke into flakes. Some cavities in this crust were lined with mammillary forms, and it had many seams with a vitreous luster. It failed to give the Widmanstätten figures.

The analysis gave :

Iron	93.00
Nickel	5.74
Cobalt.....	0.52
Phosphorus	0.36
Sulphur.....	traces.
Chlorine.....	traces.
Copper.....	traces.
Carbon.....	not determined.
	99.62

From four analyses by Smith and Mackintosh. Meteorite in the possession of Hidden.

Literature—Am. Jour. Sci., 3d Ser. xx, p. 324; Min. and Min. Loc., p. 17.

Present Possessors—Main mass in Vienna, 887 grams; London, 20; Paris (Nat. Hist.), 41; Harvard, 6; Bailey, 38; Hidden, ? Nat. Mus. (Shep. Cab.), 9.72.

12.

GUILFORD METEORITE.

Locality—Guilford county.

Analyst—Shepard.

This was secured by Prof. Olmsted in 1820 from a man who told him that it had been detached from a large mass weighing twenty-eight pounds, which was wrought by a blacksmith of the neighborhood into horse nails. The fragment weighed seven ounces. It was a distinct crystal in the form of an octahedron. The axis measured three inches, the angle at the summit was 60° , that at the base 122° . Its structure was distinctly foliated, the laminae being uniformly one-twentieth of an inch in thickness and arranged parallel with the planes of the octahedron. The exact locality of the find is not given, but it was stated that it was found some ten or fifteen miles distant from the locality where the Randolph county specimen was found. It exhibited, when etched on tarnished or polished surfaces, very perfect Widmanstätten figures.

Analysis :

Iron	92.750
Nickel	3.145
Iron sulphide	0.750

Literature—Am. Jour. Sci., xvii, p. 140; xl, p. 369; Clark, 61; Rep. Am. M., p. 24; Partsch, p. 114; Huntington, p. 52; Min. and Min. Loc., p. 13; Kerr Appendix, p. 56.

Present Possessors—Amherst, 2.15 grams; Yale, 20; London, 15; Vienna, 8; Göttingen, 8; Calcutta, 10.5.

13.

HAYWOOD METEORITE.

Locality—Haywood county.

Analyst—Shepard.

This fragment, weighing one-eighth of an ounce, was sent to Dr. Shepard by Hon. T. L. Clingman, accompanied by the following remark: "It was given me by a person in Haywood county whose father had obtained it in that region, but without his being able to designate the locality. It is evidently meteoric iron, but is perhaps from some mass already known."

The fragment was highly crystalline and somewhat tetrahedral in form. One side was polished and etched. It displayed a marked character, and one which has no analogue among meteoric irons. It was irregularly veined by a black ore, which was not acted upon by acids and which presented all the properties of magnetite.

Specific gravity=7.419. It contained iron, sulphur, phosphorus, chromium, and was rich in nickel.

Literature—Am. Jour. Sci., 2d Ser. xvii, p. 327; Min. and Min. Loc., p. 15; Kerr Appendix, p. 56; Buchner, p. 189.

Present Possessor—Amherst, 10 grams.

14.

HAYWOOD METEORITE.

Locality—Ferguson, Haywood county.

Mr. Harrison, of Ferguson, N. C., noticed about 6 P. M., July 18, 1889, a remarkable noise west of him. Fifteen minutes later he saw something strike the earth, and this on examination proved to be a meteoric stone, so hot that he could scarcely hold it in his hand five minutes after it fell. Two-thirds of its bulk was buried in the earth when found. The

stone was slightly oblong, covered with a deep black crust which had been broken at one end, showing a great chondritic structure with occasional specks of iron. Its weight was about eight ounces and it very closely resembled the meteoric stone from Mocs, Transylvania. It was unfortunately lost in New York before examination.

Literature—Mitchell Soc., Vol. VII, p. 29.

15. 16, 17.

MADISON METEORITES.

Locality—Duel Hill, Madison county. *Analysts*—Smith and Burton.

There are several meteoric masses attributed to Duel Hill and to Jewel Hill, Madison county. The similarity of these names in pronunciation, and apparent confusion between them, led to inquiry as to their exact location. The result of the inquiry is that at present no Jewel Hill is known in this county. There was a Jewel Hill, at one time the county-seat, but its name was changed to Duel Hill and the county-seat removed to Marshall. These two are therefore one and the same locality.

Several masses have been found there.

No. 16. Found in 1856 and recorded as preserved in the Amherst collection. It weighed forty pounds. No analysis has been found. Amherst has two pieces—one of 600 grams and one of $167\frac{1}{2}$ grams.

No. 17. This meteorite was presented to Dr. Smith in the year 1854 by Hon. T. L. Clingman. It came from Jewel Hill, Madison county, of that State. There was a great deal of thick rust on the surface, with constant deliquescence from chloride of iron. Its form and surface indicated that it was entire. Its dimensions were 7 by 6 by 3 inches, with a number of indentations. Its weight was eight pounds thirteen ounces. The analysis gave:

Iron	91.12
Nickel	7.82
Cobalt.....	.43
Phosphorus .....	.08
Copper.....	trace.
	<hr/>
	99.45

Literature—Scient. Res., p. 317, 410; Min. and Min. Loc., p. 15; Kerr App., p. 56; Huntington, p.

Present Possessors—London, 130.2 grams; Vienna, 4; Paris (Nat. Hist.), 104; Göttingen, 38; Dorpat, 17; Harvard, 160; Yale, 5.610; Nat. Mus., 91; Nat. Mus. (Shep. Cab.,) 31.85; Calcutta, 16; Bailey, 11.4; Gregory, 40.

18.

Locality—Duel Hill, Madison county.

Analyst—Burton.

This mass was found in August, 1873, on the land of Robert Farnsworth, near Duel Hill, Madison county. It was lying on a hill-side where it had been used in supporting a corner of a rail fence, which was quite decayed at the time of finding. It is said to have weighed, when first found, about twenty-five pounds. Two or three pounds were hammered off as specimens before it fell in the hands of Prof. Burton, who analyzed it.

Mr. Farnsworth reported that a similar mass weighing about forty pounds had been found about a mile farther west, probably about 1857, and had since disappeared. Efforts to find it again were unsuccessful.

This meteorite was of a rounded irregular shape, $9 \times 6\frac{1}{2} \times 3\frac{1}{2}$ inches, and weighed twenty-one pounds. On being etched, it gave the usual markings, though indistinctly. Distinct particles of schreibersite were irregularly disseminated over the surface. Deliquescent beads of lawrencite were also to be seen.

Specific gravity=7.46.

Iron	94.24
Nickel	5.17
Cobalt	0.37
Phosphorus	0.14
Copper	trace.
Residue	0.15
	100.07

The residue contained SiO₂, Fe., Cr., Ni. and P.

Literature—Amer. Jour. Sci., 3d Ser. XII, p. 439; Min. and Min. Loc., p. 15.

Present Possessors—London, 12 grams; Vienna, 160; Harvard, 222; Baumhauer, 29; Bailey, 3; Gregory, 1.

19.

NASH METEORITE.

Locality—Castalia, Nash county.

Analyst—Smith.

This meteorite fell May 14, 1874, at 2:30 P. M., near Castalia (lat. $36^{\circ} 11'$, long. $77^{\circ} 50'$). Its fall was accompanied by successive explosions and rumbling noises, lasting about four minutes. The stones that fell must have exceeded a dozen or more—three only were found and they gave evidence that the territory over which the fragments fell was ten miles long by over three miles wide. Although occurring in the day, the body appeared luminous to some observers. The three stones found weighed respectively, one kilogram, 800 grams and five and one-half kilograms.

The exterior coating was dull. The interior in many parts is of a dark gray color, and in other parts quite light. The principal cause of the dark color is, doubtless, the larger amount of nickeliferous iron in that part. The specific gravity was 2.601.

Its composition was

Nickeliferous iron.....	15.21
Stony minerals.....	84.79

The nickeliferous iron consisted of

Iron	92.12
Nickel	6.20
Cobalt.....	.41

Copper and phosphorus not estimated.

The stony part, when treated with a mixture of hydrochloric and nitric acids, gave: insoluble part, 47.02; soluble part, 52.98. The former consisted of

Silica	52.61
Alumina.....	4.80
Ferrons oxide.	13.21
Magnesia.....	27.31
Alkalies (soda, with traces of potash and lithia).....	1.38
	<hr/>
	99.31

and is essentially bronzite. The soluble portion gave:

Silica	38.01
Ferrous oxide.....	17.51
Magnesia	41.27
Alumina. ....	.46
Sulphur.....	1.01

This is evidently olivine, with a small amount of sulphide of iron so dis-seminated through the stone that it is not easily separated by mechanical means. The meteorite then consists of nickeliferous iron, bronzite and olivine with small particles of anorthite and enstatite.

Literature—Amer. Jour. Sci., 3d Ser. x, p. 147; Min. and Min. Loc., p. 16; Smithson. Rep., 1885-'86, Part II, pp. 258, 262; Huntington, p. 94; Kerr, p. 314; Smith's Res., p. 478.

Present Possessors—Harvard, 211 grams; National Museum, 19.7; London, 29.4; Vienna, 285; Yale, 248; Bailey, 9.8; Baumhauer, 40; Gregory, 10.5.

20.

RANDOLPH METEORITE.

Locality—Randolph county.

Analyst—Shepard.

This was first described by Prof. Olmsted in 1822, in a descriptive catalogue of rocks and minerals collected by him, during his geological survey of North Carolina. It is there spoken of as occurring in the vicinity of a bed of argillaceous iron ore. It is distinctly foliated, the laminae being thin and much interlaced. It weighed originally about two pounds. When etched it presents very fine, almost invisible, feathery lines much resembling hoar frost on a window-pane. Hardness equal to that of the best tempered steel. Specific gravity=7.618. The only metal detected, besides iron, was cobalt, which was present in traces only. A reddish brown powder, insoluble in *aqua regia*, was considered to be silicon.

Literature—Amer. Jour. Sci., 1st v, p. 262; 2d iv, p. 85; Jahresber., 1847-'48, p. 1311; Clark, p. 75; Min. and Min. Loc., p. 13; Kerr Appendix, p. 56; Buchner, p. 160.

Present Possessors—This is reported by Buchner as in collection of Amer. Geolog. Society and in London.

21.

ROCKINGHAM METEORITE.

Locality—Smith's Mt., Rockingham county. *Analysts*—Genth and Smith.

This was found in 1866 at Smith's Mountain, two miles north of Madison, in an old field grown up with pines, but cultivated ten or fifteen years previously. It fell probably in the interval. The original weight was eleven pounds. It is highly crystalline and on etching gives fine Widmanstätten figures, showing that it consists of probably three kinds of iron. It contains also schreibersite in short, very minute quadratic crystals, and, according to J. L. Smith, solid chloride of iron. Specific gravity, 7.78.

Iron	90.41	90.88
Nickel }	8.74	8.08
Cobalt } .....		.50
Copper .....	.11	.03
Insoluble	{ Iron ..... .27 Nickel (Cobalt)... .33 Phosphorus..... .14	.03
Phosphide.....		
	100.00	99.46

Literature—Min. and Min. Loc., p. 15; Kerr, p. 313; Kerr Appendix, p. 56; Scient. Res., p. 526.

Present Possessors—N. C. State Museum; Jardin des Plantes, Paris; London, 77.3 grams; Vienna, 124; Göttingen, 54; Harvard, 821; Nat. Mus., 58.8; Gregory, 8; Bailey, 128.

22.

ROCKINGHAM METEORITE.

Locality—Rockingham county.

Analyst—Venable.

This mass was reported to have fallen about the year 1846 on Deep Springs Farm, Rockingham county. Its fall caused much terror among the negroes on the place. It was dug out immediately after falling, being buried four or five feet under the surface. After lying about the house for many years, it was in the fall of 1889 presented to the State Museum.

The weight of the mass was 11.5 kilos. It measured 270 x 210 mm., having a varying thickness of 10 to 70 mm. It is coated

with a crust of several millimetres thickness. The surface is irregularly pitted with broad, shallow pits. On being polished it gave faintly the Widmanstätten figures. It belongs to the class of sweating meteorites.

Analysis:

Iron	87.01
Phosphorus.....	.04
Silica .....	.53
Chlorine.....	.39
Nickel	11.69
Cobalt.....	.79
	100.45

Literature—Amer. Jour. Sci., 3d Ser., 1890, p. 161; Mitchell Soc., VII, p. 29.
Present Possessor—N. C. State Museum.

23.

RUTHERFORDTON METEORITE.

Locality—Rutherfordton, Rutherford Co. *Analysts*—Shepard, Rammelsberg.

This was analyzed by Shepard, who found Fe.=84.00, Si.=13.57, P.=1.31. He called it “ferrosilicine.” A partial analysis made in Wöhler’s laboratory gave Fe.=87.1, Si.=10.6, C.=0.4. Rammelsberg on examining it declared it to be nothing more than a piece of white pig iron of inferior quality.

This is placed among pseudo-meteorites in the Catalogue of the British Museum.

Literature—Amer. Jour. Sci., 2d XXXIV, p. 298; Kerr Appendix, p. 56; Clark, p. 67; J. prakt. chem., LXXXV, 87.

Present Possessor—Amherst (?)

24.

RUTHERFORD METEORITE.

Locality—Ellenboro, Rutherford county.

Analyst—Eakins.

This iron was found in the latter part of 1880, on a farm near Ellenboro, Rutherford county, N. C. Its nature remained unknown until February, 1890, when it was brought for examination to Mr. Stuart W. Cramer, of the U. S. Assay Office at Charlotte, N. C. It seems to have weighed about $2\frac{1}{5}$ kilos. In

shape it was roughly two globular ends with a connecting bar, the total length being about 150 mm. with end diameters 75 mm., and 50 mm. in the middle.

The iron is very tough and highly crystalline, the Widmanstätten figures showing distinctly on a polished, unetched face, and after etching they are unusually strong. Small, irregularly distributed patches of troilite are visible, and schreibersite also seems to be present. The analysis is as follows :

Fe	88.05
Ni	10.37
Co .....	.68
Cu.....	.04
P .....	.21
S .....	.08
Si .....	.02
	99.45

Literature—Amer. Jour. Sci., 1890, p. 395.

Present Possessors—Charlotte Assay Office and Geo. F. Kunz.

LIST OF WORKS REFERRED TO.

Some of these works are referred to from citations only. The limitation of library facilities prevented direct reference.

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Jahresbericht—Jahresbericht über die Fortschritte der, etc., Chemie, etc. Liebig and Kopp.

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Huntington—Catalogue of all Recorded Meteorites, 1887.

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Scient. Researches—Mineralogy and Chemistry, Original Researches. J. L. Smith, 1873.

Kerr—The Geology of North Carolina, Vol. I. Kerr, 1875.

Kerr Appendix—Appendix to Kerr's Geology.

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Partsch—Die Meteoriten in Hof-Mineralien-Kabinette zu Wien, 1843.

Buchner—Die Meteoriten in Sammlungen, 1863.

Gilb. Ann.—Gilbert's Annalen der Physik.

Chladni—Ueber Feuer-Meteore und über die mit denselben herabgefallenen Massen, 1819.

NO.	COUNTY.	ACCREDITED NAME.	DATE.	WEIGHT.	PAGE.
1	Alexander Co.	.....	secured 1875.....	56 grams.....	33
2	Ashe	.....	.....	.....	34
3	Buncombe	Asheville.....	found 1839.....	13630 grams.....	35
4	"	Black Mountain..	" 1835.....	590 grams.....	36
5	"	Hominy Creek....	" 1845.....	2000-3000 grams.....	37
6	Burke	Linville.....	" 1842.....	442 grams.....	38
7	"	Bridgewater.....	" 1888.....	13630 grams.....	39
8	Cabarrus	.....	fell 1849.....	8860 grams.....	39
9	Caldwell	.....	.....	5½ grams.....	40
10	Caswell	.....	fell 1810.....	1360 grams.....	41
11	Davidson	.....	found 1879.....	12720 grams.....	41
12	Guilford	.....	described 1841..	1250 grams.....	42
13	Haywood	.....	described 1854..	3.6 grams.....	43
14	"	Ferguson.....	fell 1889.....	227 grams.....	43
16	Madison	Jewel Hill.....	found 1856.....	18180 grams.....	44
17	"	" ".....	" 1854.....	4000 grams.....	44
18	"	Due! Hill.....	" 1873.....	11360 grams.....	45
19	Nash	.....	fell 1874.....	(3) 1000, 800, & 5500 grams.	46
20	Randolph	.....	described 1822..	900 grams.....	47
21	Rockingham	Smith's Mountain	found 1866.....	5000 grams.....	48
22	"	.....	fell 1846.....	11500 grams.....	48
23	Rutherford	Rutherfordton..	.....	.....	49
24	"	.....	found 1880.....	2500 grams.....	49

NEW AND IMPROVED METHODS OF ANALYSIS.

 BY S. J. HINSDALE.

 COLORIMETRIC METHOD FOR ESTIMATING THE MORPHINE
 STRENGTH OF LAUDANUM AND OTHER PREPA-
 RATIONS OF OPIUM.

Prepare an officinal tincture of opium with assayed opium. You will know the morphine strength of this tincture.

Make three dilutions of it with dilute alcohol, as follows:

One 3	parts	tincture	and	1	part	dilute	alcohol.
One 2	"	"	"	2	"	"	"
One 1	"	"	"	3	"	"	"

Put 12 cc. of the tincture and of the dilutions in vials, and add to each 12 cc. dilute alcohol—cork well and keep them as standard dilutions of known strength. Label them Nos. 1, 2, 3 and 4. Let the dilute officinal tincture be No. 1. Dissolve 0.04 gram potassic ferridcyanide in 500 cc. water, and add to it fifteen drops liquor ferri chloridi. Call this *Ferridcyanide Mixture*. (*This must be freshly prepared*). Prepare it in a glass-stoppered bottle, with water perfectly free of iron.

Place four 50 cc. clean glass tumblers or wine-glasses on a white surface, and deliver *with a pipette* (about one-third filled) one drop of the dilutions in the glasses, commencing with No. 4 (the weakest), blowing out the pipette after each dropping. (The pipette should be about four inches long, and made of one-quarter inch tubing, and should deliver drops of the dilutions weighing *about* .016 gram or one-fourth grain. To test the pipette, see how many drops will balance a .200 gram weight. The reason for using so small a drop, and for diluting the tincture, is because a full drop of the undiluted tincture would develop too deep a blue color).

Now add to each glass about 5 cc. ferridcyanide mixture (it is convenient to use a homeopathic vial as a measure), and in

about one minute add 15 or 20 cc. water, and observe the shades of color. This observation must be made *within five minutes*, as the air and light will soon cause all to be uniformly blue.

By comparison with the shades of color produced by these standard dilutions, you can easily estimate the strength of any sample of laudanum with much accuracy. The sample must, of course, be diluted with an *equal part of dilute alcohol*. The presence of tannin interferes with this method, but opium does not contain tannin. Tannin is easily detected with a solution of a salt of iron. The ferridcyanide mixture *must be freshly prepared* and the glasses must be *clean and clear*, as the slightest bluish tinge interferes. Wash them with caustic soda and then with hydrochloric acid and rinse if they are soiled with Turnbull's Blue.

The ferridcyanide mixture is probably the best confirmatory test for morphine. If one drop of water containing .000001 gram of morphine is mixed on a white slab with one drop of the ferridcyanide mixture a blue color will be developed within *one* minute. With water alone the mixture will become of a bluish shade in about *ten* minutes, owing to the action of air and light.

P. S.—To estimate the strength of vinous or aqueous compounds of opium they must be brought to about the same specific gravity as the "standard dilutions" with alcohol, that the drops may be uniform in size.

COLORIMETRIC METHOD FOR ESTIMATING TANNIN IN BARKS, ETC.

Dissolve 0.04 gram potassic ferridcyanide in 500 cc. water, and add to it 1.5 cc. (about 22 drops) liquor ferri chloridi. Call this *Iron Mixture*.

Dissolve 0.04 gram "pure tannin (gallotannic acid) which has been dried at 212° F. in 500 cc. of water. Call this *Tannin Solution*.

Exhaust 0.8 gram oak bark with boiling water, and make it up to 500 cc. with cold water.

Place six two-ounce clear glass tumblers (or beaker glasses) on a white surface, and in one of them, *with a dropping pipette* (about four inches long and one-quarter inch wide) *about half filled*, put *five drops* of the infusion of bark, and in the others, *with the same pipette* (after rinsing), put 4, 5, 6, 7 and 8 drops of the "tannin solution." (The drops of the infusion and of the tannin solution must be uniform. The use of the same pipette, about half filled, *insures that*).

Now, add to each 5 cc. of "iron mixture," and in about one minute add to each tumbler about 20 cc. water, and *within three minutes* observe the shades of color. The number of drops of "tannin solution" used in the tumbler which corresponds in shade of color to the tumbler containing the infusion of bark *indicates the percentage of tannin in the bark; i. e.*, if it is the one in which seven drops were placed, the tannin strength of the bark is *seven per cent*.

It is best to observe the shades of color horizontally, rather than vertically, and to hold up the infusion tumbler, with the one which most nearly corresponds, opposite to a white wall, with your back to the light.

The above is written for *oak bark*, but the same process will answer for any substance containing less than ten per cent. of tannin.

For substances containing between about 10 and 20 per cent., it is best to dilute the infusion with an equal part of water and proceed as above, using *five drops* of the *dilute* infusion, and for the answer *double the result*. Thus, if the *diluted* infusion of tea required eight drops tannin solution to correspond, call the percentage *sixteen*.

For substances containing less than one, or one and a half per cent., exhaust 8 *grams* instead of 0.8 *gram*, and take *one-tenth* of the result for the answer. For substances containing more than twenty per cent., as galls, sumach, catechu, etc., you may dilute the infusion with two, three or more times its bulk with

water, and calculate as above (as with tea), or you may use 1, 2, 3 or 4 drops of the undiluted infusion in the first glass and make the calculation thus, *i. e.*: As the number of drops of infusion used is to the number of drops "tannin solution" used (to correspond), so is 5 to the answer—thus, suppose *two* drops infusion were used and the corresponding tumbler contained *fifteen* drops tannin solution— $2 : 15 :: 5$, answer 37.5 per cent.

The object in diluting the infusions is because the infusion glass may be of too deep a blue shade. It is better that it should just produce a *light blue*.

The tumblers must be perfectly clear and clean.

The "iron mixture," "tannin solution" and infusion must be freshly prepared and not exposed to the rays of the sun.

The water used must be free of iron and tannin.

The results are necessarily in terms for commercial gallotannic acid, and not for those of pure tannin, or of the particular tannin in the material assayed.

TEST FOR IRON.

A solution of neutral sulphite of soda containing a little pyrogallie acid has been proposed as a test for copper. A few drops of it mixed with a dilute solution of a salt of copper produces a red color similar to that which is developed by the addition of sulphocyanide of potash to a solution of a persalt of iron. The test is much more delicate for *iron*, as the following experiment will show:

Dissolve 0.7 gram ammonia ferrous sulphate (= 0.1 gram iron) in a liter of water; it will be 1 part in 10,000. To 10 cc. of this solution add water to make 100 cc.; this will be 1 to 100,000. Dilute some of this by adding four times its bulk of water; it will then be 1 in 500,000.

Make a saturated solution of sodium sulphite, and separately a solution of pyrogallie acid 0.5 gram in 50 cc. water. Put some of the iron solution in a wine-glass, add 4 drops of the

solution of sodium sulphite and afterward 2 drops of the pyrogallic solution and a purple color will be developed.

This test with distilled water alone develops a light pink shade, which, however, soon fades. This is due to the trace of free ammonia which it usually contains. Iron produces a purple tint. The test is so delicate that it will detect iron in 100 cc. of water, in which a bright cambric needle has been immersed for an hour.

FAYETTEVILLE, N. C.

(ISSUED SEPTEMBER 23, 1890).

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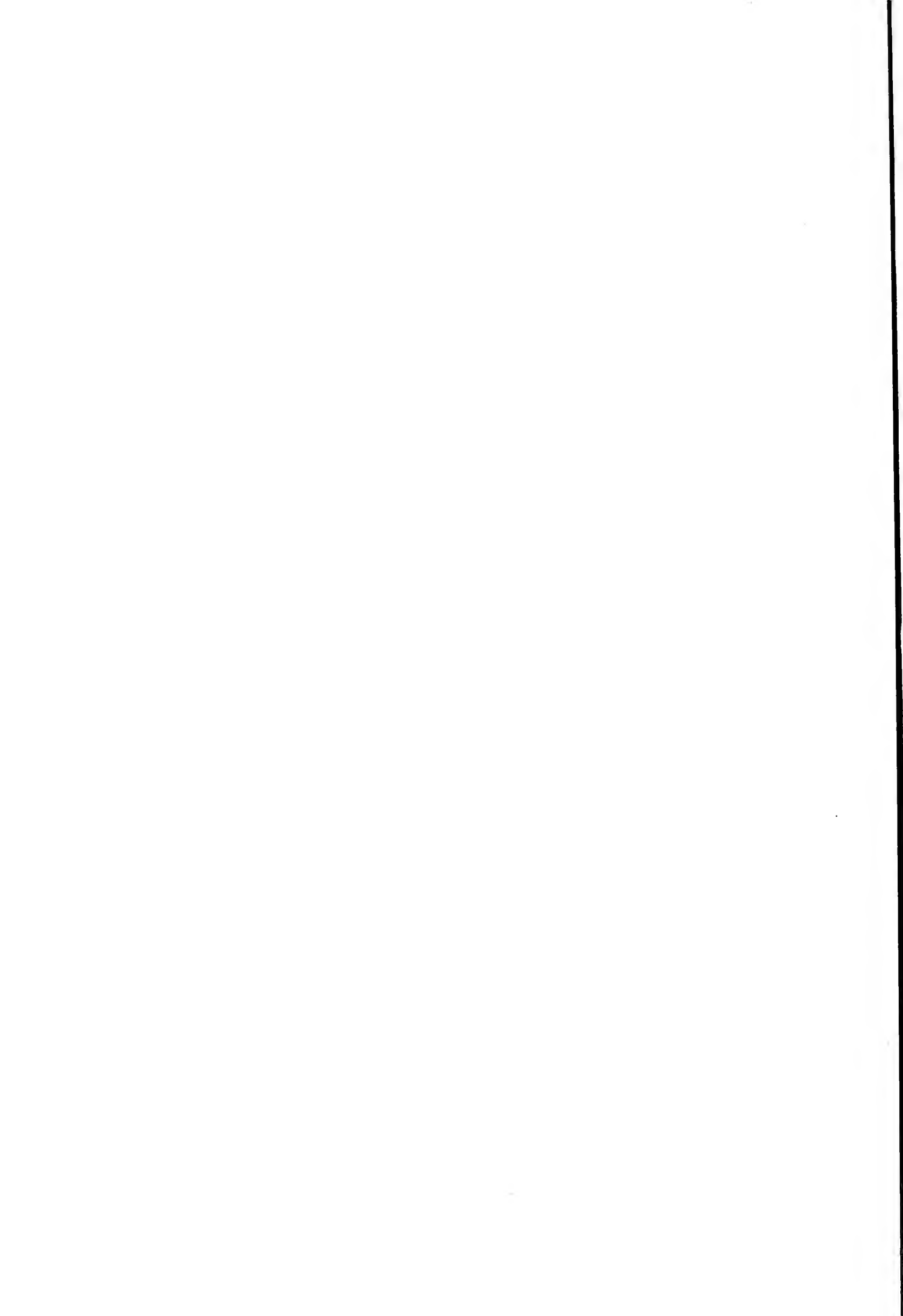
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JOURNAL
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SOME ERYSHIPHELE FROM CAROLINA AND
ALABAMA.

BY GEO. F. ATKINSON.

During the past four years the writer has collected occasionally species of this group in parts of North and South Carolina and Alabama, some of which are of interest in showing the extended range of species found elsewhere, while others throw some light on the relationships of imperfectly known forms.

The descriptions of the species enumerated are in reality notes upon the forms collected in this comparatively circumscribed region, so that in some cases the specific description may seem to lack the broader character which would be given from a description based upon a comparison of specimens from widely different latitudes and on a much greater variety of host plants.

The paper is not monographic, but professes the simple character of being a contribution to a knowledge of some southern forms. Bearing this in mind, it is hoped the small contribution given will not be devoid of interest to students of this fascinating group of microscopic plants.

A list of the works consulted will be found at the close of the article. In prescribing the limitations of the species I have tried to follow the admirable work of Professor Burrill on the *Erysipheæ* of Illinois* so far as consistent with the characters of the specimens.

*Parasitic Fungi of Illinois, Part II. In Bull. Ill. State Lab., Nat. Hist. 1887.

Perhaps the chief point of departure from that work is in regarding *Microsphaera Van Bruntiana* Ger. as a distinct species and not one of the many synonyms of *M. Alni* (D C.) Winter. The appendages are totally different from the description there given or from those of the other species placed as synonyms. On the other hand, an examination of a large series of specimens of *Microsphaera* on different species of oak only confirms the correctness of the judgment displayed in uniting Peck's *extensa et abbreviata* into one variable species. It is doubtful, however, if *Microsphaera Quercina* (Schw.) Burrill can be morphologically distinct from *M. Alni* (D C.) Winter, since many of the intermediate forms between Peck's *extensa et abbreviata* agree perfectly with the description of *M. Alni* (D C.) Winter, and have constantly been referred by various authors and to *M. Hedwigia et penicillata* which are now regarded by many as synonyms of *M. Alni* (D C.) Winter. I prefer, however, to suspend a final judgment on this subject, considering the local character of this contribution.

There seems to be no necessity for a full presentation of the synonymy of all the species, and where synonyms are given it is only because of the peculiar value of these expressions in interpreting a few of the forms.

It is hoped that to members of the Society, and other readers in the South who are interested in microscopic study, this contribution will prove a stimulus and aid in the study, collection and determination of this common, easily recognized and interesting group of plants. For this reason the notes are so arranged as to enable one to determine the species presented here.

The *Erysipheae*, or, as they are commonly called, the powdery mildews, are parasites growing generally upon the surface of the leaves, often on the stems, occasionally upon the fruits and deformities of plants. The vegetive condition from which they obtain the name of *mildew* consists of a loose web of white fungous threads distributed over the affected parts, sometimes covering a large part or all of the leaf surface, or again confined to definite spots. The fungus derives its nourishment through the medium of short suckers, or haustoria, which here and there

pierce through the epidermis of their host. The conidial stage consists of short branches arising perpendicularly to the wall of mycelium which abjoin serially oval or oblong *conidia*, which in numbers give a powdery appearance to the mildew.

The mature condition of the fungus is manifested to the unaided eye in the form of minute conceptacles of a dark color, which can be seen here and there to dot the surface of the leaf, sometimes very numerous and quite evenly distributed, or again loosely aggregated or very few in number.

It is outside the purpose of this paper to describe the rather complex development of these conceptacles which result from sexual organs. With proper magnification they are seen to be of a blackish, or various shades of a brown, color, the surface being more or less definitely reticulated, and in a single plane of the periphery they have a number of filamentous appendages of various forms of development, either hyaline or colored. The interior of a conceptacle, or *perithecium*, is occupied with one or several sacs, or *asci*, which themselves contain a variable number, two to eight, of one-celled spores.

It is a source of regret to myself that a greater number of species have not been collected, and the absence of some common ones will be noticed. In a number of cases the conidial stage of *Erysiphe graminis* and *Sphærotheca pannosa* have been very abundant, but I have not collected the fruit in the past four years.

During the past year the conidial stage of *Sphærotheca pannosa* has been very injurious to roses in Auburn, Ala.

The measurements are given in terms of the micromillemeter.

To serve in distinguishing the genera the following brief key will be found serviceable:

I. Appendages simple.

a, Irregularly flexuous.

1, One ascus—*Sphærotheca*.

2, Several asci—*Erysiphe*.

b, Coiled at the tips—*Uncinula*.

c, Needle-shaped, swollen at base—*Phyllactinia*.

II. Appendages dichotomously branched.

a, One ascus—*Podosphæra*.

b, Several asci—*Microsphæra*.

III. Appendages percurrent, primary branching opposite—*Microsphæra*.

SPHLEROTHECA LÉV.

Perithecium containing only one ascus; appendages simple, irregularly flexuous, frequently interwoven with the mycelium.

S. CASTAGNEI, Lév.

Amphigenous; mycelium thin, evanescent. Perithecia scattered or subgregarious, numerous, small, 70–80, chestnut brown, reticulations large, distinct. Appendages few, flexuous, of uneven diameter, colored, in length one to four times the diameter of the perithecium, interwoven with the mycelium. Asci oval to suborbicular 45 x 50. Spores eight, oval, small, 14–15.

On *Bidens*, Auburn, Ala., October 20, 1889, 1020.

S. HUMULI (D C.) Burrill (?).

Leaves of the common hop plant were collected at Auburn, Ala., in the autumn of 1889, which bore numbers of a specimen probably of this species. My laboratory not being ready at that time, the specimen was lost.

ERYSIPHE (HEDW.) LÉV.

Perithecium containing several asci; appendages simple, irregularly flexuous and frequently interwoven with the mycelium.

E. COMMUNIS (Wallr.) Fr.

Amphigenous; mycelium dense, persistent. Perithecia scattered or subgregarious, 80–120, reticulations distinct. Appendages few, long, hyaline when young, strongly colored when mature, frequently lying upon the mycelium. Asci three to eight 30–35 x 45–60, ovate, shortly pedicellate. Spores three to eight, 15–20.

On *Oenothera biennis*, Auburn, Ala., June 3, 1890, 1144; Columbia, S. C., November 25, 1888, 635; Champion of England peas, Auburn, Ala., June, 1890, 1135.

This is sometimes very injurious to cultivated peas in this part of Alabama, entirely covering the vines, leaves and fruit with the dense mycelium. In mature specimens the appendages are very dark, clearly showing that the form on peas cannot on account of hyaline appendages be separated from this species.

E. CICHORACEARUM D. C.

Syn. *E. spadicea* B. & C. Grev. IV, p. 159. Amphigenous; mycelium abundant, persistent. Perithecia numerous, scattered or gregarious 100-140. Appendages numerous, two to three times diameter of perithecium, woven with the mycelium, colored. Asci six to ten, 30-40 x 50-70, ovate or oblong, pedicellate. Spores two to four, variable in size, oval to elliptical, 15-20.

On *Ambrosia trifida*, Chapel Hill, N. C., September 15, 1885, 626; Uniontown, Ala., July, 1890; *Ambrosia artemisiifolia*, Auburn, Ala., June 3, 1890, 1193; *Verbesina Seigesbeckia*, Columbia, S. C., November 3, 1888, 624; *Xanthium Canadense*, Chapel Hill, N. C., autumn, 1885, 627; Auburn, Ala., October 21, 1889, 1018; *Helianthus*, Chapel Hill, N. C., September 7, 1885, 632.

The specimens on *Xanthium Canadense* collected at Auburn, No. 1018, seem to agree with *Erysiphe spadicea* B. & C., except that the perithecia are gregarious, and the spores vary to less than four. Berkeley's description is as follows:

"Perithecia scattered, rich brown, appendages flexuous, three times longer than their diameter; sporidia four." On leaves of *Xanthium*, Car. Inf.

The notes taken from my 1018 are as follows: Amphigenous; mycelium persistent, abundant, perithecia gregarious, 120-140, appendages two to three times diameter of perithecium, woven with the mycelium; perithecia and appendages rich chestnut brown. Asci six to ten, 30-40 x 60-70, pedicellate. Spores two to four, very often four, variable in size. For several of the first examinations the spores were quite uniformly four. Recognizing this variability which is known to occur in the species there is no reason why *E. spadicea* B. & C. should not belong to this species.

E. LIRIODENDRI Schw.

Good specimens of this species were collected in the autumn of 1888 at Columbia on young twigs of *Liriodendron tulipifera*. The mycelium was very abundant both on the leaves and twigs.

The perithecia were only found on the twigs, imbedded in the dense felt of mycelium.

UNCINULA LÉV.

Perithecium containing several asci; appendages coiled or incurved at the tips, free from the mycelium.

U. SPIRALIS B. & C.

*Syn. *U. spiralis* B. & C. Berkeley, Introduction to Cryptogamic Botany, 1857, p. 278, Fig. 64.

U. Ampelopsidis Peck, Trans. Albany Inst., Vol. VII, p. 216, 1872.

U. Americana Howe, Journal Bot., 1872.

U. subfusca B. & C. Grev. IV, p. 160, 1876.

Epiphyllous; mycelium thin, evanescent. Perithecia numerous, scattered, black, 70–100. Appendages twenty-five to thirty, three to four times the diameter of the perithecium, colored, faintly septate, tips loosely coiled. Asci five to eight, 30–40 x 50–65, ovate, pedicellate. Spores four to six, small.

On cultivated grape, autumn, Auburn, Ala., 1889, 1030. It appears to come too late to do harm, so far as I have observed here for two years.

U. MACROSPORA Peck.

Amphigenous, mostly epiphyllous; mycelium thin, persistent. Perithecia numerous, scattered, 100–120, globose biconvex, reticulations evident, but not very distinct, small. Appendages thirty to fifty, about equal to diameter of perithecium, radiating, or ascending to erect from crown of upper side. Asci five to ten, ovate or elliptical, pedicellate 25–30 x 60–65. Spores two to three, large, oval, 25–30.

On *Ulmus Americana*, Columbia, S. C., October 28, 1888, 622; *Ulmus*, Auburn, Ala., August 6, 1890, 1788.

U. FLEXUOSA Peck.

Hypophyllous; mycelium thin, evanescent. Perithecia scat-

*Prof. B. T. Galloway, who has recently made cultures of this species to determine the different hosts, kindly furnished me with the synonymy of this species.

tered, 100–130, black, wall tissue hard, brittle, reticulations obscure. Appendages twenty to fifty, hyaline, rough, short, flexuous and enlarged toward ends, coiled at tips. Asci five to ten, 30–35 x 50–65, ovate, pedicellate. Spores six to eight, about 20.

On *Aesculus*, Wright's Mill, Lee county, Ala., July 5, 1890, 1223; August 6, 1890, 1535.

U. PARVULA C. & P.

Hypophyllous; mycelium thin. Perithecia globose, lenticular, 80–100, soft, reticulations distinct. Appendages numerous, fifty to one hundred, or more, about equaling diameter of the perithecium, or less, arising in crown on upper side, somewhat scattered toward center, hyaline, slender, tips well coiled. Asci four to five, 35–40 x 50–60, ovate, pedicellate. Spores four to eight, about 20 long.

On *Celtis occidentalis*, Columbia, S. C., November 8, 1888, 621; Auburn, Ala., autumn, 1889 (Wright's Mill). All the specimens were collected on shrubs.

U. POLYCHÆTA (B. & C.) Masse (see Figs. 5, 11, Pl. I).

Syn. *Erysiphe polychæta* B. & C. Grev. IV, 159, 1876.

Uncinula Lynckii Speg. Fung. Arg. Pug. II, p. 17.

Pleochæta Curtisii Sacc. & Speg. Fung. Arg. Pug. II, p. 44; Sacc. Syll., Vol. I, p. 9 (in part).

Pleochæta Lynckii Speg. Sacc. Syll., Vol. II, Addend., p. 9.

Uncinula polychæta Ell. Jour. Mycol. 1886, p. 43 (in part).

Pleochæta Curtisii Sacc. & Speg, Sacc. Syll. Addit., p. 2 (in part).

Uncinula polychæta T. & G. Bot. Gaz., XIII, p. 29 (in part).

Uncinula polychæta Masse, Grev. XVII, p. 78, 1889.

Uncinula polychæta Rav. Fung. Car. ex. fasc. 4, 68.

Hypophyllous; mycelium in dense, definite patches, or distributed over a large part of the leaf surface. Perithecia generally numerous, scattered, brown, becoming black, globose, lenticular, 225–280, reticulations minute. Appendages numerous, two hundred or more, hyaline, about equal to diameter of perithe-

cium, arising in circle toward one side, straight when young, to incurved or coiled at the tips when mature. Asci about fifty, cylindrical, clavate or rarely oblong, ovate, abruptly contracted into a prominent pedicel, 30-35 x 45-50. Spores two, about 30 long.

On *Cellis occidentalis*, Columbia, S. C., autumn, 1888, 620 and 634. Very common.

Plate I, Fig. 5, is from a camera lucida drawing of a mature perithecium on leaves of *C. tara* from Buenos Ayres, S. A., which was kindly loaned me by Rev. J. B. Ellis. A majority of the perithecia were young and possessed straight appendages. Figs. 6, 7 and 8 are from the same specimen. Figs. 9, 10 and 11 are from a South Carolina specimen; all from camera lucida drawings.

PHYLLACTINIA LÉV.

Perithecium containing several asci; appendages needle-shaped, abruptly swollen at the base, free from the mycelium.

P. SUFFULTA (Reb.) Sacc.

Hypophyllous; mycelium abundant, persistent. Perithecia scattered, large, 180-200, reticulations small, distinct. Appendages seven to twelve, one to four times diameter of the perithecium, hyaline. Asci eight to twenty, irregularly ovate to oblong or elliptical, 25-30 x 70-80, pedicellate. Spores two to three, 30-35.

On *Ulmus Americana*, Columbia, S. C., October 13, 1888, 619; *Ulmus*, Auburn, Ala., October 20, 1889, 1017; *Alnus*, Columbia, S. C., November, 1888, 623.

Var. *macrospora*, perithecia 200-250; asci elongated, curved or straight, 40-50 x 70-120, long pedicellate; spores two, 35-50.

On *Quercus nigra*, Auburn, Ala., February, 1890, 1103; *Q. nigra* or *aquatica*? Auburn, Ala., November 25, 1890, 1799; *Q. phellos et aquatica*, December, 1890.

There is a second kind of appendage on the perithecia of this species. They are hyaline, knobbed at the end, the knobbed end bearing numerous slender flexuous short filaments. On

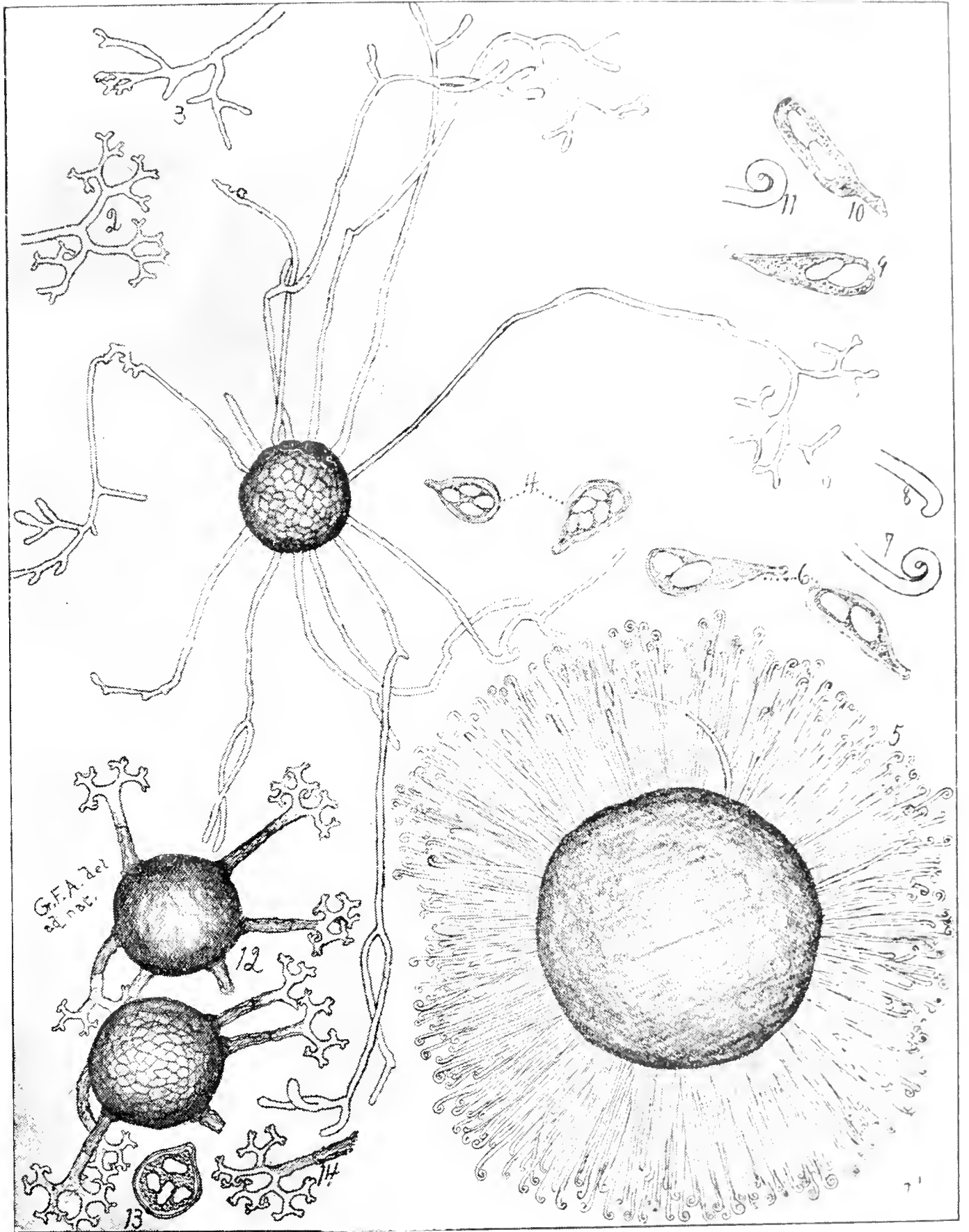
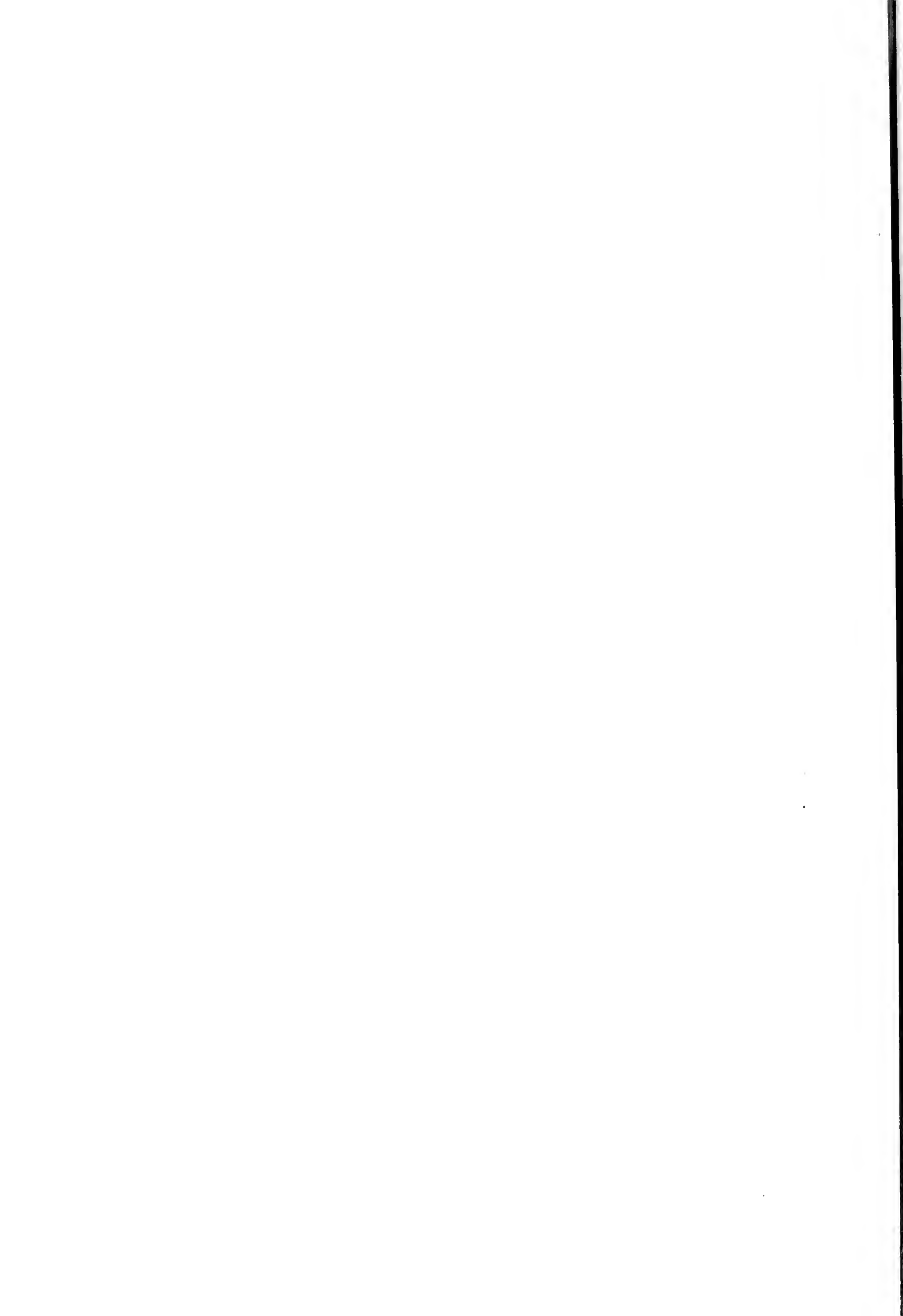


PLATE I.--ATKINSON, SOME ERYSIPIHEAE FROM CAROLINA AND ALABAMA.



specimens from elm these appendages are quite equal to one-half the diameter of the perithecium; on specimens from oak they are quite short and apt to be overlooked.

PODOSPHERA (D. C.) D. BY.

Perithecium containing one ascus; appendages dichotomously branched, free from the mycelium.

P. BIUNCINATA C. & P.

Epiphyllous; mycelium abundant, thin, diffuse. Perithecia black, numerous, scattered, small, 65-70, reticulations rather large, distinct. Appendages five to ten, three to five times the diameter of the perithecium, hyaline, faintly colored at the base, rough, once dichotomous, tips rather long, strongly divergent, slightly recurved. Asei globose or oval, sometimes with a short broad pedicel, 45-50 x 50-55. Spores eight, 15-18.

On *Hamamelis Virginiana*, Blowing Rock, Watauga county, N. C., August 24, 1888, 613.

P. OXYACANTHE (D. C.) D. BY.

Amphigenous; mycelium thin, not very persistent. Perithecia numerous, scattered, small, 65-70, dark brown. Appendages eight to twelve, about twice the diameter of the perithecium, dark brown for over half their length, three to four times dichotomously branched, branching compact, tips incurved. Asei sub-orbicular, 55 x 60, thick-walled. Spores eight.

On *Crataegus punctata*, Blowing Rock, Watauga county, N. C., August, 1889, 663.

MICROSPHERA LÉV.

Perithecium containing several asei, appendages dichotomously branched, or percurrent and then the primary branching opposite, tips of the branches dichotomous.

M. SEMITOSTA B. & C. (see Figs. 12, 13 and 14, Pl. I).

Hypophyllous; mycelium thin, evanescent. Perithecia scattered, usually numerous, small, black, about 80, reticulations obscure in age. Appendages rough, five to ten, about the length

of the diameter of perithecium or sometimes very little longer, dark brown for about half their length, sometimes the color ceasing abruptly midway as if the appendage were septate, sometimes extending to near the tips, four to five times dichotomous. Asci four to five, obovate, about 35 x 50, shortly pedicellate. Spores three to four, mostly four, small, about 15.

On *Cephalanthus occidentalis*, Auburn, Ala., autumn, 1889, 1031.

M. DIFFUSA C. & P.

Amphigenous or mostly epiphyllous; mycelium thin, persistent or evanescent. Perithecia numerous, scattered or subgregarious, black, small, 100–120. Appendages ten to twenty-five, long, two to five times the diameter of the perithecium, sometimes colored at the base, loosely several times dichotomous, tips straight or flexuous. Asci five to ten, ovate or elliptical, 30–40 x 50–60, pedicellate. Spores six, small, 16–18.

On *Desmodium*, Auburn, Ala., autumn, 1889, 1019; *Lespedeza striata*, November, 1889, 1014.

On *Desmodium* the specimens were mostly epiphyllous, while on *Lespedeza* they were common on both sides of the leaf.

M. VACCINII C. & P.

Amphigenous; mycelium thin. Perithecia numerous, scattered, black, 100–130, reticulations distinct. Appendages six to fifteen, three to four times the diameter of the perithecium or longer, hyaline, colored at base, rough, slender, three to four times dichotomous, tips incurved when mature, branching usually compact, sometimes the first branches strongly divergent. Asci six to eight, 25–30 x 50–60, oval or elliptical, pedicellate. Spores four to six, 17–20.

On *Vaccinium*, Blowing Rock, Watauga county, N. C., August, 1888, 616.

M. EUPHORBIE B. & C. (see Figs. 1–4, Pl. I).

Amphigenous; mycelium dense, persistent. Perithecia numerous, scattered, soft, 80–100, reticulations distinct. Appendages five to fifteen, roughened, hyaline, two to six times the diameter of the perithecium or longer, short ones usually not branched,

longer ones irregularly dichotomous, tips sometimes enlarged, sometimes irregularly lobed. Asci four to twelve, ovate to elliptical, pedicellate. Spores four to six.

On *Euphorbia* (several species), Chapel Hill, N. C., autumn, 1885, 628; Auburn, Ala., November, 1889, 1023; June, 1890, 1143. This species is quite common throughout the greater part of the year. I have collected it maturing its fruit in January.

M. VAN BRUNTIANA Ger.

Syn. *M. Alni* Burrill, Bull. Ill. State Lab. Nat. Hist., Vol. II, Parasitic Fungi of Ill., p. 421 (in part).

M. Van Bruntiana Ger. Torr. Bull., Vol. VI, p. 31.

Amphigenous; mycelium abundant, rather thin and covering large part of the leaf surface, or in spots, persistent. Perithecia numerous, scattered or subgregarious, 90–100, reticulations distinct.

Appendages ten to sixteen, about equal to diameter of the perithecium or little longer, rough, slightly colored at base, stout, several times dichotomous, tips long and flexuous, or short and blount, sometimes toothed, never recurved. Asci four to five, 35–40 x 50–60, ovate, pedicellate. Spores four to eight, 18–20.



On *Sambucus Canadensis*, Blowing Rock, Watauga county, N. C., August, 1888, 615.

M. ALNI (D C.) Winter.

Amphigenous, or epiphyllous; mycelium abundant and persistent or thin and evanescent. Perithecia numerous, scattered, small, 80–100, black, reticulations rather distinct. Appendages eight to fifteen, one to two times diameter of perithecium, colored toward base, four to five times regularly dichotomous, tips incurved when mature. Asci four to five, oval, 30–45 x 50–70, pedicellate. Spores six to eight, about 20.

On *Castanea sativa*, Blowing Rock, Watauga county, N. C.,

August, 1889, 617. The asci are quite regularly eight-spored and larger than in the two following specimens. *Syringa*, Union Springs, Ala., May, 1890, 1146. (Sent by Rev. J. L. Moultrie). Asci six-spored. *Corylus Americanus*, Blowing Rock, Watauga county, N. C., August 24, 1888, 614. Asci six-spored.

These specimens do not represent the variation in numbers of asci in a perithecium (two to eight) nor spores in an ascus (four to eight) given by Burrill (*l. c.*). This is probably owing to the small number of hosts represented.

M. QUERCINA (Schw.) Burrill.

Amphigenous, sometimes entirely epiphyllous or hypophyllous, persistent or evanescent. Perithecia generally numerous and scattered, mostly small, 80–100–130, dark brown or black. Appendages eight to fifteen, from less than to three or four times the diameter of the perithecium, colored at the base, rough or smooth, four to five times dichotomously branched, branching regular and compact, or open or sometimes quite irregular, tips of mature specimens incurved, frequently an incurved tip is unpaired, its mate having divided and formed a pair of incurved tips. Asci three to eight, shape and size variable, 35–50 x 60–80, usually pedicellate. Spores two to eight, 20–30.

Var. *extensa*, appendages three to five times diameter of the perithecium, branching regular, compact; asci three to five, 45–50 x 65–70. Spores four to eight, 20–25. On *Quercus nigra*, mostly epiphyllous, Chapel Hill, N. C., autumn, 1885, 630.

Var. *abbreviata*, appendages about equal to diameter of the perithecium, branching open; asci three to eight, 40–50 x 60–70; spores four to eight, 20–30. On *Quercus nigra*, mostly hypophyllous, asci three to five, spores four to five, 30, Auburn, Ala., December 22, 1890, 1797; *Q. nigra*, hypophyllous, asci four to six, spores eight, Chapel Hill, N. C., autumn, 1885, 631; *Q. falcata* (*Q. triloba Michx.*), amphigenous, mostly hypophyllous, branching appendages open and irregular; asci three to eight, spores six to eight, 25, Chapel Hill, N. C., autumn, 1885, 629; *Q. falcata*, hypophyllous, asci four to six. Spores four to eight, Columbia, S. C., October 13, 1888, 636.

Forms intermediate and varying to *M. Alni* (D. C.) Winter.

On *Quercus stellata*, amphigenous, mycelium dense, appendages one to two times diameter of perithecium, asci three to five, spores four to five, 25–30, Auburn, Ala., October, 1889, 1803; *Quercus rubra?* epiphyllous, appendages one to three times diameter perithecium, rough, asci three to five, 50–60 x 70–80, spores two to six, 30. Auburn, Ala., December, 1890, 1798.

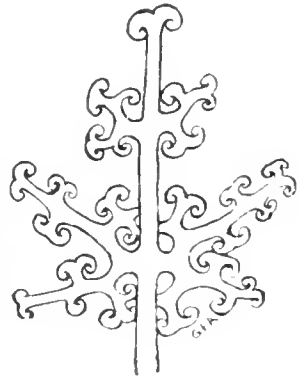
M. CALOCLADOPHORA Atkinson.

Syn. *M. densissima* E. & M. Journal Mycology, Vol. 1, 1885, p. 101.

M. densissima E. & M. N. A. F. No. 1538.

M. densissima Sacc. Sacc. Syll. Addit., p. 2 (in part).

Hypophyllous, mycelium thin, diffuse, or in orbicular patches, dense. Perithecia scattered, black, rather stout, 100–140, reticulations rather distinct. Appendages one to two times diameter of the perithecium, percurrent, primary branching opposite or nearly so, branches dichotomous, tips incurved, some of the tips unpaired as in *M. Quercina*.* Asci four to six, ovate or elliptical, pedicellate, 35–40 x 65–80. Spores six to eight, 20–25, granular. Through the kindness of Dr. Charles Peck I have had the opportunity of examining specimens of *M. densissima* (Schw.) Peck. The specimens are very distinct from those of *M. densissima* E. & M. The appendages are dichotomous throughout and the orbicular patches of the mycelium are very different. The specimens in N. A. F. No. 1538 agree perfectly with those I have collected except that the mycelium is in orbicular patches, and more dense. This, however, is a very common variation in a number of species.



Some might think this species deserving to be the type of a new genus from the character of the appendages, but the dichotomous branching of the branches shows its close relationship to *Microsphaera*.

On *Quercus aquatica*, Columbia, S. C., October, 1888, 618; Auburn, Ala., December, 1890, 1804.

*This is not a peculiarity of the tips of specimens on oak. I have noticed it in *M. Alni* on *Syringa*.

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EXPLANATION OF FIGURES IN PLATE I.

Microsphaera Euphorbiae B. & C. (from Alabama).

Fig. 1, Perithecium with appendages.

Fig. 2, End of appendage quite evenly branched four to five times.

Fig. 3, End of appendage quite unevenly branched.

Fig. 4, Asci.

Uncinula polychaeta (B. & C). Massee.

Fig. 5, Perithecium from Buenos Ayres, S. A.

Fig. 6, Asci from Fig. 5.

Fig. 7, End of well coiled appendage of same.

Fig. 8, End of incurved appendage of same.

Figs. 9. and 10, Asci from specimen from South Carolina.

Fig. 11, End of well coiled appendage of same.

Microsphaera semitosta B. & C. (from Alabama).

Fig. 12, Two perithecia.

Fig. 13, Ascus containing four spores.

Fig. 14, End of appendage.

All of the figures were drawn with aid of camera lucida, and the plate then reduced one-half in length and width in the process of photo-engraving.

Figs. 1, 5, 12 and 14 drawn by objective *A A* and compensation ocular 12.

Figs. 2, 3, 4, 6, 9, 10 and 13, objective *D*, comp. ocular 4.

Figs. 7, 8 and 11, objective *D*, comp. ocular 12.

Zeiss microscope used.

THE PROPER STANDARD FOR THE ATOMIC WEIGHTS.

BY F. P. VENABLE.

Among the important questions attracting the attention of chemists to-day is that of the proper standard to be adopted for the atomic weights. It is a question whose settlement cannot be much longer postponed without injury. It must be settled by careful consideration on the part of associations and individuals, and then by general usage—a sort of majority vote. I therefore venture to bring the question in its present status to the attention of chemists, asking a careful, thoughtful discussion and consideration of it.

Two elements lay claim to the position of standard for all other atomic weights, hydrogen and oxygen. Hydrogen is called by Meyer and Seubert the Dalton-Gmelin unit and oxygen the Wollaston-Berzelius unit. The contention is an old one then, and first one then the other has been forced to give way in the struggle. For a long time oxygen was the accepted standard of the only approximately accurate atomic weights—those of Berzelius. It was then displaced by hydrogen, and this element has so fixed itself in the literature that it cannot well be in turn displaced as the unit. But I would make a careful distinction between unit and standard. To make a radical change now would be inconvenient and difficult, and should be done only under stress of absolute need. When one considers the difficulty and tediousness of becoming accustomed to new numbers and the decrease in value and intelligibility of all the literature in the old notation that would follow a change of unit, one can properly realize the cost of such a change.

We are closing a century's labor, however, and a century's history, and it is important that we should come to some agreement on this point, and so be in a position to confer some degree of constancy upon our so-called constants. As it stands now

each revision, or redetermination, is calculated by two standards, and the individual chemist is left to choose between them at his own sweet will. There is no necessity for this, and it is a blot upon our science. Other sciences, notably electricity, are getting their standards in order, their loins girt, as it were, for the race of the twentieth century. We must settle this question, as well as others, if we would move freely in the grand onward march.

The best settlement comes, as is often the case, in the way of a kind of compromise. Let oxygen be the standard and hydrogen practically the unit. This reduces the changes to the least possible, and tables arranged on this basis have been in use a long time. In fact, it was only with the idea of securing greater accuracy that this arrangement was ever changed. The use of $O = 15.96$ as a factor for calculation appeared about the time of the first appearance of Meyer's work on the Modern Theories of Chemistry, and is mainly due to his instrumentality. The pursuit of accuracy in that direction has proved an *ignis fatuus*, and the necessity for something more fixed becomes every day more and more apparent.

The extent of this need impressed me greatly while studying the various recalculations of the atomic weights as made by Clarke, Meyer and Seubert, Sebelien and Ostwald, and led to an article on the subject first published by the Elisha Mitchell Scientific Society, and afterwards by the *Chemical News* and the *Journal of Analytical Chemistry*.* This seems to have been the first article published in the discussion, but to Dr. Brauner, of Prague, belongs the credit of arousing the discussion which was carried on in the *Berichte* of the German Chemical Society during 1889, and which was participated in by Ostwald, Meyer and Seubert, and Brauner.† Meyer and Seubert alone opposed the adoption of $O = 16$ as the standard.

*See Vol. III, p. 48.

†See also *Chem. Zeit.* 1890, No. 13, where Dittmar says: "Ich wage zu hoffen dass diejenigen Chemiker, welche seither, nachdem sie die Ueberzeugung gewonnen hatten dass $O:H$ kleiner ist als 16, darauf bestanden haben, dass $H = 1$ als einheit für die Atomgewichte festgehalten werden müsse, diese absurde Praxis aufgeben und die 16 Theil des Atomgewichtes des Sauerstoffs als einheit adoptiren werden."

Without dwelling separately on these articles, or the arguments adduced on one side and the other, I shall content myself with trying to state clearly the reasons for adopting $O = 16$ as the standard. Were it a mere matter of sentiment, of securing a larger number of integers in the table of atomic weights, or something of that kind, I think all will agree with me that the change would be mere folly. Such men as Ostwald and Brauner would not waste time quibbling over anything so insignificant. There must be and is something deeper, and it is strange to me that Meyer and Seubert seem unable to see the true point of contention.

The facts of the case are as follows: Hydrogen, as having the least atomic weight, seems, at first sight, the most appropriate unit for measuring the others. It admits of all being represented by numbers greater than unity, and none of them of such inconvenient size as in the Berzelius table with $O = 100$. If we could determine the ratio of the other elements to hydrogen directly, that is, if their atomic weights were determined by means of hydrogen, and hence were directly dependent upon this as unit, there would be nothing further for us to desire. Unfortunately, very few such direct ratios can be secured. Only three or four have been determined.

Under these circumstances, two things are possible. First find the ratio between hydrogen and oxygen, then, using this as a factor, calculate the other atomic weights. Could we find this ratio absolutely, there would be no objection to this method, but it is impossible to eliminate or allow for personal and experimental errors. The ratio found can at best be but an approximation. Evidently, by using an approximation to calculate other approximations, we get further and further from the truth. As Ostwald has said, we are introducing totally uncalled for and unnecessary errors, and he is right in styling it, in this stage of our science, a barbarism. As Brauner has pointed out these errors can easily amount to several integers in the higher atomic weights.

It is not for lack of skilled workers to undertake the determi-

nation of this ratio. Much excellent work has been done upon it, and especially in the last two or three years. Ostwald has summed these up, and says there is an error of at least 0.3 per cent, which has not been removed by recent workers. Brauner agrees with him that the variations are irreconcilable, and though Meyer and Seubert think the ratio can vary but little from that assumed by them as justifiable by the best determination, it is manifestly a point on which the best authorities differ and hence one of uncertainty.

Why should we then make use of the number 15.96 if it is not fixed by incontrovertible, unerring, universally accepted experiments? It makes the matter no whit better for Meyer and Seubert to profess their willingness to recalculate their table should a change in the number 15.96 prove necessary. It is merely a confession of the insecurity of their own position. We do not wish any recalculation. We wish a standard by which the calculations can be made once and for all, one that will give us the least possible error and is itself independent of other calculations. The present use of the double standard 15.96 and 16 seems puerile and leads to all manner of inaccuracies.

The second possibility is to use oxygen as the standard.

The question reduces itself, then, really to this: Shall we use $O = 15.96$ or $O = 16$? For oxygen must be used from very necessity. If $O = 15.96$ is not the absolute ratio or is not generally accepted as such then the reason for its use ceases.

It is not necessary to bring forward arguments as to the relative convenience of the two, nor as to their effect upon the periodic law. Such arguments have little weight or significance when it is seen that the question lies between $O = 15.96$ and $O = 16$, and that hydrogen can never be the actual standard or factor from purely chemical reasons. Nor yet is there much in any argument from analogy with other standards and units. Such only lead us away from the one all-important consideration—the avoidance of unnecessary errors.

I have said that the present proposition could be looked upon in the light of a compromise. If oxygen takes the place of hydrogen as standard, what falls to the share of the latter ele-

ment? If oxygen were made 100, as in the Berzelius table, or 10 or 1, as have been proposed, then the present numbers, as referred to hydrogen, would be entirely changed and lost sight of. The plan is to change them as little as possible, giving oxygen the number sixteen, which was once regarded as the ratio between it and hydrogen, and, according to the views of some, may still be it. Then the number for hydrogen will vary very little from unity, and the whole table is nearly based upon it as the unit. This number will change from time to time with new determinations, but such changes will involve no others. Oxygen, the standard, will then be fixed, and our task lies in the accurate determination of the others by it.

Meyer and Seubert cling to the idea that if oxygen be adopted it must be taken equal to unity, maintaining that $O = 16$ is neither flesh nor fowl, and by no means a unit. It is true that the standard or basis of a series of physical constants has in the past usually been taken equal to unity, but I cannot conceive the power of this habit to be sufficiently strong to force us into inconveniences or inaccuracies. That it is not regarded as a binding rule has been shown by the choice of some recent standards, especially in the new science of electricity.

The atomic weights are but relative numbers. To be in any respect constants, they must be relative to but one single element. With but few exceptions the ratio to oxygen can be determined. In revision of atomic weights, then, this should receive the chief attention and the oxygen ratio should be most carefully and directly determined.

Where the intermediation of another element is made use of (even though this be one which "may be counted among those of which the atomic weights are already known with the nearest approach to exactness," as Dr. Mallet recommends) it must be borne in mind that the result is subject to a certain error, which is generally multiplied several times and hence cannot give concordant results with the direct oxygen ratio, and less stress must be placed upon it. If the well determined ratio $H : O$ is subject to an error of 0.3 per cent., how much greater is the error in the case of ratios less well known?

THE ACTION OF PHOSPHORUS UPON CERTAIN METALLIC SALTS.

BY GASTON BATTLE.

The action of phosphorus upon solutions of copper sulphate has been examined with some detail.* The precipitates given with certain metallic solutions by phosphorus dissolved in carbon bisulphide have also been noted.† But no account could be found of any research upon the prolonged action of phosphorus upon aqueous solutions of the ordinary metallic salts.

An investigation of these changes was, therefore, begun but interrupted and finally finished under pressure for time, consequently it cannot be looked upon as complete or satisfactory and is reported only to show the progress made and to place on record whatever new facts were observed. The solutions experimented upon and the results were as follows:

1st. *A solution of Silver Nitrate.*

The phosphorus was added in thin shavings and the whole placed in the dark. On the first day needle-like crystals were formed. By the third day these had lost much of their lustre and a dirty white residue began to be formed. On the fourth day a heavy spongy mass had formed over the phosphorus.

Qualitative tests showed the presence of nitric, phosphoric, and phosphorous acids in the liquid and in the solid residue silver and silver phosphide. A quantitative analysis gave 99.19 p. c. of silver. These tests were made after the solution had stood two months or more, and show that the silver was almost perfectly reduced from solution.

2d. *Solution of Potassium Bichromate.*

After two months' standing of a dilute solution of this salt over phosphorus it had turned green and there was a dirty greenish deposit over the phosphorus. The excess of phosphorus was

*Compt. Rend. 84, 1454. This Journal, Vol. II, p. 57.

†Zeit. Chem. IV, 161.

removed from the solid by washing with carbon bisulphide, and on analysis gave :

$$\text{p. c. Cr} = 21.98.$$

$$\text{p. c. P}_2\text{O}_5 = 29.20 \text{ or p. c. P.} = 11.34.$$

The liquid contained both acids of phosphorus, chromic acid-potassium and chromium. Unfortunately the condition of the phosphorus in this residue was not determined. The amount on hand was insufficient and the changes took place too slowly for another supply to be secured. If possible the reaction will be investigated more closely at some subsequent time. Another solution exposed for a shorter period gave a brownish deposit which yielded an analysis

$$\text{p. c. Cr} = 41.48.$$

$$\text{p. c. P}_2\text{O}_5 = 7.96 \text{ or p. c. P.} = 3.47.$$

3d. *Solution of Ferric Chloride.*

A very slight precipitate was given after standing several days. Finally a whitish pasty precipitate settled to the bottom. After washing, drying and powdering the color was yellowish white.

Much iron was left in solution along with hydrochloric and phosphorous acids. The dried precipitate contained

$$\text{p. c. Fe} = 42.90.$$

$$\text{p. c. P.} = 13.17.$$

This approximates to $\text{Fe}_2\text{O}_3 \cdot 3 \text{ Fe PO}_4$. The drying was done at 115°C . and the precipitate was possibly not entirely dried. It can only be definitely stated then that a basic phosphate of something like the above composition was formed.

Phosphorus placed in a solution of ferrous sulphate became covered with a black, soot-like deposit which seemed to be iron phosphide.

4th. *Solution of Mercuric Chloride.*

A white precipitate was formed within the first twelve hours. This increased with time and proved to be mercurous chloride. The usual oxidation of the phosphorus took place and its oxy-acids could be detected in the solution.

When a solution of mercuric sulphate was used instead of the chloride a blackish deposit containing mercury and phosphorus was gotten and at the same time much metallic mercury was formed, showing a complete reduction.

A number of other solutions were tested in the same way, but lack of time prevented a thorough examination. No effect was noticed in the case of antimony chloride, bismuth nitrate, chromium sulphate, titanium chloride, manganous sulphate, sodium tungstate, zinc sulphate, potassium chromate and cobalt sulphate; with nickel sulphate a green amorphous deposit was gotten, containing nickel and phosphorus; with potassium permanganate a dark, heavy, green deposit was obtained; with lead acetate a white deposit, containing lead, and acetic and phosphoric acids; with uranium acetate there seemed to be first an oxidation of the phosphorus to phosphoric acid, this precipitating uranium in the well-known way. No phosphoric acid could be detected in the solution above the yellow deposit. In the case of ammonium molybdate the liquid went through many changes of color, indicating the stages of reduction, but the resulting products were not closely examined. This, then, cannot be looked upon as a report of work finished, but rather of work interrupted and necessarily given up for the present. The examination of these changes more thoroughly offers much of interest, and will be taken up again when opportunity offers.

The reducing action of phosphorous acid upon metallic solutions is known and often quoted. The formation of phosphorous acid is most probably an intermediate step here and the reactions are to be accounted for by its presence.

LEAD CHLORO-BROMIDES.

BY F. P. VENABLE.

The double compounds of the halogen salts of lead have commonly very simple and regular formulas assigned to them, often as if they occurred only with equal proportions of the constituents. In some previous work upon these compounds* it was seen that in several classes of compounds, at least, this was not the case. As a contribution to our knowledge of this combining power of lead some further experiments were tried upon the chloro-bromides of lead and the results are given in detail.

First Experiment. In the first experiment 13.2 gm. of lead bromide and 5 gm. of lead chloride were dissolved in hot water. This is in the proportion of two parts of bromide to one of chloride. A very small portion, less than one-tenth of a gram remained undissolved. Three crops of crystals were gotten from this. The following percentages of lead were obtained on analysis:

1st Fraction 62.48: 3 Pb Br₂. 2 Pb Cl₂ has 62.41 p. c. lead.

2d Fraction 64.80: Pb Br₂. Pb Cl₂ has 64.14 p. c. lead.

3d Fraction 62.50: 3 Pb Br₂. 2 Pb Cl₂ has 62.41 p. c. lead.

On evaporating further on a water bath three more crops of crystals were gotten.

4th Fraction contained 60.26: 3 Pb Br₂. Pb Cl₂ has 60.42 p. c. lead.

5th Fraction contained 59.48: 4 Pb Br₂. Pb Cl₂ has 59.26 p. c. lead.

6th Fraction contained 59.09: 5 Pb Br₂. Pb Cl₂ has 58.71 p. c. lead.

The next crop of crystals gotten on further evaporation was very evidently lead bromide mixed with a few crystals similar to fractions 5th and 6th.

Second Experiment. Two parts of chloride were taken to one of bromide. Four fractions of crystals were gotten and the percentage of lead in them determined.

*This Journal, V, 10.

1st Fraction contained 64.50; Pb Br₂, Pb Cl₂ has 64.14 p. c. lead.

2d Fraction contained 64.76: Pb Br₂, Pb Cl₂ has 64.14 p. c. lead.

3d Fraction contained 66.34: 2 Pb Cl₂, Pb Br₂ has 66.16 p. c. lead.

4th Fraction contained 69.11: 3 Pb Cl₂, Pb Br₂ has 68.97 p. c. lead.

When it is remembered that these various crops of crystals cannot be thoroughly washed and purified because of the ease with which they are usually decomposed by water, and furthermore that there is no probability of procuring absolutely distinct crystallization from one fractionation, the variations between calculated and observed numbers in the analyses will not appear large.

Of course it cannot be absolutely maintained from the agreement of the analytical numbers with those for certain formulas that such and such compounds were obtained. But the fact that these were well-formed crystals and that not even the magnifying-glass could reveal evidences of mixing lends strong probability to the view that lead chloride and lead bromide have the power of uniting in a great many distinct proportions, depending upon the relative amounts in solution and perhaps upon other factors, such as concentration and temperature.

That the crystals were very similar in appearance in all cases makes the solution of the question of the actual existence of these various compounds more difficult. It is hoped that some other double compounds may be found which lend themselves better to the decision of the question.

LEAD BROMO-NITRATES.

—
BY H. L. MILLER.
—

A solution of lead nitrate, containing also some lead bromide, on standing and slowly evaporating gave handsome clumps of needle-like crystals very different in appearance from crystals of lead bromide. Some of these were collected, washed, dried and on analysis gave 33.05 per cent. of bromine.

Attempts were then made to prepare this compound and so by determining its method of preparation and by further analyses to decide whether it could be called a definite compound or not. Three grams of lead nitrate were dissolved in hot water and ten grams of lead bromide added. The whole was filtered hot and allowed to cool. The bromide (as judged by the appearance of the crystals) crystallized out with very little admixture of nitrate.

Next a saturated solution of lead nitrate was taken and lead bromide dissolved in it while hot in such amount that it did not crystallize out immediately on cooling. Four crops of crystals were gotten from this mixture on its slow evaporation. These presented very much the same appearance, that of stellated groups of needle-like crystals.

On analyzing these after drying at 100° the following results were obtained:

1st Crop	percentage	bromine	41.23.
2d	"	"	36.75.
3d	"	"	33.40.
4th	"	"	34.68.

There are reasons for thinking this last analysis faulty as the amount of substance at command was insufficient.

The percentage of bromine in lead bromide is 43.58; in $\text{Pb}(\text{No}_3)_2 \cdot 5 \text{Pb Br}_2$ it is 36.92, in $\text{Pb}(\text{No}_3)_2 \cdot 3 \text{Pb Br}_2$ it is 33.50.

The first crop of crystals then contained only a small amount of lead nitrate and this amount increases with each subsequent crop, approaching nearly to two definite compounds as far as the analyses can point out. It is of course highly improbable that one could secure pure compounds by one such fractional crystallization, but the fact that figures approximately corresponding to $\text{Pb}(\text{No}_3)_2 \cdot (\text{Pb Br}_2)_3$ were obtained in each of the two experiments certainly affords ground for believing that such a compound is formed.

CHEMICAL LABORATORY U. N. C., May, 1890.

ADULTERATED SPIRITS OF TURPENTINE.

A CONVENIENT METHOD FOR DETECTING AND FOR ESTIMATING PETROLEUM
IN SPIRITS OF TURPENTINE.

BY SAMUEL J. HINSDALE.

Put ten drops of the spirits to be examined in a (moderately concave) watch glass, and float the glass on about a quart of water which has a temperature of about 170° F. If the spirits is pure it will evaporate and leave the glass quite dry in seven minutes. If the spirits contains even five per cent. of petroleum it will not have completely evaporated in that time.

This experiment will prove the absence or presence of petroleum in the sample.

To estimate the *percentage* of petroleum, weigh a watch glass and put into it ten drops of the mixture, and weigh again. Put into another glass ten drops of pure spirits of turpentine and float both glasses on about a quart of water at about 170° F.

As soon as the pure spirits has evaporated take off the glass which contained the mixture and weigh it. The difference between this weighing and the weight of the glass will indicate the amount of petroleum in the mixture. Knowing the weight of the ten drops, the percentage can be calculated.

A bent loop of wire is convenient to place on and remove the watch glass from the water.

The hydrometer will detect adulteration with benzine or petroleum, but it cannot be used to estimate the amount of adulteration.

The specific gravity of pure spirits of turpentine is about 0.865.

Petroleum is the usual adulterant.

OCCURRENCE OF GOLD IN MONTGOMERY COUNTY, NORTH CAROLINA.

BY J. M. MOREHEAD.

In his Geological Report of the midland counties of North Carolina* Dr. Emmons says, concerning the origin of the gold in the Uharie Mountain region of Montgomery county:

“One of the most interesting instances of the occurrence of gold in consolidated sediments is at a place called Zion, twelve miles from Troy.” And again in a following paragraph: “The gold which has been obtained was derived from the *debris* of the rock, but the rock itself sometimes shows particles of gold”; and further, “notwithstanding the evidences there are of the sedimentary origin of the gold it is a curious and interesting fact that it is visible in seams which traverse the rock.”†

These quotations and the context show clearly Dr. Emmons' opinion to have been that the gold of the gravel of this region was deposited as a sediment contemporaneous with the rock, and along with the subsequent processes of weathering of the rock and the formation of the deposits that the gold which was formerly distributed in finer particles through the rock, later by the segregating process collected into larger particles and nuggets.

From observations made during the past summer at the Sam Christian Gold Mine and vicinity near Zion I am led to doubt the correctness of this opinion and to believe rather that at least much the larger part, if not all, of the gold found in these gravels came from the numerous small quartz veins which traverse the region in a N. W. by S. E. course and with a nearly vertical dip.

The reasons for this belief are as follows: No gold of any consequence has ever been found in places where there were no evidences of quartz veins either broken down or intact. The

*North Carolina Geological Survey, Emmons, New York and Raleigh, 1856, p. 135.

†Same as above, pp. 135-136.

gold is generally found in the immediate proximity of these broken down quartz veins or down, never up, the slope from them. In several cases good-sized nuggets have been found in the veins themselves. Large nuggets have been found with the edges sharp and angular, showing very conclusively that they had not been transported any distance by water. Quite a number of small nuggets have been found attached to fragments of the vein quartz.

These facts show that the larger part, if not all, of the gold of this region first occurred in the small quartz veins, and that with the breaking down of the veins the gold and the vein quartz settled down into and formed part of the gravel in the immediate vicinity or below it, and not, as Dr. Emmons had supposed, that the gold found in the gravels had existed originally in the country rock in minute quantities on a sedimentary deposit.

The Sam Christian Gold Mine property lies among the hills at the southern end of the Uharie Mountains. The characteristic rock of the region is quartzite in places quite cherty and so thoroughly altered as to leave the original bedding in places quite obscured. Here and there these rocks, everywhere quite obdurate, rise into steep and irregular hills traversed by numerous quartz veins, the great majority of which are small, but a few of which are several feet in thickness, though quite irregular. Only a few of the large, many of the small veins are gold-bearing. In depressions ("channels") on the slopes of these hills lies the auriferous gravel one to four feet thick, composed of numerous irregular angular fragments of vein quartz and a larger proportion of quartzite of from very small size to two feet and more in diameter and with a matrix of gritty sand, with a small portion of clay. These gravels lie on the irregular surface of the country rock and are in turn overlaid by one to six feet of a gravelly loam soil. The origin and distribution of the gravels has been due largely, if not entirely, to frost action.*

*Kerr, American Journal of Science, May, 1881 (reprinted as Appendix C, Ores of North Carolina, 1888, p. 329). Also Transactions American Institute Mining Engineers, Vol. VIII, p. 462 (reprinted as Appendix A in Ores North Carolina, 1888, p. 321).

MINERALOGICAL, GEOLOGICAL AND AGRICULTURAL SURVEYS OF SOUTH CAROLINA.*

BY J. A. HOLMES.

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INTRODUCTION.

Several years ago, under instructions from the Director of the United States Geological Survey, the writer undertook the collection of materials for an historical sketch of the scientific surveys of North and South Carolina.

Records relating to such surveys in the first named of these States were found to be fairly well preserved, and an historical sketch of these surveys was prepared in 1888, and an abstract of the same was published in this Journal, Part I, for 1889. But the records relating to such surveys in South Carolina have been imperfectly preserved, and the collection of material for the following sketch has involved a considerable amount of labor, a large part of which has been attended with unsatisfactory results.

Nearly all of the citizens of the State who were interested in such matters during the surveys of Ruffin and Tuomey (1843-'47) have since passed away; and, although Lieber's survey (1856-'60) came at a later date, this was immediately followed by the civil war, during which Lieber himself was killed, and many of the records of the survey destroyed. Moreover, the thoughts of the citizens of the State were then drawn in other directions with such intensity that the details concerning a scientific survey were seemingly forgotten beyond recall.

*Published by permission of the Director of the U. S. Geological Survey.

Nevertheless, by applying to several hundred of the older citizens of the State, I have secured a considerable amount of information that could not otherwise have been obtained.

Among those who have contributed most to the supply of information, it is but just that I should mention the names of Professor L. R. Gibbes, of Charleston; the late Dr. H. W. Ravenel, of Aiken, and the late Col. James H. Rion, of Winnsboro.

The writer has in preparation also a sketch of the early geographical surveys of the Carolinas, but this is not yet ready for publication. Of the State surveys in South Carolina bearing on Mineralogy, Geology and Agriculture there have been made three that deserve consideration in the present sketch. These are in the order of their occurrence: The Vanuxem Geological and Mineralogical Tour (1825-'26), the Ruffin-Tuomey Agricultural and Geological Surveys (1843-'47), and the Lieber Geological, Mineralogical and Agricultural Survey (1855-'59).

VANUXEM SURVEY (1825 AND 1826).

The survey by Professor Vanuxem deserves special consideration mainly by virtue of its early date, it having been preceded by but one of the State surveys, as far as I am informed—the Olmsted Geological and Mineralogical Survey in North Carolina (1824-'25).*

It may be considered as a geological and mineralogical tour through the counties (then called districts) in the upper portion of South Carolina. These tours were made by him during his vacations while he was connected with the South Carolina College as Professor of Geology and Mineralogy, during the years 1825 and 1826.

The survey was originated in the following manner: Lardner Vanuxem was elected Professor of Geology and Mineralogy in the South Carolina College in December, 1821, on a salary of \$1,000 per annum. In April, 1824, he tendered his resignation

*See Jour. Elisha Mitchell Soc., 1889, Part I, pp. 5-8.

(to take effect in December following) on account of the insufficiency of the salary paid him. In the meantime, however, it was suggested to him by members of the Board of Trustees that there might arise an opportunity for him to make a geological and mineralogical survey of the State and thereby have his salary increased. Accordingly he indicated to the Board of Trustees his willingness to act on the suggestion and outlined the proposed work of the survey in a letter, of which the following is an extract :*

This idea I find meets with the sanction of many of the members of the Legislature; and it is thought that an application for funds for this purpose from your Honorable Board would meet with little or no opposition from the Legislature; I therefore request you, Gentlemen, before accepting my resignation to consider the propriety and expediency of making said application. I propose, Gentlemen, to make a thorough examination of *each District* of the State, as to its Rocks, Minerals and Fossils. To collect specimens of every different kind that comes under notice in the different Districts; and to arrange the same by *Districts* in the South Carolina College, giving to each specimen its *name* and its *location*. Likewise to mark on the map of the State the rocks as they exist, and also such valuable minerals as may have been noticed. As the mineral history of the State will be interesting at home and abroad, it is a part of my plan to prepare a work of the kind. It is thought that an examination of the State in the manner aforementioned, would occupy three years; giving to each year about six months, or as much of my time as could with convenience be taken from my present duties.

After consultation with Professor Vanuxem the Board of Trustees recommended to the General Assembly that he be placed "on equality with the other professors in point of salary and that he be required to perform the additional duties of a Geological and Mineralogical Survey of the State by Districts, collect and arrange the specimens, as proposed in his communication, during the summer months."†

The result of the above action was the insertion into that part of the appropriation bill for 1825, relating to the South Carolina College, the following: " * * * For the salary of the

*MS. Minutes of the Board of Trustees of the South Carolina College, 30th November, 1824, now in the College Library, Columbia.

†MS. Minutes of the Board of Trustees of the South Carolina College; proceedings of December 1 and 6, 1824, now in the College Library, Columbia.

Professor of Geology and Mineralogy, one thousand dollars; and five hundred dollars for making a Geological and Mineralogical Tour during the recess of College, and furnishing specimens of the same";* also the appropriation of a like amount for the year 1826.†

After 1826 the appropriation of the \$500 for the support of the survey was discontinued. In November, 1827, Professor Vanuxem resigned his connection with the South Carolina College to accept a lucrative position as superintendent of a gold mine near the City of Mexico.‡

Concerning the extent and character of Professor Vanuxem's work and his methods of operation, we are left largely to conjecture, as but little information has been left on record. But as based upon the data given above and in the records referred to, the following statement may be considered as substantially correct:

The work of the survey extended over two years, occupying about one-half of each year.§ During this time Professor Vanuxem was regularly connected with the South Carolina College as Professor of Geology and Mineralogy and the remainder of his time was give to teaching work; and, indeed, his work on the survey was regarded as a part of his college duties. To his regular college salary of \$1,000 per annum, the sum of \$500 per annum was added for making the survey; and out of this additional \$500 a year, or \$1,000 for the two years thus added to his salary, Professor Vanuxem bore the entire expense of the survey.

Thus limited in time and money, working alone, with the science of Geology in its infancy, and with organized geological surveys almost unknown, but little could have been expected in the way of methods and results from the survey. It was in reality but a mineralogical or geological "Tour" or series of tours

*Laws of South Carolina, 1821.

†Ibid., 1825.

‡LaBorde's History of South Carolina College, Revised Edition, 1874, pp. 138-143, gives a brief sketch of Professor Vannuxem and his connection with the South Carolina College.

§In a letter dated March 29, 1845 (LaBorde's Hist. S. C. College, 2d Edi., p. 141), Professor Vannuxem alludes to the "only year given to the survey of the State," but he here probably refers to the two halves of two years.

through some of the Piedmont counties of the State (portions of Abbeville, Pickens, Spartanburg and York, and perhaps also of Pendleton and Greenville), during which Professor Vanuxem examined in a superficial way the rocks and various important mineral deposits which he found in these regions, and collected more than 500 specimens, which he placed in the cabinet of the college.

As a further result of his work, he located on a copy of the State map* the characteristic rock formations over which he passed in making his explorations, and also published them in *Mill's Statistics of South Carolina*, 1826, pp. 25-30.†

No formal report of his survey is now to be found, or was probably ever published other than this list. He subsequently presented a copy of his report, probably in manuscript, to Mr. Tuomey, who describes it as "little more than a descriptive catalogue of the rocks and minerals collected."‡

His work doubtless stimulated the search for valuable minerals among some of the citizens along the line of his tours; and his map and collections of specimens added to the teaching facilities of the college. But other than as to these general points there is little to be said as to the beneficial results or additions to science resulting from the survey. As to this latter point, however, it must be added that at some time during his stay in South Carolina Mr. Vanuxem determined the post-pliocene age of the deposits underlying Charleston, and along with Dr. Morton, in 1829,§ he pointed out the existence of tertiary formations in the eastern portion of the State.||

RUFFIN AGRICULTURAL SURVEY, 1843.

The establishment of this survey, near the close of the year 1842, was "due to a movement altogether agricultural."

*As early as 1845 this map and many of the specimens had disappeared from the college cabinet. (LABORDE'S HISTORY S. C. COLLEGE, p. 141). All the specimens have since disappeared.

†See also Tuomey's *Geology of South Carolina*, 1848, Appendix, pp. XXXI and XXXII.

‡Tuomey's Report on the Geological and Agricultural Survey of S. C., 1844, p. IV.

§Silliman's Journal, July, 1829, pp. 254-256. Jour. Phil. Acad. Nat. Sci.

||For further discussions of Professor Vanuxem's life and work see LaBorde's *History S. C. College*, 1874, Revised Edi., pp. 138-143; Silliman's *Journal of Science*, May, 1848, pp. 445-446.

For a decade and more previous to this date the more intelligent planters in South Carolina had become deeply interested in the recent improvements of modern agriculture. A number of agricultural societies were organized in different regions of the State, and here these planters met together for discussions of various topics relating to their profession. The doctrines of modern agricultural chemistry concerning soils, the adaptability of crops, manures, and especially calcareous manures (marls, etc.), were taking root among a few of the more intelligent planters; but they felt the need of more information and of having some better informed person show how to put these doctrines into practice.

For several years an agricultural and geological survey of the State had been advocated by R. W. Roper, chairman of the legislative committee on agriculture; and now the demand for such a survey had become quite extended. Accordingly at the session of the Legislature of November and December, 1842, Governor James H. Hammond, one of the more intelligent and progressive planters in the State, in his annual message to the Legislature, urged the establishment of such a survey, and his recommendation was seconded by memorials from several of the agricultural societies (S. C. Agricultural Society, Wateree Agricultural Society and Milton Laureus Agricultural Society).

In December* (1842) the General Assembly authorized the establishment of an "Agricultural Survey of the State, * * * for the examination of our soil, discovery and application of marl lime, and developing all other resources and facilities of improvement"; and "as a means of testing this salutary measure," appropriated the sum of \$2,000 a year for two years, authorizing the Governor to appoint the surveyor, "who shall report all geological information which may be incidentally collected."

It was further authorized in the establishing act that the results of each year's survey be reported to the Legislature, and that copies of the reports be distributed to every agricultural society in the State.†

*Dec. 14, in the House of Representatives, and Dec. 17, in the Senate.

†Extracts from the Acts of South Carolina, 1842, pp. 92 and 93.

Soon after the passage of the above act, Governor Hammond appointed to the position of "Agricultural Surveyor for the State" Mr. Edmund Ruffin, of Virginia, who, early in the year 1843, assumed the duties of his office.

A word or two will suffice to show the fitness of the appointment. It was Mr. Ruffin, who, in 1818, had discovered the agricultural value of marl and other calcareous manures, by the use of which the producing capacity of much of the land in Eastern Virginia was nearly doubled. In 1832 he published his "Essay on Calcareous Manures," which soon passed through three editions and was widely circulated. From 1832 to 1842 he edited and published the *Farmers' Register*, an agricultural periodical, which had a wide circulation and exerted an important influence, especially in Eastern Maryland, Virginia and North Carolina. In all of his writings Mr. Ruffin advocated the improvement of soils by drainage, by use of manures of all kinds, and especially by the use of marls and lime; and his opinions were based upon the fact that by the use of marl he and his neighbors in Virginia had nearly doubled the productive capacity of their lands.

All of this gave Mr. Ruffin a reputation second to none in the South Atlantic States in matters pertaining to agriculture.

In South Carolina a few leading planters, among them Governor Hammond, under the guidance of Mr. Ruffin's advice, had begun to use marl extensively and with success. It was believed that marl existed in abundance over the eastern part of the State, but a general ignorance prevailed with regard to it, and it was especially desired that the agricultural surveyor should examine this region and show the people where marl existed, and how to procure and use it.

Mr. Ruffin's appointment was then in every way a suitable one; and he accepted it for one year with the understanding that he should "direct his efforts, for the most part, to discovering and examining the beds of marl and other calcareous deposits, and urging their use upon the people of the State."* He devoted the

*DeBow's Rev. O. S., Vol. XI, 1851, p. 435.

year to this work, and at the end of the year he resigned and returned to Virginia. His work met with popular favor, and it was generally regretted that he could not be induced to continue it longer.

His methods of operation were simple. The occurrence of marl being limited to the eastern or southern half of the State (the coastal plain region), his work was largely confined to this area, all portions of which he traversed in search of marl, shell-rock and other sources of lime, and in explaining their use to the planters.

In locating marl beds he used (1) a long auger, boring through the overlying soil; and in some cases (2) a steel gouge attached to the end of a long measuring rod; in still other cases (3) he had holes dug through the overlying soil with ordinary farm tools; occasionally supplementing these methods by searching along the banks of creeks and larger streams. The presence or absence of carbonate of lime in specimens was determined by use of muriatic acid or vinegar. For a number of samples the percentage of lime present was determined by chemical analyses, made in part by Mr. Ruffin himself, and in part by Dr. J. Lawrence Smith,* who subsequently became so well known as a chemist.

The following extract from a letter written long afterwards by the late Dr. H. W. Ravenel, of Aiken, S. C., well illustrates Mr. Ruffin's general mode of procedure. He says:

At the time of Mr. Ruffin's survey I was a planter in St. John's, Berkley Parish, about forty miles north of Charleston. We had a flourishing agricultural society, and my first acquaintance with him was at one of our anniversary meetings. He attended this meeting by invitation purposely to consult with the planters and to urge and recommend the use of calcareous marls, which were abundant in that region. He made a long address (or lecture) on the subject, and remained in our neighborhood for some weeks, going from place to place and assisting and suggesting how and where to obtain these marls.

Thus he traveled about from county to county, neighborhood to neighborhood, urging upon farmers the use of marl and other

*Prof. L. R. Gibbes, of Charleston, S. C., in a letter to the writer.

manures, a better drainage of the land and other improvements in agricultural methods.

In the prosecution of the survey Mr. Ruffin labored alone, except during December (1843), when other duties and ill health rendered necessary his stay in Columbia, he employed an assistant to examine for him calcareous deposits along the north-east border of the State. I am unable to obtain any information as to the name and history of this assistant. Mr. Ruffin says concerning him in a letter to Governor Hammond published in Tuomey's Report for 1844:* "But having had latterly the services of an assistant in whose care and accuracy I could implicitly rely, he was sent with special and particular instructions, to examine the most extensive and important of the omitted localities, as soon as it was certain that I could not perform the duty. The ground left for these last intended observations, and where calcareous deposits were expected to be found, was along Lynch's Creek, the Waccamaw River, and any other places on and near the line of route to the north-eastern border of the State, in which marl might be discovered, or heard of, on the journey."

No claim is made for additions to science resulting from this survey. Mr. Ruffin was an intelligent and careful observer, but he had enjoyed no training in any department of science, and his entire aim here was economic results; though in the prosecution of his work he added materially to the then existing knowledge as to the boundaries and character of the tertiary deposits and corrected many errors as to localities for characteristic fossils. As to material benefits resulting to the people of the State from his labor, it may be said (1) to have awakened a more general spirit of inquiry and experiment among the planters; (2) to have led to the more general adoption of some improved methods, such as ditching the lowlands, using green manure for a supply of vegetable matter, and (3) it led to a more general use of marl, which, in many cases at least, proved highly beneficial.

*Report on the Geological and Agricultural Survey of South Carolina, 1844, p. 57.

It must be admitted that the use of marl among the planters of the State has of late years been largely discontinued, owing to the cheapening of lime and the wide-spread use of phosphates and other concentrated commercial fertilizers, and further that the use of marl by many planters in years immediately following Mr. Ruffin's work proved a disappointment; but there can be but little doubt that on the whole such use was beneficial when the marl was judiciously applied.

The entire expense of conducting the survey was borne by Mr. Ruffin, the only appropriation made by the State being the \$2,000 referred to above.

The publications of the survey consisted of a report of 175 pages submitted by Mr. Ruffin November 30, 1843, and published by the State, and a supplemental report of seven pages submitted January 12, 1844, and published as a part of Tuomey's first report, 1844.*

TUOMEY'S GEOLOGICAL AND AGRICULTURAL SURVEY,
1844-'47.

When at the close of the year (1843) Mr. Ruffin resigned his position as Agricultural Surveyor to the State, he recommended as a suitable person to succeed him M. Tuomey, of Virginia. Mr. Tuomey was accordingly appointed to this position by the Governor (James H. Hammond) near the beginning of the next year and began to discharge the duties of his office about the end of February following (1844).

From the account which follows it will be seen that, notwithstanding the fact that the law under which Mr. Tuomey was appointed was that authorizing an agricultural survey, upon the assumption of his duties, and with the approval of the Governor, he at once began a geological exploration of the Piedmont region of the State, and that throughout the prosecution of the work of the survey he regards the geological examination as the more important part of his work and subordinates the agricult-

*See Bibliography, p. 113.

ural work to it. Hence I have considered it more appropriate to treat of these as two different surveys, having different objects in view, notwithstanding the fact that legally one was a continuation of the other.

This difference between the two surveys grew naturally out of the difference between the surveyors. Mr. Ruffin was a planter whose ambition was to improve the agricultural condition of the country by the introduction of better methods, and especially by the use of calcareous manures. Mr. Tuomey, on the other hand, was by profession a geologist and possessed also a fairly good knowledge of chemistry and botany. In his first Report on the Geological and Agricultural Survey of the State* he signs himself "Geological Surveyor"; and his work during this first year's connection with the survey was devoted to the examination mainly of the general and mining geology of the Piedmont region of the State.

In his Report of 1846† he gives the following statement of the objects of the survey:

In the renewal of my commission, by his Excellency, Gov. Aiken, in 1844, I was directed to make a Geological and Agricultural Survey of the State. Such a survey, as it is at present to be understood, includes the following objects.

1. The determination and description of the various minerals and rocks of the State.
2. Their examination as to extent and relation to each other in their order of superposition, as well as their influence upon the physical features of the State.
3. The discovery of metallic veins, and beds of other useful substances, such as lime, rock, marl, etc., that they may contain.
4. The relations of the rocks to soils, and their chemical examination, to a certain extent.
5. The pointing out of such improvements in mining and metallurgy, as may be thought useful to those engaged in those operations.

Concerning the methods of operation followed by Mr. Tuomey in the prosecution of the survey, there is very little information to be had. But the following extract from his letter to

*Columbia, 1844.

†Geol. of S. C., Columbia, 1848, p. 11.

Governor Hammond transmitting his report for 1844* throws some light on his operations during this the first year of his connection with the survey :

In accordance with my instructions, I hastened early in the spring, with all possible despatch, to the upper portion of the State, there to commence my labors. But before proceeding to a minute and systematic exploration, it was necessary that I should make myself acquainted with the general geological character of the region to be examined, for without such knowledge, I could scarcely know what to look for, and in science, it is a maxim that "what is not looked for is seldom found." By tracing a number of sections, at right angles with the general direction of the strata, and by determining carefully the strike of the rocks passed over, and by connecting these observations, I was enabled to determine, with some accuracy, the boundaries of the different formations.

While making this geological *reconnaissance* of the "hill country" of the State (the region of crystalline rocks) many observations were made as to the occurrence, distribution and extent of various ores and other minerals and rocks of economic value, and as to the character of the soils. Many specimens of ores, minerals and soils were collected for future analysis. Special attention was also given to the gold mines of the region.

During the two years following (1845 and 1846) Mr. Tuomey extended his explorations into every portion of the State, in the "hill country" continuing the work as indicated above, while in the "low country" or coastal plain region, he devoted himself mainly to a study of the stratigraphy and paleontology of the recent geological formations, his predecessor, Mr. Ruffin, having already investigated with considerable thoroughness the marls and soils of this latter region.

In his studies of the fossil forms found so abundantly in the coastal plain region of South Carolina Mr. Tuomey had the volunteer assistance of Professor F. S. Holmes, of Charleston, and of several other occasional collectors, and also of Professor Louis Agassiz, who visited Charleston in 1846, and who, during the ten years following, took great interest in and rendered great assist-

*Report on the Geological and Agricultural Survey of South Carolina, 1844, p. III.

ance in the identification and description of the fossil forms. The results of the combined labors of these gentlemen were published in two large and beautiful volumes, *Pleiocene Fossils* and *Post Pleiocene Fossils of South Carolina* (1857-'60).*

In his study of the soils of the several regions of the State, Tuomey collected a number of samples, and of many of these chemical analyses were made. In his reports he publishes a considerable number of these analyses of both soils and marls, made in part by himself and in part by Dr. J. Lawrence Smith, and Dr. Charles U. Shepard, of Charleston.

The economic results of Tuomey's works cannot perhaps be fairly or intelligently discussed at a time so long after the survey was made. But there can be no doubt that his survey was of considerable and lasting benefit to the State.

In the line of agricultural improvement he encouraged the farmers to adopt the improved methods which Mr. Ruffin had introduced. In person, as he traveled through the State, and in his reports, he instructed them as to the character of soils and their improvement by rotation of crops and manures of various kinds. He located and described the various sources of limestone rock in the "hill country," and instructed the people as to building furnaces and burning lime for agricultural and architectural purposes. He investigated with considerable thoroughness the gold mining interests of the State, and the results of this work published in his reports helped in bringing a considerable amount of capital into the State and in properly directing the investment of home capital. And so, also, his examination and advertisement of the iron ore deposits, building materials, material for millstones, and potters' clay deposits has at various times brought capital in considerable quantity into the State, and has saved to its citizens equally as great an amount by directing their own investments and thus preventing waste of money.

The results of the Tuomey survey are not rich in additions to science, but nevertheless some valuable advances were made along this line, especially as a result of the work done in the coastal

*See Bibliography at end of this paper, p. 113.

plain region. His work among the crystalline rocks of the "hill country" left to the public a better knowledge of the general character and distribution of these rocks, but the results involve nothing of importance in the form of either data or principles new to geologic science.

As to legislation relative to the Tuomey survey, it will be remembered (see p. 94) that the act of December, 1842, establishing the Ruffin survey, provided for a continuation of this survey for two years; and that Mr. Tuomey, having been appointed early in the year 1844, prosecuted his work during that year under the authority of this act.

In December, 1844, sundry petitions from the people of the State were submitted to the General Assembly, asking for a continuance of the "Agricultural and Geological Survey," and the General Assembly authorized "a continuance of the survey under the direction of the present incumbent, for a period of two years, and at an annual salary of two thousand dollars."*

In December, 1845, a resolution was adopted by the General Assembly authorizing a continuance of the Survey during the following year.† And again in December, 1846, a resolution was adopted authorizing that the "Geological Survey of this State be continued for four months from the first day of January next.‡ * * *§" According to this, the existence of the survey appears to have ended with the last day of April, 1847. Soon thereafter Mr. Tuomey left the State and went to Alabama, where he was elected to the professorship of Geology, Mineralogy and Agricultural Chemistry at the State University.

The annual appropriation of two thousand dollars for the salary of the geologist, was the only appropriation made for the prosecution of the work of the survey, the geologist being expected to bear all of the expenses incurred, except for publication, out of his salary.

The publications of the survey consisted of two reports;§—(1)

*Proceedings of House of Reps. of S. C., Dec. 14, 1844.

†Reports and Resolutions of S. C., 1845, p. 195.

‡Ibid., 1846, p. 203.

§See Bibliography, p. 113.

the first a small report submitted for publication November, 1844, which contains, in addition to Tuomey's report of 48 pages, an appendix giving the "Prize Report of Agricultural Experiments, submitted to the State Agricultural Society of South Carolina," November, 1844, by F. S. Holmes, consisting of 7 pages, and a "Supplement to Mr. Ruffin's Report," by Edmund Ruffin, 7 pages. (2) The second, a "Report on the Geology of South Carolina," is a volume of larger proportions. It was submitted for publication November, 1846 (though not published until 1848), and contains a summary of what was known at that time relative to the geology of the State. In addition to Tuomey's report, covering 293 pages, it contains as an appendix a Catalogue of the Fauna of South Carolina, by Professor L. R. Gibbes (24 pages); Meteorological Tables (6 pages); and several lesser papers, among which is an abstract of "Vanuxem's Report" on minerals and rocks collected in the State, taken from "*Mill's Statistics of South Carolina.*"*

LIEBER'S GEOLOGICAL, MINERALOGICAL AND AGRICULTURAL SURVEY, 1856-'60.

The results of the surveys by Ruffin and Tuomey were such as to arouse a deeper interest in the development of the agricultural and mineral resources of the State. Among these results, and accompanying them, the development and successful working of various gold deposits of Chesterfield, Lancaster, York, Abbeville, Edgefield and other counties, and iron deposits of York and Spartanburg, served to increase this interest. And it was doubtless this growing interest in the mineral wealth of the State which led to the inauguration of the Lieber survey.

The immediate *establishment* of this survey is explained in the following Report and Resolutions adopted by the General Assembly of South Carolina, December, 1855:

The Committee on Agriculture and Internal Improvements, to whom was referred the memorial of sundry citizens of St. Helena Parish, on the subject of an Agricultural and Geological Survey of the State, and also a resolution

*Columbia, S. C., 1826, p. 25.

of the Senate on the propriety of selecting a suitable person to procure and effect a mineralogical survey, respectfully report: That they have considered the same, and now submit the following report with accompanying resolutions:

The limits of a report on the present occasion forbid your committee attempting anything more than an exhibition of those general results which have been derived from the numerous examinations and explorations which all the Governments of Europe and many States of the Union have ordered, under the guidance of men of high scientific attainments.

In 1823, our State took the lead (North Carolina only excepted) in giving direction for a Geological survey in charge of Professor Vanuxem, and although his explorations were unaccompanied by any of those notable discoveries, which tend to diversify the industrial pursuits of a people, yet the subsequent labors of a Ruffin and a Tuomey, are so full of hope in the future, that the State should feel encouragement in prosecuting immediately what she has already so well begun. * * *

Believing, then, that these enlightened examples of other countries can be advantageously imitated by us, your committee recommend the adoption of the following resolutions:

Resolved, That this General Assembly authorize the appointment of a Geological, Mineralogical and Agricultural Surveyor, whose services shall be engaged for four years, and whose duty it shall be to explore the several districts, make a geological map, analyze minerals, ores, soils, and manures free of charge, and submit an annual report to the Legislature for general circulation.

Resolved, That this officer shall receive a salary of three thousand dollars, to be appointed by joint resolution of the two houses, and that it shall be the duty of the joint committees of Agriculture and Internal Improvements of the Senate, and of Internal Improvements of the House, to nominate a suitable person to fill this office.*

In accordance with the above resolutions, and within a few days after their adoption, Oscar M. Lieber was nominated by the committees and unanimously elected by the General Assembly Geological, Mineralogical and Agricultural Surveyor of the State for a term of four years, and his election was confirmed by the Governor December 22, 1855.

As to other *legislation* concerning the survey, the following may be noted: By a resolution of the General Assembly, December, 1856, the State Geologist was instructed to endeavor

*This Report was adopted by the Senate Dec. 13, 1855; concurred in by House of Representatives Dec. 19, 1855. See also REPORTS AND RESOLUTIONS OF S. C. FOR 1855, pp. 324-327.

to discover a "hydraulic limestone" which could supply lime and cement for use in the building of the new State House at Columbia.*

At the annual meetings of the General Assembly, December, 1856, '57, '58 and 1859, resolutions were passed ordering the printing of the Reports of the Survey, and commending the work of the Geological, Mineralogical and Agricultural Surveyor.†

The survey having been established in December, 1855, for a period of four years, was to be discontinued after 1859, unless otherwise ordered by legislative enactment. At its annual session in December, 1859, the General Assembly ordered the continuance of the survey for another year, with Mr. Lieber in charge. At a later date in the same session, however, a resolution making the usual appropriation (\$3,000) for the salary and expenses of the geologist for the year 1860 failed to pass the General Assembly; and the survey was necessarily discontinued. Lieber did not resign his position, however, until April 2, 1860, for reasons which can best be stated in his own language:‡

My resignation has been postponed until the present time, because I desired first to complete my last Report in such a manner that it might, together with those previously published, embrace the statements concerning everything of any importance which had been observed or effected during the four years of my service. This fourth Report, therefore, contains several chapters of a general character, and others referring to portions of the State where the survey had not yet advanced to completion. Believing that such work of reference would be of little practical value without a glossary and index, I have prepared one for the four Reports, and now append it.

The arrangement and writing these matters, and seeing the entire Report through the press, has occupied me three months.§

By way of further statement of the *objects of this survey*, I cannot do better than insert here a few extracts from the Intro-

*See Lieber's Second Annual Report, 1857, p. 117; and Senate Journal for 1856, pp. 142 and 143. At the same session of the General Assembly a resolution was adopted in the Senate, instructing the State Geologist to deposit in the cabinet of the S. C. College complete and duplicate sets of the rocks and fossils collected during the survey of the State, all to be properly arranged and labeled. But I find no record showing that the House of Representatives concurred in the resolution. (See Senate Journal, 1856, p. 146).

†Reports and Resolutions of S. C., 1856, pp. 317-319; and *Ibid.*, 1858, p. 415.

‡Fourth Annual Report (1859), p. V.

§The General Assembly, at its session in December, 1860, appropriated the sum of \$750.00 to pay Mr. Lieber for his services during these additional three months.

duction to Lieber's Fourth Annual Report, thus giving his own statement of the opinions which guided him in the prosecution of the survey. He says:*

The object of a survey of this description appears to me to be endowed with various and entirely distinct features. The primary cause of its institution is unquestionably the development of our natural resources; and this intention of its originators should always continue to retain its prominent position. But yet this commendable object by no means comprises all that should be embraced within the duties of a State Geologist. I think he should not merely endeavor to discover more occurrences of useful minerals and, here and there, labor to repress and prevent expenditure of private means in the search for such gifts of nature, where there is really no promise of sufficient importance to warrant it. Attentive as he ought to be to these more practical duties, whether of a positive or negative character, if interested in his own studies, he should not rest satisfied with them alone. His office empowers him with the means of extending a knowledge of the current progress of his science, and of aiding, often in no inconsiderable degree, in that field of research and exploration of nature, to which he has more particularly devoted his attention. For this purpose he must endeavor to obtain correct information of the latest developments in his department of science, and of the newest results of contemporary explorations of a cognate character.

Impressed with the conviction that the objects of a geognostic survey should be thus diversified, I have endeavored to explore and define our natural resources, to contribute as much as possible to the enlargement of knowledge in the particular department of science concerned, and to enable these Reports to become the vehicles for the distribution of that information on connected subjects, both technological and scientific, which is gradually accumulating elsewhere. * * * *

The only subject, apart from running notes on petrology, which I have deemed it expedient to enlarge upon more fully, on account of its immediate technological bearings, and the absence of its notice in almost all American and English books on geology, is the study of veins; and in this particular branch, I believe, indeed, that at least the general outlines have been presented in the different Reports.

The *special character* assumed by the survey was the resultant of the following conditions:

(1) Mr. Ruffin's work related to the agriculture of the "low country" more especially. Mr. Tuomey's work extended in a general way over the entire State, but a large share of his atten-

*Report on the Survey for S. C. for 1859, pp. 1 and 5.

tion was given to the stratigraphy and paleontology of the Low country. It seems now (1855) to have been generally conceded that the time had come for a more thorough survey of the general and economic geology of the "up country"—the region of crystalline rocks.

(2) Mr. Lieber's early training as a geologist and the work to which he seemed most devoted was petrology and "vein geognosy." His studies in Germany with Humboldt, Von Cotta and others, and his work on the geological survey in Alabama, under Tuomey, were along this line. And these features of his work in South Carolina were prominently in view during the entire existence of the survey.

(3) The smallness of the appropriation* prevented the employment of any regular assistants, by the aid of whom a larger amount and greater variety of work could have been accomplished.

As to the *area* covered by the survey, Lieber has left on record the following statement:†

The Districts (counties) which I have now surveyed and mapped out are: Chesterfield, Lancaster, Chester, York, Union, Spartanburgh, Greenville, Pickens, Anderson and Abbeville—my plan having been first to proceed along the North Carolina line from the margin of the sand region. As our metamorphic rocks strike very uniformly north-east, this plan enabled me to reach the heads of the columns as it were. Having effected this, and thus facilitated the mechanical part of the operation, I was engaged in proceeding down the Savannah, intending this year to have commenced filling up the intermediate Districts, when the Survey was stopped.

Edgefield has been partially surveyed and also, in part, reported upon; but I could not yet prepare a map.

Other Districts in which cursory or partial examinations have been made are: Lexington, Richland, Laurens, Newberry, Fairfield, and the Districts along the coast from the mouth of the Savannah to Bull's Bay. These observations on the coast were made during a portion of the winter (1859), but they are, as yet, quite incomplete.

Concerning the *methods of operation* followed by Lieber during the prosecution of the survey, but little can be said other

*\$3,000 per annum.

†Fourth Annual Report, 1859, p. 146.

than what is given in his Reports, supplemented by private letters from persons who came in contact with him more or less during this time. A few interesting suggestions are given in the extract just quoted, and also in the extract quoted below relative to the making of maps.

The resolution establishing the survey (p. 104), in enumerating the duties of the State Geologist, specifies that he shall "explore the several Districts and make a geological map, analyse minerals, ores and manures, free of charge," etc. The chemical work here specified, Lieber does not appear to have undertaken at all. He was not a chemist by profession nor by training, and furthermore, realizing that the performance of this part of the work would require the whole time of a competent chemist, he proceeded with that part of the work for which he was the better qualified, and which, he believed, would result more beneficially to the State—the field explorations, and making the geological maps. During the progress of the survey, however, he collected, from time to time, numerous specimens of rocks, minerals, ores and soils, with the hope that the General Assembly would further provide for their analysis by the employment of a chemist.* This, however, was never done, and the specimens were subsequently destroyed by the burning of the capitol building at Columbia during the civil war.

In prosecuting his field explorations, Lieber traveled on foot or in a wagon. During much of the time he had as his headquarters a tent, which was removed from place to place as his field work demanded. His only constant assistant was a servant, usually a negro or an Indian, who served as cook and general attendant.

In the following notes concerning the maps accompanying his reports Lieber suggests some of his methods of operation:†

A word in regard to the maps may be suitably added. These have been engraved with so much care and beauty by Mr. Colton,‡ that it has been a

*See Report for 1856, pp. 101 and 108; Report for 1857, p. 117; Report for 1858, p. VIII.

†Fourth Annual Report (1859), pp. 6-8

‡Mr. G. Woodworth Colton, formerly of the firm of J. H. Colton & Co., now (1859) of that of Thayer & Colton, New York.

great stimulus to me in seeking to increase to the utmost the accuracy of my portion of the labor. The manner of preparing the manuscript maps, by noting the points where different rocks present themselves, and afterwards connecting such points in accordance with nature, is too readily comprehended to demand farther explanation.

But there are instances where the maps might possibly engender the belief, that an amount of accuracy had been attained which would, under no circumstances, be within the reach of an examination of the surface. Where solid rocks are observed out-cropping near the margin of their area, the case is easy of solution; nor is the difficulty of the determination of boundaries much increased, where a conspicuous variation in the soil is seen, and the mother-rock of such soil is known; but many soils, derived from distinct rocks, are very similar in character (those of granite rocks and mica-slate, for instance), while some again, from their lightness, are drifted into the area of another rock. In these instances we are forced to rest satisfied with the utmost *attainable* accuracy. But as a uniform rule, precision in all details has been aimed at. Hence, the region around Limestone Springs, whose great scientific and technological interest appeared to demand the utmost care, was first drawn on a scale of one statute mile to two inches. From this manuscript, the plate XII was reduced by Mr. Colton. The ordinary scale on which the manuscript maps are drawn is that of two miles to the inch, the subsequent reduction being to a scale of five miles to one inch.

As the maps of Report I were the first regularly printed in colors in the United States, it was necessary to make a number of experiments in regard to the manipulation of the work, before arriving at that degree of excellence which, I certainly think, Mr. Colton has now successfully attained. A great difference is even observable between the maps accompanying the different Reports. Those of the First were engraved on stone; those of the Second on zinc, and those of the Third and Fourth on copper, without any increased expense, the recent improvements in the art of engraving having rendered the latter sufficiently cheap for the purpose. In comparing these maps with those colored by hand, the incomparably greater accuracy of the printed colors will appear at once, and it is, therefore, with gratification that we may perceive our State to be the first to introduce a new system, as it were, in a branch of engraving in which, until recently, almost all other countries have far surpassed us. These colors are applied in such a way that the blue, for instance, is employed for the blue, purple and green; the yellow for the yellow, orange and green; the red for the red, purple and orange—so that the impression of one and the same color applies to different rocks, by being used alone or in combination. In the maps of the present Report (for 1859), a great additional improvement will be seen in the representation of the gradual passage of one rock into another—a highly important feature, which it would be impossible to indicate with uniformity and precision by hand-coloring. The colors employed throughout have been the deep and decided ones seen in the geognostic maps of continental Europe, which appeared to me far preferable

to the weak, watery and indefinite colors hitherto employed in our country and England, whose difficulty of discrimination and early fading are certainly very objectionable features.

The *expenses* incurred in conducting the survey were borne by Lieber out of the annual appropriation of \$3,000 for the "salary" of the geologist; and the total cost of carrying on the survey (including the salary of the geologist) during the four years and three months of its existence amounted to the sum of \$12,750.

The *personnel* of the Lieber survey can be briefly stated. No provision was made in the establishing act or in the appropriations for the employment of assistants on the survey; and in reality the survey was conducted by Lieber himself, working alone during the larger part of the time. I have found mention of only two persons who rendered him professional assistance, as follows:

During a portion of the year 1856, Mr. Abraham Hardin, at Lieber's request, made a "geodetic survey" of the itacolumite region of York and Spartanburg counties.*

Lieber has left on record the following note concerning the assistance rendered him by Mr. J. Friedeman during a portion of the year 1856:†

To J. Friedeman, Esq., I am, however, certainly most indebted, as he kindly accompanied me throughout the main portion of the field duties, which the great heat of last summer rendered more arduous perhaps than might be expected in other years. Mr. Friedeman's thorough knowledge of mining engineering, and mining geognosy—a fact which his having passed through the whole course of tuition, practical and theoretical, at the far-famed mining school of Clausthal, and elsewhere in Germany, would of itself insure—and his extensive experience in the mines of North Carolina, specially in the talcose slate mines, were of the greatest value in the investigation of the analogous occurrences of metals in our State. It would be difficult and, indeed, scarcely possible to distinguish his labors from my own since he attached himself to the survey, and I am under still greater obligations to him as his valuable services were gratuitously rendered, a fact which was unfortunately made necessary on account of the inconsiderable amount of the appropriation and the necessary outfit expenses which, of course, fell somewhat heavily upon the first year.

*Lieber's First Annual Report, Survey of S. C., 1856, p. 23. I have no information as to the exact amount of time devoted to this work by Mr. Hardin. It is presumed that he was paid for his services by Mr. Lieber. See Biographical Notes, p. 115.

†First Annual Report, S. C. Survey, 1856, p. 4. I have no further information concerning Mr. Friedeman's career.

The *reports* of this survey* consisted of four Annual Reports, one for each of the years 1856, 1857, 1858 and 1859. These were published in editions of 2,000 copies each, by the State printer, and distributed in accordance with the following resolution:†

Resolved, That two thousand copies of the Report be printed; that each member of the Senate and of the House of Representatives be allowed one copy, and that the remaining copies be placed in the hands of the Governor, and that he be requested to have twelve copies deposited in the Legislative Library, two copies in each college and Public Library in the State, and the remaining copies in the hands of the booksellers of Columbia and Charleston, and in one store at each Court House in the State, to be sold at fifty cents a copy, the same commissions to be allowed them as on the Statutes at Large, and they would further recommend that the copies now on hand‡ shall be sold at a like price.

Of the Report for 1856 at first only 1,000 copies were printed, but at the session of the General Assembly for 1857 1,000 additional copies were ordered, and were printed as a second (and somewhat revised) edition, in 1858.

During the civil war many copies of these reports were lost in the burning of Columbia and other towns, and they are now exceedingly rare.

The *economic results* of the Lieber survey were mainly in the line of mining enterprises. His investigations of the characteristics and distribution of metalliferous veins in the gold regions of South Carolina (and the neighboring portions of North Carolina), and the best methods of working the same, helped in bringing about the successful working of a number of these mines, such as the Brewer, Hale, Dorn, etc., and would have resulted much more advantageously in the development of these mines but for the untimely interruption of all such undertakings by the civil war. There was then every indication of growing industrial progress. Mr. Lieber's discussion of agricultural and other industrial matters in his reports exercised a beneficial influence, through the "hill country" especially.

*See Bibliography, p. 114.

†Third Annual Report of S. C. (1858), p. 111.

‡Copies of the Reports for 1856 and 1857 had formerly been sold "at cost," distributed as above stated.

Something may be said by way of conclusion concerning the *additions to science* resulting from the Lieber survey, though it will be difficult to discuss these intelligently until the regions and problems he studied can be worked over again in the light of more recent investigations. The region in which he labored, embracing a considerable area of the crystalline rocks of the south Appalachian region, is one of great geologic and economic interest and importance. The general problems that interested Lieber more especially were the characteristics, classification, nature and origin of the metalliferous veins, the character and age of metamorphic rocks, including the age and history of the Appalachian mountain region and especially of the itacolumite formation, and the character and relative age of the eruptive rocks. It must be borne in mind that the science of petrography was in its infancy, and the use of the microscope in the study of crystalline rocks almost unknown at the time of Lieber's work; and yet it may be fairly claimed that he added considerably to our knowledge and understanding of these problems connected with the crystalline rocks and "vein geognosy" of the southern Appalachian regions. Those interested in the subject should read his four annual Reports where his conclusions are stated at length, as the limits of the present sketch preclude a full statement of them here. One of his conclusions—as to the age of the itacolumite series of rocks and the neighboring crystalline schists of portions of upper South Carolina, Western North Carolina and upper Alabama—may be stated here as of special interest; and it will be better to state it in his own words:*

If, then, we remember that in some localities the itacolumite, or rather the quartzite stratigraphically identical with it, has already been established to be of lower silurian age, and also take into consideration that appearances certainly favor the view that the crystalline slates of Alabama belong to that geologic period, we may, it is true, still justly regard the proof as imperfect, but we cannot deny that the weight of evidence is greater for than against the supposition that the itacolumite rocks of the South are lower silurian, and that such also is the probable age of all the crystalline slates of the Alleghanies in general.

*See THE ITACOLUMITE AND ITS ASSOCIATED ROCKS—Supplement to The Third Annual Report of the Survey of S. C., (1858) p. 149.

Lieber devoted but little time to the investigation of geology of the coastal plain region, but, as stated above, during the winter of 1859 he examined the coast region from the Savannah river to Bull's Bay, and he has added somewhat to our knowledge of the recent geologic history of this region. He distinguishes five or six "prominent effects of change":*

1. An ancient depression along our coast.
2. A total change in the course of the portions of the rivers near the coast.
3. A more recent superficial elevation of the coast, and
4. Consequent gradual seaward extension of the land.
5. A present depression of the coast, and
6. A southward translocation of our littoral islands.

BIBLIOGRAPHY OF THE SEVERAL SURVEYS.†

L. Vanuxem. Report on Geology, published in newspapers, and most of it in Mills' Statistics of South Carolina, 1826, 8vo., pp. 25-30; and in Tuomey's Geology of South Carolina, 1848, pp. XXXI and XXXII.

Report of the Commencement and Progress of the Agricultural Survey of South Carolina for 1843; by Edmund Ruffin, Agricultural Surveyor of the State. Columbia, 1843, 8vo., 120 and 55 pp.

Report on the Geological and Agricultural Survey of the State of South Carolina; by M. Tuomey. Columbia, 1844. 8vo., iv, and 63 pp.

Report on the Geology of South Carolina; by M. Tuomey. Columbia, 1848. 8vo., vi, 293, and lvi pp., plate and 2 maps.

Pleiocene Fossils of South Carolina: containing descriptions and figures of the Polyparia, Echinodermata and Mollusca; by M. Tuomey and F. S. Holmes. Charleston, 1857. Quarto, 152 pp. and 30 plates.‡

Post-Pleiocene Fossils of South Carolina; by Francis S. Holmes. Charleston, 1860. Quarto, 122 pp. and 28 plates.‡

*Fourth Annual Report (1859), p. 117; also Am. Jour. Sci., XXVIII (1859), pp. 354-59.

†A more elaborate list of publications relating to the geology, natural history and resources of South Carolina will be published in a future number of this Journal.

‡The propriety of placing these two publications among the reports of the surveys may be questioned, but they were published largely at the expense of the State, and much of the material was originally intended for Tuomey's Report (1848).

Report on the Survey of South Carolina: being the first annual report to the General Assembly; by Oscar M. Lieber. Columbia, 1856. 8vo., viii, and 136 pp. and 9 plates.*

Report on the Survey of South Carolina: being the second annual report to the General Assembly; by Oscar M. Lieber. Columbia, 1858. 8vo., viii, and 145 pp. and 5 plates.

Report on the Survey of South Carolina: being the third annual report to the General Assembly; by Oscar M. Lieber. Columbia, 1859. 8vo., xv, and 223 pp. and 3 plates.

Report on the Survey of South Carolina: being the fourth annual report to the General Assembly; by Oscar M. Lieber. Columbia, 1860. 8vo., ix, and 194 pp. and 4 plates.

[The last four reports are bound in one volume, with the title, Reports on the Geognostic Survey of South Carolina; by Oscar Montgomery Lieber, State Geologist of S. C., I, II, III, IV. 1856-1860. Columbia, 1860, with an index and glossary to the four Reports.]

BIOGRAPHICAL NOTES.

Lardner Vanuxem.—See notes and references, pages 90-93, above. He was born in Philadelphia, 23d July, 1792, and died in Bristol, Pa., 25th January, 1848. He was graduated at the *École des Mines*, Paris, 1819, and soon thereafter (1821) accepted his position in the South Carolina College. While connected with this institution he devoted his vacations during 1825 and 1826 to making geological tours through various portions of the State. After his return from Mexico, during 1827-'28, under the auspices of the State of New York, he studied the geological features of the States of New York, Ohio, Kentucky, Tennessee and Virginia; and in 1836 the geological survey of New York was established and Vanuxem was placed in charge of the third geological district, where he remained in active service until 1841, and published his results in the *Geology of New York, Third District* (Albany, 1842). Subsequently he spent some time in arranging the collections of the survey, in Albany. In 1838 he sug-

*A second (and slightly revised) edition of this report was published in 1858.

gested a meeting of geologists from Virginia, Pennsylvania and New York for the purpose of devising and adopting a uniform geological nomenclature for use among the several State geologists, which meeting was held in 1840, when the Association of American Geologists was organized. He published numerous papers on scientific subjects in the *American Journal of Science*, *Journal of the Philadelphia Academy of Natural Sciences*; and "An Essay on the Ultimate Principles of Chemistry, Natural Philosophy and Physiology" (Philadelphia, 1827).

Edmund Ruffin.—See pages 93–98, above. He was by profession an agriculturist; born in Prince George county 5th January, 1794; died at Redmore, Amelia county, Virginia, 15th June, 1865. During 1810–'12 he attended William and Mary College. In 1813 he took charge of the estate left him by his father, at a time of general agricultural depression; and at once began various experiments looking to the improvement of soils. In 1848 he tried the first experiment in the use of lime (marl) as a supposed counteractant of the acidity of the soil, and found the results greatly beneficial.

During the few years following this the use of marl, through Mr. Ruffin's exertions, extended rapidly throughout Eastern Virginia, generally with like beneficial effects. During 1841 and 1842 he was a member (and Secretary) of the Board of Agriculture of Virginia, and for several years he was President of the State Agricultural Society. During 1843 he served as "Agricultural Surveyor" of South Carolina, and published a report of his results (Columbia, 1843). From 1832 to 1842 he edited the *Farmers' Register*, a journal which exerted a widespread and beneficial influence on the agriculture of Virginia and other Southern States. He was also the author of "An Essay on Calcareous Manures" (Richmond, 1832), an "Essay on Agricultural Education" (1833), and "Sketches of Lower North Carolina" (Raleigh, 1861).

Michael Tuomey.—Pages 98–103, above. Born in Cork, Ireland, September 20, 1805; died at Tuscaloosa, Ala., March 30, 1857. Came to New York, and studied at the Troy Polytech-

nic School, where he graduated in 1835. He subsequently conducted a school in Petersburg, Va., where he lived when early in 1844 he was appointed State Geologist of South Carolina. In 1847 he resigned this latter position and was elected Professor of Geology, Mineralogy and Agricultural Chemistry in the University of Alabama. From 1848 to 1854 he acted as State Geologist in addition to his duties at the University; 1854 and 1855 he gave all of his time to the survey, and afterwards returned to his professorship at the University, which he held until the date of his death. In addition to his two Reports on the Geology of South Carolina (1844 and 1848) he published two Biennial Reports on the Geology of Alabama (1850 and 1858) and several papers on geological subjects. At the time of his death, in connection with Professor F. S. Holmes, he had in hand the publication of a "splendid work on the Fossils of South Carolina, which has not been surpassed in the country for the beauty of its palæontological illustrations. Geological science is greatly indebted to Professor Tuomey's zeal and fidelity."*

Professor Tuomey was a member of the Boston Society of Natural History and the American Association for the Advancement of Science.

Oscar Montgomery Lieber. †—Pages 103-13, above. He was born in Boston, Mass., September 8, 1830; was educated in Boston, at the South Carolina College—where his father, Francis Lieber, was a member of the faculty—and at the Universities of Berlin and Göttingen (1847-'48). In 1851 he was elected Assistant Professor of Geology in the University of Mississippi, his duties being confined to the work of making a geological survey, and extending over but seven months, when he resigned. In 1854-'55 he was Assistant Geologist on the Alabama survey, under Tuomey. In December, 1855, he was elected by the Legislature of South Carolina Geological, Mineralogical and Agricultural Surveyor of the State, which position he held for

*Am. Jour. Sci., XXIII, 1857, p. 448.

†A more elaborate sketch of Lieber will be published in a future number of this Journal.

four years and three months, the survey being discontinued by the failure of the Legislature to make the necessary appropriation. In July, 1860, he accompanied the U. S. Astronomical Expedition to Labrador as Meteorologist and Geologist, under Professor Charles S. Venable. At the breaking out of the late civil war in 1861 he joined the Confederate army, was fatally wounded in the retreat from Williamsburg, Va., and died in Richmond, June 27, 1862.

In addition to his South Carolina Reports Lieber was the author of "The Assayer's Guide" (Philadelphia, 1862); "The Analytical Chemist's Assistant," translated from the German of Wöhler's "Beispiele zur Uebung in der Analytischen Chemie," with an introduction (1852); *Der Itacolumit, Seine Begleiter und die Metallführung desselben*, in *Von Cotta's Gangstudien* (Freiburg, 1860), Vol. III, pp. 309-507; and numerous papers on scientific subjects published in the *New York Mining Magazine*, and other journals in this country and in Germany.

Abraham Hardin.—See page 110 above. Born in what is now Cleveland county, N. C., 22d June, 1789; died at Black's Station, S. C., 11th July, 1881. In 1836 he was elected to the Legislature of South Carolina and served for three terms. In 1856 he was employed by Lieber to make a "geodetic survey" of the King's Mountain and adjoining itacolumite regions.

J. Friedeman.—See page 110 above.

RECORDS OF MEETINGS.

FIFTIETH MEETING.

PERSON HALL, January 14, 1890.

Professor Holmes called the meeting to order. The following papers were read:

1. How the Distance Between the Sun and Earth is Measured. Professor J. W. Gore.

2. A Sketch of Pasteur's Life and Work. Mr. W. H. Shaffner.

3. Pasteur's Treatment of Rabies. Mr. V. S. Bryant.

The following were read by title:

4. Some Modifications of the Method for Determining Crude Fiber. Professor W. A. Withers.

5. The Determination of Crude Fiber. Professor W. A. Withers.

These are published in this number of the Journal.

FIFTY-FIRST MEETING.

PERSON HALL, February 18, 1890.

6. The Chemical Problems of To-day; A Resumé of Professor Victor Meyer's Address. F. P. Venable.

7. The Recent Geologic Formations on the Roanoke River. J. A. Holmes.

8. Recent Progress in Electricity. J. W. Gore.

FIFTY-SECOND MEETING.

PERSON HALL, March 4, 1890.

9. On the Great Ship Canals. Wm. Cain.

FIFTY-THIRD MEETING.

PERSON HALL, April 1, 1890.

10. Note on Work on New Elements. F. P. Venable.

11. Abundance of the Elements. J. S. Callison.

12. Occurrence of Boracic Acid in the Caustic Alkalis. J. S. Callison.

13. On the Suez Canal. Wm. Cain.

14. Exhibition of some Minerals from the Mica Mines and of some Fine Crystals. J. A. Holmes.

FIFTY-FOURTH MEETING.

PERSON HALL, May 7, 1890.

15. Sanitary Disposal of the Dead. H. L. Miller.

16. Inter-oceanic Canals Crossing the Isthmus of Panama. Wm. Cain.

Read by title:

17. On the Determination of Available Phosphoric Acid in Fertilizers Containing Cotton Seed Meal. F. B. Dancy.

18. The Distribution of Boracic Acid Among Plants. J. S. Callison.
19. Three New Masses of Meteoric Iron. Geo. F. Kunz.
20. Two New Meteoric Irons. F. P. Venable.
21. New and Improved Methods of Analysis. S. J. Hinsdale.
22. List and Description of North Carolina Meteorites. F. P. Venable.

The Secretary reported as the result of the meeting of the Council the election of the following Corresponding Members:

- Marcus Benjamin, Esq., New York City.
 Geo. F. Kunz, Esq., New York City.
 Professor A. Giard, Paris.

By order of the Council all officers were to continue holding their offices until the December meeting, so that in the future their terms should begin and close with the year.

FIFTY-FIFTH MEETING.

PERSON HALL, September 16, 1890.

23. On the Germination of Some of the Gramineæ; A Resumé of the paper by Brown and Morris. F. P. Venable.
24. Report on the Meeting of the American Association for the Advancement of Science. J. W. Gore.

FIFTY-SIXTH MEETING.

PERSON HALL, October 14, 1890.

26. The Discoverer of Oxygen; A Discussion of Berthelot's paper and Thorpe's reply. F. P. Venable.
27. A Raining Tree in the Campns of the University. P. Dalrymple.
28. Some Notes on Aluminium. J. V. Lewis.
29. The New Object Glass for the Great Telescope at the University of South California. J. W. Gore.
30. Exhibition of Specimens and Photographs. J. A. Holmes.

FIFTY-SEVENTH MEETING.

PERSON HALL, November 11, 1890.

31. Reports as to Koch's Lymph. V. S. Bryant.
32. Improvements in Explosives. F. P. Venable.
33. The Croton Aqueduct. Wm. Cain.
34. A New Method of Propelling Ships. J. W. Gore.

FIFTY-EIGHTH MEETING.

PERSON HALL, December 2, 1890.

35. Problems of the Atlantic Coastal Plane. J. A. Holmes.
36. Some Erysiphææ from Carolina and Alabama. Geo. F. Atkinson.
37. Action of Phosphorus on Certain Salts. Gaston Battle.
38. Lead Bromo-Nitrate. H. L. Miller.
39. On Lead Chloro-Bromides. F. P. Venable.
40. Adulterated Spirits of Turpentine. S. J. Hinsdale.

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1889

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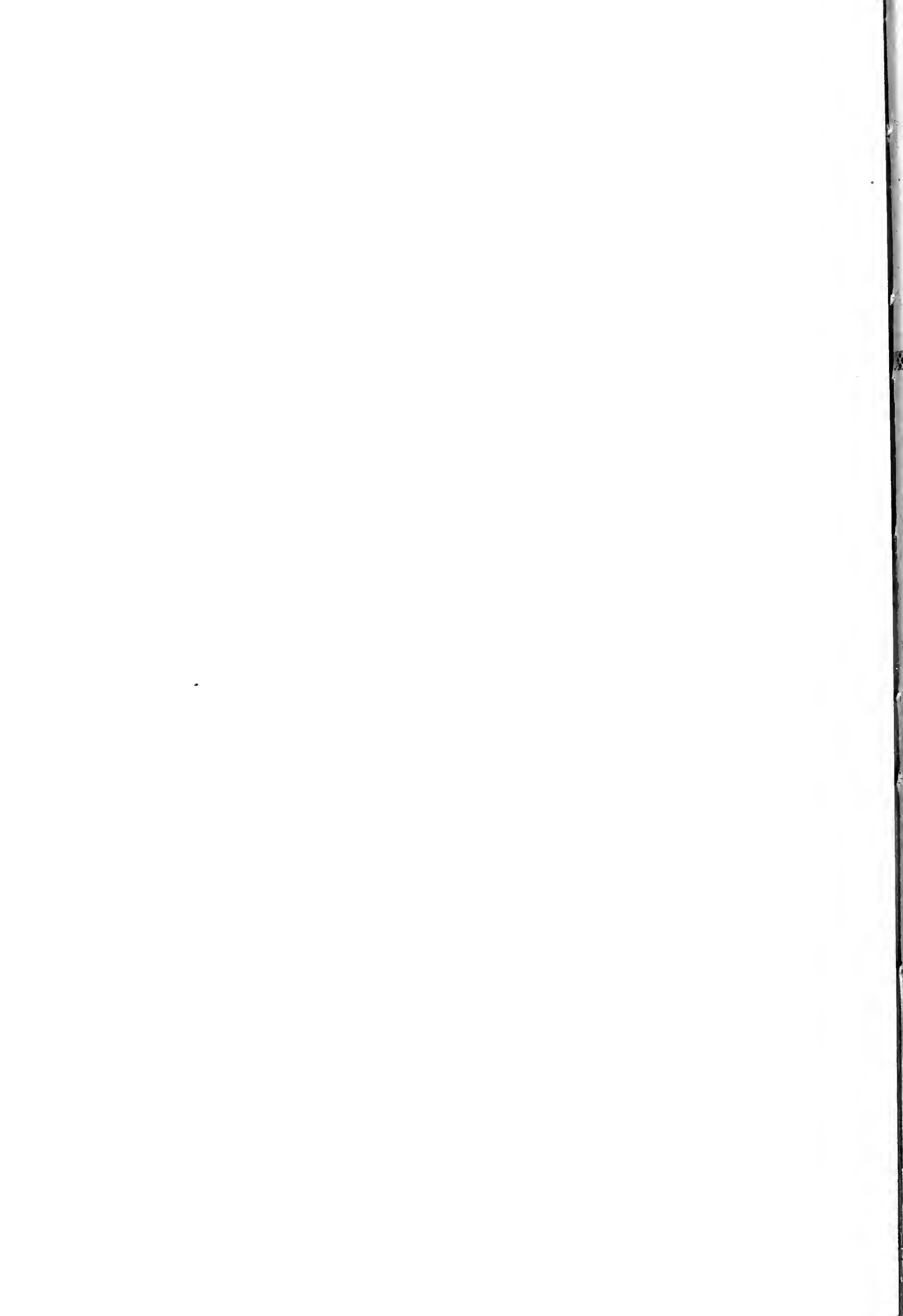
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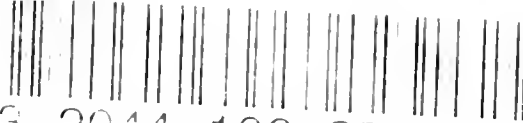
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