.A419
Ser. 2
v. 6
Nov. 1848

THE

AMERICAN JOURNAL

OF

SCIENCE AND ARTS.

CONDUCTED BY

PROFESSORS B. SILLIMAN AND B. SILLIMAN, JR.,

AND

JAMES D. DANA.

SECOND SERIES.

VOL. VI.—NOVEMBER, 1848.

MO. BOT. GARDE.
1911

NEW HAVEN:

PRINTED FOR THE EDITORS BY B. L. HAMLEN,

Printer to Yale College.

Sold by DAY & FITCH, *New Haven.*—LITTLE & BROWN, and T. WILEY, Jr., *Boston.*—C. S. FRANCIS & Co. and GEORGE P. PUTNAM, (late Wiley & Putnam,) *New York.*—CAREY & HART, *Philadelphia.*—N. HICKMAN, *Baltimore, Md.*—GEORGE P. PUTNAM, 142 Strand, *London.*—HECTOR BOSSANGE & Co., *Paris.*—NESTLER & MELLE, *Hamburgh.*

CONTENTS OF VOLUME VI.

NUMBER XVI.

SCIENTIFIC INTELLIGENCE.

NUMBER XVII.

SCIENTIFIC INTELLIGENCE.

NUMBER XVIII.

SCIENTIFIC INTELLIGENCE.

Correction.—Vol. v, ii ser., p. 37, line 12 from bottom, after "times," insert "less than."

P. 403, line 5 from bottom, for *quantitative* read *qualitative.*

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. I.—*Notes and Remarks connected with Meteorology on Lake Superior, and on the variations in its level by barometric causes, and variations in the season;* by WM. W. MATHER, Professor of Natural Science in Ohio University.

THE author of this paper has spent three summers and parts of the autumns, on Lake Superior, exploring the coasts, and examining mines in operation besides undeveloped veins of ore. Some meteorological observations were at the same time made, that may not be unacceptable to the scientific public.

During June and a part of the month of July, the weather is generally serene, with a clear sky, and little rain except occasional thunder-showers. The lake is calm, and this is the most favorable season of the year for coasting in boats and canoes. The prevalent winds during the summer are from the west and s.w. Many parts of the lake even in this calm season of the year, are subject to sudden squalls. The Indians and voyageurs are very cautious; but many persons unacquainted with the coast and the local land blasts, frequently expose themselves to great peril. These land blasts are often violent when nothing is seen to indicate their approach. Some of the voyageurs state that while coasting along with the weather calm or only a gentle breeze, the boat, just before one of these blasts, seems to be suddenly lifted as if struck by some unseen force; and in such cases they at once make a landing. Boats strongly manned cannot always make headway against these sudden squalls, and frequently they are driven off the land.

There are some localities where these blasts are frequent. At Sand Bay, as it is called—a mere indentation or bight of the coast between Eagle Harbor and Eagle River, four or five miles across at its capes—puffs and blasts of warm air from the land are common, especially in the afternoon and evening. The land rises very gradually from the coast for one half to one mile, and then rapidly ascends to the height of the mountain eight hundred to twelve hundred feet, and this range of hills extends for many miles with nearly uniform surface and height, rarely broken by ravines. The wind often blows strongly from the land for many hours. The same facts have been observed at Porter's Island and at Copper Harbor; both open to the north on the lake, and both have similar ranges of high land on the south.

At Bete Gris Bay on the southern side of Kewena Peninsula, a range of mountains eight hundred to thirteen hundred feet high, bounds the north shore of the bay and extends many miles to the west, gradually curving around to the w.s.w. and s.w.; and a flat country skirts the bay on the south and west, and extends thirty or forty miles to the s.w. between the mountains and the south coast of the peninsula, with a breadth of four to eight miles. Violent blasts of warm air often blow from the west out of this bay in the afternoon. The bay opens to the S.E.

In Yellow Dog Bay at the mouth of Yellow Dog River, similar facts have been observed. This bay opens to the N.E. While it was calm at the capes of the bay and on the lake, a strong blast of warm air from the land blew from the s.w. out of the middle of the bay; and between this axis and the capes, the air blew in towards the axis, converging towards a point outside the bay in the lake. Such facts are common in calm weather when the sun shines brightly. Similar observations have been made in many places, and they are here noticed because they seem to be in opposition to the generally received notions of the action of the sun and heated air in a hilly and mountainous region. These phenomena often extend into and through the night. The theory of the land breeze explains it for the night, but not for the day.

Notes in regard to the weather and barometric waves on Lake Superior, 1846.

The following memoranda from my diary, are introduced with a view not only to shew the general character of the weather on the lake coast, but also to shew some of the facts from which the inference is drawn that the sudden fluctuations of level of the water on the lake coast, generally precede gusts or storms. The aurora borealis has long been considered a precursor of gales. In the meteorological register annexed, some observations of greater exactness are registered bearing on these points.

June 9. On Lake Superior, between White Fish Point and Manito Island; calm, occasionally a light s.w. wind; fog banks at a distance through the day, appearing like distant land.

10 to 15. Pleasant weather; nothing noted in diary.

15. Rain last night and cloudy morning; wind east by north; cleared off at 10 A.M.

16 to 25. Pleasant weather; nothing noted in diary.

25. Wet stormy morning and fog till 11 A.M. at Salmon Trout River; cleared at 12; calm.

26 to July 1. Pleasant hot weather; in Ontonagon region.

July 1. Pleasant hot weather; on the west branch of the Ontonagon.

2. Thunder in morning, and succession of heavy thunder showers all day; twenty miles south of Lake Superior, on the west branch of the Ontonagon.

3 to 9. Pleasant weather and very warm; exploring as above, and returning to the mouth of the Ontonagon, and coasting to Iron River.

9. Wind strong from the west until 3 P.M.; then calm and very warm; heavy thunder shower and very vivid lightning in the evening, in the direction of Thunder Cape, north, and Thunder Bay, where almost every evening after a pleasant calm day in summer, a thunder cloud may be observed.

10. Calm in the morning; coasting west till 9 A.M., when the heavy west wind obliged us to land; calm at evening.

11. Surf heavy on shore from a blow in the N.W. last night, when there was a heavy thunder gust. Pleasant day; wind eastward till 3 P.M., when it came around to the west.

12. At Iron River, pleasant day; wind in the morning strong from the east.

13. Strong current set into the river this morning early. Heavy wind at sea from the west at 5 A.M. Embarked with boat sail reefed, carried away main sheet and broke rudder. Wind hauled from the west at 6¼ A.M. to N.E. blowing a gale, but we were enabled with great difficulty, and danger of swamping on the bar of the Ontonagon, to enter that harbor. After 10, cleared off hot and sultry; cold evening and had a fire before my tent door at Mendenhalls mines; musquetoes in myriads.

14. Pleasant, calm day, except the land blasts which were observed on the Ontonagon River as hot blasts of air, now from one point and then from another. Calm, except occasional hot puffs and blasts from the shore of the lake when off the re-enterings of the coast; went to Misery River.

15. Calm and pleasant, except warm puffs of air off shore as yesterday.

16. Same as yesterday, except that on arriving within a few miles of Copper Harbor where the woods were extensively on fire, momentary hot blasts of air were often felt, and the air was so thick with smoke that rocks could not be seen at three times the boat's length. In the evening and day, there was a steady heavy

blast from the land, and large flakes of fire from the burning forest were carried entirely across Lake Fanny Hooe, so that it was with great difficulty the buildings at Fort Wilkins, half a mile off, could be preserved from the fire.

17 to 28. At Presque Isle, eighty miles south by east of Kewena Point. A rise and fall of the waters of the lake were observed in the bay, and the captain of the Schooner Swallow consequently looked for a blow, though the weather was pleasant and calm, excepting a slight off shore breeze. The vessel sailed at 4 P.M., but in the night a severe blow came from the north and lasted two days, and the vessel with difficulty was kept off the shore.

28, 29. Rainy part of the day, but without heavy wind at Presque Isle; the wind was from the south. A heavy gale and severe rain set in in the night from N.E., and continued till next (30th) morning, when the waves were from fifteen to twenty feet in perpendicular height.

31 to Aug. 7. Weather pleasant but very warm, except on the lake shore, where the cold waters temper the heat. There was little wind, except warm puffs and blasts from the shore during the middle and latter parts of the day, off the reëntering of the coast. During these days I was coasting between Presque Isle and Huron River, encamped on the shore, or exploring in the interior from five to ten miles from the coast.

On the evening of the 6th, at the mouth of Huron River, the water flowed rapidly into the mouth of the river for fifteen minutes, and was raised twelve to sixteen inches above the usual level, after which it flowed out until it reached the usual level.

Aug. 7. Similar variations in the level of the lake and river, were observed in the morning. Severe thunder-showers from N.W. succeeded, with very strong winds, uprooting trees.

8. Heavy thunder-gusts and showers through the night, and forenoon of to-day.

9. Pleasant day; wind east at six in the afternoon; another rise in the water of the lake of eighteen inches, and a sudden fall again in fifteen or twenty minutes, about 1 P.M. Heavy thunder-gust and some rain at 4 P.M. Strong N.W. wind (7 to 9) all night, with some rain. Trees uprooted by the gale.

10. Pleasant day; wind strong from east in afternoon; calm in evening.

11. Pleasant day; calm till 8 A.M; wind south out of Huron Bay at 8½; N.W. 5, at Point Abbaye, 9 to 10 A.M.; calm at 10; south on the side of Kewena Bay at 10½ A.M., and S.W. 4, near Traverse Island. Sailed from the middle of Kewenaw Bay, with this wind constantly increasing in force till evening, when I reached Bete Gris Bay, and landed with difficulty through the surf, although the wind there blew off shore, and the waves

came in to the bottom of the bay at an angle of about 110°, different from the direction in which they rolled outside the bay.

12. Rained hard in the night, with strong wind from the east, and this morning from east and S.E., and thence hauled to N.N.W., and finally in the afternoon to S.W. Started this afternoon to go west from Bete Gris Bay to the west end of Lac la Belle; but the wind blew so hard from W.S.W., that this little lake of two and a half miles in length was a sheet of foam. A strongly manned boat was at times unable to stem the wind in the outlet, and on going into the lake, was half filled with water by the waves in a few moments, and the excursion was abandoned for that day. At sunset it was calm.

13. Calm in the morning at Bete Gris Bay. At 11 A.M. the wind began to blow out from Lac la Belle as yesterday, and increased in violence till 4 P.M., after which it abated gradually. To-day at 3 P.M., a well manned boat could not head the wind and sea in this little sheet of water, and make any progress. At 7 P.M. it was calm. This W.S.W. wind flowing out to the open lake from along the base of the mountains, is very common in the afternoon of warm pleasant days in summer.

14. Loons were very vociferous between 2 A.M. and daylight. This is generally considered by voyageurs as an indication of strong winds, or of approaching storms. I aroused my men before day, and embarked for Copper Harbor. The air was clear and calm till 8 A.M. Wind then from S. 2, towards the land; at 9 A.M., S.S.E. 5, near the southeast point of Kewena Peninsula; at 10 A.M., S. 3, at the east end of that peninsula, with frequent strong blasts off shore from the west, of warm air; 11 A.M. till 2 P.M. on north side of the peninsula, a dead calm, except occasional puffs of warm air from the land; from 2 P.M. the wind blew very strong from the west all night.

15, 16. Stormed all day, wind and sea heavy from the west.

17. Pleasant, but wind and sea heavy from the west.

18. Stormed all day.

19. Stormed till noon, with heavy west wind, then clear and calm. Embarked at 4 P.M. for the Portage, but heavy squall and dense fog from west forced us to land at 4½ P.M. Stormed and blew strongly from N.W. all night.

20. Very heavy surf on shore: could not pass the breakers. Calm. Sea calmed down enough to pass the breakers on the deep part of the reef at 1 P.M., but lake still too rough to travel in safety even in a fine whale boat.

21. Pleasant, warm day; little wind, except occasional warm blasts from south, off the land.

22. Wind and sea heavy from west till 12 M., when it hauled suddenly to east. Went from Eagle River to near the Portage.

23 to 26. Pleasant, fine weather; wind not noted.

26. Rain last night and this morning; pleasant afternoon.

27. Pleasant day; wind west and N.W. 3; calm in evening.

28. Pleasant day; wind W. 3; calm in evening.

29. Pleasant day; wind W. 5. Run to Copper Harbor in afternoon, about thirty-five miles.

30 to Sept. 3. Pleasant weather; winds not noted, except on 2d in afternoon, a strong current of water set out of the bay at Copper Harbor, and one of our voyageurs in a light bark canoe came near being driven off the land. A heavy blast of warm air from the land blew at the same time out of the harbor, and the water fell in the Bay about one foot.

Sept. 3, 4. Heavy wind and rain storm from the north, both days.

5. Pleasant, with warm land breeze from the south.

6. Stormy, and strong west wind. Blew violently with heavy rain through last night. Embarked on board steamboat Julia Palmer; but she did not leave harbor in consequence of the violent storm. In the afternoon, blew very heavily and in gusts from the south.

7. Blew a gale with hard rain all night and till noon to-day from the west, and then hauled to N.W. and north, and continued through most of the night with equal force.

8. Pleasant, calm morning and day. Light breeze from S.E. and east. Landed at 10 P.M. at the Ontonagon River. Boat nearly swamped among the breakers at the mouth of the river, and with difficulty recovered the channel.

9. Cloudy and rainy most of the day; N.E. storm. Cleared off in the afternoon. A moderate land breeze with strong puffs of warm air blowing off shore. Water rose suddenly 1½ feet, and in receding carried off some boats. Heavy squall approaching from N.W. At 10½ P.M. the thunder-gust came on, blowing a perfect gale, blowing down the tents, and unroofing a house, and the steamer had great difficulty in keeping off the lee shore. Rain fell in torrents, and the lightning was almost constant. Heavy wind and rain from N.W. and north continued all night.

10. Wind still heavy from north, but otherwise a pleasant day.

11. Pleasant day, but very windy, and lake very rough. Calm evening. Beautiful aurora borealis in the evening; stripes of light of varied colors passing with rapid motion. Calm through the night.

12. Calm, bright, beautiful day. Went to Misery River.

13. Boisterous day, but sun shone. Wind west.

14. Severe thunder-storm last night, and wind through the day from the north and N.W.

15. Pleasant day; wind not noted.

16. Pleasant morning, with strong west wind. Went to the Portage. Voyageurs said we must land—"wind too much."

Nearly swamped the whale boat, in landing in the most sheltered place that could be found on that coast. Wind continued all day till night, when it became calm.

17. Pleasant day; wind west and N.W. 4. Embarked and went to the Cross, near Gratiots River.

18, 19. Pleasant days; wind west. Went to Eagle Harbor. Severe thunder-storm evening of 19th. Heavy wind from north all night.

20. Wind N. 8. Lake a sheet of foam, and very heavy sea.

21. Pleasant; wind not noted.

22. Pleasant; calm in morning. Embarked and went to Agate Harbor. Squalls from every direction in afternoon. Sky looked very threatening, and water oscillated repeatedly a foot in level every half hour, and sometimes more frequently, at Agate Harbor. Blew a gale from the north and N.W. through the night.

23. Lake very rough, and several sets of waves, producing a very cross, chopped sea. Squall clouds in various directions. Embarked, but nearly swamped several times, from the cross seas. Heavy squall came suddenly from N.W. Run into a little boat harbor before it struck us. In a moment the lake was a sheet of foam, and the wind continued blowing heavily from the N.W. all day and night.

24. Pleasant and calm, but lake too rough to pass the breakers on the deeper parts of the reef. In afternoon, embarked and went to Copper Harbor. Strong blasts of warm air from off the land, with intervals of calm.

25. No note of weather.

26. Storm; heavy surf on the shore from N.E.

27. Storm; heavy surf on the shore; wind N.W.

28. Storm; N.E. misty rain.

29. Pleasant day; wind not noted.

30. Pleasant day; wind W.N.W. 6; heavy surf on the shore.

Oct. 1. Stormy day; wind from east, and hauled round to south in the afternoon.

2. Pleasant calm day.

3. Cold stormy day. Embarked on board steamer Julia Palmer, for a voyage along the Canadian shore.

4. Sailed from Copper Harbor. Pleasant; wind moderate from the west in the forenoon, freshened too much for the steamer to head it in the afternoon, and went into Siskowit Bay and anchored. Calm in the evening. This was the first voyage of a steamboat on the north coast of the lake, where there are many unexplored reefs and islands.

5. Sailed from Siskowit Bay at 7 A.M. Calm, but wind soon came from W.S.W., and freshened till 3 P.M., when its force was about 7. Anchored in Prince's Bay, opposite Spar Island, twenty-five miles north of west end of Isle Royal. Shifted to N.E. at 10 P.M.

6. Northeast storm; wind very heavy all night and all day. Low scudding clouds and some rain, and a little snow.

7. Wind N.E. 5; some rain and a little snow; misty thick weather. Sailed from Prince's Bay to mouth of river near Fort William, in Thunder Bay. Clear and calm in the afternoon. Beautiful aurora borealis in the evening; waving stripes of light.

8. Sailed from Point William at $3\frac{1}{2}$ A.M., where it was calm, but at the Welcome Islands, heavy N.E. wind, storm struck us, and continued all day. Steamer battled against the storm and heavy head sea all day to reach the western inlet to Neepigon Bay.

9. Wind blew from the north last night with great violence. Beautiful aurora in the evening. Several arcs visible, one above the other, and an apparent bank of clouds below the two lower ones, but stars visible through it. Arcs variable in height and progressive undulating movements of these arcs, strongly marked like waves, thus . Almost always in the afternoon and beginning of the evening, before the light of the aurora borealis was observed in the north as a segment of a circle with its highest point in the magnetic meridian.

Long lines and stripes of light of various colors sprung up from the east, and extended entirely over the western horizon and from all points from east around by north to west, and some extended even over to the southern horizon. The crowns of the successive arches were a few degrees east of north, but in the magnetic meridian.

10. Wind blew a gale all day from the east. Water rose so much as to carry away the trestle pier, and create a very strong current to the south from Neepigon Bay to Lake Superior. Wind hauled to south in the evening and blew a gale all night with rain. Strong current from the Lake into Neepigon Bay.

11. Wind S.E., a gale with rain till 12th when the rain ceased but wind did not moderate very much. The air over the main Lake seemed to be clear, but when the masses of air from the Lake reached the mountains of St. Ignace and Fluor Islands, dense black threatening clouds were formed and rolled up and spread over the land with great velocity. This was observed continuing for hours. Steamer weighed anchor and went to a little harbor on the N.W. side of Flour Island. Wind hauled to west at 10 P.M. and blew a heavy gale.

12. Wind hauled to N.W. at daylight, blowing very violently, but gradually moderated. Some hail and sleet last night. Sailed for Sault St. Marie with strong but fair wind from N.W. Pleasant but windy day.

13. Heavy squalls from west and N.W. in night. Arrived at Sault St. Marie. Weather very foggy from White Fish Point, which we passed at 9 A.M. Squalls from north and west. Steamer had to feel her way frequently with the sounding line.

Propeller Independence arrived at Sault St. Marie, Monday evening the 12th, in twenty-five hours from Copper Harbor; she must have had a strong west or N.W. wind all that time.

14. Pleasant time, but cold and gusty.

15. Snow fell last night about two or three inches. Stormy day of rain and some snow. Squalls from N.W. and N.E. Cold uncomfortable weather.

16. Raw, damp, cold, uncomfortable day, cloudy with squalls from N.W. and N.E. Snow fell in the evening and through the night.

17. Raw, cold and boisterous day. Embarked for Detroit.

June 13, 1847. On Lake St. Clair and in St. Clair River. Pleasant weather, but at 1 P.M. heavy squall from the west accompanied by some rain. This had been indicated by black squally looking clouds in the west for an hour. The weather continued squally with dashes of rain through the day and night.

14. On Lake Huron. Heavy gale increasing from daylight till 2 P.M. from N.W. After battling with the storm for hours, the bow occasionally plunging under the heavy waves, the steamer put back and made lee under Point au Barque. At 4 P.M. the wind lulled some and the boat proceeded at 5 P.M., but it was a very tempestuous stormy night. Did not see land on north side of Saginaw Bay till 7 A.M.—fourteen hours going about eighty miles. The gale abated about 8 A.M. but blew hard from W.N.W. and N.W. all day.

15. On N.W. part of Lake Huron between Drummond's Island and Sault St. Marie. Strong west wind all day.

The schooner Merchant is supposed to have foundered on Lake Superior and all on board perished, on the night of the 13th or day of the 14th. She was seen on the afternoon of the 13th forty miles west of White Fish Point, and has never been heard of since. A few fragments were found on the Canada shore.

16. Weather pleasant but windy; course not noted, but westerly, as the Napoleon, which was ready, did not sail.

17. Embarked on the schooner Napoleon for Copper Harbor at 12. Wind fresh from S.E. Opposite Carabou Island at dark, having come one hundred miles since noon, about twelve miles per hour.

18. Wind S.E. and very fresh all night, but died away when opposite Kewenaw Point at 7 A.M. Light breath of air from the south till 9 A.M.; when about to enter Copper Harbor strong east wind with dense fog came off land, and could not see to get into harbor. Wind soon hauled to S.W. Fog blew off at 4 P.M.

19. Weather not noted; strong wind from S.W.

20. Pleasant day; wind not noted.

21. Beautiful calm day.

22. Beautiful calm day; moderate wind from the west.

23, 24. Pleasant weather; wind not noted.

25. Pleasant weather, very fine day; but in the afternoon a breeze came off from the lake, and it became suddenly so cold that a fire was necessary. Strong land breeze off shore in the evening.

26, 27. Pleasant; winds not noted. Generally at this season of the year calm, or with moderate winds during the warmer part of the day, and a land breeze in the evening from S.S.E. at Copper Harbor.

28. Pleasant day; land breeze off shore in the evening.

29. Clear but very windy day; strong wind from the south. Temperature of water on the shore 44° F.

30. Temperature of water on the shore very cold, not noted. Clear day; wind not noted. Probably calm, as I used the artificial horizon without the glass cover.

July 1. Clear day; calm in middle of the day; wind not noted. Used artificial horizon without glass cover with sextant.

2 to 8. Pleasant weather (from recollection, not noted in diary.) Land breeze almost every evening from about 6 P.M. from S.S.E. at Copper Harbor, on Porter's Island.

On the 7th of July, Dr. C. T. Jackson kindly supplied me with a barometer, by means of which a register has been kept to Sept. 6, shewing the barometric pressure, with the temperature, the courses and force of winds, variations in the lake level, &c. The thermometer detached from the barometer, corresponded with the attached thermometer within less than half a degree, and only one is registered except where a fire was made in the room, and then the detached thermometer was removed to the outside of the building with a proper exposure.

During this calm season of the year the surface of the lake water becomes warm, while a little below the surface it is quite cold. The northerly winds, which make the air cold, drive the warm water upon the shore; while the warm land breezes that blow at Copper Harbor almost every day, and often through the night, carry the warm surface water out to sea, and the cold underlying stratum replaces it along the coast. This fact has been frequently observed at Porter's Island during the last summer. Sometimes a change of wind from north to south of a few hours duration, makes a difference of 20° F. in the temperature of the water on the north side of Porter's Island during the calmer period of the summer.

TABLE I.—*Barometrical Register, kept at the Government House on Porter's Island, Lake Superior, from the 8th of July,* 1847, *to September 6th,* 1847.—Latitude 47° 28′ N. Longitude about 88° W. from Greenwich.

Date.	6 A.M.				9 A.M.				12 M.				3 P.M.				6 P.M.				9 P.M.			
	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.
July 8	29·478	70	.	S.S.E., fresh	29·507	78	.	S.S.E, light.	29·519	79	.	0, calm.	29·466	75	.	0	29·450	71	.	S.E. 2	29·450	68	.	S.E. 4
" 9	·505	70	.	0, calm.	·509	73	.	0	·540	76	.	0, calm.	·479	70½	.	0	·468	74	.	S.S.E. 3	·401	74	.	0
" 10	·470	66	.	0	·491	72	.	0	·476	71	.	0	·460	73	.	0	·429	70	.	0	·412	67	.	0
" 11	·470	69	.	0	·444	70	.	0	·442	76	.	W. light.	·408	74	.	W.	·350	75	.	S.S.E. 3	·351	73	.	S.S.W. 5
" 12	·320	70	.	0	·358	66	.	W. by N. 4	·412	74	.	W. by N. 4	·460	76	.	W. 3	·508	72	.	W. by N. 3	·548	67	.	0, calm.
" 13	·654	65	.	0	·681	66	.	0	·698	69	.	0	·654	64	.	0	·605	68	.	0	·605	70	.	0
" 14	·549	66	.	S.W. 4	·516	70	.	0	·481	74	.	W. by N. 2	·448	73	.	0	·353	73	.	S.S.E. 1	·360	80	.	S.S.E. 1
" 15	·288	72	.	0	·220	77	.	S.E. 3	·214	74	.	N.W. 2	·170	68	.	S. by W. 6	·150	70	.	0	·308	70	.	S.S.W. 1
" 16	·220	70	.	S.W. 2	·160	69	.	S.E. 5	·151	74	.	S. W. 1	·159	73	.	S. by W. 1	·130	72	.	W. 1	·150	72	.	S.S.W. 2
" 17	·320	70	.	S.W. 2	·394	70	.	W. 3	·460	64	.	W. 2, foggy	·480	64	.	W. by N. 1	·530	68	.					
" 18	·500	60	.	N.W. 1	·540	68	.	W. 1	·550	65	.	N.W. 1	·540	68	.	N.W. 1	·510	63	.	N.W. 1	·540	66	.	0
" 19	·460	61	.	S. by W. 3	·450	67	.	S. by W. 3	·438	70	.	N. by W. 1	·368	69	.	W. 1	·348	.	.	S. 4	·340	65	.	S.W. 1
" 20	·230	68	.	S. by E. 1	·320	72	.	W. 2	·300	76	.	S. E. 3	·232	82	.	S.E. 2	·168	80	.	S.E. 4	·170	78	.	S.W. 3
" 21	·100	72	.	W. 1	·101	73	.	W. 6	·174	75	.	W. 6	·220	74	.	W. 5	·240	72	.	W. 4	·290	67	.	W. 4
" 22	·470	60	.	W. 4	·530	64	.	W. 4	·550	68	.	W. 4	·550	70	.	S.S.E. 1	·520	70	.	N.W. 4	·526	68	.	S.S.W. 3
" 23	·550	65	.	S.W. 3	·556	70	.	W. 3	·558	73	.	W. 3	·548	76	.	W. 2	·508	73	.	S.S.W. 3	·430	70	.	S.S.W. 1
" 24	·486	71	.	S.E. ½	·465	73	.	S. by E. 2	·450	76	.	S.W. 1	·371	72	.	S. by W. ½	·328	70	.	0	·281	69	.	0
" 25	·250	66	.	0	·320	62	51	N.W. 1	·416	65	49	N.W. 3	·500	60	48	N.W. 5	·541	62	49	N.W. 4	·587	62	47	0
" 26	·670	56	48	N.W. 1, cl.	·700	62	60	N.W. 1	·710	66	.	W. 1	·690	68	.	W. 1	·680	60	.	W. 1	·670	70	.	0
" 27	·596	57	.	S.W. 1	·630	62	.	S. 2	·600	67	.	S.S.E. 3	·500	68	.	S.E. 4	·440	64	.	S.E. 4	·440	66	.	S.W. 1
" 28	·280	60	.	S.S.W. 4	·264	65	.	S. 5, cldy.	·260	68	.	S. 2, cldy.	·224	66	.	0, cloudy.	·169	64	.	0, clear, 5	·132	65	.	S. 3
" 29	28·969	61	.	W. 4	29·000	64	.	W. 5	·032	67	.	W. 6, cirri.	·050	64	.	W. 3, cldy.	·076	62	.	W. 7, st'g.	·099	69	.	W. 7
" 30	29·031	56	.	W. 5, st., r.	·040	64	50	W. 5, r. st.	·050	70	50	W. 5, r. st.	·069	66	.	W. 1, cldy.	·080	70	48	W. 1, storm	·091	68	50	W. 2, st'g.
" 31	·094	55	49	W. 2, st'g.	·170	60	51	W. 3, cldy.	·250	70		W. 3, cldy.	·272	67	.	W. 3, clear.	·290	70	55		·331	68	54	0, clear.
Aug. 1	·381	60	56	0	·444	67	57	W. 1	·458	68	62	W. 2	·468	62	62	W. 2	·470	62	62	0, clear.	·500	64	60	clear.
" 2	·540	60	.	0, clear.	·568	64	.	S. 1	·590	69	65	S.S.E. 1, cl.	·570	65	65	E.N.E. 3, cl.	·560	65	65	S. 2, clear.	·550	62	60	S. 5, clear.
" 3	·560	61	.	0, clear.	. .	.	.	E. ½, clear.	. .	.	.	E. ½, clear.	. .	.	.	E. 1.	. .	.	.	S. 2	. .	.	.	0, clear.
" 4	. .	.	.	storming.	. .	.	.	storming.	. .	.	.	storming.	. .	.	.	storming.	. .	.	.	storm.	. .	.	.	storm.
" 5	. .	.	.	. .	. .	.	.	. .	. .	.	.	cloudy.	. .	.	.	clear.	. .	.	.	clear.	. .	.	.	clear.
" 6	. .	.	.	foggy.	. .	.	.	foggy.	. .	.	.	clear.	. .	.	.	clear.	. .	.	.	clear.	. .	.	.	clear.

NOTE.—Cl. stands for *clear*; r. for *rain*; st. for *stormy*; cldy, for *cloudy*.

TABLE I.—(*Continued.*)

Date.	6 A.M.				9 A.M.				12 M.				3 P.M.				6 P.M.				9 P.M.			
	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.
Aug. 7	. .	.	. .	w., clear.	. .	.	.	0, clear.	. .	.	.	0, clear.	. .	.	.	s. 1	. .	.	.	E., cumuli.	. .	.	.	E. 1
" 8	. .	. .	. .	w. 1, clear.	. .	.	.	E. 2, clear.	29·610	68	.	E. 5, clear.	29·604	70	.	E 4, clear.	29·588	66	.	E. 3, clear.	29·610	68	.	E. 1, clear.
" 9	29·589	64	. .	s. 2, floculi	29·610	70	.	s. 3, clear.	·504	74	.	s. by E. 3, cl.	·599	74	.	s. by E. 4	·580	70	.	E. by s. 3	·560	66	.	s. by E. 4, cl.
" 10	·524	58	. .	s. by w. 3, cl	·604	74	.	s. 1, clear.	·541	75	.	0	·548	76	.	w. 3	·573	70	.	w. 3	·516	68	.	w. 2, cldy.
" 11	·508	67	. .	0, cirri.	·510	66	.	0	·564	69	.	0	·510	60	.	0, clear	·526	68	.	0, clear.	·522	64	.	0, clear.
" 12	·562	65	. .	0, clear.	·568	60	.	N. 1.	. .	.	.	N. E. 3	·500	60	.	N.E. 3	·470	60	.	N. 1, clear.	·460	60	.	s. 3
" 13	·294	66	. .	s by E. 3	·270	68	.	s. by E.	·250	70	.	0	·240	70	.	w. 1	·294	63	.	w. 1	·338	64	.	0, foggy.
" 14	·318	64	. .	s. by w. 5, cl	·309	70	.	0, calm.	·330	76	.	w. 5, clear.	·340	76	.	w. 4, clear	·330	75	.	N.E. 3, cl.	·300	70	.	s.E. 1, cl.
" 15	·341	70	. .	s.w. 1, r.	·350	70	.	w. 2, clear.	·351	73	.	W.N.W. 3	·350	72	.	0, calm.	·344	68	.	s. by w. 1, cl	. .	.	.	
" 16	·330	65	. .	0, cloudy.	·326	66	.	0	·314	64	.	E. 1,	·230	63	.	N.W. 6	·300	60	.	N. 4	·330	65	.	W.N.W. 1.
" 17	·320	60	. .	w. 5, cldy.	·350	63	.	w. 4, cldy.	·400	62	.	w. 4, cldy.	·480	62	.	w. 4, cldy.	·470	61	.	w. 4, cldy.	·500	60	.	w. 5, cldy.
" 18	·560	58	. .	N.W. 5, cl.	·615	67	.	N.W. 5, cl.	·600	67	.	WNW. 5, cl.	·585	64	.	WNW. 5, cl.	·560	60	.	WNW. 4, cl.	·564	60	.	
" 19	·501	58	. .	w. 4	·480	65	.	w. 5	·474	67	.	w. 5, clear	·410	71	.	w. 5, clear.	·416	67	.	w. 3	·410	66	.	w. 1, cum.
" 20	·410	65	. .	w. 2, clear.	·414	68	.	w. 2, clear.	·400	69	.	w. 3, cirri.	·396	69	.	w. 3, cirri.	·400	67	.	E.S.E. 1, cl.	·401	66	.	0, clear.
" 21	·371	62	. .	w. 2, clear.	·380	67	.	w. 5, clear.	·391	69	.	w. 3, clear.	·450	72	.	w. 1, clear.	·450	66	.	0, clear.	·450	66	.	0, clear.
" 22	·550	65	. .	0, clear.	·560	66	.	E. 3, clear.	·581	67	.	E.N.E. 3, cl.	·580	67	.	E.N.E. 3, cl.	·560	65	.	E. 2, clear.	·564	62	.	0, clear.
" 23	·640	65	. .	s. 1, clear.	·650	69	.	s. 1, clear.	·660	74	.	E. 3, clear.	·628	64	.	E. 4, clear.	·656	64	.	s. by E. 3, cl	·650	65	.	s. by E. 2, cl
" 24	·701	66	. .	0, clear.	·712	68	.	0, clear.	·704	70	.	E. 3, clear.	·672	67	.	E. 4, clear.	·674	66	.	E. 2, clear.	·680	64	.	s. by E. 1, cl
" 25	·632	70	. .	s. 3, clear.	·610	74	.	s.s.w. 6, cl.	·550	77	.	S.S.E. 5, cir.	·486	80	.	E.S.E. 5, cir.	·400	76	.	S.S.E. 6	·364	76	.	s.s.w. 5
" 26	·300	71	. .	s w. 6	·344	68	.	w. 5, rain.	·410	68	.	w. 4	·450	68	.	w. 4, clear.	·474	68	.	w. 3, clear.	·466	69	.	w. 2, clear.
" 27	·350	60	. .	s.w. 5, cl.	·300	64	.	w. 7, clear.	·280	67	.	w. 7, clear.	·280	77	.	w. 7, cum.	·350	70	52	N. 8, squall	·491	70	48	N. 5, cldy.
" 28	·516	57	49	w. 1, clear	·558	66	52	w. 1	·564	67	55	N.N.W. 2, cl.	·530	63	63	N.N.W. 2, cl.	·526	70	55	s. 1, clear.	·540	62	48	s. 1, clear.
" 29	·490	54	50	s. by w. 3	·500	59	55	s. by E. 5	·478	64	57	s. by E. 3	·464	72	53	E.N.E. 2	·400	70	53	E.S.E. 3	·386	66	52	E.S.E. 2.
" 30	·420	55	48	N. W. 4	·450	62	56	N.W. 5	·560	66	56	N.W. 5, cl.	·570	61	.	W.N.W. 3	·588	66	56	s.w. 3, cldy	·621	66	60	0, cldy.
" 31	·600	65	58	s. 3, cloudy	·580	68	68	s. 4, clear.	·550	67	.	s.w. 5	·458	65	.	s.w. 4, cldy	·400	66	60	s.w. 4, cldy	·350	62	60	s.w., cldy.
Sept. 1	·250	63	60	w. 3, clear.	·350	66	58	w. 4, cldy.	·380	68	.	0	·380	65	.	w. 1, clear.	·400	60	.	0, clear.	·415	66	.	0, clear.
" 2	·392	57		s. 5.	·360	60		s. 4, r.	·270	74	55	E. 5	·261	68	54	E. 6	·180	67	52	N.E. 7	·178	65	50	N. 7, r. st.
" 3	·500	57		N. 3, clear.	·528	60		N. 3, clear.	·626	63	.	N. 3, clear.	·621	60	.	N.E. 2, cl.	·601	60	54	s. 1, clear.	·630	62	42	0, clear.
" 4	·533	52	48	s. 1, cldy.	·528	61	52	E. 2, cldy.	·485	53	.	E. 4, cldy.	·430	52	.	E. 6	·424	53	.	E. 4, cldy.	·415	54	50	E. 4, cldy.
" 5	·320	52	48	s.E. 1, cldy.	. .	.	.	E. 1, cldy.	. .	.	.	E. 3, cldy.	. .	.	.	E. 4, cldy.	. .	.	.	E. 5	. .	.	.	E. 5, cldy.

Monthly Averages of Barometer, Thermometer, &c., during the period of observation.

Date.	6 P.M.			9 A.M.			12 M.			3 P.M.			6 P.M.			9 P.M.		
	Bar.	Ther. det.	Winds, &c.	Bar.	Ther. det.	Winds, &c.	Bar.	Ther. det.	Winds, &c.	Bar.	Ther. det.	Winds, &c.	Bar.	Ther. det.	Winds, &c.	Bar.	Ther. det.	Winds, &c.
July,	29·331	67	calm 7 days	29·336	66·7	calm 5 days	29·405	69·9	calm 4 days	29·383	69·5	calm 6 days	29·369	67·2	calm 5 days	29·368	67·1	calm 9 days
			W. 5 "			S.E. 4 "			S.E. 2 "			S.E. 3 "			W. 6 "			W. 3 "
			S.W. 7 "			S.W. 1 "			S.W. 2 "			S.W. 3 "			N.W. 3 "			S.W. 3 "
			N.W. 2 "			rain 2 "			S. 1 "			N.W. 2 "			S.S.W. 1 "			S.S.W. 5 "
			S.E. 3 "			W. 9 "			rain 2 "			W. 9 "			S. 2 "			S. 1 "
		64·25	rain 2 "			S. 2 "			W. 9 "			rain 0			S.E. 3 "			S.E. 1 "
						N.W. 3 "			W. by N. 2			fog 0			S.S.E. 3 "			S.S.E. 1 "
						fog 1 "			N.W. 4 d'ys						rain 3 "			rain 1 "
									fog 1 "						fog 0			
Aug.	29·396	61·6	calm 8 "	29·482	65·4	calm 5 "	29·488	67·5	calm 4 "	29·476	67·3	calm 2 "	29·475	64	calm 3 "	29·484	62·6	calm 7 "
			N.W. 2 "			N.W. 2 "			N.W. 2 "			N.W. 2 "			W. 6 "			W. 6 "
			W. 7 "			W. 9 "			W. 10 "			W. 10 "			S.W. 2 "			S.W. 1 "
			S.W. 3 "			S. 8 "			S.W. 1 "			S.W. 1 "			S. 5 "			S. 7 "
			S. 10 "			E. 3 "			S. 3 "			S. 2 "			E. 7 "			E. 3 "
			W. 1 "			rain 4 "			E. 6 "			E. 6 "			N.E. 1 "			N. 1 "
			rain 4 "			fog 4 "			N.E. 1 "			N.E. 1 "			N. 3 "			rain 2 "
			fog 2 "						rain 2 "			rain 2 "			rain 3 "			fog 1 "
									fog 1 "			fog 1 "			fog 1 "			
Sept.	29·399	54	S. 2 "	29·441	57·5	W. 1 "	29·440	59·7	calm 1 "	29·423	57·7	W. 1 "	29·401	54·7	calm 1 "	29 409	47·3	calm 2 "
			S.E. 1 "			S. 1 "			E. 3 "			E. 3 "			N.E. 1 "			E. 2 "
			N. 1 "			E. 2 "			N. 1 "			N. 1 "			S. 1 "			N. 1 "
						N. 1 "						rain 1 "			E. 2 "			
						rain 1 "												

REMARKS.—*July* 9th. 9 A.M., clear, little breeze off on lake: 3 P.M., slight breath to north.—11th. 12 M., wind very light: 3 P.M., wind very light, but a heavy ground swell breaks on shore. Steamboat Julia Palmer passed Harbor at 2 P.M., and returned at 12 P.M. to Copper Harbor.—15th. Vide Table II. Thunder gust. Pleasant, but a violent storm came up suddenly from northwest, 11h. 20m. A.M. Water repeatedly rose and fell in bay two feet, with barometric changes.—16th. 6 P.M., raining gently. Thunder in west, 8 P.M., and rainbow in east.—17th. Steamboat Julia Palmer returned from Fond du Lac.—21st. Sudden fall of water in bay, eight inches at 7h 40m. P.M.—23d. Steamboat Julia Palmer arrived from Sault St. Marie, and left in evening.—25th. 9 A.M., and 12 M., heavy ground swell on lake, rain: 6 P.M., heavy sea, clear. Cold stormy day; fire necessary all day for comfort; water rose and fell in bay by barometric changes.—26th. Frost last night: Propeller arrived from Sault St. Marie.—28th. 6 P.M., clear, clouds in N.W., N. and N.E.: 9 P.M., heavy clouds in N and W.—29th. 6 A.M., cloudy in parts: 9 A.M., cloudy, but sun shines. Very windy and cold stormy day: boats did not venture to cross the bay.—30th. Cold and stormy day; Propeller arrived in twenty-seven hours from Fond du Lac without steaming.—31st. Cold and stormy till noon, after which the sun shone.—*August* 1st. 6 A.M., and 9 A.M., fleecy clouds: 12 M., cirri, some cumuli.—2d. 9 A.M., fog bank. Steamboat J. Palmer arrived from La Pointe.—3d. 3 P.M., clear, cumuli in W.: 6 P.M., cloudy, cumuli in S.W.—4th. Cold stormy day, and storm in the night.—5th. 6 A.M., and 9 A.M., fog and drizzling. Cold and stormy till noon.—7th. 3 P.M., clear, few cumuli in W: 9 P.M., cloudy in W. and S.—8th. 6. A.M., and 9 A.M., heavy ground swell from E.—10th. 12 M., cumuli in W.: 3 P.M., squally in W., threatening rain: 6 P.M., cloudy, threatening rain. —11th. 9 A.M., dense fog: 12 M., cirri, sun shone a little.—12th 9 A.M., 12 M., and 3 P.M., dense fog: 6 P.M., few cirri: 9 P.M., some clouds.—13th. 6 A.M, cirri: 9 A.M., cloudy: 12 M., cloudy, thunder in west: 3 P.M., rain and fog from 2 P.M. to 3: 6 P.M., fog and rain.—15th. 12 M., few cirri.—Wind E N.E. at 4 P.M.—16th. 9 A.M., cloudy, thunder: 3 P.M., squalls and calm: 9 P.M., cloudy. Thunder shower and vivid lightning at 10 A M.; heavy at 12h. 30m.; heavy wind and sea all day and night from W. and N W.—19th. 6 A.M., and 9 A.M., clear, few cirri: 6 P M., few cirri. Heavy wind and sea all day.—25th. 6 P.M., and 9 P.M., cloudy. Wind strong, and in heavy squalls all day and night.—26th 6 A.M., a little rain: 12 M., cloudy, partly clear. Stormy; wind blowing a gale part of time.—27th. Wind shifted from west to N.W. at 4 P.M., and thermometer fell 10° in a moment, and 29° in a few hours; heavy gale on lake to N.W. and west.—29th. 6 A.M., and 9 A.M., cloudy: 12 M., rain since 10 A.M.: 3 P.M., 6 P.M., and 9 P M., storming. Cold stormy day.—30th. 6 A.M., and 3 P.M., cloudy.—31st. 12 M., clear in spots.—*September* 1st. 12 M., some clouds.—2d. 6 A.M., cloudy, clear at 5 A.M.: 12 M., raining, thunder in south: 3 P.M., severe storm and heavy rain: 6 P.M., severe storm, wind and rain: 9 P.M., rain storm. Severe and cold storm.—4th. 3 P.M., cloudy and rain. Heavy wind from west and south in night.—5th. 6 P.M., heavy storm clouds in west.

TABLE II.—*Register of Observations made at Copper Harbor, Lake Superior, from July* 15*th to* 29*th, Lat.* 47° 28′ *N.; Long. about* 88° *W. of Greenwich.*

Day.	Hour. h. m.	A.M. & P.M.	Bar.	Th. att.	Barometric waves of water.	Remarks.
15	6 00	A.M.	29·288	72	. . .	
"	9	"	·220	77	Water varied 1½ feet in a few minutes, and in a few more sunk a foot below the *usual* level.	
"	10	"	·200	80	Water higher than usual, although the wind is blowing off shore.	Wind blowing towards a heavy thunder-storm in W. and N.W; wind S.E. 5.
"	11 15	"	·480		Water suddenly fell one foot. Strong current along shore to east outside of the island.	Wind S.E. 4.
"	11 20	"	·264	78	Water running into the bay with great velocity.	Wind N.W. 9; constant roar of thunder and very vivid lightning; wind in an instant shifted from S.E. to N.W., uprooting trees, blowing down tents, &c.; lake a sheet of foam; heavy rain.
"	11 25	"	·260		. . .	Wind N.W. 9. Lake a sheet of foam; heavy rain.
"	11 40	"	·356		. . .	Wind N.W. 8. Lake a sheet of foam; heavy rain.
"	11 50	"	·316		. . .	Lull of wind; another gust coming on.
"	11 55	"	·328		. . .	Calm.
"	12 05	P.M.	·300		. . .	"
"	12 08	"	·260		Water a foot lower than usual, and flowing into bay from the lake with a strong current.	Calm; clearing in N.W., and sun soon came out.
"	12 15	"	·256		. . .	Calm.
"	12 20	"	·250	74	. . .	"
"	12 30	"	·251		Water high on lake shore, flowing rapidly into the harbor.	" clear in N. and N.W.; heavy thunder to E.N.E. and S.E.
"	12 40	"	·236	73	. . .	Calm.
"	1	"	·220		. . .	Wind S.S.E. 1; clear N. and N.W.
"	1 40	"	·206	70	. . .	Wind S.S.E. 2; another shower apparently coming from S.S.W. and W.
"	2	"	·200	69	. . .	Wind S. by W. 4.
"	2 15	"	·200	68	Water high in bay.	" " " 4.
"	2 20	"	·200	68	Water fallen 9 in. in 5 minutes in bay, and is 9 in. still lower on the outside of island. Running out with strong current.	" " " 4.
"	2 22	"	·204	68	Water 4 inches lower than at 2h. 20m.	Very strong breeze S. by W. 5; white caps all over the bay.
"	2 25	"	·200		Water stationary in bay and on lake shore.	Very strong breeze S. by W. 6; white caps all over the bay.
"	2 30	"	·200		Water rising rapidly in bay.	Very strong breeze S. by W. 6.
"	2 35	"	·192		Water risen 6 inches in bay.	" " " " " 6.
"	2 40	"	·190	68	Water fallen 8 in. in bay.	" " " " " 6.
"	2 50	"	·172		Water risen a full foot above its usual level.	Wind S. by W. 6.

TABLE II.—(*Continued.*)

Day.	Hour. h. m.	A.M. & P.M.	Bar.	Th. att.	Barometric waves of water.	Remarks.
15	2 55	P.M.	29·170		Water still up, but fallen a little.	Wind s. by w. 6.
"	3	"	·170		Water fallen a foot to its usual level.	" " " 6.
"	3 20	"	·190		Water fallen a foot *below* usual level.	" " " 6.
"	3 30	"	·182		Water risen a foot to the usual level.	" " " 6.
"	3 40	"	·180		Water fallen 1½ feet.	" " " 6.
"	3 50	"	·180		Water risen 1½ feet.	" s.s.w. 4.
"	4 10	"	·176		Water rising and falling a foot every few minutes.	" " 4.
"	4 20	"	·170	68	. . .	" s. by w. 4.
"	5 50	"	·150	70	. . .	Calm; heavy wind clouds to s. and s.w.
"	6	"	·150	70	. . .	
"	9	"	·300	70	. . .	Wind s.s.w. 1; thunder cloud in west.
"	10	"	·200		. . .	
16	1 40	A.M.	·200		. . .	Wind N.W. 6; thunder for hours in the west; heavy driving rain; heaviest rain from 2 A.M. to 2h. 40m. A.M.
"	2 20	"			. . .	Wind N.W. 9.
"	6	"	·220	70	. . .	" s.w. 2.
"	8	"	·190	72	. . .	" s.E. 1.
"	9	"	·160	69	Water at medium height.	" " 5.
"	12	M.	·151	74	. . .	" s.w. 1.
"	12 30	P.M.			Water very high in bay.	
"	12 35	"			Water gone down one foot.	
"	3	"	·159	73	. . .	" s. by w. 1.
"	4 25	"	·150	70	. . .	Raining gently; thunder in w.
"	5 20		·128	70	. . .	" " " "
"	5 40	"	·128	"	. . .	" " " "
"	6	"	·130	72	. . .	Wind w. 1.
"	7 20	"	·150	"	. . .	Clear in west and N.W.; sun shining; rainbow in east.
"	8	"	·150	"	. . .	Wind s.w. by s. 3; thunder clouds in west and north.
"	8 35	"	·150	74	. . .	Calm.
"	9	"	·150	72	. . .	Wind s.s.w. 2.
"	10 10	"	·170	"	. . .	Calm.
17	9 40	A.M.	·420	69	. . .	Wind w. 4.
"	10 30	"	·450	67	. . .	" " 4; fog coming on.
"	1 40	P.M.	·480	64	. . .	" " 1.
"	2	"	·480	"	. . .	" " 1; drizzling rain.
"	4 30	"	·490	"	. . .	" N.W. by w. 1; "
18	10 40	A.M.	·548	66	. . .	" w. 1.
"	12 30	P.M.	·540	64	. . .	" N.W. 1.
"	3 30	P.M.	·530	68	. . .	" " 1; temperature of lake water on the shore, 62°.
"	5	"	·520	64	. . .	Wind N. 1.
"	5 45	"	·510	"	. . .	" " 1.
19	10 40	A.M.	·440	69	. . .	" " 1; temperature of water on shore 65°.
"	2 20	P.M.	·412	"	. . .	Wind N. ½.
"	4	"	·360	"	. . .	" east, and in a few minutes shifted to s.E.; sky looked threatening.
"	5	"	·348	70	. . .	Wind s. 4; temperature of water on lake shore, 64°.
20	1 30	P.M.	·265		. . .	Wind s.E. 5.

TABLE II.—(*Continued.*)

Day.	Hour. h. m	A.M. & P.M.	Bar.	Th. att.	Barometric waves of water.	Remarks.
20	9 40	P.M.	29·170		. . .	Wind S.W. 4; circle around the moon.
21	8 30	A.M.	·100		. . .	Wind W.N.W. 5.
"	11	"	·160		. . .	" N.N.W. 5.
"	7 40	P.M.	·260		Sudden fall of water in bay of about 8 inches.	" W. 5.
22	11	A.M.	·556		. . .	
"	6 40	P.M.	·550		. . .	" N W. 1; squall clouds in north; thunder clouds in N., N.E. and N.W.
23	.	.	. . .	.	. . .	Temperature of the water on shore, with wind at west and N.W. two days, 60°.
24	1 30	P.M.	·425	72	. . .	Calm; cloudy.
"	2 30	"	·360	"	. . .	Wind S. by W. 3; raining a little.
25	8 30	A.M.	·266	63	Water in the bay a foot above the usual level, and fell again in a few minutes.	Wind N.W. 1; lake rough with a heavy ground swell, from wind at a distance.
"	11	"			Ibid.	
29	4 30	A.M.	28·971	62	. . .	Wind S.W. 4; heavy black clouds in east; rained hard in the night.
"	10	P.M.	. . .	.	. . .	Storm began with wind in the morning at 9 o'clock, but did not rain till 1 P.M.; fine misty rain; continues blowing hard and storming.
30	.	.	. . .	.	. . .	Storm continued all day.

Throughout the preceding table where time is registered, fluctuations in the level of the water were observed, though the amount of rise and fall was not always registered. As a general thing, fluctuations in the barometer accompanied the fluctuations in the level of the water; but sometimes the water level varied rapidly in the harbor, while no such variations occurred in the barometer at the place of observation. These variations in the level of the water, may be caused by varied barometric pressure of the air on the water, either at the place of observation, or at some distant point. A local increased pressure of the atmosphere at the place of observation, would lower the water level where there is a wide expanse of water; or a diminished pressure under the same circumstances, would cause the water to rise above its usual level. If the barometer remain stationary at the place of observation, an increased pressure at a distant part of the lake would cause the water to rise; and a diminished pressure at such a point, would cause it to sink at the place of observation. During the last three summers, I have been on and near the coast of Lake Superior, much of the time coasting in a boat, and encamping on the shore. I have often observed at the mouths of streams, when encamped, that the outward flow of the water would be interrupted, and a strong current flow into the river or creek until the water was raised from two or three to sixteen or eighteen inches above its common level, and after remaining thus for a few minutes or sometimes a longer period, again flow into the lake with a strong current, until the usual level of the water on the bar is attained. Sometimes the water of the lake would also recede below its usual level, so as to leave the bars naked that were generally covered with water. Toward the extremities of long lakes and bays, the wind causes very sensible fluctuations in the level of the water, which have long been observed at Whitehall and Buffalo, N. Y. The variations in level in Green Bay, observed by many persons, and carefully registered by Mr. Cass in 1828, and by Lieut. Ruggles in Sept. and Oct., 1836, are believed to be due to the influences of the wind *in part*, but *mostly* to variation of atmospheric pressure.

Copper Harbor is situated nearly in the centre of Lake Superior, near the extremity of a peninsula extending about seventy miles into the lake; and whatever may be the direction or force of the wind, the water retains its level so far as this cause is concerned in producing variations of level. The place of observation (on Porter's Island) is entirely sheltered from any influence of the waves, which break with great force in storms on the reefs and shore, on the outside of the island. It is in a little bay on the south side of the island, and opens into Copper Harbor. Copper Harbor is three miles in length parallel to the lake coast, and opens with a breadth of a mile. Any fluctuations that are not momentary, like those of the waves produced by wind, are perceived in a few minutes at the place where the observations were made, both by the variation of level, and by the rapid flow into or out of the harbor in the narrow opening that separates the west end of Porter's Island from the main land.

The quantity of water flowing through the rapids at the Sault St. Marie, at the outlet of Lake Superior, is subject to very considerable variation, and is dependent on two causes, viz., the direction and force of the wind, and, second, upon barometric waves. Capt. Peck, who resides at the Sault St. Marie, related to me instances in which the smooth flat rocks at the head of the rapids were bare for a considerable distance on or near the Canada shore, where ordinarily there was a strong current. He had walked far out on these rocks, but observation had taught him not to tarry long, as the water would return sometimes in half an hour; these depressions of the water usually preceded a storm.

During my visit to the Sault on the 7th of Sept. last, the water was remarkably low on the rapids all day, being one and a half feet lower than usual. A daring New England man wishing to see if the falls could be ascended, made the attempt in a sharp skiff sail boat, with a strong fair wind, almost a gale, and succeeded—a thing never before attempted, or even deemed possible.

A heavy rain storm from the N. and N.W. succeeded on the following day.

Many observing men on the lakes have noticed that the extraordinary variations in the level of the water precede a storm. I regret that I did not accurately note down more of them. The preceding notes may call the attention of those favorably situated for these investigations, carefully to observe the attending circumstances, and especially the barometric fluctuations, wind, weather, and temperature. A rise of the barometer in the annulus of a storm precedes the depression, and would account for the fluctuations of level, whether the variations in atmospheric pressure occur at the place of observation or at some distant point, on a broad expanse of water.

Periodical Rise and Fall of Lake Superior.—The gradual rise and fall of the level of the water in the great lakes, through a series of years, has long been noticed. Its cause is doubtless due to a greater quantity of rain and snow, or of a lower mean of temperature and diminished evaporation during the period of rise, and the reverse during the time of fall of the water-level of the lakes. During the year 1838 or 1839, the waters were higher than they had been before for at least two centuries. This is demonstrated by the large tracts of land that were inundated, which are covered with forest trees, many of them the growth of ages. These trees were destroyed by this overflow around Lakes Erie and Huron and on the St. Mary's river, between Point Detour and the Sault St. Marie.

We have no accounts of Lake Superior at that time, and I have seen no similar tracts of destroyed timber on the shores of that lake, although I have coasted along most of the shore. There are facts however that indicate a marked variation within a few years. In 1845 a rock in the middle of the entrance of Eagle Harbor showed itself only in the trough of the waves; and the narrow inlet betwen the west end of Porter's Island and the main land at Copper Harbor, was of such depth that loaded Macinaw boats could enter Copper Harbor without touching the rocks. In the summer of 1846 the rock at the mouth of Eagle Harbor was a foot and a half above water; boats could not get into Copper Harbor through the inlet above mentioned, and skiffs and canoes rarely attempted to enter by that passage. In June, 1847, the rock above mentioned was still more out of water, and the western inlet to Copper Harbor could be crossed, by stepping on the projecting points of the reef, without wetting the feet; and during some depressions of the water by barometric waves, it was laid almost entirely dry. From the 18th of June to the 6th of September the general level of the water rose fully twelve inches. Several large rocks in the water opposite the government house, with their points projecting at different heights above the water, were daily observed (except from the 3d to the 8th of August), when the water was calm, and a steady progressive rise noticed by means of them, the lowest being first covered and others in succession. It has been observed on this lake, that the water is lowest in spring and highest in autumn. This is readily explained by the fact that in winter most of the ordinary supplies of water from the drainage of the surrounding country, are cut off by being converted into ice and snow, while evaporation from the surface of the lake by the dry northern winds continues to carry away a very sensible quantity of water. During the spring and early part of summer* the snow and ice melt, and the accumulated stores of winter, flow into the lake in greater quantity than to compensate for the evaporation and the drainage at the outlet. The summer of 1846 was remarkably dry and warm; that of 1847 more than usually cold and wet. A small canal was cut some years since, from the head of the rapids at the Sault St. Marie, to supply the government saw mill near the foot of the rapids with water, and boats used to navigate this canal to the saw mill. In 1845 a little water entered this canal, perhaps eight inches to twelve inches in depth. In 1846 and 1847 the water did not ordinarily come within a foot or more of the level of its bottom.

Ancient Levels of the Lake.—During a century past, the waters of Lake Superior cannot have been more than four feet above the level of the summer of 1847, for any considerable length of time. This is evident from the growth of trees of two feet in diameter on Porter's Island, within one hundred yards of the Government House that would have died had the ground around been inundated for any length of time.

The evidences of higher levels of this lake in times more remote, but during the modern epoch, are numerous and striking. They consist in the beaches of shingle, and sand, and gravel, in successive elevations. The shingle and pebble beaches may be seen, well characterized, between Copper Harbor and Lake Fanny Hooe at Fort Wilkins, from the lake beach to a height of about forty feet. The sand beaches and dunes, may be seen at the mouths of Huron and Pine Rivers, and near Presque Isle, between the Presque Isle River and Point Abbaye; also east and west of Eagle River, from Eagle Harbor to the Portage, for about twenty-five miles; also most of the distance between Elm River, Sleeping River, Misery, Flint-steel, Fire-steel, Ontonagon and Iron Rivers, where the rocky coast is not too high to break the force of the waves when the lake was above its present level.

* On the 20th of June, 1847, snow still remained in the swamp on Porter's Island, two feet in depth, over a small area where the evergreen trees were so thick that the sun's rays could scarcely penetrate.

The most remarkable dunes or hills of blown sand, observed, are those w.s.w. of Eagle Harbor, between there and Sand Bay, which are fifty feet or sixty feet high on the coast, and much higher in the interior, near the base of the hills; those near Eagle River to the west four to five miles; and those at the mouth of Pic River on the Canada shore. Dunes of twenty feet to forty feet high are common in almost every part of the lake coast where sand beaches are formed, and where the strong dry winds can sweep over a considerable length of beach. The highest and most remarkable dunes are so situated as to demonstrate that the westerly and northwesterly winds are the prevailing ones, that blow with force enough to drift much sand. Mr. Schoolcraft has described remarkable dunes on the lake coast, three hundred feet high,* between Grand Island and White Fish Point. All who have coasted that shore, have observed them.

An estuary deposit at the mouth of Pic River, may also be adduced as an evidence of a former higher level of the lake. This is about twenty feet to forty feet above the lake, nearly level, and where the river was cutting it away, great numbers of fresh-water bivalve shells were found, such as are now living in great numbers in the adjacent waters, and occur on the beach. This deposit is not blown sand, as it is nearly level, while that near the beach is piled in hills sixty feet to seventy feet high, and continually encroaching upon the level estuary deposit, burying the forest on the landward side in its progress.

Lake Superior, so far as is known, does not show any indication of having had any other outlet than that through which its surplus water now flows, and so far as the facts observed justify any conclusion, we may infer, that the lowering of level indicated by the preceding facts, may be ascribed to the gradual wearing down of its outlet at the Sault St. Marie. The rocks at this place are gray and red variegated sandstones highly indurated, which wear away with extreme slowness. They are nearly horrizontal in position, and dip slightly to the west and northwest. The outlet in former times, when the lake was twenty feet or thirty feet higher, must have been two miles in width, but shallow; the flat lands at the Portage of the Sault St. Marie, consist of gravel and boulder of almost every variety of rock found on the shores of Lake Superior, intermixed with loam, and these materials rest on the flat and often smoothed surface of the subjacent sandstone.

The facts considered as demonstrating a water level some hundred feet above the present level will be adduced in another article on the geology of that region.

---

* Am. Journal of Science, vol. xliv, p. 369.

Art. II.—*Contributions to the Geology of Texas;* by Dr. Ferdinand Rœmer.

At the time when I wrote the short sketch of the geology of Texas, contained in a previous number of this Journal,* I had seen only a comparatively small portion of the country. I have since extended my observations over a much larger surface and, profiting by some peculiarly favorable circumstances, I have become acquainted with sections of the country generally considered inaccessible on account of the dangerous character of the Indian tribes by which they are inhabited.

I have collected a sufficient number of facts for a geological map of the whole state, which will be true at least in all its general features. My collections of fossils will serve to test the correctness of the observation and the inferences drawn from them. They contain a considerable number of new forms, chiefly from the cretaceous formation, which require to be described.

At present I wish only to present a short account of the general results which I have derived from my geological survey of the country.

An ideal line drawn from Presidio de Rio Grande on the Rio Grande in a n.e. direction, and crossing the San Antonio River at the town of the same name, the Guadaloupe at New Braunfels, (the German settlement,) the Colorado at Austin, the Brazos at the falls of this river, the Trinity below its forks, and reaching from there to the Red River in the same n.e. direction, divides the tertiary strata and the diluvial and alluvial deposits (of the level and "rolling" part of the country) from the cretaceous and older formations (of the hilly and mountainous sections).

The few remarks to be made about the former region, are first that the tract of level country which extends like a broad belt along almost the whole coast of Texas, is diluvial and partly alluvial in character. Its small elevation of a few feet only above the level of the sea, and its perfectly level surface, indicate, at once, the recent origin of the soil. The fossil remains, found in many places in the deposits of clay and sand, prove their modern age still more conclusively. At the head of Galveston bay and even near the town of Houston, I found at a height of twelve to twenty feet above the general level of the bay, large deposits of shells of Gnathodon, a bivalve mollusc, which lives abundantly in the brackish waters along the coast of the Mexican Gulf, and in the bay of Galveston particularly. Some few oyster shells of the common kind occur in these deposits of half fossilized Gna-

* Volume ii, ii Ser., p. 358.

thodon shells, but there are no shells different from those now living in the bay. Every thing tends to the supposition that the conditions of climate, etc., at the period when these deposits along the coast of Texas were formed, did not differ materially from the present, except that a change in the relative level of land and sea has since taken place.

To the diluvial period must be likewise referred the deposits of clay and sand which form the banks of the Brazos and probably all the other large rivers of the country. Mr. Hough, a gentleman residing at San Felipe, has discovered in the muddy banks of the Brazos near his place of residence, many fossil bones of extinct species of mammalia, and has made a valuable collection of them, which I had an opportunity to examine when it was exhibited about two years ago at Galveston. It contains bones of mastodon, megalonyx (claw bones), tapir, and of a gigantic and undescribed species of ox.*

To the diluvial age of the globe must be further referred the *deposits of gravel and sand*, which form a broad belt of barren or poor land covered with pine and post-oak timber, in the "rolling" or undulating portion of Texas, and extending from west to east across a considerable part of the country. Following up the Colorado from Columbus to Bastrop, or the Guadaloupe from Gonzales to Seguin, we pass directly across this belt. The gravel is mostly composed of pebbles of silex evidently derived from decomposed cretaceous strata. Within the limits of this gravel formation, fossil wood of dicotyledonous trees in smaller or larger fragments is found almost every where. In some localities it is particularly abundant, and whole trunks are occasionally met with. I have sent to Europe the lower part of a trunk, about three and a half feet in diameter, weighing about six hundred pounds, and showing distinctly the beginning of the ramification of the roots and most beautifully the fibrous internal structure of the wood. This specimen was discovered together with many smaller ones, in the banks of a small creek near the town of Boonville on the Brazos. When I wrote my former paper, I was not sure about the formation in which this fossil wood was originally deposited. I am now perfectly convinced that it is derived from cretaceous strata, having afterwards found pieces of it among cretaceous fossils at localities where for hundreds of miles around, there are no other but cretaceous strata, and no traces of diluvium or drift are met with.

Strata, belonging decidedly to the *tertiary* period, I did not see at all during the first part of my stay in the country, and I was inclined almost to doubt their existence in Texas altogether, although this would have been against the general analogy of the

* This Journal, volume i, ii Ser., p. 244.

other southern states. While on a tour to the upper Brazos, I discovered in the neighborhood of the town of Caldwell, strata of a ferruginous sandstone with numerous and well preserved tertiary shells. Crossing afterwards the Brazos not far from this town, I had a still better opportunity to see this formation along the steep banks of the river. It consists of alternating strata of brown ferruginous sandstone and of dark colored plastic clay, both teeming with fossils. Unfortunately, the circumstances did not allow me to make a complete collection of them; the few, however, which I gathered are sufficient to prove that those strata belong to one of the older divisions of the tertiary period. I have good reason to suppose that these same tertiary deposits have a wide range in the eastern part of Texas, though I am unable to give their exact limits. Tertiary fossils from Nacogdoches seem to indicate that the deposits of the Brazos extend as far as there.

Cretaceous formation.—We come next to the *cretaceous* strata, which of all the stratified formations take the most important part in the geological constitution of Texas and chiefly her upper hilly part. The immense tract of land which extends from the above mentioned line, connecting the Rio Grande with Red River, to the head waters of the Colorado and the other large rivers of Texas, is occupied entirely by cretaceous deposits, except a belt of silurian and carboniferous strata and a mass of granitic rocks, both covering comparatively a small area.

When we examine first the mineralogical constitution of these cretaceous rocks, a striking difference from other deposits of the cretaceous period on the North American continent at once becomes apparent; for whereas these latter, on the whole Atlantic coast, are almost entirely composed of loose and incoherent materials, the cretaceous strata of Texas constitute mostly compact and hard rocks, some of them equalling in compactness the hardest strata of more ancient secondary formations. A calcareous character is very commonly observed; in fact, I have not seen any sandstones or strata of clay in the whole series. Generally speaking, there is an alternation of compact siliceous limestones and less compact beds of either pure, or marly, limestone. The former contain the silex as well diffused through their whole mass, as in separate concretions or nodules. The siliceous character of these rocks, excluding the decomposing action of the atmosphere, almost entirely produces the general dry and barren aspect of the country which they occupy. Every where in the mountainous region, north from Austin or San Antonio de Bexar, on both sides of the Piedernales and San Saba Rivers, it is only in the valleys that a fertile stratum of soil is found; on the heights of the table land the bare rock appears almost every where at the surface, hardly supporting the scanty growth of grass and some scattered specimens of stunted live-oak and post-oak trees.

In regard to the organic character of these strata, the opinion expressed in my first paper has, on the whole, been confirmed by later researches, and is at present supported by a much greater number of facts. Most of the fossils belong to known types of the cretaceous formation. The number of species, however, exactly identical with described species is very limited. By comparing the fossils with those of the different divisions of the cretaceous formation as they are established in Europe, it appears that the rocks of Texas do not agree in any particular with received divisions. It is evident only that they belong to the upper part of the cretaceous formation, for there is a complete absence of all the characteristic forms of the gault and lower greensand, and on the other hand, there is an undoubted analogy with the organic character of the chalk and chalk marl.

Notwithstanding the considerable thickness of the whole system of strata, (which cannot be less than about eight hundred feet,) it seems impossible to divide it into different groups. Neither the mineralogical constitution of the rocks, nor the distribution of the organic remains allows of any such division. By a comparison of these cretaceous deposits with those of New Jersey, and other localities on the Atlantic coast, the difference in the zoological character appears hardly less striking than the difference in the mineralogical constitution which was alluded to before. Except the *Pecten quadricostatus* and the *Exogyra costata*, (the latter being rare in Texas,) I do not know of any other identical species, and the number of closely allied species is not very small. A little more analogy seems to exist with the cretaceous deposits of Alabama and Western Tennessee. At least a species of Ammonite, common at Prairie Bluff in Alabama, occurs also in Western Texas, and a species of Hippurite is closely allied to a species which I found at Austin, Texas, if not identical with it.

The analogy of the Texian strata with the cretaceous deposits on the Upper Missouri, is hardly greater than with those on the Atlantic coast. Not one of those beautiful species of *Scaphite*, *Baculite* and *Ammonite*, discovered by Nicollet, and described by Morton,* has been met with in Texas.

The entire absence of the *Belemnites mucronatus*, and every other *Belemnite*, is one of the principal negative characters of the Texian strata.

It is more difficult to define in a few words, the positive character of the Fauna.

All the species except a very few, (which form perhaps two new genera,) belong to genera which are either peculiar to, (as for instance, *Baculites*, *Turrilites*, etc.,) or are represented in the cretaceous formation.

---

*Journal of the Acad. of Nat. Sc. Philad., vol. viii., p. 2.

Among the latter, the genus *Exogyra*, acts a very important part in the constitution of the fauna, some species of the genus having a very wide geographical range, and occurring almost everywhere in a great number of individuals. One species which resembles a Chama in external shape, composes at some localities, whole beds of itself, and is met with through the whole extent of the hilly parts of Texas.

Another still more important fact must be considered in the general distribution throughout the whole formation of the genera *Hippurites* and *Caprina*. The former being entirely wanting in the cretaceous deposits of New Jersey, makes its first appearance towards the south, in the cretaceous strata of Alabama, where it is represented by one single species, of which only a few specimens have been hitherto discovered.* In Texas, at least three species of the same genus have been recognized, and those are of wide and frequent occurrence. The genus Caprina which has never been met with, either in New Jersey, or in Alabama, is one of the most characteristic and abundant types in the siliceous limestone of Texas. One species in some places constitutes of itself whole strata. It is well known that these two genera act an equally important part in the cretaceous strata in the Alps and around the Mediterranean, whereas they are hardly represented at all in the cretaceous formation of England and Germany. An interesting analogy is hereby established between the Texian deposits of the cretaceous period, and those of the south of Europe, the more striking, if we consider at the same time, the similarity of mineralogical constitution. Between the continents of America and Europe, there must therefore have existed at the time of the cretaceous period, such a relation that in both, the same modifications in the zoological character distinguished the marine Fauna of the north from that of the south. And thence, we proceed farther to the interesting conclusion, that the same southern inflection of the isothermal lines which is at present so remarkable in their course from the west side of the continent of Europe towards the east side of the continent of America, already existed at a period of the globe, as remote as that of the cretaceous formation.

Strata older than Cretaceous.—At the time when I wrote my first paper on the geology of Texas, I had no knowledge of the existence in the country, of any strata older than the cretaceous deposits, except that there was a single rock of granite about fifteen miles northeast of Fredericksburg. But in the early part of this year, a short time before my leaving the country, I had a

* I saw a specimen of this species at Philadelphia, in the Museum of the Acad. of Natural Sciences, which has been brought from Green county, Alabama, by Mr. Conrad.

very favorable opportunity to visit that section of country which lies between the Piedernales, Llano, and San Saba, (all three of them tributaries of the Colorado,) and which, on account of the dangerous character of the Indians by whom it is inhabited, has remained until now, almost entirely unknown. In this region, I found besides the cretaceous formation, not only an extensive tract of granite, and other crystalline rocks, but also stratified deposits, which from the fossils they contain, are clearly Silurian strata, and carboniferous limestone. In order to make the geographical distribution of these rocks distinctly understood, it will be necessary first, to point out the route which I took in the exploration of this region. Starting from Fredericksburg, a German settlement which is situated about ninety miles north of the town of San Antonio de Bexar, and about four miles from the Piedernales, we took a northwestern course, and followed it not only as far as the Llano river, but also beyond it, until we reached the San Saba. We then ascended the valley of this river about fifty miles, until we reached the San Saba, that is to say, beyond the ruins of the old Spanish fort, and within about eight miles of the sources of the river. From there, we went down the valley again, passed the point where we first struck it, and continued descending the valley, until we arrived at a camp of the Camanche Indians, about twenty-five miles from the mouth of the river. There we left the valley of the San Saba, and went back to Fredericksburg, in an almost exactly southern course. On this tour the following rocks were observed.

From the Piedernales to the Llano, the same cretaceous strata extend, which, consisting of a compact white, or yellowish limestone, with occasional nodules of flint, occupy likewise the whole tract of land from the Piedernales down to San Antonio and Austin. On the banks of the Llano, a calcareous sandstone distinctly stratified, but evidently much altered, begins to show itself; its extension, however, is only a limited one, for about five miles beyond the river it is superseded by granite. This latter rock, occupies almost the whole tract of country between the Llano and San Saba, and it is only on the dividing ridge of the last mentioned river, that limestone beds reappear again.

The granite is on the whole, coarse grained, and appears red from the color of the feldspar. It constitutes either large rocks with bold outlines, or flattened masses, which project only very little above the surface of the ground, and become visible mostly in the beds of several small streams, by which the country is intersected.

About ten miles from the place where we first entered the San Saba valley, on the right bank of the river, horizontal beds of limestone, of a decidedly Palæozoic character, were first met with. This limestone, of a grayish impure color and of a granular structure, bears strong evidence of alteration by the action of heated plutonic rocks. This igneous action has not however obliterated all the organic remains of the limestone. Fossils, on the contrary, although not of many species, are abundant. Among them Trilobites are especially numerous. Those which I collected belong to the genera *Asaphus* and *Bronteus*. In specific characters they differ from many found in the valley of the Mississippi, or in other palæozoic strata of America. Besides these Trilobites, some indistinct species of Orthis were found at the same locality. Some miles further up this river, at a place where the limestone does not exhibit any marks of plutonic action, some other genera of fossils are met with, as for instance *Euomphalus*, *Spirifer*, etc. Of the latter genus one species was found which is closely allied to the *Spirifer lynx*, Eichw., a fossil shell so widely spread in the beds of Trenton limestone of the state of New York, and the corresponding strata of the western states. In ascending still higher the valley of the San Saba, we lost sight of all Palæozoic strata, cretaceous strata of the same character as those which we had seen before, taking their place at the surface, and occupying especially all the neighborhood of the old Spanish fort. We met Silurian strata again nearer to the mouth of the San Saba river. Here they consisted of a white siliceous limestone, evidently much altered, although not to such a degree as to destroy all marks of organic remains. A species of Euomphalus with a great number of whorls, analogous to a species from the Silurian strata of Russia, could be distinctly recognized. Still further down the river, and about thirty miles from its mouth, we found in the narrow valley of a tributary of the San Saba river, inclined strata of a dark colored compact limestone, with layers and nodules of black silex. These beds of limestone abound with fossils which evidently belong to the carboniferous period, and some of them are even exactly identical with species of the carboniferous limestone of the Mississippi valley. Most of the species which were observed in the very short examination of the locality, belong to the genera *Productus*, *Spirifer*, and *Terebratula*.

On our return from the San Saba to Fredericksburg, we crossed again the same belt of granitic rocks which we had seen previously after passing the Llano, and did not observe any cretaceous strata before reaching the dividing ridge of the Piedernales and Llano.

The main results of this journey, as well as of former investigations, may be more clearly exhibited in the following statements.

The immense tract of hilly or mountainous country extending from the Rio Grande to Red River, is mostly formed by strata of the cretaceous formation differing in their fossil fauna from the cretaceous deposits in New Jersey and in other localities on the Atlantic coast, but exhibiting a striking analogy with some of the cretaceous deposits in the south of Europe around the Mediterranean, in the same degree as those of the Atlantic coast are similar to the cretaceous deposits of England and northern Germany. Surrounded by these cretaceous deposits, there exists between the Piedernales and San Saba rivers, a belt of granitic rocks and of palæozoic strata. The latter are characterized by their fossils as Silurian strata and carboniferous limestone, both are different in their organic characters from the corresponding formations in the Mississippi valley, as might be expected considering the great distance and difference of latitude.

As a fact bearing on the geography of the western part of Texas, I will mention before concluding this paper, that the range of mountains which, under the name of the San Saba mountains, is laid down on some maps, does not exist. On either side of the San Saba river no elevation of any importance is seen above the general level of the table land.

The detail of my geological researches in Texas will be given in a more elaborate work. The publication of which will take place with the least possible delay.

Berlin, August, 1847.

Art. III.—*On the Orbits of the Asteroids*; by B. A. Gould, Jr., A.A.S.

The recent discoveries of Hencke and of Hind, by which the number of small planets known to us between the orbits of Mars and Jupiter has been doubled, have directed the attention and interest of astronomers in a still higher degree to the group of these remarkable bodies.

By the common consent of astronomers, they have received the name of "asteroids," a name proposed by the elder Herschel, in consequence of a theory of his own. The word asteroid, in its present signification, may be defined as "a small planetary body, which revolves around the sun between the orbits of Mars and of Jupiter."

Immediately upon the discovery of Pallas, the calculations of Gauss showed that the orbits of Ceres and Pallas approach very near to one another in the descending node of Pallas upon the Ceres-orbit.

Upon this fact Olbers grounded his well known and not unnatural hypothesis, that these two extremely small bodies, whose orbits approach one another so nearly in the node, were merely the fragments of a larger planet, which by some force unknown to us, had exploded or been shattered by some external shock.

For if this supposition be true, the planet would almost exactly have filled the gap between Mars and Jupiter, where, according to an empirical formula, much in vogue at that time, an unknown planet had been long suspected. Indeed a society of German astronomers had been already formed, to search for this suspected member of our solar system.

As a corroboration of this hypothesis, he referred to the circumstance that both Pallas and Ceres seemed to vary considerably in magnitude, which he explained by the conjecture that these bodies were not round, but of very irregular figure.

"This idea," he wrote to Zach,* "has at least one great advantage over some other hypotheses, that it can be soon tested. For if it is true, we shall be able to find still more fragments of the shattered planet, and the easier still, because all those fragments, which describe an elliptical orbit around the sun, must pass the descending node of Pallas upon the orbit of Ceres."

The discovery of Juno soon after, and not far from the apparent place of this node, seemed to afford a strong confirmation of Olbers's hypothesis, and Zach immediately began† to consider it a tested and confirmed theory.

A simple calculation gives however the following results:

		True anomaly of Ceres.
In ☋ of Pallas on the Ceres-orbit,	- -	220° 9′ 56″·6
" " " Juno " " " "	- -	242 2 18 ·3
		True anomaly of Pallas.
In ☊ of Ceres on the Pallas-orbit,	- -	249° 32′ 36″·0
" " " Juno " " " "	- -	232 33 1 ·9

In October, 1804, Olbers wrote‡ Zach again that the distance between the two nodes on the Ceres-orbit (the calculations of Gauss gave 24° at that time) was in no wise discordant with his hypothesis; that as a necessary consequence of the very different inclinations to the plane of Jupiter's orbit, the motion of their lines of nodes produced by Jupiter's attraction must be very different from the motion of their apsidal lines, which would result from the same attraction; that still farther, inasmuch as these orbits have nearly equal major-axes, but very unequal excentricities, they must have cut one another at some former time in their node upon the Ceres-orbit. Indeed if we assume according to the determinations of Oriani, the annual motion of the aphelion for Pallas = 106″·1, and for Ceres = 120″·9, and consider the nodes as sidereally at rest, and the inclinations constant, it results that a section of the Ceres and Pallas orbits in the above mentioned node, must have taken place 7463 years before, and in 282 years again occur. In the descending node the same would happen in 925 years.

---

* Monatliche Correspondenz, vi, 88. † M. C., x, 377, 8.

Later, after Gauss had computed the secular variations of Ceres and Pallas, Encke, at his suggestion, made farther investigations for the purpose of determining whether the distance of the two orbits at the node, were on the increase or decrease. The result of his computations was, that the orbits are approaching one another.

Encke found* the following radius-vectors.

Year.	In the ☊ of Ceres on the Pallas-orbit.			In the ☋ of Ceres on the Pallas-orbit.		
	Ceres.	Pallas.	Diff.	Ceres.	Pallas.	Diff.
808	2·82294	2·70322	−0·11972	2·67612	2·37780	−0·29832
1808	2·92427	2·84945	−0·07482	2·59569	2·40346	−0·19223
3475	2·95374	2·95743	+0·00369	2·57987	2·49163	+0·08824

"According to this," to use the words† of Gauss, "a section in the node would actually take place about the year 3397, which may be considered, at any rate, as an approximation to the truth. To be sure a section must also at some former period have occurred; but from the progression of the numbers in the third and sixth columns, we can at least conclude that this can only have been many thousands of years before. If we therefore adopt the hypothesis of Dr. Olbers concerning the origin of the new planets, the occurrence must have taken place at an epoch, for us at present immeasurably long before the times to which history reaches back."

It is also evident from the foregoing table, that the distance between the two orbits in the descending node upon the Pallas-orbit, is at present on the decrease.

At any rate we are justified in concluding, without any farther computation of the secular variations, that at the last time that a section of the Pallas and Ceres orbits took place, neither of the nodes of Juno coincided with the node of Pallas. Although the subsequent discovery of five more asteroids has most certainly confirmed the conjecture of Olbers, that still more similar bodies would be found, it has nevertheless almost immeasurably multiplied the difficulties in our way;—if indeed it has not rendered it absolutely impossible to assign a period, by computation of the secular variations of the apsidal and nodal lines of these eight orbits, when at the same time all the nodal lines upon one of the orbits coincided, and all the radius vectors were equal.

In this place belongs, perhaps, the remark, that as far as we are yet able to determine the orbit of Flora, the aphelion of this planet falls within the perihelion distance of Ceres.

On the other hand, it must be mentioned that all the nodes upon the Ceres-orbit fall within a single quadrant.

The following table gives the distances of the several nodes upon the orbit of Ceres from one another. These distances are

* Monatliche Correspondenz, xxvi, 299. † M. C., xxvi, 299.

reckoned in heliocentric arcs upon the orbit, and counted from the Hebe-node, inasmuch as the latter lies nearest to the perihelion of Ceres, corresponding to a true anomaly of only 35° 20′.

	Distances from the node of Hebe on the Ceres-orbit.
Pallas, - - - -	4° 49′
Juno, - - - -	26 42
Vesta, - - - -	43 31
Astræa, - - - -	47 55
Flora, - - - -	50 18
Iris, - - - - -	77 46

These interesting considerations seemed to me to make it worth while to make still more accurate and extensive investigations concerning the relative position of the asteroidal orbits. I have, therefore, for every pair of the eight known to us, i. e., for twenty-eight combinations, calculated the radius vectors in each node.

The elements of which I have made use are, for the four older asteroids, the osculating elements for the epoch nearest to the 1st January, 1848, which Dr. Bremiker in Berlin has computed. I am indebted for them to the kindness of Professor Gauss.

For the four newly discovered, I have selected those elements which, of all known to me, satisfy all observations best. These are for Astræa and for Hebe, the orbits* of Hrn. D'Arrest in Berlin; for Iris, the excellent orbit of Prof. Goldschmidt in Göttingen; and for Flora, an orbit lately published by myself.

The longitudes are referred to the mean Equinox of Jan. 1, 1848. The notation I have used, is that of the Theor. Motus.

Elements of the Orbits of the Asteroids.

	Epoche.	M	☊ − π	☊	i	φ	μ
Pallas,	1848, March 4·0	24° 57′ 23″·4	51° 26′ 35″·1	172° 42′ 12″·3	34° 37′ 31″·1	13° 54′ 48″·9	768″·8858
Hebe,	1847, July 10·0	274 54 2·6	123 36 42·1	138 40 44·8	14 44 25·3	11 31 11·4	942·3754
Juno,	1847, July 9·5	258 6 2·1	116 35 4·0	170 53 52·0	13 2 39·3	14 42 19·6	812·7012
Ceres,	1848, March 12·0	21 4 0·5	293 28 14·7	80 47 17·9	10 37 13·1	4 24 56·8	770·9866
Vesta,	1847, April 4·0	310 46 14·7	212 16 15·4	103 22 1·3	7 8 30 3	5 7 21·5	977·9481
Flora,	1848, Jan. 1·0	35 53 32·0	77 26 49·1	110 18 50·8	5 52 55·9	9 1 36·9	1086·1100
Iris,	1847, Sept. 1·0	298 16 37·2	218 18 35·6	259 45 19·6	5 28 10·9	13 20 50·1	963·4498
Astræa,	1847, March 16·0	63 30 49·3	6 0 31·4	141 29 29·2	5 19 17·1	10 49 55·6	857·8493

I subjoin the following table of subsidiary quantities, because, as far as my knowledge extends, they are no where else to be found together.

	Per. Dist.	Aph. Dist.	Period of rev. in sidereal days.
Pallas, . . .	2·105304	3·438312	1685·55
Hebe, . . .	1·936886	2·903557	1375·25
Juno, . . .	1·993166	3·349363	1594·68
Ceres, . . .	2·553746	2·979793	1680·96
Vesta, . . .	2·150345	2·571997	1325·22
Flora, . . .	1·856244	2·547126	1193·25
Iris, . . .	1·834262	2·935335	1345·16
Astræa, . . .	2·092456	3·060943	1510·75

* Ast. Nachr., xxv, p. 321; xxvi, p. 147.

From these elements I have employed the following table, where for the sake of simplicity and in order to have a definite rule, each orbit is referred to those other orbits whose inclination is inferior.

Upon the orbit of Astræa.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad. vect. Astræa.	Rad. vect.	Rad. vect. Astræa.
Pallas-orbit,	2·308615	2·180479	3·005974	2·890263
Hebe . .	2·599472	2·092602	2·100824	3·060630
Juno . .	3·033050	2·807325	2·125046	2·230187
Ceres . .	2·775450	2·442815	2·725737	2·530106
Vesta . .	2·562481	2·407127	2·157039	2·569565
Flora . .	1·862868	2·480134	2·534758	2·491281
Iris . .	2·083886	2·993750	2·463162	2·125061

Upon the orbit of Iris.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad. vect. Iris.	Rad. vect.	Rad. vect. Iris.
Pallas-orbit,	2·214686	2·585784	3·181677	2·003507
Hebe . .	2·480293	2·193029	2·185698	2·326314
Juno . .	2·537652	2·420336	2·461760	2·115556
Ceres . .	2 669673	1·914261	2·863094	2·751336
Vesta . .	2·386301	2·427211	2 299979	2·110331
Flora . .	2·003169	1·989275	2·314213	2·609881

Upon the orbit of Flora.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad vect. Flora.	Rad. vect.	Rad. vect. Flora.
Pallas-orbit, .	2·340702	2·477143	2 953261	1·895266
Hebe .	2·743165	2·341091	2·015498	1·982454
Juno . .	3·140343	2·529811	2·075370	1·865549
Ceres .	2·766548	1·872111	2·734377	2·517845
Vesta . .	2·564879	1·958076	2·155343	2·377464

Upon the orbit of Vesta.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad. vect. Vesta.	Rad. vect.	Rad. vect. Vesta.
Pallas-orbit,	2·361500	2·266614	2·920807	2·423312
Hebe . .	2·801046	2·335006	1·985355	2·349731
Juno . .	3·198536	2·210443	2·050712	2·490982
Ceres . .	2·791893	2·549792	2·710061	2·166114

Upon the orbit of Ceres.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad. vect. Ceres.	Rad. vect.	Rad. vect. Ceres.
Pallas-orbit,	2·409084	2·597537	2·851153	2·922309
Hebe . .	2·889707	2·587842	1·943098	2·934678
Juno . .	3·255644	2·654538	2·027906	2·853377

Upon the orbit of Juno.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad. vect. Juno.	Rad. vect.	Rad. vect. Juno.
Pallas-orbit,	2·278408	2·854559	3·058776	2·222411
Hebe .	2·120485	2·025683	2·569983	3·261389

Upon the orbit of Hebe.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad. vect. Hebe.	Rad. vect.	Rad. vect. Hebe.
Pallas-orbit,	2·432568	2·901680	2·818945	1·937722

Of these twenty-eight combinations there are eighteen cases in which the orbits lock into one another, like the links of a chain, and ten where the one orbit is entirely inclosed within the other.

Linked into one another are the following orbits:

Hebe and Astræa.	Hebe and Iris.	Ceres and Juno.
Juno " "	Vesta " "	Pallas " Hebe.
Vesta " "	Flora " "	Vesta " "
Flora " "	Pallas " Juno.	Ceres " "
Iris " "	Vesta " "	Pallas " Flora.
Pallas " Iris.	Hebe " "	Vesta " "

Entirely included are the following orbits:

Flora in that of Hebe.

Iris and Flora in that of Juno.

Astræa and Vesta in that of Pallas.

Iris, Flora and Pallas, and consequently, also Astræa and Vesta in that of Ceres.

I add a second table, similar to the foregoing, which shows the so-called *longitude in the orbit* for each of the nodes. The first two columns give the longitude of the ascending node of the first named orbit upon the second. The third contains the mutual inclinations of the two.

	Longitude in the first orbit.	Longitude in the second orbit.	Inclination.
Pallas and Astræa, .	178° 11′ 18″·4	177° 20′ 19″·1	30° 11′ 5″·2
Hebe " " . .	137 9 18 ·6	137 11 19 ·5	9 25 42 ·0
Juno " " .	188 13 4 ·1	187 55 12 ·9	8 47 54 ·0
Ceres " " . .	50 34 38 ·6	50 50 31 ·6	9 15 53 ·6
Vesta " " .	55 16 47 ·4	55 29 4 ·3	4 24 46 ·0
Flora " " . .	46 0 56 ·6	46 9 58 ·6	3 3 12 ·9
Iris " " .	290 15 51 ·6	290 2 24 ·2	9 15 33 ·4
Pallas and Iris, .	163 4 58 ·1	164 47 7 ·2	34 43 19 ·6
Hebe " " . .	123 29 51 ·0	124 6 21 ·0	18 9 51 ·5
Juno " " . .	147 44 30 ·0	148 22 2 ·2	14 1 30 ·7
Ceres " " . .	80 25 59 ·0	80 26 32 ·2	16 5 21 ·9
Vesta " " . .	149 11 25 ·6	149 3 14 ·3	3 3 5 ·3
Flora " " . .	95 31 58 ·1	95 40 33 ·9	10 56 59 ·7
Pallas and Flora, .	182 29 47 ·0	180 52 56 ·5	32 16 12 ·2
Hebe " " . .	155 2 10 ·2	154 40 35 ·4	9 57 20 ·3
Juno " " .	197 51 41 ·2	197 16 46 ·6	11 21 17 ·6
Ceres " " . .	52 57 40 ·6	53 13 47 ·3	6 12 40 ·4
Vesta " " .	84 45 34 ·7	84 48 14 ·2	1 29 1 ·4
Pallas and Vesta, .	185 8 5 ·9	183 3 49 ·7	16 21 15 ·5
Hebe " " . .	163 38 40 ·9	163 6 48 ·6	9 48 11 ·2
Juno " " .	203 47 11 ·9	203 1 59 ·4	12 12 52 ·4
Ceres " " . .	46 10 45 ·8	46 45 59 ·0	4 51 44 ·2
Pallas and Ceres, .	190 48 13 ·2	187 28 59 ·8	36 21 42 ·2
Hebe " " . .	183 49 11 ·9	182 39 37 ·6	12 43 21 ·2
Juno " " .	210 34 25 ·0	209 21 21 ·5	16 46 42 ·0
Pallas " Juno, . .	173 48 39 ·1	173 41 12 ·0	21 35 27 ·6
Hebe " " .	76 23 27 ·3	77 16 59 ·5	7 48 43 ·6
Pallas " Hebe, .	193 26 36 ·3	190 56 32 ·0	23 42 18 ·6

In a paper like this, the influence of the perturbations is of course, not to be considered ;—still less the mutual action of the asteroids upon one another. Be it allowed me here, however, to express my belief that in future calculations this influence cannot always be neglected.

Should, at any future time, as is by no means impossible, two of those coupled in the following table, approach the node at the same time, their mutual action must, in spite of their excessively small mass, be extremely strong.

Such an occurrence is for Ceres and Pallas and for similar pairs, where the periods of revolution are very nearly equal, not so probable as for such pairs as Flora and Astræa, whose periods of revolution differ by $317\frac{1}{2}$ days and which revolve, moreover, in planes inclined to another by a small angle.

The following are those nodes at which the asteroid orbits are at a less distance from one another than one-fifth of the mean radius-vector of the earth, and where, as before, the first mentioned orbit is referred to the other.

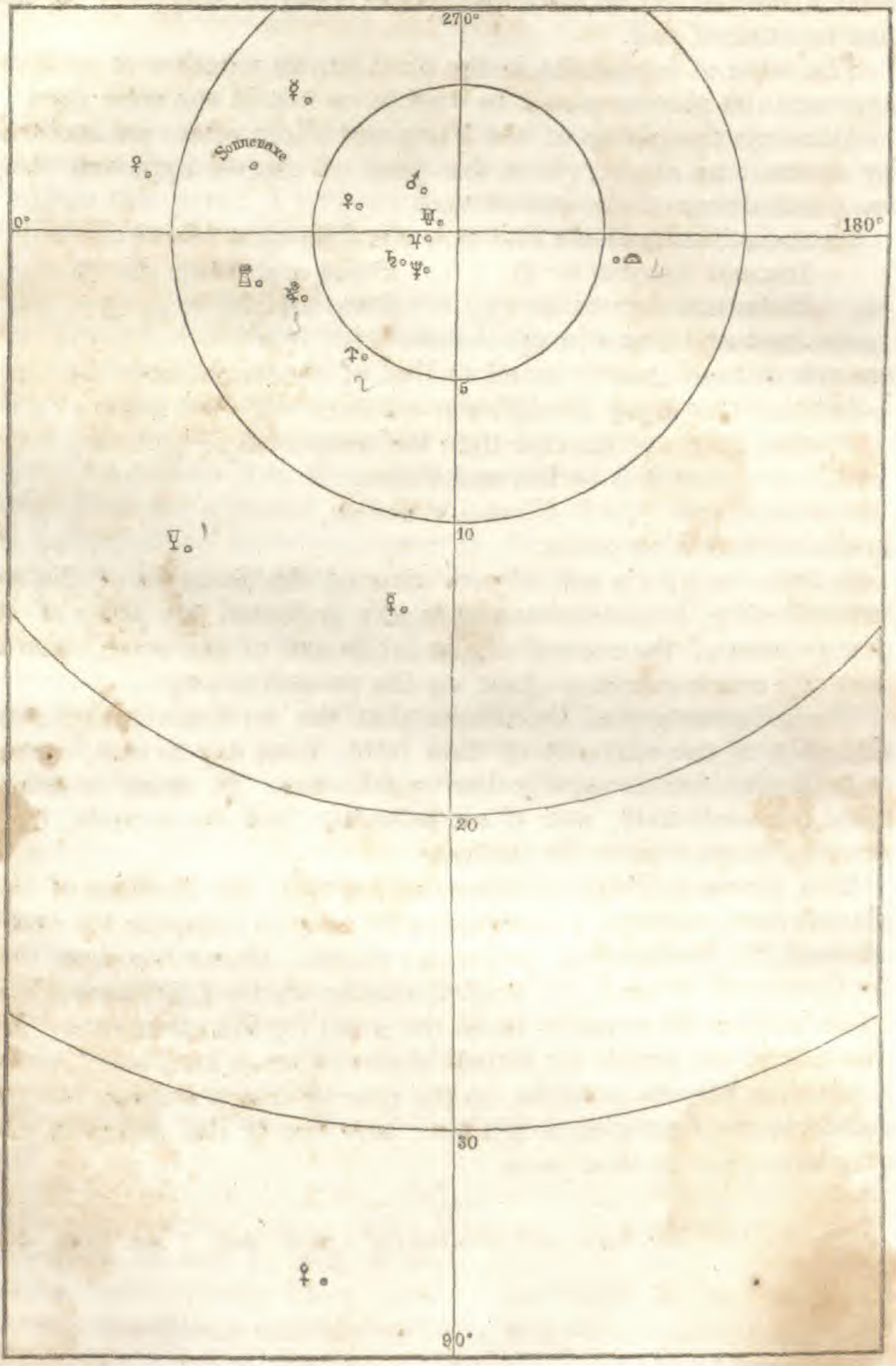
Distance of the orbits.

	Asc. Node.	Desc. Node.
Pallas and Astræa, ...	0·12	0·11
Juno " "		0·11
Ceres " "		0·19
Flora " "		0·04
Hebe " Iris, ...		0·14
Juno " "	0·11	
Ceres " "		0·11
Vesta " "	0·04	
Flora " "	0·02	
Pallas " Flora, ...	0·13	
Hebe " "		0·03
Pallas " Vesta, ...	0·10	
Pallas " Ceres, ...	0·19	
Hebe " Juno, ...	0·10	

The shortness of the period in which Astræa and Flora complete each an integral number of revolutions (nineteen revolutions of Flora are very nearly equal to fifteen of Astræa), renders such an approach to one another in the vicinity of the above mentioned node, by no means improbable. Indeed if the elements of both planets could at present be considered as sufficiently accurate, it would be very easy to name a not very distant epoch, at which this must happen.

A somewhat similar relation is that of Iris and Hebe to Flora, and of Iris to Vesta, in the descending nodes. The periods of revolution are in the case of Iris and Vesta, very nearly equal—on the other hand the mutual inclination of the two orbits is very small.

The periods of Iris and Flora are to one another, nearly as 9 to 8, of Hebe and Flora, nearly as 15 to 13. Here however


270°
Sonnenaxe
0°
180°
5
10
20
30
90°

the inclination is in both cases quite considerable, so that these must approach much nearer to their common node in order that such a mutual action may take place, than is necessary for the first mentioned pair.

The table of longitudes in the orbit shows whether at such an approach the planets would be visible, or lost in the solar rays.

Although the planes of the Vesta and Flora orbits are inclined by so small an angle, yet at the point of nearest approach they are 0·222 distant from one another.

On the other hand we find that the following orbits,

Iris and Astræa in ☊	Pallas and Hebe in ☋
Hebe and Astræa in ☋	Ceres and Hebe in ☊
Juno and Vesta in ☊	

are at a distance nearly equal to that of the earth from the sun, —*but that this is for the different orbits in different nodes.*

Farther from one another than the astronomical unit are,

Iris and Pallas,
Flora and Pallas,

in their descending nodes.

In order to give a still clearer view of the situation of the asteroidal orbits, I have stereographically projected the poles of all these planes of the several planet-orbits and of the sun's equator upon the accompanying chart, on the preceding page.

The observation of Dr. Olbers that the asteroids varied considerably in the intensity of their light, from day to day, seems to hold also for the newly discovered ones. In order to determine this definitely, and if confirmed to find the periods, long series of observations are requisite.

The investigations* of Gauss concerning the Zodiacs of the planets have rendered it comparatively easy to compute for every asteroid, the limits of its geocentric places. Gauss has done this for Ceres and Pallas,† and Prof. Goldschmidt for Iris,‡ and calculators will not be wanting to do the same for the other five. By this means the search for former observations is facilitated, since it has thus become possible, in the case of every missing star, to decide at the first glance whether any one of the asteroids can ever have been in that place.

---

* M. C., x, 173. Ast. Nach., xxvi, No. 614 (?) † M. C., ibid. ‡ Ast. Nach., ibid.

ART. IV.—*Continuation of the List of Localities of Algæ in the United States;* by Prof. J. W. BAILEY.

(Continued from vol. iii, ii Ser., p. 403.)

DEFERRING for the present, a list of American Desmidiaceæ and select Diatomaceæ or Bacillariæ with which I intended to complete this paper, I proceed to give the following catalogue of genuine Algæ, localities of which have been recently discovered in the United States.

For some of the most interesting species I am indebted to Prof. Lewis R. Gibbes of Charleston College, South Carolina, who, in addition to some fine Algæ, collected by himself in Charleston Harbor, gave me a most valuable collection made at Key West, Florida, by Dr. F. Wurdemann.

The Algæ from Key West are generally so different from those of the Northern Atlantic, which I have hitherto chiefly studied, that I determined to submit them to the examination of the distinguished British Algologist, W. H. Harvey of Trinity College, Dublin, who by means of his extensive Herbarium and great familiarity with the Algæ of all parts of the world, could easily determine the proper position of the species which to me appeared new or doubtful. To this gentleman I am greatly indebted for his liberal communication of information, relating to many of our Algæ which, for want of standard collections in this country, I was unable to determine satisfactorily.

I am also indebted to the eminent French Algologist, Dr. Montagne, for interesting remarks upon some specimens which I sent to him.

A few additional localities are given of plants already included in the preceding portions of this list.

MELANOSPERMEÆ.

Sargassum vulgare, Ag. Key West, Florida. Dr. F. Wurdemann.

Padina Pavonia, Lamour., fine specimens. Key West.

Dictyota ciliata, J. Ag. Key West. Fine specimens.

Dictyota linearis? Key West.

Ectocarpus viridis, Harv. MSS. Charleston, S. C. "Not in fruit and therefore a doubtful species, but its color very remarkable." Harv.

Ectocarpus fasiculatus, Harv. Rhode Island. Common.

Ectocarpus littoralis, Lyngb. New Brighton, Staten Island.

Chordaria divaricata, Harv. Stonington, Conn. Fine specimens near the light-house.

RHODOSPERMEÆ.

Rhodymenia cristata, Grev. Massachusetts Bay. Fine specimens of this interesting plant were given me by Miss Saltonstall of Salem, Mass. It has been found also at Newport and Staten Island, while in the Eastern Atlantic, according to Harvey, it is not found south of the Orkney Islands.

Amansia multifida, Lamour. Key West.

Laurencia obtusa, Lamour. Key West.

Laurencia pinnatifida, Lamour. Key West.

Laurencia Baileyanum, Mont. in litt. I had supposed this to be a variety of *L. dasyphylla*, but Dr. Montagne, to whom I sent some specimens of it, pronounces it new, and gives the following as its specific characters.

"*L. Baileyanum*, Mont. Fronde elongata filiformi subsimplici, ramentis subternis lineari-lanceolatis utrinque attenuatis erectis obsessa. (Individuum tetrasporophorum)." He adds, that "notwithstanding the close affinity of this Alga to *Laurencia tenuissima* and to *L. dasyphylla*, it cannot be confounded with either of them. The absence of ramification distinguishes it sufficiently from the first, and the form of the ramenta does not permit it to be referred to the second, from which it is in other respects quite distinct."

It occurs at Newport, R. I., Stonington, Conn., and Fort Hamilton, N. Y.

Hypnea robusta, Harv. MSS. "A fine species quite new to me." Harv. Key West.

Hypnea musciformis, Lamour. Key West.

Ceramium clavulatum, Ag. Abundant at Key West.

Ceramium fastigiatum, Harv. Common at Newport, R. I., and Fort Hamilton, N. Y.

Callithamnion Baileyi, Harv. MSS. "A distinct and beautiful species." Harv. Abundant at Fort Hamilton and New Brighton, N. Y.

Callithamnion arachnoideum, Ag. Rhode Island.

Alsidium triangulare, J. Ag. Key West.

Polysiphonia (Alsidium?) *Gibbesii*, Harv. MSS. Key West. "A very remarkable plant." Harv.

Polysiphonia breviarticulata, Ag. "A Mediterranean species, the Florida specimens very similar to the European but smaller." Harv.

Polysiphonia variegata, Ag. Very fine specimens near the light-house at Stonington, Conn.

Polysiphonia nigrescens, Grev. I collected beautiful specimens of a slender variety of this plant at New Brighton, N. Y.

Polysiphonia Harveyi, Bailey. A distinct and beautiful species which I found growing in considerable quantity on leaves of Zostera at Stonington, Conn. Its habit distinguishes it at a glance from all other species, yet it is difficult to frame a description of it which will serve to characterize it; the following, however, are some of its principal characters. Frond two to four inches, rising by a single filament from a spreading root and almost immediately giving off one or more robust branches. These in their turn give off, at irregular intervals, long branches which are beset with short robust ramuli, the ultimate divisions of which are acute cones, at the apices of which a few slender fibres are attached. The plant is articulated throughout. Its color when fresh is reddish brown, when dry it appears nearly black. The fruit has not yet been observed. I take peculiar pleasure in making use of this beautiful plant to associate the name of Harvey with those of the other distinguished Algologists to whom species of Polysiphonia have been dedicated.

Dasya elegans, Ag. Spec. 11, 117 = *D. pedicellata*, Agardh, Syst., 211. To the localities of this beautiful plant previously given, I can now add Charleston, South Carolina, at which place it has been collected by Prof. Gibbes; and Fort Hamilton, New York, where it is very abundant.

Unless I am greatly mistaken, Agardh's *Sphærococcus Torreyi* was founded on a battered specimen of this plant. I judge so from the examination of a fragment of the original specimen still preserved in Dr. Torrey's Herbarium.

Dasya Wurdemanni, Bailey. This species from Key West, which Harvey thinks is new, I would dedicate to Dr. Wurdemann to whom we are indebted for so many fine specimens of the Algæ of Florida.

Spyridia filamentosa, Harv. Key West, also abundant at Stonington, Conn.

Gracilaria dura? Ag. Key West.

Gracilaria Helmintochorton, J. Ag. Key West.

Digenea simplex, Ag. Key West.

Halodictyon sp.? "An imperfectly developed specimen from Key West, the only known species is from the Adriatic." Harv.

Rhodymenia palmata, Grev. A small much divided variety has been collected at Charleston by Prof. Gibbes.

Rhabdonia Baileyi, Harv. MSS. I found this plant several years ago at Staten Island, but for want of fruit-bearing specimens, its proper relations could not be determined. From the examination of dried specimens without fruit, Harvey at first supposed it to be a species of Chrysimenia, but after studying the fructification which I was recently fortunate enough to detect on specimens at Fort Hamilton, N. Y., and which I sent to him preserved in Goadby's solution, he was enabled to determine its true characters. He says, "It is not a Chrysimenia, the fruit and structure being that of the *Cryptonemeæ*, not *Chondrieæ*. Oddly enough it agrees in structure with some Algæ from Van Diemens Land, on which I lately founded the genus Rhabdonia. The *tetraspores* only of the Tasmanian species are known, and the American specimen has only *favellidia*. The tetraspores ought to be ellipsoidal, divided by transverse rings, and to occur dispersed through the smaller branches."—Very fine specimens of this plant with abundance of fruit may be found in July, near Fort Hamilton and Bath, Long Island, N. Y.

Chondrus Brodiæi, Grev. Newport, R. I.

Chondrus Norvegicus, Lamour. Massachusetts Bay. G. B. Emerson.

Ptilota plumosa, Ag. Very fine specimens of variety α, have been given me by Miss Saltonstall of Salem, who collected them in Massachusetts Bay. At Newport I could only find variety β, which is a much less elegant plant.

Corallina officinalis, Linn. Very abundant on shores of New England.

A number of species of *Corallineæ* collected at Key West by Dr. Wurdemann were presented to me by Prof. Gibbes, but as it is only recently that the vegetable nature of these bodies has been established, few of them are included in Algological works, and the determination of the species is attended with much difficulty; I hope, however, to present, at some future time, a list of our North American species.

CHLOROSPERMEÆ.

Dasycladus clavæformis, Ag. Key West.

Acetabularia crenulata, Lamour. Key West. Common.

Conferva melagonium, Web. et Mohr. Near Beverly, Mass. Dr. Asa Gray!

Cladophora prolifera. Key West.

Cladophora prasina, Harv. MSS. "Its recent affinity is to *C. rupestris*." Harv. Abundant on rocks below low water mark in the Hudson River at West Point.

Caulerpa concinna, Harv. MSS. Key West. "A most charming new species, allied to *C. Webbiana*, Mont., but very distinct. Most of the species are tropical." Harv.

Anadyomene flabellata, Ag. Key West. Rather common.

Ulva latissima, Linn. Key West.

Dictyosphæria favulosa, Decaisne. Key West.

Bryopsis plumosa, Ag. New Brighton, N. Y., Miss Saltonstall! Charleston, S. C., Prof. L. R. Gibbes!

Ectocarpus viridis, Harv. MSS. Charleston, S. C., Prof. Gibbes! "Not in fruit and therefore a doubtful species, but its *color* very remarkable." Harv.

Enteromorpha compressa, Grev. Charleston, S. C. Prof. L. R. Gibbes!

Enteromorpha clathrata, Grev. Staten Island, N. Y.

Porphyra vulgaris, Ag. Charleston, S. C. Staten Island, N. York.

Porphyra laciniata. Fort Hamilton, N. Y.

Gnathum leve, Bailey. I propose this name for a small microscopic plant which I have found growing in considerable abundance as a parasite on stems of Nitella. The whole Alga consists of a single irregular branching layer of green cells, which like those of Coleochæte scutata are closely adherent to the plant on which it grows, but it has no trace of the setiform processes belonging to that species. It appears to grow both by the addition of new cells and the spontaneous division of the old ones. In many of the cells one or more small vesicles, (zoospores?) similar to those in the spiral threads of Zygnema, were observed. No other traces of fruit have been seen. Its place in the systems must be near Coleochæte. Abundant on stems of Nitella, in ponds near West Point, N. Y.

Lyngbya fulva, Harv. MSS. I found this forming erect tufts in small pools of water between high and low-water mark, in cavities of the granite blocks, composing the pier at Stonington, Conn. Whether its color has been affected by exposure to air and sunlight, I cannot say. Harvey says, "I do not know any thing like it."

Lyngbya crispa? Ag. A plant which grows in immense quantities in salt water ditches, near Hoboken. It appears to me to be identical with English specimens marked *L. ferruginea*, Ag., which I received from J. Ralfs, Esq., but Harvey says, "it agrees better with *some* specimens of L. crispa, Ag., under which name, probably more than one species are confounded."

Oscillatoria Friesii? Ag. A common plant forming erect tooth-like fasciles half an inch in height, among mosses on damp ground near West Point. I sent it by the name of *O. Friesii* to Harvey and he remarks concerning it, "this looks different from *O. Friesii*, but comes near it. It is, probably, a different species. But in the fearful confusion that reigns here, I have no fancy for making more names."

Tetraspora lacunosa, Chauv. in Duly. Bot. Gall. I am informed by Dr. Montagne that this is the same as the plant which I had named *T. perforata*, under the supposition that it was an undescribed species.

Lemania Americana, Harv. MSS. This species is founded on an Alga which grows in rivers in Virginia, and which I had supposed to be only a variety of L. fluviatilis, Ag. Harvey remarks that "the European plant is very much more simple with distant nodules, the American one is much branched and quite moniliform."

Hydrodictyon utriculatum, Roth. This plant which is one of the most interesting of the fresh water Algæ, grows abundantly in ditches near the West Point Foundry.

From the above list it appears that the number of species of Algæ now known to occur in the United States, is as follows:

Melanospermeæ, ...	31
Rhodospermeæ, ...	59
Chlorospermeæ, ...	82
or in all, ...	172 species,

exclusive of Byssoideæ, Desmidiaceæ and Diatomaceæ. When it is considered that the study of our Algæ has as yet hardly commenced, it is reasonable to expect that very large additions will be made by further research.

We append to this article by Professor Bailey, a few observations on Algæ and the modes of preserving them, taken from "The Dublin University Museum."—Eds.

Directions for Collecting and Preserving Algæ; by Dr. Wm. H. Harvey.

(From a Report by the Directors of the Dublin University Museum.)

"*General Character of the Algæ.*—The *Algæ* may, for popular purposes, be divided into *four* principal groups, viz.:—

"1. Fuci, or *Olive-colored Sea-weeds*, which are generally of large size, and leathery texture; sometimes membranaceous and leafy, and more rarely of a gelatinous or filamentous nature.

"2. Florideæ, or *Red-colored Sea-weeds;* cartilaginous and fleshy, membranous or gelatinous sea-weeds; often filamentous; of a red, purple, brown-red, or livid greenish-red color.

"3. Chlorosperms, or *Green Sea-weeds;* membranaceous or filamentous; rarely somewhat horny plants, of a green color and simple structure.

"4. Corallines; vegetables coated with a crustaceous epidermis composed of carbonate of lime, either red or green when fresh, becoming white and often brittle on exposure to the air. (These must not be confounded with the true *zoophytes*, which often assume the appearance of plants.)

"*Places of Growth, and Mode of Collecting.*—The *Algæ* are found, in greater or less abundance, from the extreme of high-water mark to the depth of from thirty to fifty fathoms. Those within the reach of the tide are to be collected at low water, especially of *spring tides*, the most interesting species growing frequently at the verge of low-water mark, either along the margin of rocks partially laid bare, or, more frequently, fringing the deep tide-pools left by the recess of the tide on a flattish rocky shore. Those which grow at a greater depth than the tide exposes, must be sought by *dredging*, or by dragging after a boat an iron cross furnished with numerous strong hooks, on all shores where such contrivances can be applied; but where dredging for deep-water plants is impossible, the collector must trust to finding his *desiderata* among the heaps of weed thrown up on flat shores after a gale. Even after ordinary tides many delicate species float ashore, and may be collected along the beach in a perfect state. Therefore, after visiting the more rocky places at low water, the sandy or shingly beach should always be inspected at the return of the tide. In collecting from heaps, care should be taken to select those specimens which have suffered least in color, &c., from exposure to the air, rejecting those that are *bleached* white.

"Collectors should be provided with one or two strong glass bottles with wide mouths, or with a hand basket lined with japanned tin, for the purpose of bringing home the smaller and more delicate species in *sea water*. This precaution is often absolutely necessary, many of the filamentous *florideæ* decomposing with rapidity if exposed, even for a short time, to the sun and air, or if allowed, to become massed together with plants of a coarser texture. All these delicate kinds,—to distinguish which can only be learned by experience,—must be brought home in sea water, and kept in it until they can be arranged for drying.

"A common vasculum, a basket, or a bag, will serve to bring home the larger and less delicate kinds; but even these should not be left so long unsorted as to allow of their becoming clotted together.

"In collecting algæ from their native places of growth, great care should be taken to pluck the whole plant from the very base, and, if it have an obvious root, to gather the specimen with its root attached. This is of much importance, and apt to be neglected by young collectors, who are satisfied with plucking branches or scraps, which often afford no just notions of the mode of growth, or natural habit of the plant from which they have been plucked, and which, in many cases, are wholly insufficient for the first purpose of a specimen, that of ascertaining its position in the system. In many of the leafy *fuci* (*sargassa*) the leaves which grow on the lower and on the upper branches are quite different; and were a lower and an upper branch to be plucked from the same individual, they might pass for portions of different species. It becomes of moment, therefore, to gather, when it can be done, the *whole plant, including the root.* It is true that the larger kinds may be *judiciously* divided; but the young collector had better aim at selecting moderate sized specimens of the entire plant, than attempt the division of large specimens, unless he keep in view that *every specimen should be an* *epitome of the essential characters of a species.* Several duplicates of every species should be collected.

"*Preserving Specimens of Algæ.*—Where it is a collector's object to preserve algæ in the least troublesome manner, for the purpose of transmitting them to Europe, it is merely necessary to spread the specimens, immediately on being brought fresh from the sea, without any previous washing, and even without squeezing their natural moisture from them, in an airy situation, as hay is spread out to dry, only they must not be exposed to too powerful a sun. In dry weather, if the layer be turned over a few times, they will very rapidly dry, and no other preparation is necessary. They will have shrunk considerably, and many will have darkened in color, and the bundle may have become very unsightly; nevertheless, if *thoroughly* dried (to prevent mouldiness or heating), and packed loosely in paper bags or rough boxes, such specimens will, generally speaking, reach Europe after many months, in a perfectly sound state; and, on being re-moistened and properly pressed, will make excellent cabinet specimens. It is very much better, when drying algæ in this rough manner, *not* to wash them in fresh water, because the salt they contain serves the double purpose of preserving them, and of keeping them in a pliable state, causing them to imbibe water on re-immersion more readily. Washed algæ, roughly dried, become very hard and unmanageble. I would recommend that all the larger and coarser kinds of algæ, sent from abroad, be preserved in this manner. With the more delicate and smaller kinds, a different course may be pursued.

"*Preserving delicate Algæ.*—Small, filamentous, and gelatinous algæ cannot be well preserved in the rough manner just described, and, when practicable, should be put up, after gathering, on the papers on which they are intended to remain. With a little care, and after a few trials, the mode of preparing them will be easily learned.

"The collector should have two or three flat dishes, one of which is to be filled with salt water and two with fresh; in the first of these the specimens are to be rinsed and pruned, to get rid of any dirt or parasites, or other extraneous matter; they are then to be floated in one of the dishes of fresh water for a few minutes, care being taken not to leave them too long in this medium, and then one by one removed to the third dish, and a piece of white paper, of the size suited to the size of each specimen, is to be introduced underneath it. The paper is to be carefully brought to the surface of the water, the specimen remaining displayed upon it, with the help of a pair of forceps or a porcupine's quill, or any fine-pointed instrument, and it is then to be gently drawn out of the water, keeping the specimen displayed. These wet papers, with their specimens, are then placed between sheets of soft soaking-paper, and put under pressure, and in most cases the specimen in drying adheres to the paper on which it is laid out. Care must be taken to prevent the blotting-paper sticking to the specimens and destroying them. Frequent changes of drying-paper (once in six hours), and cotton rags laid over the specimens, are the best preservatives. The collector should have at hand four or five dozen pieces of unglazed thin calico [white muslin] (such as costs five or six cents a yard), each piece about eighteen inches long and twelve wide, one of which, with two or three sheets of paper, should be laid over every sheet of specimens as it is put in the press. These cloths are only required in the first two or three changes of drying-papers, for, once the specimen has begun to dry, it will adhere to the paper on which it has been floated, in preference to the blotting-paper laid over it. Should it perversely adhere to the calico, it is better not to attempt to detach it till it is nearly dry, when by a little care it may generally be got free. Algæ do not take so long to dry as other plants, and many, in warm weather, will be found to be sufficiently dried after forty-eight hours, if the papers have been changed three or four times.

"*Corallines, and Sponges*, require no trouble when once collected; it is merely necessary to dry them roughly, and pack them among the rough-dried sea-weeds in boxes. As much interest attaches to these productions, and as those of tropical and sub-tropical countries are still very imperfectly known to naturallists, collectors of algæ are earnestly requested to secure them whenever they present themselves."

ART. V.—*Objections to the Theories severally of Franklin, Dufay and Ampère, with an Effort to Explain Electrical Phenomena by Statical or Undulatory Polarization;* by ROBERT HARE, M.D., Emeritus Professor of Chemistry in the University of Pennsylvania.

(Continued from ii Ser., vol. v, p. 351.)

Process by which the Ethereo-ponderable Atoms within a Galvanic Circuit are polarized by the Chemical Reaction.

58. In order that an ethereo-ponderable particle of oxygen in any aqueous solution shall unite with an ethereo-ponderable particle of zinc in a galvanic pair, there must be a partial revolution of the whole row of ethereo-ponderable zinc atoms, with which the atom assailed is catenated by the attractions between dissimilar poles. Moreover, at the same time that the metallic atoms are thus affected, the atoms of water between the metallic sur-

faces must undergo a similar movement, by an analogous reaction with poles of an opposite character, and this movement must extend through the negative plate to the conductor, by which it communicates with the zinc or electro-positive plate. When the circuit is open, the power of combination exercised by the zinc and oxygen is inadequate to produce this movement in the whole chain of atoms, liquid and metallic; but as it is indifferent whether any two atoms are united with each other, or with any other atoms of the same kind, the chemical force easily causes them to exchange partners, as it were, when the whole are made to form a circuitous row in due contiguity.

59. As we know that during their union with oxygen, metals give out an enormous quantity of heat and electricity, it is reasonable to suppose that whenever an atom of oxygen and an atom of zinc jump into union with each other, a wave is induced in the ethereo-ponderable matter, and that this wave is sustained by the decompositions and recompositions by means of which an atom of hydrogen is evolved, at the negative plate and probably enabled to assume the aëriform state. There must, at the same time, be a communication of wave polarity by contact of the negative plate with the connecting wire, by which the positive wave in the wire is induced. Although the inherent polarities of the metals are not, agreeably to this view, the moving power in galvanism, yet they facilitate, and in some cases induce the exercise of that power, by enabling it to act at a distance, when otherwise it might remain inert.

60. This, I conceive is shown in the effect of platina sponge upon a mixture of the gaseous elements of water; also in Grove's *gas* battery, by means of which hydrogen and oxygen gas severally react with water in syphons, so as to cause each other to condense, without any communication besides that through the platina, and an electrolytic decomposition and recomposition extending from one of the aqueous surfaces in contact with one of the gases, to the other surface in contact with the other gas.

Difference between Electro-ethereal and Ethereo-ponderable Polarization.

61. There are two species of electro-polarity which come under the head of statical electricity. One of these Faraday illustrates by supposing three bodies, A, B and C, in proximity, but not in contact, when A, being electrified, electrifies B, and B electrifies C by induction. This Faraday calls an *action* of the particles of the bodies concerned, whereas, by his own premises, it appears to me to be merely a superficial affection of the masses or of a circumambient ethereal matter. This species of polarization, to which the insulating power of air is necessary, affects the superficies of a body only, being displayed as well by a gilt

globe of glass, as a solid globe of metal. No sensible change appears to be produced in the ponderable conducting superficies by this inductive superficial electrification of masses; and of course no magnetism.

62. When a small image, of which the scalp has been abundantly furnished with long hair, is electrified, the hairy filaments extend themselves and move apart, as if actuated by a repulsive power: also when iron filings are so managed as to obey the influence of the poles of a powerful magnet (51), they arrange themselves in a manner resembling that of the electrified hair. There is, moreover, this additional analogy, that there is an attraction between two portions of hair differently electrified, like that which arises between filings differently magnetized. Yet the properties of the electrified hair and magnetized filings are, in some respects, utterly dissimilar. A conducting communication between differently electrified portions of hair would entirely neutralize the respective electrical states; so that all the electrical phenomena displayed by them would cease. Yet such a communication made between the poles, exciting the filings, by any non-magnetic conductor, does not in the slightest degree lessen their polar affections and consequent power of reciprocal influence. Upon the electrified hair, the proximity or the contact of a steel magnet has no more effect than would result under like circumstances from any other metallic mass similarly employed; but by the approximation, and still more, the contact, of such a magnet, the affection of the filings may be enhanced, lessened, or nullified, according to the mode of its employment. In the case of the hair, the affection is superficial, and the requisite charging power must be in proportion to the extent of surface. In the case of the magnetized ferruginous particles, it is the mass which is affected, and, cæteris paribus, the more metal, the greater the capacity for magnetic power. In the instance of the electrified hair, as in every other of frictional excitement, the electrical power resides in imponderable ethereo-electric atmospheres which adhere superficially to the masses, being liable to be unequally distributed upon them in opposite states of polarity, consequent to a superficial polarization of the exciting or excited ponderable masses; but in the instance of bodies permanently magnetic, or those rendered transiently magnetic by galvanic influence, the ethereo-electric matter and the ponderable atoms are inferred to be in a state of combination, forming ethereo-ponderable atoms; so that both may become parties to the movements and affections of which the positive and negative waves consist.

63. Thus an explanation is afforded of the hitherto mysterious diversity of the powers of a gold leaf electroscope and galvanoscopes, although both are to a wonderful degree sensitive; the latter to the most feeble galvanic discharge, the former to the

slightest statical excitement; yet neither is in the most minute degree affected by the polarization which affects the other.

64. The charge which may exist in a coated pane affords another exemplification of statical or electro-ethereal polarity. In this case, according to Faraday, the particles of glass are thrown into a state of electro-polarity, and are, in fact, partially affected as if they belonged to a conductor; so that insulators and conductors differ only in the possession in a high degree by the one, of a susceptibility of which the other is possessed to an extent barely perceptible. The facts seem to me only to show, that either an insulator or conductor may be both affected by the same polarizing force, the transmission of which the one facilitates, the other prevents. I am under the impression that it is only by the diruptive process that electricity passes through glass; of course involving a fracture. It gets through a pane or jar, not by aid of the vitreous particles, but in despite of their opposing coherence. The glass in such cases is not liable to be fused, deflagrated, or dissipated, as conductors are. It is forced out of the way of the electrical waves, being incapable of becoming a party to them. Discharges will take place through a vacuity, rather than through the thinnest leaf of mica. But if, as Faraday has alleged, from within a glass flask hermetically sealed, an electrical charge has been found to escape, after a long time, it proves only that glass is not a perfect insulator, *not that perfect insulation and perfect conduction are different extremes of the same property.* On the contrary, the one is founded upon a constitution competent to the propagation within it of the electro-polarizing waves, with miraculous facility, while the other is founded either on an absolute incapacity, or comparatively an infinitely small ability to be the medium of their conveyance. The one extremely retards, the other excessively expedites its passage through a space otherwise void.*

Competency of a Wire to convey a Galvanic Discharge is as its sectional area, while statical discharges of frictional electricity preferring the surface are promoted by its extension. Yet in proportion as such discharges are heavy, the ability of a wire to convey them and its magnetic energy become more dependent on its sectional area and less upon extent of surface.

65. Reference has been made to two modes of electrical conduction, in one of which the efficacy is as the surface; in the other, as the area of a section of the conductor. Although glass be substantially a non-conductor, the power of the surface of glass when moistened, or gilt, to discharge statical electricity,

* By a void, I mean a Torricellian vacuum. The omnipresence of the electro-ether must render the existence of a perfect void impossible.

is enormous. It has been generally considered, that as a protection against lightning, the same weight of metal employed as a pipe, would be more efficacious than in the usual solid form of a lightning rod: yet this law does not hold good with respect to galvanic discharges, which are not expedited by a mere extension of conducting surface. Independently of the augmentation of conducting power, consequent to radiation and contact with the air, the cooling influence of which, according to Davy, promotes galvano-electric conduction, a metallic ribbon does not convey a galvanic discharge better than a wire of similar weight and length.*

66. Agreeably to the considerations above stated, the sectional area of a conductor remaining the same, in proportion as any *statical* accumulation which it may discharge is greater, the effects are less superficial; and the ethereo-ponderable atoms are affected more analogously to those exposed to galvanic discharges. It is in this way that the discharge of a Leyden jar imparts magnetic polarization. Thus, on the one hand, the electro-ethereal matter being polarized and greatly condensed, combines with and communicates polarization, and consequently magnetism, to ethereo-ponderable bodies; while, on the other hand, these, when polarized by galvanic reaction, and thus rendered magnetic, communicate polarity to the electro-ether. Hence statical electricity, when produced by galvanism, and magnetism, when produced by statical electricity, are secondary effects.

67. Where a wire is of such dimensions, in proportion to the charge, as to be heated, ignited, or dispersed by statical electricity, there seems to be a transitory concentration of the electric power, which transforms the nature of the reaction, and an internal wave of electro-ponderable polarization, similar to those of galvano-electricity, is the consequence.

68. As above observed, (31,) the current produced by the magneto-electric machine, has all the attributes of the galvano-electric current; yet this is altogether a secondary effect of the changes of polarity in a keeper, acting upon a wire solely by dynamic induction. But if, by mere external influence, the machine above mentioned can produce within a circuit a current such as above described, is it unreasonable to suppose that the common machine, when it acts upon a circuit, may put into activity the matter existing therein, so as to produce waves of polarization,

* It is well known that Wollaston effected the decomposition of water by the aid of a powerful electrical machine. Having enclosed platina wires within glass tubes, these were fused so as to cover the ends. The glass was afterwards so far removed, by grinding, as to expose minute metallic points to the liquid. Under these circumstances, the electricity conveyed by the wires, being prevented from proceeding over them superficially, was obliged to make its way through the ethereo-ponderable matter of which metals consist (38). Instead of proving the identity of galvanism with frictional electricity (note 39), this experiment shows that in one characteristic at least there is a discordancy. At the same time it may indicate that ethereal may give rise to ethereo-ponderable undulations.

MO. BOT. GARDEN 1911

having the power of those usually ascribed to a galvano-electrical current?

69. It has been shown that both reason, and the researches and suggestions of Faraday, warrant the inference that ponderable atoms, in solids and liquids, may be considered as swimming in an enormous quantity of condensed imponderable matter, in which all the particles, whether ponderable or imponderable, are, in their natural state, held in a certain relative position due to the reciprocal attraction of their dissimilar poles. A galvano-electrified body differs from one in its ordinary state, in having the relative position of the poles of its ethereo-ponderable atoms, so changed, that their inherent opposite polarities not being productive of reciprocal neutralization, a reaction with external bodies ensues.

70. In statical excitement the affection is superficial as respects the ponderable bodies concerned, while in dynamic excitement the polarities of the whole mass are deranged oppositely at opposite ends of the electrified mass; so that the oppositely disturbing impulses, proceeding from the poles of the disturbing apparatus, neutralize each other intermediately. Supposing the ponderable as well as the imponderable matter in a perfect conductor, to be susceptible of the polar derangement, of which an electrified state is thus represented to consist, non-conductors to be insusceptible of such polar derangement; imperfect conductors may have a constitution intermediate between metals and electrics. When an electrical discharge is made through any space devoid of air or other matter, it must then find its way solely by the polarization of the rare imponderable matter existing therein; and consequently its coruscations should be proportionably more diffuse, which is actually found to be true; but when gaseous ethereo-ponderable atoms intervene, they enable competent waves to exist within a narrower channel, and to attain a greater intensity. I consider all bodies as insulators which cause discharges through them to be more difficult than through a vacuum, and which, by their interposition within a circuit, can prevent that propagation of the oppositely polarizing undulations which would otherwise ensue. This furnishes a good means of discrimination between insulators and conductors, the criterion being, that a discharge ensues more readily as there is more of the one and less of the other in the way: that the one leads the waves where they would not go, the other impedes their going where they would proceed. Both in the case of disruptive discharge through air, producing a spark, or of a deflagrating discharge through wire, causing its explosion, there is a dispersion of intervening ponderable particles; and yet there is this manifest discordancy, that in one case the undulatory process of transfer is assisted, in the other resisted. The waves follow

the metallic filament with intense attraction, while they strive to get out of the way of those formed by the aëriform matter, as if repelled. Hence the term diruptive, from dirumpo, to break through, was happily employed by Faraday to designate spark discharges. The zigzag form of the diruptive spark, shows that there is a tendency in the aëriform particles to turn the waves out of that straight course, which, if unresisted or facilitated, they would naturally pursue. On the one hand the aërial filaments being unsuitable for the conveyance of the electric waves, these are forced by them out of the normal path, first in one direction, then in another; while on the other hand, the finest metallic filament furnishes a channel for the electric waves, so favorable that this channel is pursued, although the consequent polarization of the conducting particles be so intense as to make them fly asunder with explosive violence. Even when a bell wire has been dissipated by lightning, it has been found to facilitate and determine the path of the discharge.

71. The various forms of the electric spark, resulting from varying the gas through which it may be made to pass, agreeably to the researches of Faraday, is explained by the supposition that the peculiarity of the spark is partially the consequence of the polarizability of the gaseous atoms through which the discharge is made, and varies accordingly in its appearance.

Difference between Frictional Electricity and Galvanic, does not depend on the one being superior as to quantity, the other as to intensity; but on the different degrees in which the Ethereo-ponderable Atoms of the bodies affected, are deranged from their natural state of neutralized Polarity.

72. I infer that all magneto-polar charges are attended by an affection of ponderable particles; and that the reason why the most intense statical charge does not affect a galvanometer, is, that it is only when oppositely excited bodies are neutralized by the interposition of a conductor, as during a discharge, that ethereo-ponderable particles are sufficiently polarized to enable them to act upon others in their vicinity, so as to produce a polar affection the opposite of their own. In this way dynamic induction is consistently explained, by supposing that the waves of polarization, in passing along one conductor, produce, pari passu, the opposite polarization in the proximate part of any neighboring conductor suitably constituted, situated and arranged to allow it to form part of a circuit.

73. It is only during the state of the incessant generation and destruction of what has been called the two electricities, that the circuit, which is the channel for the passage of the polarizing waves, is endowed with electro-magnetic powers. It was, no doubt, in obedience to a perception of this fact, that Oersted ascribed the mag-

netism of a galvanized wire, to a conflict of electricities. Undoubtedly that state of a conductor in which, by being a part of an electrical circuit, it becomes enabled to display electro-magnetic powers, is so far a conflict of the two electricities, as the affections of matter which are denominated electrical, consist of two opposite polar forces, proceeding, agreeably to the language of Faraday, in opposite directions from each side of the source, and conflicting with each other so as to be productive of reciprocal annihilation.

74. That a corpuscular change in conductors is concomitant with their subjection to, or emancipation from, a galvanic current, is proved by an experiment of Henry's, which he afforded me an opportunity, on one occasion, of witnessing. I allude to the fact that sound is produced whenever the circuit is suddenly made or suddenly ruptured. By I. P. Marrian it has been observed, that a similar result takes place during the magnetization or demagnetization of iron rods, by the alternate establishment or arrestation of galvanic discharges through wires coiled about them so as to convert each into an electro-magnet. Mr. Marrian represents the sound as resembling that produced by striking a rod upon one of its ends.*† Sounds from this source were observed by Dr. Page in 1838. This Journal, vol. xxxiii.

75. Thus it appears that there is an analogy between the state of matter which involves permanent magnetism, and that which constitutes a galvanic current, so far as this; that either by one or the other, during either its access or cessation, an affection of the ponderable particles concerned ensues, sufficient to produce sound.

76. Simultaneously with the production of sounds as above stated, by the opening or closing of the galvanic circuit through a metallic rod or the coils of an electro-magnet, secondary waves are induced, called secondary currents. It seems reasonable to ascribe these waves to the same shifting of the poles, which produces the sonorific undulations.‡

---

*Agreeably to recent experiments of Faraday, the particles of a glass prism may be so influenced by an electro-magnet as to affect the passage of polarized light.

† L. and E. Phil. Mag. and Jour., vol. xlv, p. 383, 1844.

‡ These phenomena excite more interest in consequence of the employment, for medical purposes, of an apparatus originally contrived by Callan, but since ingeniously modified by our countryman, Dr. Page, into a form which has been designated as the electrotome. A coil of coarse copper wire, covered with cotton, like bonnet wire, is wound about a wooden cylinder. Around the coil thus formed, a coil of fine copper wire, similarly covered, is wound, leaving the extremities accessible. One end of the coarse coil communicating constantly with one pole of a galvanic battery, the other end is left free; so that by scraping with it, the teeth of a rasp attached to the other pole, a rapid closing and opening of the circuit may be effected. Under these circumstances, an observer, holding the ends of the fine coil, receives shocks more or less severe, according to the construction of the battery, the energy of the agents employed to excite it, or the total weight and

77. Within the bodies of animals and vegetables, the electro-ether may be supposed to exist as an atmosphere surrounding the ethereo-ponderable atoms of which their organs are constituted, so as to occupy all the space which is not replete with such atoms. Hence a discharge of frictional electricity may indirectly polarize the whole animal frame, by producing ethereo-ponderable polarization in the constituent atoms of the fibres of the nerves aud muscles. Probably this polarization is produced more immediately in the ponderable solids, by a discharge from a vol-

---

relative dimensions of the coils, as to length and sectional area. Agreeably to the received doctrine, the shocks thus produced, are owing to secondary currents caused by dynamic induction. Agreeably to the hypothesis which I have advanced, the atoms of the coarse wire, polarized by waves proceeding from the poles of the battery, induce a corresponding polarization of the atoms of the fine wire; the aggregate polarity imparted, being as the number of atoms in the former, to the number of atoms in the latter; or, (to use an equivalent ratio,) as the weight of the coarse, to the weight of the fine wire. But as on breaking the circuit, through the coarse wire, the ethereo-ponderable atoms in both wires resume their neutral positions, while this requires each circuit to be run through within the same minute interval, the velocities of their respective waves will be inversely as their sectional areas and directly as their lengths: in other words, the velocity in the fine wire, will be as much greater, as the channel which it affords is narrower and longer. The cylinder, included within the coils as above stated, being removed; a cylindrical space is vacated. If into the cavity thus made, iron rods, like knitting needles, be introduced, one after the other, while the apparatus is in operation, the shocks increase in severity as the number augments: so that from being supportable, they may be rendered intolerable. The shock takes place without the presence of iron, but is much increased by its assistance.*

These facts appear to me to justify a surmise, that the ethereo-ponderable atoms of iron, in becoming magnetized and demagnetized, coöperate with the ethereo-ponderable atoms of the copper coils in the induction of secondary undulations. It is conceived that these may be owing to thé intestinal change, attended by sound, as above stated (73); this being caused by a sudden approximation of the poles of the atoms, previously moved apart by the influence of the galvanized coil. But if this sudden coming together of the previously separated poles of atoms within a magnetized cylinder of iron, can contribute to the energy of secondary waves, it is consistent to infer that these waves owe their origin to an analogous approximation of the separated poles of the cupreous atoms, forming the finer coil, in which the secondary undulations may be created without the presence of iron. Of course this reasoning will apply to all cases in which the phenomena hitherto attributed to Faradian currents are the result of dynamic induction.

Thus it appears that the polarization of magnets, and that created and sustained when a galvanized coil or helix acts upon another in proximity, have the same relation to galvanic discharges that the charges upon insulated surfaces have to their appropriate discharges. The permanent magnetism of steel seems to have some analogy with the charge upon a coated pane, while we may consider as analogous with the charges upon insulated conductors, already adverted to (61, 62), that state of the ethereo-ponderable particles (38) of a wire helix, which *state*, resulting from the influence of an included magnet, or neighboring galvanized coil, and being discharged on a change of relative position, or breach of the galvanizing circuit, is productive of spark, shock, ignition, or electrolysis, as exemplified by Callan's coil, Page's electrotome, or the magneto-electric machine.

* Agreeably to the usual construction, the cylinder about which the inner coarse wire coil is wound, is originally of iron, so that there is as much of this metal contained as it can hold. Various contrivances are résorted to for the closing and opening of the circuit, which are more ingenious and convenient than scraping a rasp, as above described.

taic series, or a wire subjected to electro or magneto-dynamic induction. In the latter instances the shock is reiterated so rapidly as to appear more enduring, while in the former, it is more startling and producible at an infinitely greater distance.

78. Agreeably to Faraday's researches (1485 to 1543), there is reason to suppose that in frictional spark discharges, the consequent shock, light, and other peculiarities, are in part owing to waves of ethereo-ponderable polarization, indirectly produced in the intervening gaseous matter. (71.)

Of Ethereo-ponderable Deflagration.

79. It is well known, that between two pieces of charcoal attached, one to the negative, the other to the positive pole of a numerous and well excited voltaic series, an arch of flame may be produced by moving them apart after contact. This phenomenon evidently depends upon the volatilization of the ponderable matter concerned; since it cannot be produced before the carbon has been volatilized by contact, nor by any body besides charcoal, this being the only conductor which is sufficiently infusible, and yet duly volatilizable. Metals, similarly treated, fuse at the point of contact and cohere. On separation, after touching, a single spark ensues; which, without repetition of contact, cannot be reproduced. Hence, it may be inferred, that the carbonaceous vapor is indispensable to this process, as a medium for the ethereo-ponderable polarizing waves, being soon consumed by the surrounding atmospheric oxygen. The excrescence upon the negative charcoal, observed by Silliman, together with the opposite appearance on the positive charcoal, may be owing to the lesser affinity for oxygen on the negative side.*

80. There may be some resemblance imagined between this luminous discharge between the poles, and that which has already been designated as diruptive (69); but this flaming arch discharge does not break through the air, it only usurps its place gradually, and then sustains this usurpation. It differs from the other as to its cause, so far as galvanic reaction differs from friction; moreover, it requires a volatilizable, as well as a polarizable ponderable conducting substance to enable its appropriate undulations to meet at a mean distance from the solid polar terminations, whence they respectively proceed.

81. The most appropriate designation of the phenomenon under consideration, is that of ethereo-ponderable undulatory deflagration. Under this head, we not only place the flaming arch, but likewise the active ignition and dissipation of fine wire or leaf metal, or when attached to one pole, and made barely to touch the other.

---

* American Journal of Science, vol. x, p. 121, 1826.

82. In one of Faraday's experiments, a circuit was completed by subjecting platinum points, severally proceeding from the poles of a voltaic series, while very near to each other, to the flame of a spirit lamp. This was ascribed by him to the rarefaction of the air, but ought, as I think, to be attributed to the polarizable ethereo-ponderable matter of the flame, performing the same office as the volatilized carbon in the flaming arch, between charcoal points, to which reference has been made.

Summary.—From the facts and reasoning which have been above stated, it is presumed that the following deductions may be considered as highly probable, if not altogether susceptible of demonstration.

The theories of Franklin, Dufay and Ampère, are irreconcilable with the premises on which they are founded, and with facts on all sides admitted.

A charge of frictional electricity, or that species of electric excitement which is produced by friction, is not due to any accumulation, nor to any deficiency either of one or of two fluids, but to the opposite polarities induced in imponderable ethereal matter existing throughout space however otherwise void, and likewise condensed more or less within ponderable bodies, so as to enter into combination with their particles, forming atoms which may be designated as ethereo-ponderable.

Frictional charges of electricity seek the surfaces of bodies to which they may be imparted, without sensibly affecting the ethereo-ponderable matter of which they consist.

When surfaces thus oppositely charged, or, in other words, having about them oppositely polarized ethereal atmospheres, are made to communicate, no current takes place, nor any transfer of the polarized matter: yet any conductor touching both atmospheres, furnishes a channel through which the opposite polarities are reciprocally neutralized by being communicated wave-like to an intermediate point.

Galvano-electric discharges are likewise effected by waves of opposite polarization, without any flow of matter meriting to be called a current.

But such waves are not propagated superficially through the purely ethereal medium; they occur in masses formed both of the ethereal and ponderable matter. If the generation of frictional electricity, sufficient to influence the gold leaf electrometer, indicate that there are some purely ethereal waves caused by the galvano-electric reaction, such waves arise from the inductive influence of those created in the ethereo-ponderable matter.

When the intensity of a frictional discharge is increased beyond a certain point, the wire remaining the same, its powers become enfeebled or destroyed by ignition, and ultimately deflagration:

if the diameter of the wire be increased, the surface, proportionally augmented, enables more of the ethereal waves to pass superficially, producing proportionally less ethereo-ponderable undulation.

Magnetism, when stationary, as in magnetic needles and other permanent magnets, appears to be owing to an enduring polarization of the ethereo-ponderable atoms, like that transiently produced by a galvanic discharge. (Note, page 230, vol. v, and paragraph 68.)

The magnetism transiently exhibited by a galvanized wire, is due to oppositely polarizing impulses, severally proceeding wave-like to an intermediate part of the circuit where reciprocal neutralization ensues.

When magnetism is produced by a frictional discharge operating upon a conducting wire, it must be deemed a secondary effect, arising from the polarizing influence of the ethereal waves upon the ethereo-ponderable atoms of the wire.

Such waves pass superficially in preference; but when the wire is comparatively small, the reaction between the waves and ethereo-ponderable atoms becomes sufficiently powerful to polarize them, and thus render them competent, for an extremely minute period of time, to produce all the affections of a galvano-electric current, whether of ignition, of electrolysis or magnetization. Thus, as the ethereo-ponderable waves produce such as are purely ethereal, so purely ethereal waves may produce such as are ethereo-ponderable.

The polarization of hair upon electrified scalps is supposed to be due to a superficial association with the surrounding polarized ethereal atoms, while that of iron filings, by a magnet or galvanized wire, is conceived to arise from the influence of polarized ethereo-ponderable atoms, consisting of ethereal and ponderable matter in a state of combination.

Faradian discharges are as truly the effects of ethereo-ponderable polarization, as those from an electrified conductor, or coated surfaces of glass, are due to static ethereal polarization (39, 40, 41); last paragraph, note, p. 346.

It is well known that if a rod of iron be included in a coil of coated copper wire, on making the coil the medium of a voltaic discharge, the wire is magnetized. Agreeably to a communication from Joule, in the L. and E. Phil. Mag. and Jour. for Feb., 1847, the bar is at the same time lengthened, without any augmentation of bulk; so that its other dimensions must be lessened in proportion to the elongation.

All these facts tend to prove that a change in the relative position of the constituent ethereo-ponderable atoms of iron, accompanies its magnetization, either as an immediate cause, or as a collateral effect.

ART. VI.—*Upon a peculiar kind of Isomorphism that plays an important part in the Mineral Kingdom;* by Professor SCHEERER of Christiania.*

(Continued from vol. v, p. 389.)

THE query might be started, how it is then, since aspasiolite and cordierite are so closely associated, that serpentine is not accompanied by olivine? This circumstance, which, it must be confessed, does appear paradoxical, I purpose to enter upon towards the close of this paper.

Upon the theory based on the above mentioned relations of cordierite and aspasiolite, being thus borne out by the precisely similar relations subsisting between olivine and serpentine, the probability was increased, that the part played by this species of isomorphism in the mineral kingdom was not one restrained within very narrow limits. And this opinion has taken a development more extended than I even imagined it might be susceptible of, as my investigations have been carried out. In the sequel I purpose touching upon the principal minerals concerned in this inquiry, and to develope their suitable formulæ, upon the supposition that their water may be treated as a basic constituent, capable of replacing in the ratio that has been stated, (viz. three atoms to one atom,) the magnesia, and consequently all the other bases isomorphous therewith, as for instance, protoxyd of iron, protoxyd of manganese, and so forth.

In order to express as simply as possible that in a member of a formula $\dot{R}$, a portion of the 1 : 1 atomic bases is replaced by more or less water, I have in these cases invariably made use of the sign $(\dot{R})$, as was already the case with regard to serpentine. The formula of aspasiolite would therefore, upon this principle, be $(\dot{R})^3\,\dddot{Si}^2 + 3\bar{R}\,\dddot{Si}$. Prior to proceeding to the results of my calculations, let me however very briefly further elucidate the kind of isomorphism forming the subject of our investigations, in a chemical point of view. From the composition of aspasiolite and of serpentine, it follows that in the former, one equivalent $\dot{R}$ (one-third of the entire 1 : 1 atomic bases contained in cordierite) is not replaced by water *exactly*. It is likewise clear that, as in serpentine the amount of water ranges between 12, 27 and 21 per cent., it does not observe any definite atomic proportion relative to the portion of the 1 : 1 atomic bases not made good by water. This is to be explained as follows, in a very simple manner, strictly upon the principle of an isomorphic substitution.

* From Poggendorff's Annalen, vol. lxviii, p. 319; translated for this Journal by Mr. W. G. LETTSOM.

From the circumstance of three equivalents of water being able to replace isomorphically one equivalent of magnesia, it directly follows that combinations such as $\dot{Mg}^3 \dddot{Si}$, $\dot{Mg}^2 \dddot{Si} + 3\dot{H}$, and $\dot{Mg} \dddot{Si} + 6H$, must, of necessity, possess the same crystalline form. Such combinations therefore, under this common form, can occur mixed together in every possible proportion, and thereby explain the occurrence of *non-definite proportions* in the respective amounts of water and of magnesia, not only as met with in aspasiolite and in serpentine, but also, as may be deduced from the sequel, in a very considerable number of other minerals containing water.

I. Silicates.

A. Silicates of magnesia and other bases isomorphous therewith, (minerals allied to serpentine.)

1. *Gymnite.* (Thomson.)

Oxygen ratio, $\dddot{Si} : (R) = 20{\cdot}86 : 20{\cdot}56$. Formula deducible therefrom, $(\dot{R})^3 \dddot{Si}$.

$(\dot{R})$ in this mineral $= 36{\cdot}00\,\dot{Mg},\ 21{\cdot}60\,\dot{H},\ 0{\cdot}80\,\dot{Ca}$. In addition thereto, Thomson found in gymnite 1·16 ferriferous alumina. Deducting this as a $\frac{1}{3}$ silicate, the oxygen ratio given above becomes modified to 20·36 : 20·56, approximating therefore even yet closer to 1 : 1.

2. *Deweylite.* (Shepard.)

20·78 : 21·40. $(\dot{R})^3 \dddot{Si}$.

$(\dot{R}) = 40{\cdot}0\,\dot{Mg},\ 20{\cdot}0\,\dot{H}$. The siliceous hydrate of alumina from Baltimore has a similar composition, according to Allan.

3. *Villarsite.* (Dufrènoy.)

20·47 : 21·37. $(\dot{R})^3 \dddot{Si}$.

$(\dot{R})$ from two analyses $= 45{\cdot}33\text{–}47{\cdot}37\,\dot{Mg},\ 4{\cdot}30\text{–}3{\cdot}59\,\dot{Fe},\ 2{\cdot}86\text{–}2{\cdot}42\,\dot{Mn},\ 0{\cdot}54\text{–}0{\cdot}53\,\dot{Ca},\ 0{\cdot}46\,\dot{K},\ 5{\cdot}80\,\dot{H}$.

4. *Dermatine.* (Ficinus.)

19·74 : 18·79. $(\dot{R})^3 \dddot{Si}$.

$(\dot{R})$ in two analyses $= 23{\cdot}70\text{–}19{\cdot}33\,\dot{Mg},\ 11{\cdot}33\text{–}14{\cdot}00\,\dot{Fe},\ 2{\cdot}25\text{–}1{\cdot}17\,\dot{Mn},\ 0{\cdot}83\text{–}1{\cdot}83\,\dot{Ca},\ 0{\cdot}50\text{–}1{\cdot}33\,\dot{Na},\ 25{\cdot}20\text{–}22\,\dot{H}$, and in addition thereto, $0{\cdot}42\text{–}0{\cdot}83\,\dddot{Al}$; deducting this latter as $\frac{1}{3}$ silicate, the oxygen ratio becomes altered to 19·44 : 18·79.

5. *Chrysotile.* (*Metaxite*, Delesse.)

21·90 : 20·60. $(\dot{R})^3 \dddot{Si}$.

$(\dot{R}) = 41{\cdot}9\,\dot{M}g,\ 3{\cdot}0\,\dot{F}e,\ 13{\cdot}6\,\dot{H}$, and in addition, $0{\cdot}4\,\dddot{A}l$. The lustrous asbestus from Reichenstein has a similar composition, according to von Kobell, as has also the Baltimorite, according to Thomson. The oxygen ratio of the former is 22·4 : 20·04, and that of the latter, 20·57 : 19·45.

6. *Chlorophæite.* (Forchhammer.)

17·07 : 17·24. $(\dot{R})^3\,\dddot{Si}$.

$(\dot{R}) = 3{\cdot}44\,\dot{M}g,\ 21{\cdot}56\,\dot{F}e,\ 42{\cdot}15\,\dot{H}$.

All these minerals, whose amount of water varies from 5·80 to 42·15 per cent., have therefore the same formula as *serpentine*, and in a chemical point of view, are only distinct therefrom in consequence of the different but isomorphous composition of the member $(\dot{R})$. Of these minerals, there is as yet but one that has been met with distinctly crystallized—this is villarsite. Its crystalline form belongs, like that of serpentine, to the rhombic system, but the prism of villarsite has angles of 120°, whereas those of serpentine are 130°. The macrodiagonals of both prisms are therefore as *tan* 65° : *tan* 60° = 2·144 : 1·732, or very nearly = 5 : 4. The form of villarsite therefore, may be supposed to be one derived from that of serpentine.

7. *Picrophyll.* (Svanberg.)

Obtained, 25·87 : 16·35 }
Required, 25·00 : 16·66 } * $(\dot{R})^2\,\dddot{Si}$.

$(\dot{R}) = 30{\cdot}10\,\dot{M}g,\ 6{\cdot}86\,\dot{F}e,\ 0{\cdot}87\,\dot{C}a$, a trace of $\dot{M}n$, $9{\cdot}83\,\dot{H}$, besides $1{\cdot}11\,\dddot{A}l$. Deducting this latter as a ⅓ silicate, the oxygen ratio becomes = 25·52 : 16·35, very nearly therefore as 3 : 2. The analysis gave 1·52 per cent. loss.

8. *Aphrodite.* (Berlin.)

26·79 : 17·11 }
26·79 : 17·86 } $(\dot{R})^2\,\dddot{Si}$.

$(\dot{R})$ from two analyses = $33{\cdot}72\text{–}34{\cdot}07\,\dot{M}g,\ 1{\cdot}62\text{–}1{\cdot}49\,\dot{M}n,\ 0{\cdot}59\text{–}0{\cdot}55\,\dot{F}e,\ 12{\cdot}32\text{–}11{\cdot}34\,\dot{H}$, besides $0{\cdot}20\text{–}0{\cdot}13\,\dddot{A}l$.

9. *Spadaite.* (v. Kobell.)

29·09 : 15·38 }
29·09 : 14·55 } $(\dot{R})^3\,\dddot{Si}^2$.

$(\dot{R}) = 30{\cdot}67\,\dot{M}g,\ 0{\cdot}66\,\dot{F}e,\ 11{\cdot}34\,\dot{H},\ 0{\cdot}66\,\dddot{A}l$, 0·67 loss.

10. *Picrosmine.* (Magnus.)

28·39 : 15·16 }
30·00 : 15·00 } $(\dot{R})^3\,\dddot{Si}^2$.

---

* For the facility of comparison, I have with all the following minerals given the oxygen ratio *as deduced from my formula, below* the ratio obtained from the analysis.

$(\dot{R}) = 33{\cdot}35\,\dot{Mg},\ 0{\cdot}42\,\dot{Mn},\ 7{\cdot}30\,\dot{\mathbf{H}}$ (ammoniacal), $0{\cdot}79\,\dddot{\mathbf{Al}},\ 1{\cdot}40\,\dddot{\mathbf{Fe}}$, 1·85 loss.

11. *Monradite.* (A. Erdmann.)

$$\left.\begin{matrix}29{\cdot}09 : 15{\cdot}39\\ 29{\cdot}09 : 14{\cdot}55\end{matrix}\right\}\quad (\dot{R})^3\,\dddot{Si}^2.$$

$(\dot{R}) = 31{\cdot}36\,\dot{Mg},\ 8{\cdot}56\,\dot{Fe},\ 4{\cdot}04\,\dot{\mathbf{H}}$, 0·4 excess.

12. *Talc.* (Berthier.)

(1.) From Little St. Bernhard.

$$\left.\begin{matrix}30{\cdot}24 : 14{\cdot}49\\ 30{\cdot}12 : 15{\cdot}06\end{matrix}\right\}\quad (\dot{R})^3\,\dddot{Si}^2.$$

(2.) From St. Foix.

$$\left.\begin{matrix}28{\cdot}88 : 13{\cdot}59\\ 28{\cdot}88 : 14{\cdot}44\end{matrix}\right\}\quad (\dot{R})^3\,\dddot{Si}^2.$$

In the former, $(\dot{R}) = 33{\cdot}2\,\dot{Mg},\ 4{\cdot}6\,\dot{Fe},\ 3{\cdot}5\,\dot{\mathbf{H}}$; in the latter, $(\dot{R}) = 19{\cdot}7\,\dot{Mg},\ 11{\cdot}7\,\dot{Fe},\ 8{\cdot}1\,\dot{Ca},\ 2{\cdot}6\,\dot{\mathbf{H}}$. The talc from St. Foix contains moreover $1{\cdot}7\,\dddot{\mathbf{Al}}$. Deducting this as a $\frac{2}{3}$ silicate, we obtain the oxygen ratio = 27·69 : 13·59, also very nearly = 2 : 1.

13. *Meerschaum.*

(1.) From Cabanas, according to Berthier, 27·95 : 15·14.
(2.) From Coulommiers, according to the same, 28·05 : 15·22.
(3.) From Morocco, according to Damour, 28·57 : 14·28.
} $(\dot{R})^3\,\dddot{Si}^2$.

All the three oxygen ratios are more or less nearly = 2 : 1. Lychnell however has analyzed a meerschaum from the Levant, whose oxygen ratio is 31·62 : 14·11. Supposing this mineral not to have been too highly dried, and to have been in a state of purity, the formula $\dot{Mg}\,\dddot{Si} + \dddot{\mathbf{H}}$ must be adopted for it. *Spadaite, picrosmine, monradite, talc,* and perhaps also *meerschaum,* have, as is seen above, one and the same chemical formula. The amount of water in the member $(\dot{R})$ ranges between the limits 2·6 (talc) and 20 (meerschaum). Picrosmine, monradite and talc occur crystallized, and all three of them *in crystals belonging to the rhombic system.* In picrosmine the obtuse angles of the rhombic prism are very nearly 127°, in monradite 130°, and in talc 120°. The rhombic prism of monradite and of picrosmine agrees also very nearly with the prism of serpentine, whereas that of talc is the same as that of villarsite. This accordance may cause some surprise, inasmuch as the formula for serpentine and villarsite is $(\dot{R})^3\,\dddot{Si}$, whereas for the other three minerals the formula is $(\dot{R})^3\,\dddot{Si}^2$. From analogous instances however, we are aware that minerals which we may look upon as different grades of saturation of one and the same radical, (be it simple or compound,) affect, *in numerous instances*, the same, or at any rate a very similar crystalline form.*

14. *Retinalite.* (Thomson.)

$$\left.\begin{array}{l} 21{\cdot}07\,\dddot{Si} : 13{\cdot}22\,(\dot{R}) : 4{\cdot}82\,\dot{Na} \\ 20{\cdot}25 \quad : 13{\cdot}50 \quad : 4{\cdot}50 \end{array}\right\} \quad 2(\dot{R})^3\,\dddot{Si} + \dot{Na}^2\,\dddot{Si}.$$

$(\dot{R}) = 18{\cdot}86\,\dot{Mg}$, $20{\cdot}0\,\dot{H}$, $0{\cdot}62\,\dot{Fe}$, $0{\cdot}30\,\dddot{Al}$, 0·84 loss.

15. *Some "Serpentine-like Minerals."* (Schweitzer.)†

(1.) From Monte Rosa, 22·65 : 20·50.

(2.) From Zermatt, 22·68 : 20·39.

(3.) From Col de Breona, 22·97 : 19·30.

Mean of the three analyses:

$$\left.\begin{array}{l} 22{\cdot}77 : 20{\cdot}06 \\ 22{\cdot}77 : 20{\cdot}24 \end{array}\right\} \quad 2(\dot{R})^3\,\dddot{Si} + (\dot{R})^2\,\dddot{Si}.$$

In the first member of this formula, $(\dot{R})$ consists of magnesia, water and protoxyd of iron, whereas in the second it consists chiefly only of magnesia. The formula may therefore, and indeed with greater propriety, be thus expressed: $2(\dot{R})^3\,\dddot{Si} + \dot{Mg}^2\,\dddot{Si}$. In which case it is quite analogous to that of retinalite.

16. *Schillerspar.* (Köhler.)

$$\left.\begin{array}{l} 22{\cdot}59 : 17{\cdot}12 \\ 22{\cdot}83 : 17{\cdot}12 \end{array}\right\} 2(\dot{R})^3\,\dddot{Si} + (\dot{R})^3\,\dddot{Si}^2.$$

The 1 : 1 atomic bases are according to two analyses = 25·86 –26·16 $\dot{Mg}$, 2·64 to 2·75 $\dot{Ca}$, 10·92 $\dot{Fe}$, 0·54 to 0·57 $\dot{Mn}$, 12·43 $\dot{H}$. It appears more natural to assume that in the first member of this formula, $2(\dot{R})^3\,\dddot{Si}$, we should have *a portion* of the magnesia, and in addition thereto, *the whole* of the protoxyd of iron and the water as $\frac{1}{3}$ silicates; and in the second member of the formula, $(\dot{R})^3\,\dddot{Si}^2$, the remainder of the magnesia and the whole of the

* One instance that occurs to me, is in Smaltine and Skutterudite. Although the formula of the former is $Co\,As^2$, and that of the latter $Co\,As^3$, yet their crystalline form is precisely alike. Another example is offered by the feldspars, whose atomic composition may be thus expressed.

$\dot{R}$	$\dddot{Al}$	$\dddot{Si}$	
3	3	4	= Anorthite.
3	3	6	= Labrador, Ryacolite.
3	3	8	= Andesine.
3	3	9	= Oligoclase.
3	3	12	= Orthoclase, Albite.

In accordance herewith, the feldspars are different grades of saturation of a radical compounded of equal atoms of $\dot{R}$ and $\dddot{Al}$.

† See Erdmann and Marchand's J. f. P. Ch., vol. xxxii, p. 499; and Pogg. Ann., vol. xlviii.

lime as $\frac{2}{3}$ silicates. This would give us the formula thus modified, $2(\dot{R})^3\dddot{Si}+(\dot{R})^3\dddot{Si}^2$. *Schillerspar may therefore be looked upon as consisting of two atoms of serpentine and one atom of augite.* And this is in accordance with the known fact, that the occurrence of schillerspar appears to be closely limited to formations in which serpentine is met with. In the above oxygen ratio, the presence of ·2·37 $\dddot{Cr}$, and of 1·28 to 1·73 $\dddot{Al}$, is not taken into account. What part these substances probably play in the composition of the mineral in question, will be broached as a conjecture in the sequel.

17. *Crocidolite.* (Stromeyer.)

$$\left.\begin{array}{l} 26{\cdot}61 : 11{\cdot}99 \\ 26{\cdot}61 : 11{\cdot}40 \end{array}\right\} \quad 3(\dot{R})\dddot{Si}+2(\dot{R})^3\dddot{Si}^2.$$

$(\dot{R})$ from two analyses $=34{\cdot}38\,\dot{Fe},\ 2{\cdot}48\,\dot{Mg},\ 0{\cdot}09\,\dot{Mn},\ 0{\cdot}03\,\dot{Ca},\ 7{\cdot}07\,\dot{Na},\ 4{\cdot}80\,\dot{H}$. The constituents are present in such proportions as would also admit of the formula, $3(\dot{R})\dddot{Si}+2\dot{Fe}^3\dddot{Si}^2$. $(\dot{R})$ in this case comprehending the whole soda, water, and magnesia. Compare this formula with that of hornblende, $\dot{R}\dddot{Si}+\dot{R}^3\dddot{Si}^2$.

Retinalite, Schweitzer's "*serpentine-like minerals*" (to which forsooth, a general distinctive name should be given) and *schiller spar*, form therefore a peculiar group of minerals the formula of which consists of two other members, one of them being serpentine, and therefore containing water, while the other member consists of an anhydrous silicate, but which also contains, as in the former member, 1 : 1 atomic bases. Crocidolite approaches a hydrous hornblende.

B. Silicates of magnesia and of other bases isomorphous therewith in combination with aluminates and oxydates of iron.

Chlorite and the minerals allied thereto.

1. *Chlorite.*

$$\left.\begin{array}{lll} 16{\cdot}30\,\dddot{Si} & : 7{\cdot}85\,\dddot{Al} & : 17{\cdot}72\,(\dot{R}) \\ 15{\cdot}42 & : 7{\cdot}71 & : 18{\cdot}00 \end{array}\right\} \quad 2(\dot{R})^3\dddot{Si}+(\dot{R})\dddot{Al}.$$

The oxygen ratio here given, is calculated from the mean of five analyses, namely, two analyses by v. Kobell of the chlorite of Achmatoffsk, his analysis of the Schwarzenstein chlorite, Varrentrapp's analysis of the Achmatoffsk cholite, and v. Brüels of that from the Zillerthal.

2. *Chlorite-slate.* (Varrentrapp.)

$$\left.\begin{array}{l} 16{\cdot}39 : 5{\cdot}66 : 18{\cdot}84 \\ 16{\cdot}39 : 5{\cdot}46 : 18{\cdot}21 \end{array}\right\} \quad 3(\dot{R})^3\dddot{Si}+(\dot{R})\dddot{Al}.$$

This chlorite slate was from the Pfitschthal. The composition of chlorite bears therefore a very simple relation to that of chlorite slate.

3. *Ripidolite.*

1.) From Rauris, according to v. Kobell:
13·54 : 8·63 : 16·04.

(2.) From St. Gothardt, according to Varrentrapp:
13·18 : 8·64 : 15·81.

(3.) From the Zillerthal, according to v. Kobell:
14·19 : 9·70 : 16·76.

Mean of the three analyses:

13·67 : 8·99 : 16·20
13·50 : 9·00 : 16·50

$$3(\dot{R})^3\,\dddot{Si}+2(\dot{R})\,\dddot{\mathbf{Al}}.$$

4. *Pennine.* (Schweitzer.)

17·38 : 4·44 : 18·80
17·38 : 4·35 : 18·83

$$4(\dot{R})^3\,\dddot{Si}+(\dot{R})\,\dddot{\mathbf{Al}}.$$

The oxygen ratio is calculated from the mean of two experiments.

5. *Xanthophyllite.* (Meitzendorff.)

8·47 : 20·53 : 13·20
8·80 : 19·80 : 13·20

$$4(\dot{R})^3\,\dddot{Si}+3(\dot{R})^2\,\dddot{\mathbf{Al}}^3.$$

From the mean of four analyses.

6. *Leuchtenbergite.* (Komonen.)

17·78 : 8·38 : 16·74
17·00 : 8·50 : 15·60

$$4(\dot{R})^2\,\dddot{Si}+(\dot{R})^3\,\dddot{\mathbf{Al}}^2.$$

It is here assumed, in accordance indeed with Komonen, that this mineral contains no protoxyd of iron, but 3·33 per cent. of the peroxyd. Leuchtenbergite is of a pale yellow, almost, indeed, colorless, and can therefore scarcely be supposed to contain enough of the protoxyd to correspond with 3·33 $\dddot{\mathbf{Fe}}$. It is possible that the oxygen ratio may be 17·0 : 8·5 : 17, and this would agree more closely with the ratio obtained from analysis than what is given above. But in that case the formula would be, $2(\dot{R})^2\,\dddot{Si}+(\dot{R})^2\,\dddot{\mathbf{Al}}$, which does not, it is true, appear probable, inasmuch as the silica and the alumina are therein combined with equal quantities of base. It may be further supposed that the base in combination with the silica consists only of magnesia (with a certain quantity of lime), while that combined with the alumina is composed of magnesia and water. The mineral, it is to be observed, contains 35·36 Mg, 1·75 Ca, 8·68 $\mathbf{H}$. The formula would then become modified as follows,

$$2\,\dot{Mg}^2\,\dddot{Si}+(\dot{R})^2\,\dddot{\mathbf{Al}}.$$

Cases analogous thereto have been already adduced, and there is another similar instance in the composition of the next mineral.

7. *Chlorite mineral*, from Taberg. (Svanberg.)*

$$\left.\begin{matrix}18·58 : 6·09 : 16·98\\ 18·50 : 6·16 : 16·44\end{matrix}\right\}\quad 3(\dot{R})^2\,\dddot{Si}+(\dot{R})^2\,\dddot{\mathbf{Al}},$$

which formula may likewise be thus given, $3\dot{Mg}^2\,\dddot{Si}+(\dot{R})^2\,\dddot{\mathbf{Al}}$.

The mineral contains 29·27 $\dot{Mg}$, 2·07 $\dot{K}$, 6·34 $\dot{Fe}$, 1·64 $\dot{Mn}$, 11·76 $\dot{\mathbf{H}}$, and these bases are present in such proportions as will admit of the entire magnesia and potash being combined with the silica, while the whole of the other *weaker* bases may be supposed to be in combination with the alumina. Hitherto, this mineral, notwithstanding its great external resemblance to chlorite, was reckoned among the micas, because the quantity of the 1 : 1 atomic bases which it contains (not counting the water therewith), is not sufficient for a member of the chlorite family; now however, by including the water among the basic constituents, the mineral in fact takes its place among the chlorite group.

8. *Kämmererite.* (Hartwall.)

$$\left.\begin{matrix}19·20 : 6·90 : 16·83\\ 19·50 : 6·50 : 16·25\end{matrix}\right\}\quad 6(\dot{R})_2\,\dddot{Si}+(\dot{R})^3\,\dddot{\mathbf{Al}}.$$

Pyrosclerite (v. Kobell) appears to have the same formula, unless indeed the loss of 1·9 per cent. in the analysis should cause an alteration therein.

9. *Chloritoid.* (v. Bonsdorf.)

$$\left.\begin{matrix}14·28 : 16·61 : 9·95\\ 15·00 : 15·00 : 10·00\end{matrix}\right\}\quad (\dot{R})^3\,\dddot{Si}^2+(\dot{R})\,\dddot{\mathbf{Al}}^2.$$

The analysis gave an excess of 1·64. $(\dot{R})$=27·05 $\dot{Fe}$, 4·29 $\dot{Mg}$, 0·30 $\dot{Mn}$, 6·95 $\dot{\mathbf{H}}$. A. Erdmann has examined another chloritoid which contains no water, and which (as the mean of two analyses) gives the following oxygen ratio.

$$\left.\begin{matrix}12·95 : 21·02 : 6·82\\ 13·00 : 19·50 : 6·50\end{matrix}\right\}\quad 2(\dot{R})\dddot{Si}+\dot{R}\,\dddot{\mathbf{Al}}^3,$$

this therefore, as has been remarked by Rammelsberg, is evidently another mineral.

10. *Soapstone.* (Svanberg.)

$$\left.\begin{matrix}24·32 : 3·87 : 16·39\\ 23·40 : 3·90 : 16·90\end{matrix}\right\}\quad 6(\dot{R})^2\,\dddot{Si}+(\dot{R})\,\dddot{\mathbf{R}}.$$

$(\dot{R})$=33·3 $\dot{Mg}$, 0·7 $\dot{Ca}$, 11·0 $\dot{\mathbf{H}}$; $\dddot{\mathbf{R}}$=8·0 $\dddot{\mathbf{Al}}$, 0·4 $\dddot{\mathbf{Fe}}$.

11. *Cronstedite.*

The formula of this mineral, according to v. Kobell, is

$$\left.\begin{matrix}\dot{Fe}^3\\ \dot{Mn}^3\\ \dot{Mg}^3\end{matrix}\right\}\quad \dddot{Si}+\dddot{\mathbf{Fe}}\,\dot{\mathbf{H}}^3,$$

* See Berzelius's Jahresbericht, Jahrg. 20, Part 2, p. 234.

which admits of being thus written $(\dot{R})^3\dddot{Si}+(\dot{R})\dddot{\mathbf{F}e}$. This formula differs from that of chlorite from the member $(\dot{R})\dddot{Si}$ being contained therein but singly, whereas in chlorite it is doubled, and that it contains peroxyd of iron instead of alumina. That cronstedtite finds a place among the minerals of the chlorite family by the new formula here proposed for it, is without doubt amply borne out by its external characters. Its crystalline form is a hexagonal prism, with a cleavage parallel to the terminal plane.

Chlorite, ripidolite, pennine and the other chlorite minerals treated of here, all receive, as is seen above, formulæ consisting of two members, and which, generally speaking, are very simple. One of these members consists of a silicate, the other of an aluminate or an oxydate of iron.

C. silicates of magnesia and alumina, and bases isomorphous therewith.

(*a.*) *Mica and micaceous minerals.*

1. *Mica from Iviken.* (Svanberg.)

36·97 : 7·74 : 2·78 }
36·97 : 7·40 : 2·47 } $(\dot{R})\dddot{Si}^2+\dddot{\mathbf{R}}\dddot{Si}^3$.

2. *Mica from Brattstad.* (The same.)

33·08 : 12·66 : 1·93 }
32·00 : 12·80 : 2·13 } $(\dot{R})\dddot{Si}+2\dddot{\mathbf{R}}\dddot{Si}^2$.

The analysis gave an excess of 0·89.

3. *Mica from Broddbo.* (The same.)

24·92 : 16·95 : 2·39 }
25·00 : 16·66 : 2·77 } $(\dot{R})\dddot{Si}+2\dddot{\mathbf{R}}\dddot{Si}$.

Very closely agreeing with the mica from Utön, Kimito, Fahlun and Ochotsk, according to the analyses of Henry Rose. If a small quantity of manganese which is given in Svanberg's analysis as oxyd is calculated as protoxyd, the formula agrees even closer, inasmuch as in that case the oxygen ratio is then = 24·92 : 16·61 : 2·73.

4. *Mica from Rosendal.* (The same.)

23·07 : 7·87 : 10·45 }
23·61 : 7·87 : 10·49 } $2(\dot{R})^2\dddot{Si}+\dddot{\mathbf{A}l}\dddot{Si}$.

5. *Mica from Pargas.* (The same.)

22·13 : 13·31 : 6·64 }
23·00 : 13·20 : 6·60 } $3(\dot{R})^2\dddot{Si}+4\dddot{\mathbf{R}}\dddot{Si}$.

The analysis gave 1·19 *loss.*

6. *Mica from Monroe.* (v. Kobell.)

20·78 : 9·85 : 11·06 }
21·00 : 10·50 : 10·50 } $(\dot{R})^3\dddot{Si}+\dddot{\mathbf{R}}\dddot{Si}$.

The same formula appears to apply to the mica from Miask and from Karosulik. According to v. Kobell's analysis, their respective oxygen ratio is; 21·88 : 9·18 : 10·15 and 21·30 : 9·26 : 11·14. The formula adduced, which is that of garnet, has been before applied to these micas, but from not including the water among the basic constituents, the analyses indicated a want of 1 : 1 atomic bases.

7. *Mica from Abborforss.* (Svanberg.)

$$\left.\begin{array}{l}20{\cdot}49 : 15{\cdot}30 : 3{\cdot}67\\ 20{\cdot}00 : 16{\cdot}00 : 4{\cdot}00\end{array}\right\} \quad (\dot{R})^3\,\dddot{Si}+\dddot{\mathbf{R}}\,\dddot{Si}.$$

8. *Mica from Sala.* (The same.)

$$\left.\begin{array}{l}22{\cdot}06 : 6{\cdot}01 : 13{\cdot}65\\ 21{\cdot}00 : 7{\cdot}00 : 14{\cdot}00\end{array}\right\} \quad 2(\dot{R})^3\,\dddot{Si}+\dddot{\mathbf{R}}\,\dddot{Si}.$$

9. *Pyrophyllite.* (Herrmann.)

$$\left.\begin{array}{l}31{\cdot}06 : 13{\cdot}76 : 3{\cdot}54\\ 31{\cdot}00 : 13{\cdot}78 : 3{\cdot}44\end{array}\right\} \quad 3(\dot{R})\,\dddot{Si}+2\,\dddot{\mathbf{Al}}^2\,\dddot{Si}^3.$$

The insignificant amount of iron in this mineral has been calculated as protoxyd (=1·16 per cent.), although it is cited as peroxyd. It may be remarked, that the color of the mineral is *green*, and the analysis indicated a slight excess.

10. *Pinite from Auvergne.* (C. Gmelin.)

$$\left.\begin{array}{l}29{\cdot}07 : 13{\cdot}50 : 3{\cdot}00\\ 29{\cdot}00 : 12{\cdot}88 : 3{\cdot}22\end{array}\right\} \quad 3(\dot{R})\,\dddot{Si}+2\dddot{\mathbf{R}}^2\,\dddot{Si}^3.$$

This pinite has therefore the same formula as Herrmann's pyrophyllite, the preceding mineral. The difference between them consists but in this, 1st, that in pyrophyllite there is only alumina, whereas pinite contains peroxyd of iron as well, and 2d, that in the former $(\dot{R})=4\dot{Mg}$, 1·6 $\dot{Fe}$, 5·62 $\mathbf{H}$, in the latter =3·76 $\dot{Mg}$ and $\dot{Mn}$, 7·89 $\dot{K}$, 0·39 $\dot{Na}$, 1·41 $\mathbf{H}$. Both minerals appear to crystallize in the rhombic system. But it does not seem probable to me that they should affect *precisely* similar forms, inasmuch as the amount of potash contained in pinite is too considerable for that.

11. *Pinite from Penig.* (Scott.)

$$\left.\begin{array}{l}21{\cdot}94 : 16{\cdot}04 : 3{\cdot}02\\ 25{\cdot}00 : 16{\cdot}67 : 2{\cdot}78\end{array}\right\} \quad (\dot{R})\,\dddot{Si}+2\,\dddot{\mathbf{Al}}\,\dddot{Si}.$$

This is the formula of the Broddbo mica. In the latter, $(\dot{R})=8{\cdot}31\,\dot{K}$, 1·5 $\dot{Mn}$, 3·32 $\dot{\mathbf{H}}$; in pinite =11·35 $\dot{K}$, 0·75 $\dot{Ca}$ and 3·00 $\mathbf{H}$. Assuming about a third of the iron in the mineral to exist in the state of the protoxyd, for which supposition, however, (excepting, perhaps, that the analysis indicates an excess of 0·76 per cent.) there is no particular ground, the oxygen ratio becomes,

$$\left.\begin{matrix}24{\cdot}94 : 15{\cdot}12 : 3{\cdot}63 \\ 24{\cdot}00 : 16{\cdot}00 : 4{\cdot}00\end{matrix}\right\} \quad (\dot{R})^3\, \dddot{Si}^2 + 4\dddot{\mathbf{R}}\, \dddot{Si},$$

which would give this pinite the same formula as the following mineral. The formula first stated represents it, however, evidently better.

12. *Gigantolite.* (Trolle Wachtmeister.)

$$\left.\begin{matrix}24{\cdot}04 : 16{\cdot}51 : 4{\cdot}21 \\ 24{\cdot}00 : 16{\cdot}00 : 4{\cdot}00\end{matrix}\right\} \quad (\dot{R})^3\, \dddot{Si}^2 + 4\,\dddot{\mathbf{R}}\, \dddot{Si}.$$

The analysis gave an *excess* of 1·56.

13. *Chlorophyllite.* (Jackson.)

$$\left.\begin{matrix}23{\cdot}48 : 12{\cdot}98 : 7{\cdot}75 \\ 24{\cdot}00 : 12{\cdot}00 : 8{\cdot}00\end{matrix}\right\} \quad (\dot{R})^2\, \dddot{Si} + \dddot{\mathbf{Al}}\, \dddot{Si}.$$

A small amount of potash (1·64 per cent.) was estimated only from the loss.

14. *Ottrelite.* (Damour.)

$$\left.\begin{matrix}22{\cdot}51 : 11{\cdot}50 : 7{\cdot}31 \\ 22{\cdot}50 : 11{\cdot}25 : 7{\cdot}50\end{matrix}\right\} \quad (\dot{R})^2\, \dddot{Si} + \dddot{\mathbf{Al}}\, \dddot{Si}.$$

This and the foregoing mineral have the same formula. In point of fact, both minerals occur in the same crystalline form, that of a hexagonal prism. $(\dot{R})$ in Ottrelite $= 16{\cdot}72\,\dot{Fe}, 8{\cdot}18\,\dot{Mn}, 5{\cdot}66\,\dot{\mathbf{H}}$. In chlorophyllite $(\dot{R}) = 9{\cdot}6\,\dot{Mg}, 8{\cdot}26\,\dot{Fe}, 4{\cdot}1\,\dot{Mn}, 1{\cdot}64\,\dot{K}, 3{\cdot}6\,\dot{\mathbf{H}}$.

Although the amount of water in the above named *varieties of mica* and *micaceous minerals*, generally speaking, is but moderate, ranging, as it does, between about one and six per cent., yet it, in most instances, exercises a considerable influence upon the formula of these minerals. For the greater part of them contain such a limited portion of the 1 : 1 atomic bases, that their quantity of oxygen is materially increased by that of the water, even when the amount of the latter does not exceed two per cent. If we neglect this amount of water, or endeavor to treat it as hydrate-water, we arrive for the most part at improbable and complicated formulæ, neither indicative of symmetrical relations between themselves, nor when compared with the formulæ of other minerals; objections to which the formula here adduced, as far at least as the majority of them is concerned, are assuredly not liable. Many varieties of mica contain minute quantities, scarcely exceeding one per cent., of compounds of fluorine, especially fluorid of calcium and fluorid of magnesium, which were not here taken into account. It is probable they replace a portion of the corresponding 1 : 1 atomic bases.

(*b.*) *Non-micaceous minerals.*—(*a.*) *Crystalline.*

1. *Fahlunite.* (Trolle Wachtmeister.)

$$\left.\begin{matrix}22{\cdot}89 : 14{\cdot}09 : 7{\cdot}30 \\ 22{\cdot}90 : 14{\cdot}60 : 7{\cdot}30\end{matrix}\right\} \quad (\dot{R})^3 \dddot{Si} + 2\,\dddot{\mathbf{R}}\,\dddot{Si}.$$

From the mean of two analyses.

2. *Esmarkite.* (A. Erdmann.)

$$\left.\begin{matrix}23{\cdot}88 : 14{\cdot}98 : 7{\cdot}40 \\ 23{\cdot}00 : 15{\cdot}33 : 7{\cdot}66\end{matrix}\right\} \quad (\dot{R})^3 \dddot{Si} + 2\,\dddot{\mathbf{Al}}\,\dddot{Si}.$$

The analysis gave a *loss* of 1·45. According to the above, fahlunite and esmarkite have the formula of epidote, as has likewise Meionite. In esmarkite $(\dot{R})$ = 8·99 $\dot{M}g$, 4·10 $\dot{N}a$, 1·43 $\dot{F}e$, 0·63 $\dot{M}n$, 0·68 $\dot{K}$, 3.20 $\dot{\mathbf{H}}$, in fahlunite 6·04 to 6·75 $\dot{M}g$, 0·0 to 7·22 $\dot{F}e$, 1·72 to 2·24 $\dot{M}n$, 0·0 to 4·45 $\dot{N}a$, 0·94 to 1·98 $\dot{K}$, trace to 1·35 $\dot{C}a$, 8·65 to 11·66 $\dot{\mathbf{H}}$.

3. *Pyrargillite.* (Nordenskjöld.)

$$\left.\begin{matrix}22{\cdot}82 : 13{\cdot}51 : 7{\cdot}56 \\ 22{\cdot}00 : 14{\cdot}66 : 7{\cdot}33\end{matrix}\right\} \quad (\dot{R})^3 \dddot{Si} + 2\,\dddot{\mathbf{Al}}\,\dddot{Si},$$

formula of the two foregoing minerals, and likewise of the others cited above. $(\dot{R})$ = 5·30 $\dot{F}e$, 2·90 $\dot{M}g$ and $\dot{M}n$, 1·05 $\dot{K}$, 1·85 $\dot{N}a$, 15·47 $\dot{\mathbf{H}}$. Pyrargillite, as also fahlunite, appears to affect a rhombic crystalline form. That of esmarkite is not known.

4. *Praseolite.* (A. Erdmann.)

$$\left.\begin{matrix}21{\cdot}27 : 13{\cdot}47 : 9{\cdot}16 \\ 22{\cdot}00 : 13{\cdot}20 : 8{\cdot}80\end{matrix}\right\} \quad 2(\dot{R})^3 \dddot{Si} + 3\,\dddot{\mathbf{Al}}\,\dddot{Si}.$$

5. *Zeuxite.* (Thomson.)

$$\left.\begin{matrix}17{\cdot}37 : 14{\cdot}87 : 8{\cdot}16 \\ 17{\cdot}50 : 15{\cdot}00 : 7{\cdot}50\end{matrix}\right\} \quad 3(\dot{R})^3 \dddot{Si} + 2\,\dddot{\mathbf{Al}}^3\,\dddot{Si}^2.$$

6. *Roselane.* (Svanberg.)

$$\left.\begin{matrix}23{\cdot}33 : 16{\cdot}37 : 4{\cdot}86 \\ 23{\cdot}33 : 15{\cdot}55 : 5{\cdot}18\end{matrix}\right\} \quad (\dot{R})^2 \dddot{Si} + 2\,\dddot{\mathbf{Al}}\,\dddot{Si}.$$

$(\dot{R})$ = 6·63 $\dot{K}$, 3·59 $\dot{C}a$, 2·45 $\dot{M}g$, 6·53 $\dot{\mathbf{H}}$. The oxygen ratio of polyargite (Svanberg) resembles that of roselane very closely, viz., 22·93 : 16·69 : 4·80.

$(\dot{R})$ = 6·73 $\dot{K}$, 5·55 $\dot{C}a$, 1·43 $\dot{M}g$ a trace, $\dot{M}n$, 5·29 $\dot{\mathbf{H}}$. Both minerals, moreover, have a similar cleavage, similar specific gravity and a similar color.

7. *Kirwanite.* (Thomson.)

$$\left.\begin{matrix}21{\cdot}04 : 5{\cdot}32 : 12{\cdot}28 \\ 21{\cdot}00 : 6{\cdot}00 : 12{\cdot}00\end{matrix}\right\} \quad 6(\dot{R})^2 \dddot{Si} + \dddot{\mathbf{Al}}\,\dddot{Si}.$$

8. *Stellite.* (The same.)

$$\left.\begin{matrix}24{\cdot}98 : 3{\cdot}70 : 12{\cdot}67\\ 25{\cdot}00 : 4{\cdot}17 : 12{\cdot}50\end{matrix}\right\} \quad 9(\dot{R})^2\,\dddot{Si}+\ddot{\mathbf{R}}^2\,\dddot{Si}^3.$$

It is here assumed that this mineral contains, not as Thomson asserts, 3·524 protoxyd of iron, but a corresponding quantity of peroxyd. The mineral, it must be remarked, is *snow-white*, and the alumina which amounts only to 5·301 would not, of itself, be sufficient. The formula of stellite would also answer for Thomson's vermiculite, whose oxygen ratio $=25{\cdot}50:3{\cdot}40:13{\cdot}26$, if indeed, as Thomson says, the whole of the iron is contained in the form of a protoxyd. Calculating a small portion thereof to exist in the state of peroxyd would afford an oxygen ratio still closer to that of stellite. The two minerals, however, in spite of similar formula, applicable perhaps to both, are essentially different from each other. For, whereas, in stellite $(\dot{R})=30{\cdot}96\,\dot{Ca}$, $5{\cdot}58\,\dot{Mg}$, $6{\cdot}108\,\dot{\mathbf{H}}$, in vermiculite $(\dot{R})=16{\cdot}12\,\dot{Fe}$, (or upon the aforesaid supposition somewhat less,) $16{\cdot}964\,\dot{Mg}$, $10{\cdot}276\,\dot{\mathbf{H}}$.

9. *Weissite.* (Trolle Wachtmeister.)

$$\left.\begin{matrix}31{\cdot}01 : 10{\cdot}17 : 5{\cdot}76\\ 31{\cdot}00 : 10{\cdot}33 : 5{\cdot}17\end{matrix}\right\} \quad (\dot{R})^3\,\dddot{Si}^2+2\,\ddot{\mathbf{Al}}\,\dddot{Si}.$$

Remark.—This is where *aspasiolite* belongs, whose formula, as has been already stated, is $(\dot{R})^3\,\dddot{Si}^2+3\,\ddot{\mathbf{R}}\,\dddot{Si}$.

10. *Rhodalite.* (Thomson.)

$$\left.\begin{matrix}29{\cdot}04 : 7{\cdot}38 : 7{\cdot}07\\ 29{\cdot}00 : 7{\cdot}25 : 7{\cdot}25\end{matrix}\right\} \quad 3(\dot{R})\,\dddot{Si}+\ddot{\mathbf{R}}\,\dddot{Si}.$$

$(\dot{R})$ consists *almost entirely of water*, inasmuch as it is $=1{\cdot}1\,\dot{Ca}$, $0{\cdot}6\,\dot{Mg}$ and $22{\cdot}0\,\dot{\mathbf{H}}$. According to Thomson, this mineral occurs in aggregated rectangular prisms.

11. *Neurolite.* (The same.)

$$\left.\begin{matrix}37{\cdot}92 : 8{\cdot}23 : 2{\cdot}77\\ 38{\cdot}00 : 7{\cdot}60 : 2{\cdot}53\end{matrix}\right\} \quad (\dot{R})\,\dddot{Si}^2+\ddot{\mathbf{Al}}\,\dddot{Si}^3,$$

formula of the Iviken mica. In that, $(\dot{R})=4{\cdot}661\,\dot{Mg}$, $3{\cdot}528\,\dot{K}$, $1{\cdot}292\,\dot{\mathbf{H}}$, and $1{\cdot}197\,\dot{Ca}$. In neurolite, $(\dot{R})=3{\cdot}25\,\dot{Ca}$, $1{\cdot}50\,\dot{Mg}$, $4{\cdot}30\,\dot{\mathbf{H}}$.

β. Amorphous.*

1. *Pitchstone.* (Du Menil.)

$$\left.\begin{matrix}37{\cdot}92 : 5{\cdot}65 : 3{\cdot}08\\ 38{\cdot}00 : 5{\cdot}43 : 3{\cdot}62\end{matrix}\right\} \quad 2(\dot{R})\,\dddot{Si}^2+\ddot{\mathbf{R}}\,\dddot{Si}^3.$$

---

* Or at least apparently so. Some of these minerals consist perhaps of an aggregation of microscopic crystals.

The analysis showed however a *loss* of 2·24. The pitchstone was from the Triebischthale near Meissen. The same mineral was examined also by Erdmann; the oxygen ratio obtained by him was = 39·27 : 5·79 : 4·55, but this analysis gave an *excess* of 3·948. The stone appears indeed worthy of its name!* Knox moreover examined a pitchstone from Newry, whose oxygen ratio was 37·82 : 5·37 : 4·26, and the analysis of which indicated a very trifling loss only—not above 0·2 per cent. The above formula therefore cannot well be very far from the truth.

2. *Cimolite.* (Klaproth.)

$$\left.\begin{matrix}32{\cdot}73 : 11{\cdot}12 : 3{\cdot}56\\ 33{\cdot}00 : 11{\cdot}00 : 3{\cdot}66\end{matrix}\right\}\quad (\dot{R})\dddot{Si}+\dddot{\bar{Al}}\dddot{Si}^2.$$

This is the formula of soda-spodumene. In cimolite however, $(\dot{R})$ consists only of *water*.

3. *Onkosine.* (v. Kobell.)

$$\left.\begin{matrix}27{\cdot}28 : 14{\cdot}42 : 4{\cdot}26\\ 28{\cdot}00 : 14{\cdot}00 : 4{\cdot}66\end{matrix}\right\}\quad (\dot{R})\dddot{Si}+\dddot{\bar{Al}}\dddot{Si},$$

the formula of labradorite and ryacolite. $(\dot{R}) = 6{\cdot}38\,\dot{K}, 3{\cdot}82\,\dot{Mg}, 0{\cdot}80\,\dot{Fe}, 4{\cdot}60\,\dot{H}$. The analysis showed a loss of 1 per cent.

4. *Pipestone.* (*Catlinite,* Jackson.)

$$\left.\begin{matrix}29{\cdot}15 : 10{\cdot}22 : 5{\cdot}23\\ 30{\cdot}00 : 10{\cdot}00 : 5{\cdot}00\end{matrix}\right\}\quad 3(\dot{R})\dddot{Si}+\dddot{\bar{R}}^2\dddot{Si}^3.$$

$(\dot{R}) = 12{\cdot}48\,\dot{H}, 2{\cdot}16\,\dot{Ca}, 0{\cdot}20\,\dot{Mg}$, and $4{\cdot}58\,\dot{\bar{H}}$.

5. *Fettbol.* (Kersten.)

$$\left.\begin{matrix}24{\cdot}11 : 8{\cdot}61 : 7{\cdot}26\\ 24{\cdot}00 : 8{\cdot}00 : 8{\cdot}00\end{matrix}\right\}\quad (\dot{R})^3\dddot{Si}^2+\dddot{\bar{R}}\dddot{Si}.$$

The analysis gave a *loss* of 2·59. $(\dot{R}) = 24{\cdot}50\,\dot{\bar{H}}$. The formula is that of tachylite.

6. *Huronite.* (Thomson.)

$$\left.\begin{matrix}23{\cdot}79 : 15{\cdot}84 : 5{\cdot}12\\ 25{\cdot}00 : 15{\cdot}00 : 5{\cdot}00\end{matrix}\right\}\quad (\dot{R})^3\dddot{Si}^2+3\dddot{\bar{Al}}\dddot{Si}.$$

$(\dot{R}) = 8{\cdot}04\,\dot{Ca}, 4{\cdot}32\,\dot{Fe}, 1{\cdot}72\,\dot{Mg}, 4{\cdot}16\,\dot{\bar{H}}$. *Loss*, 2·04.

7. *Agalmatolite.* (Thomson.)

$$\left.\begin{matrix}25{\cdot}88 : 14{\cdot}29 : 4{\cdot}47\\ 25{\cdot}00 : 15{\cdot}00 : 5{\cdot}00\end{matrix}\right\}\quad (\dot{R})^3\dddot{Si}^2+3\dddot{\bar{R}}\dddot{Si}.$$

---

* There is an untranslatable play upon the word "*pech*" here. I regret being unable to render it into English, as a joke in German, from its extreme rarity, always possesses a certain value.—*Translator.*

$(\dot{R}) = 6{\cdot}00\,\dot{C}a$, $6{\cdot}8\,\dot{K}$, $5{\cdot}5\,\dot{\mathbf{H}}$. Huronite and agalmatolite appear to have the same formula therefore, namely, that of aspasiolite. But in the latter, $(\dot{R}) = 6{\cdot}97$ to $8{\cdot}04\,\dot{M}g$, $\dot{C}a$, a trace, $2{\cdot}30$ to $2{\cdot}39\,\dot{F}e$ (a part thereof perhaps as $\dddot{\mathbf{F}}e$), $\dot{M}n$ a trace, $6{\cdot}58$ to $6{\cdot}88\,\dot{\mathbf{H}}$.

8. ———, from Plombières. (Berthier.)

$$\left.\begin{array}{l} 22{\cdot}86 : 10{\cdot}28 : 8{\cdot}18 \\ 23{\cdot}00 : 11{\cdot}50 : 7{\cdot}67 \end{array}\right\} \quad (\dot{R})^2\,\dddot{Si} + \dddot{\mathbf{Al}}\,\dddot{Si}.$$

$1{\cdot}0$ *loss.* $(\dot{R}) = 25{\cdot}0\,\dot{\mathbf{H}}$, $2{\cdot}0\,\dot{M}g$. The bole from Stolpen, which has been analyzed by Rammelsberg, appears to have the same formula. Its oxygen ratio is $= 23{\cdot}86 : 10{\cdot}35 : 8{\cdot}76$, whereby it is to be noticed that a loss of $2{\cdot}17$ per cent. was obtained. $(\dot{R})$ in this bole $= 25{\cdot}86\,\dot{\mathbf{H}}$, $3{\cdot}90\,\dot{C}a$.

9. *Nontronite,* from Villefranche. (Dufrénoy.)

$$\left.\begin{array}{l} 21{\cdot}13 : 11{\cdot}12 : 7{\cdot}73 \\ 22{\cdot}00 : 11{\cdot}00 : 7{\cdot}33 \end{array}\right\} \quad (\dot{R})^2\,\dddot{Si} + \dddot{\mathbf{R}}\,\dddot{Si}.$$

Essentially this is the formula of the preceding mineral. $(\dot{R}) = 23{\cdot}0\,\dot{\mathbf{H}}$, $2{\cdot}37\,\dot{M}g$. Chlorophyllite also (which see), and ottrelite (see likewise), have this formula.

10. *Kaolin.* (Forchhammer.)

Its formula, $\dddot{\mathbf{Al}}^3\,\dddot{Si}^4 + 6\dot{\mathbf{H}}$, may be also thus expressed:

$$(\dot{R})^3\,\dddot{Si} + 3\dddot{\mathbf{Al}}\,\dddot{Si}.$$

11. *Nontronite,* from Andreasberg. (Biewend.)

$$\left.\begin{array}{l} 21{\cdot}35 : 11{\cdot}44 : 6{\cdot}39 \\ 21{\cdot}00 : 12{\cdot}00 : 6{\cdot}00 \end{array}\right\} \quad 3(\dot{R})^2\,\dddot{Si} + 4\dddot{\mathbf{F}}e\,\dddot{Si},$$

formula of the Pargas mica, in which however, $(\dot{R}) = 10{\cdot}27\,\dot{M}g$, $0{\cdot}75\,\dot{M}n$, $0{\cdot}26\,\dot{C}a$, $8{\cdot}45\,\dot{K}$, $3{\cdot}35\,\dot{\mathbf{H}}$, whereas $(\dot{R})$ in nontronite consists of water alone, ($21{\cdot}56$ per cent.) The nontronite of Autun shows, according to Berthier's analysis, a similar oxygen ratio to that from Andreasberg, that is to say, $21{\cdot}46 : 10{\cdot}94 : 5{\cdot}58$. This would perhaps bear out the formula, $(\dot{R})^3\,\dddot{Si}^2 + 2\dddot{\mathbf{R}}\,\dddot{Si}$, which is at the same time that of scapolite and of amphodelite, and which requires an oxygen ratio of $21{\cdot}5 : 10{\cdot}75 : 5{\cdot}38$.

12. *Saponite.* (*Piotine,* Svanberg.)

$$\left.\begin{array}{l} 26{\cdot}45 : 5{\cdot}02 : 13{\cdot}76 \\ 26{\cdot}00 : 5{\cdot}20 : 13{\cdot}86 \end{array}\right\} \quad 4(\dot{R})^2\,\dddot{Si} + \dddot{\mathbf{Al}}\,\dddot{Si}.$$

13. *Pinguite.* (Kersten.)

Its formula, $Fe\,\dddot{Si}+\mathbf{\bar{F}e}^2\,\dddot{Si}^3+15\mathbf{\dot{\bar{H}}}$, may be also thus written, $(\dot{R})^3\,\dddot{Si}+\mathbf{\dddot{\bar{F}e}}\,\dddot{Si}$, which is the formula of garnet and likewise of the mica from Miask, Monroe and Karosulik.

14.

According to Löwigs and Wackenroder's analyses of the boles from Ellinghausen, Cap de Prudelles, and Säsebühl, these minerals have the formula, $\mathbf{\dddot{\bar{R}}}^2\,\dddot{Si}^3+9\mathbf{\dot{\bar{H}}}$, which may be also written, $(\dot{R})^3\,\dddot{Si}+2\mathbf{\dddot{\bar{R}}}\,\dddot{Si}$. This formula agrees essentially with that of pyrargillite (which see), and with that of the other minerals there cited. In bole however, $(\dot{R})$ consists almost entirely of water, (24 per cent.,) with minute quantities of magnesia and lime.

15. *Iron lithomarge.* (Schüler.)

$$\left.\begin{matrix}21{\cdot}64 : 14{\cdot}65 : 6{\cdot}55\\ 21{\cdot}00 : 14{\cdot}00 : 7{\cdot}00\end{matrix}\right\}\quad (\dot{R})^3\,\dddot{Si}+2\mathbf{\dddot{\bar{R}}}\,\dddot{Si},$$

formula of the preceding mineral, and others referred to above. $\dot{R}=14{\cdot}20\,\mathbf{\dot{\bar{H}}},\ 3{\cdot}04\,\dot{C}a,\ 2{\cdot}55\,\dot{M}g,\ 1{\cdot}51\,\dot{M}n,\ 0{\cdot}93\,\dot{K}$.

16. *Halloylite*, from La Vouth and Thiviers. (Dufrénoy.)

(1.) From la Vouth, 21·12 : 15·72 : 7·11.
(2.) From Thiviers, 22·39 : 15·16 : 7·27.

Mean of the two analyses:

$$\left.\begin{matrix}21{\cdot}76 : 15{\cdot}44 : 7{\cdot}19\\ 22{\cdot}00 : 14{\cdot}67 : 7{\cdot}33\end{matrix}\right\}\quad (\dot{R})^3\,\dddot{Si}+2\mathbf{\dddot{\bar{R}}}\,\dddot{Si},$$

formula of the preceding mineral. In the La Vouth halloylite, $(\dot{R})$ consists entirely of water (24·83), but in that from Thiviers, of $22{\cdot}30\,\mathbf{\dot{\bar{H}}}$ and $1{\cdot}70\,\dot{M}g$.

17. *Mountain Soap*, from Thuringia. (Bucholz.)

$$\left.\begin{matrix}22{\cdot}86 : 14{\cdot}83 : 6{\cdot}21\\ 22{\cdot}00 : 14{\cdot}67 : 7{\cdot}33\end{matrix}\right\}\quad (\dot{R})^3\,\dddot{Si}+2\mathbf{\dddot{\bar{R}}}\,\dddot{Si},$$

formula of the preceding mineral. There are also altogether, independent of epidote and meionite, seven different minerals possessing the same formula, namely, fahlunite, esmarkite, pyrargillite, bole, iron lithomarge, halloylite from La Vouth and from Thiviers, and mountain soap from Thuringia. The various but isomorphous nature of $(\dot{R})$ and $(\mathbf{\dddot{\bar{R}}})$, and the different grades of crystalline development, appear to form the leading differences subsisting between these minerals. Epidote and meionite cannot however be held to be isomorphous with the other minerals of this group, inasmuch as in them $(\dot{R})$ consists essentially of *lime.*

18. *Halloysite.*

(1.) From Liege, according to Berthier,
23·35 : 18·24 : 4·74.

(2.) From Guatequé, according to Boussingault,
23·90 : 18·78 : 4·94.

(3.) From Bayonne, according to Berthier,
24·26 : 17·28 : 4·74.

(4.) So-called tuesite, according to Thomson,
23·1 : 18·87 : 4·00.

Mean of these four analyses:

23·63 : 18·29 : 4·48 }
23·00 : 18·40 : 4·60 } $(\dot{R})^3\dddot{Si}+4\ddot{\mathbf{Al}}\dddot{Si}$,

formula of diploite, (according to Rammelsberg.) In the three halloylites, $(\dot{R})$ consists entirely of water, in tuesite $(\dot{R}) = 13·5\,\dot{\mathbf{H}}$, $0·7\,\dot{Ca}$, $0·5\,\dot{Mg}$.

19. *Gilbertite.* (Lehunt.)

23·46 : 19·47 : 3·16 }
23·50 : 20·14 : 3·36 } $(\dot{R})^3\dddot{Si}+6\dddot{\mathbf{R}}\dddot{Si}$.

1·98 *loss.* $(\dot{R}) = 4·17\,\dot{Ca}$, $1·90\,\dot{Mg}$, $4·25\,\dot{\mathbf{H}}$.

20. *Cerolite.* (Maak.)

19·72 : 5·69 : 13·16 }
19·50 : 6·50 : 13·00 } $2(\dot{R})^3\dddot{Si}+\ddot{\mathbf{Al}}\dddot{Si}$,

formula of massive gehlenite, and of the Sala mica. $(\dot{R}) = 31·00\,\dot{\mathbf{H}}$, $18·02\,\dot{Mg}$.

21. *Chonikrite.* (v. Kobell.)

18·54 : 7·99 : 15·24 }
19·00 : 7·60 : 15·20 } $4(\dot{R})^3\dddot{Si}+\ddot{\mathbf{Al}}\dddot{Si}$.

$(\dot{R}) = 22·50\,\dot{Mg}$, $12·60\,\dot{Ca}$, $1·46\,\dot{Fe}$, $9·00\,\dot{\mathbf{H}}$.

22. *Mountain Soap*, from Arnstedt. (Ficinus.)

21·00 : 11·62 : 14·25* }
12·00 : 12·00 : 12·00 } $(\dot{R})^6\dddot{Si}+\ddot{\mathbf{R}}^2\dddot{Si}$.

$(\dot{R}) = 3·1\,\dot{Mn}$, $1·1\,\dot{Ca}$, $43·0\,\dot{\mathbf{H}}$.

The above mentioned *amorphous minerals*, which hitherto have all been looked upon as hydrates, receive by the introduction of the water as a basic constituent, very simple formulæ, in close agreement and harmony with those of other silicates.

(To be continued.)

* Is 21·00 a misprint for 12·00? From the formula, this latter number is correct in the lower line.

ART. VII.—*On the Construction of Blast-furnaces for the Smelting of Iron with Anthracite;* by S. S. HALDEMAN, of Columbia, Penn.*

THE occurrence of inexhaustible strata of anthracite coal in Pennsylvania, has attracted the attention of miners and practical men generally, to its use in smelting iron. With charcoal, this process requires a peculiar location, and a large capital, to be invested in extensive woodland tracts, which are generally mountainous, and consequently cheaper, being unfitted for agriculture. This renders the construction of the necessary roads difficult, and transportation expensive. The number of workmen employed in wood-cutting, coaling, and hauling, is large, and the expense of horses and wagons, forms a considerable item. Charcoal being a soft, porous material, much of it is wasted in transportation and handling, and large sheds are required to store and keep it dry. These various contingencies require the general manager to have industry, judgment, and good business habits. In using anthracite, the exact expense of the fuel is known, the transportation being by railways or canals extending to most of the mines, and if the furnace is placed near such public works, there will be but little waste of coal in its final transportation. There is but little waste in the transportation of ore, which is of course common to both kinds of fuel.

The earlier attempts at smelting iron with anthracite in the ordinary furnace, failed so completely, that it was by some deemed impossible to accomplish it; while others, looking to a different construction for a solution of the problem, devised various structures, more remarkable for ingenuity than utility; later experiments having proved that no such modifications are necessary, except perhaps a higher inclination of the bosh and a less contracted tunnel-head.

Incandescent anthracite has the peculiarity of being rapidly extinguished when struck with a blast of cold air, the loss of heat from this source exceeding that resulting from combustion; and although this phenomenon does not take place when the temperature exceeds a certain point, the vast accession of cold air in a blast furnace, may be sufficient under slightly unfavorable conditions, to produce it at any time. Hence a hot blast, which is economical when charcoal is used, becomes an essential element of success with anthracite; and its temperature should not be less than is sufficient to smelt a slip of lead opposed to a jet of it near the twiers. Anthracite being a very dense and

* The figures given in connection with this article, represent the structure of the Chikiswalungo Iron Furnace, at Columbia, owned by Messrs. Haldeman.—EDS.

concentrated fuel, the amount of air thrown in must be much greater than when charcoal is used. Success, therefore, depends upon the quantity as well as upon the temperature of the blast.

The necessary amount of oxygen can be secured only by means of the proper machinery, and a certain velocity of the blast; and in consequence of this fact, the false opinion that the effect depends merely upon the velocity or sharpness of the jet, is universally maintained. In consequence of this view, the exit pipe is reduced to a small size, and the quantity secured by increased velocity under a high pressure; which causes much of the blast to be lost, as among the multitude of joints to be made air-tight, it is impossible to secure them all. Besides this, the machinery is liable to injury from the great and unnecessary strain upon it.

The stack or main structure of a blast furnace, is a quadrangular pyramid, the lower portion of which has an arched passage through the middle of each side, leaving four large piers of masonry. Three of these passages (A, fig. 1) are named twier-arches. The junction of these arches forms an open square about one-third the diameter of the stack, in which the hearth, (which requires renewal from time to time,) is built up with large cut stones of siliceous conglomerate or sandstone. Near the top of the hearth, the inner portion of the four arches is closed by forming a square with eight large sows or iron beams, four of which are shown in section at S in fig. 2, their position nearly corresponding with the dotted square in fig. 1. The dotted circle in fig. 1, indicates the internal face of the fire-brick lining (*l*, fig. 2) at its widest part, and also the top of the bosh,* (*b*, fig. 1, 2.) The lining being circular and the lower portion a square, the former is supported upon four plates (*q*) of such a form as to close the angles of the latter, and at the head of the furnace it is continued in an ordinary brickwork chimney, (*z*, fig. 3,) leaving one or two large vacant spaces for the purpose of filling. The chief use of this chimney is to protect the workmen from the heat.

The two posterior piers have a circular passage (fig. 1, 2, *g*) for the admission of the blast pipe, *p*, which descends from the hot-oven (*o*, fig. 3) at the head of the stack. This passage is sometimes continued through the front piers, which renders the front or working arch, cooler, and gives more ready access to the twiers. The blast pipe is carried by appropriate branches to the posterior and lateral twiers, *t*, *t*, *t*, fig. 1, the former being seen in longitudinal—and one of the latter in transverse section, at *t* in fig. 2.

To prevent the twier from being destroyed by contact with the fire of the hearth, it is made of an interior and exterior cone of wrought iron, with a stream of water circulating between

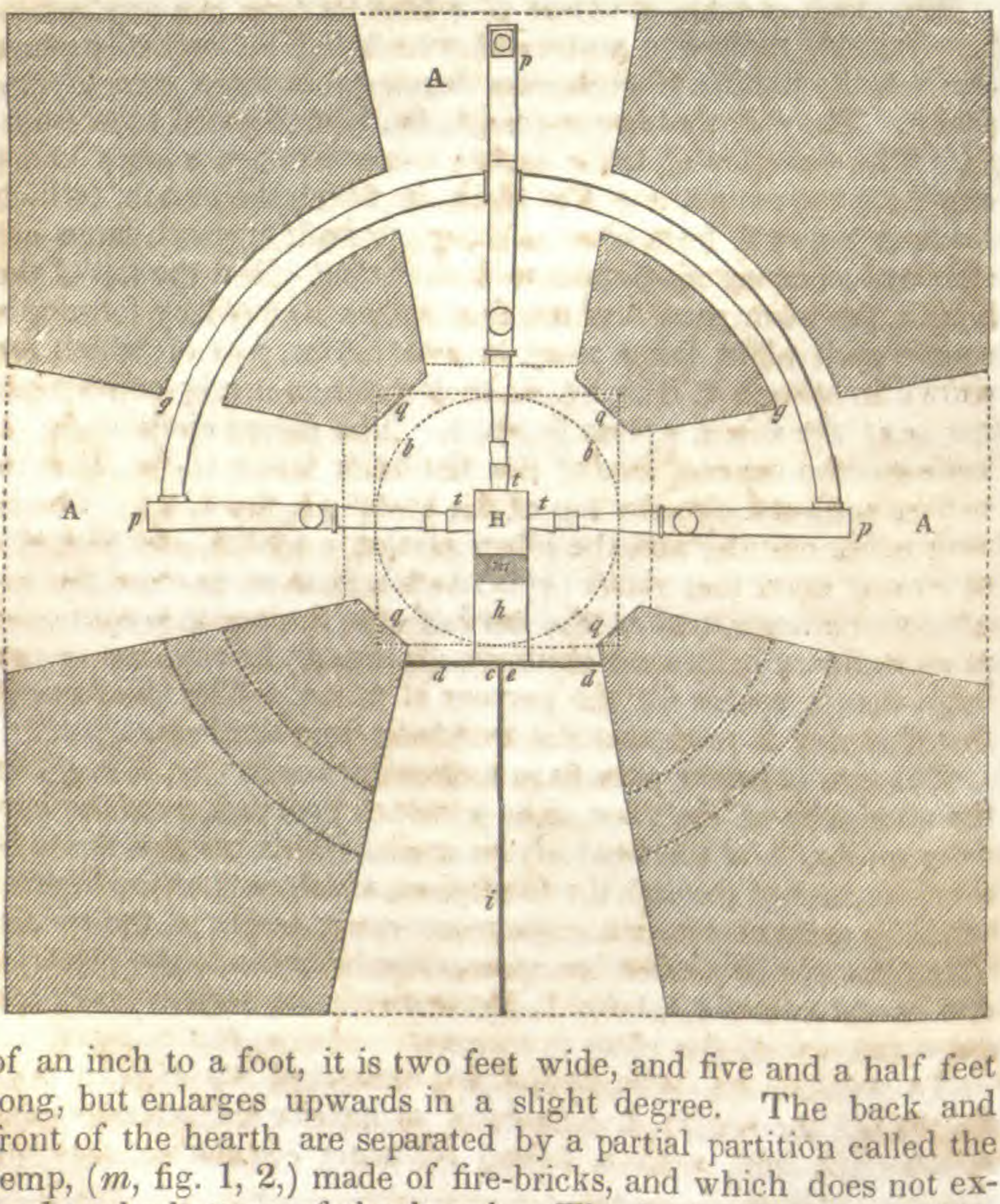
---

* This word is from the German word böschung, a *slope*.

them. The twier receives the nozzle; and this the belly-pipe, which is attached to the terminal upright portion of the blast-pipe, called the ball-and-socket joint from having a connexion of this kind. Behind this, at *k*, there is a small aperture, to insert an iron rod to detach any slag that may cling to the twier. As the smelted materials within the hearth frequently rise above the twiers, it is evident that, in case the blast should be accidentally checked, they would flow into the blast-pipe. To prevent this, a valve (*v*, fig. 2,) is interposed, which is kept open by the blast, but falls the moment the pressure is removed.

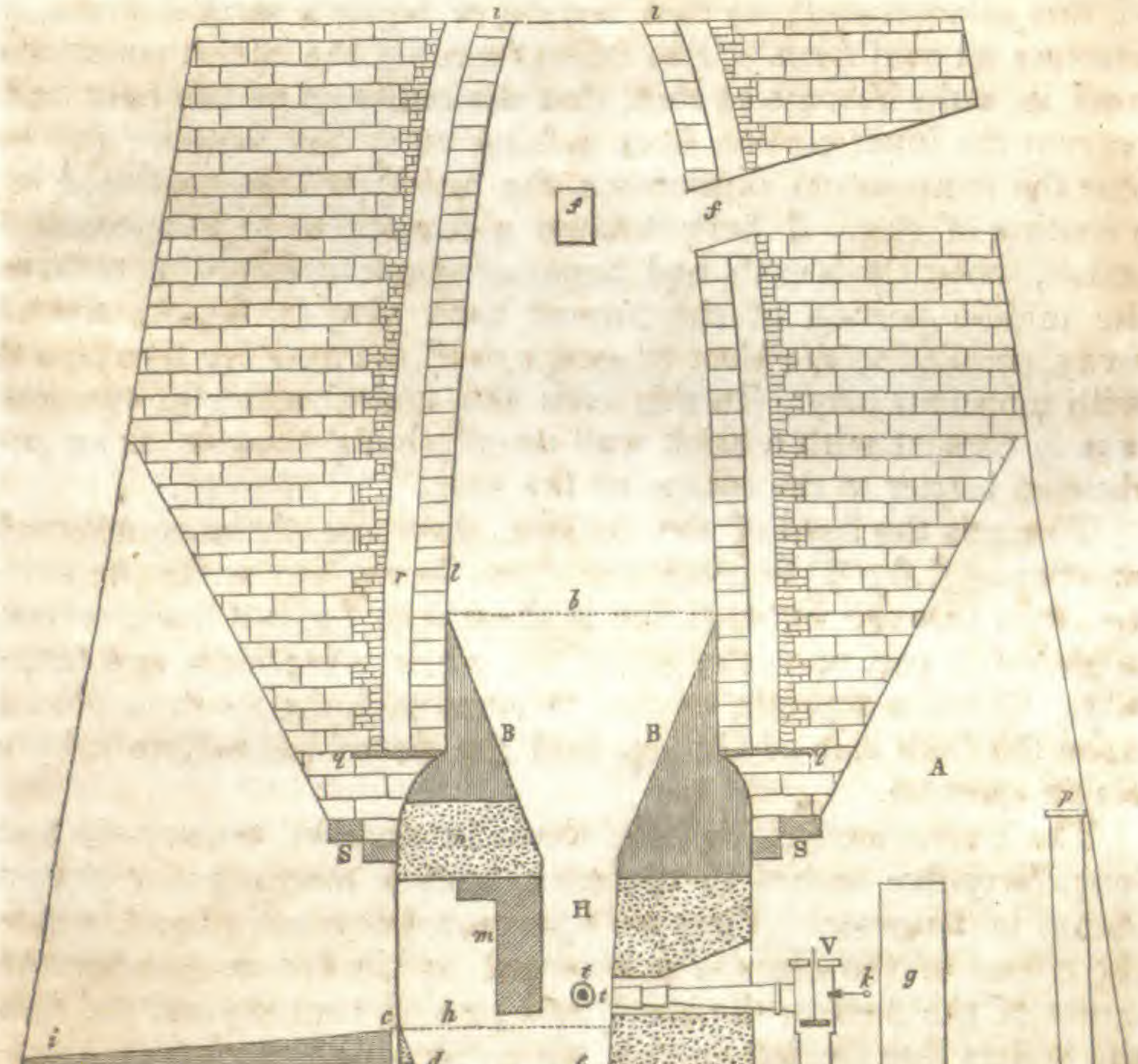
The cavity of the hearth, (H*h*, fig. 1, 2) where the metal is reduced and retained, bears a very small proportion to the size of the stack. In the figures, which are drawn to a scale of one-eighth

Fig. 1.



of an inch to a foot, it is two feet wide, and five and a half feet long, but enlarges upwards in a slight degree. The back and front of the hearth are separated by a partial partition called the temp, (*m*, fig. 1, 2,) made of fire-bricks, and which does not extend to the bottom of the hearth. The horizontal dotted line, (*h*, fig. 2) shows the level to which the smelted materials can rise before running over the dam-stone (*d*) at *c*, where the cinder will escape first, being the lightest, whilst the smelted iron occupies the bottom. To prevent the fluid matter from being forced out by the blast, clay is rammed beneath the temp, around the twiers, and upon the surface, at *h*, where it is retained by heavy iron plates, which are raised every few hours, to allow the cinder to run off along the level of the top of the dust-plate *c*, *i*, whilst the metal is run off every twelve hours, at the lower level of *d*, through an aperture at the bottom of the dam-stone. The dam-stone is defended in front by a large iron dam-plate (*de*, fig. 1) against which the dust-plate *c*, *i*, rests. The lower edge of the latter rests upon the ground, which is raised to about the level of the bottom of the hearth *d*, *e*.

Fig. 2.



Explanation of Figs. 1, 2.

A, twier arches.	*e*, tapping place.	*k*, twier key.	*q*, square of the hearth.
B, bosh.	*f*, flues for boilers.	*l*, lining.	*r*, space for loam.
b, greatest diameter.	*g*, passage.	*m*, temp.	*s*, sows.
c, cinder run.	*Hh*, hearth.	*n*, sconsh'n.	*t*, twiers.
d, dam-stone & plate.	*i*, dust-plate.	*p*, blast-pipe.	*v*, valve in blast-pipe.

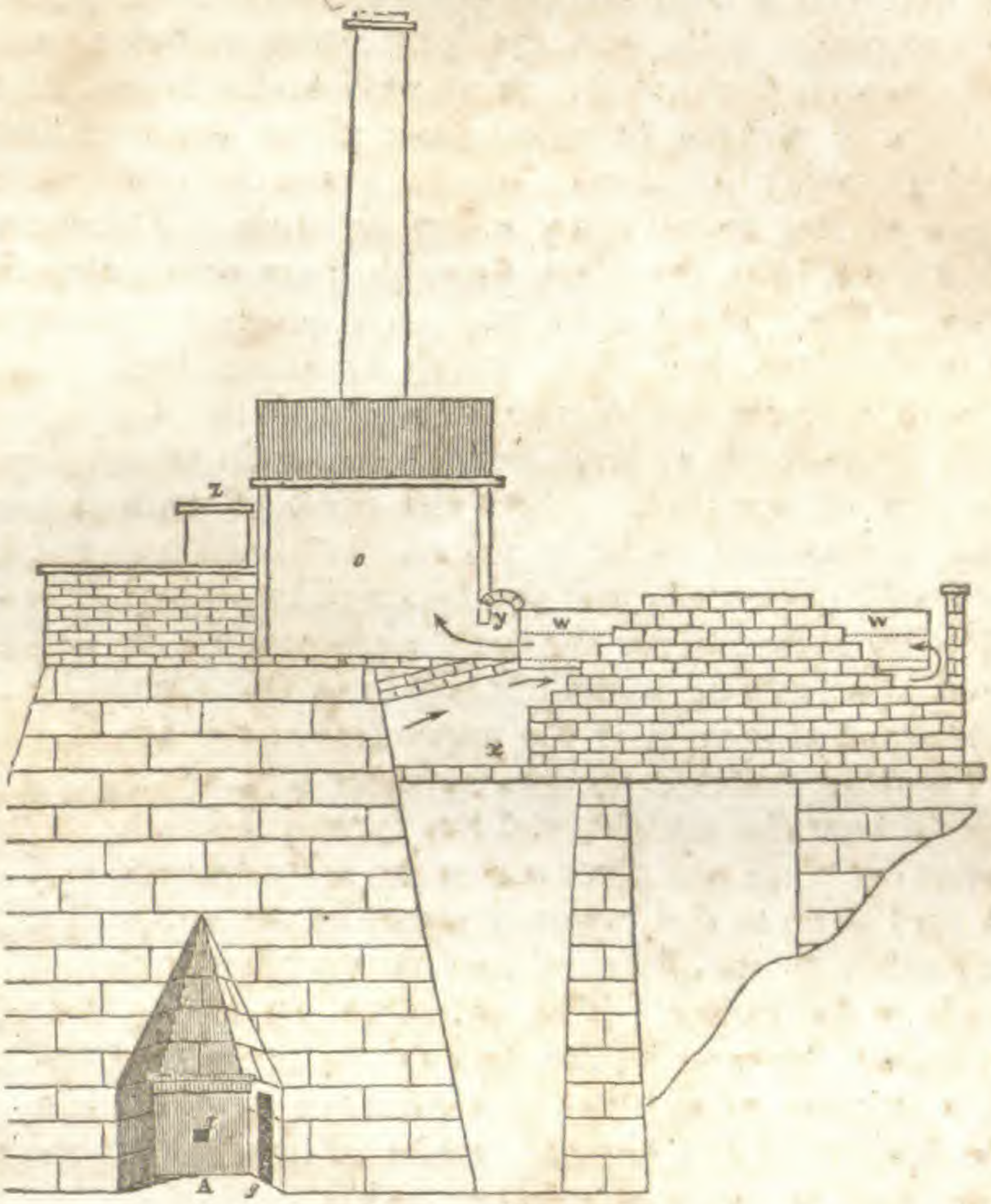
Fig. 2 would represent a transverse section of the stack, if the left half were symmetrical with the right. In this case the temp *m*, and the open space in front of it, would be filled with stone to the bottom of the hearth, and *e* would represent the place of exit for the iron.

The bosh B B, fig. 2, (shaded vertically,) resembles a large funnel, except that its termination at H, fig. 1, 2, is square. It is built of fire bricks, except its lower portion in front, where, in consequence of the open temp arch (*m*), a large stone (*n*) called the sconsh'n, is laid across the front portion of the hearth. The inclination of the bosh is seen to be at a higher angle than when charcoal is used; but it may vary considerably without affecting the result. When in blast a few months, the bosh increases in steepness from the abrasion of its surface, and the hearth partakes of this enlargement; so that instead of being a parallelogram, it assumes an oval form. The enlargement of the hearth continues until its walls become so thin, that the radiation of the heat will prevent the inner portion from melting away any further; and in case the temperature diminishes, the inside will be protected by a coating of slag. I have known a furnace to be in successful action, when the hearth had been so much enlarged as to have the middle portion of the inmost back sow (*s*, fig. 2) melted away, permitting the blast to escape until the aperture was closed with tenacious clay. In this case the under surface of the sow was in contact with a brick wall usually built beneath, as an additional barrier to the escape of the heat.

Towards the head of the furnace, there are three equidistant apertures (*f*, fig. 2) to admit the waste flame, first under the boilers, then through a return flue in them into the hot oven, which is placed in part upon the top of the stack posteriorly and laterally. When a separate engine is employed, the oven is placed upon the front side of the top, and the flame passes into it by a single aperture.

The boilers are in this case three in number, twenty-six feet long, forty-five inches in diameter, with a return flue eighteen inches in diameter. They are represented at *w w*, in fig. 3, where the course of the flame is represented by the arrows leaving the outlet of the flues in the stack, and passing beneath and through the boilers into the hot-oven *o*, which has one or two high chimneys to secure a proper draft. For the purpose of exhibiting the position of the boilers, a part only of the brickwork which supports and encloses them is represented in the figure, and the minor details of construction are omitted. Figure (3) is an elevation and partial section of the right side of fig. 1, 2, showing a twier arch, with the aperture for the admission of the blast, the parapet upon the top, and the chimney (*z*) around the tunnel-head. The engine is placed upon the ground on this side, the boilers extending to the bank against which the structure stands. When the convenience of a bank or hill cannot be had, it is evident that both the boilers and oven might be placed on or near the ground, if the chimney were sufficiently high, (not less than seventy feet,) and the walls built so as to be free from crevices.

Fig. 3.



The boilers are supported upon large iron beams, (partly shown below *x*,) between which arches are turned in their longitudinal direction. There are several doors in the position of *x*, to allow the flues to be cleared from ashes, &c. These doors open into the arches beneath, and there are others along the sides for the same purpose. The boilers are usually placed in contact with the oven; but the passage *y* (which extends to the chimneys) is proposed to be left to turn more or less of the flame into the chimneys, which will place the relative distribution of the heat to the oven and boilers under control, a point which seems not to have been hitherto attained. This might also be accomplished by separate chimneys to the oven and boilers. In either case, the chimneys must be supplied with a damper, which is best placed upon the top.

If four simple boilers were used, the flame might be passed under one pair and return under the other; or, the oven might be placed upon the bank, which would afford a good foundation for it and its chimneys; but the distance which the heated blast would be required to travel before reaching the twiers, would be an objection.

The hot-oven is built and arched over with brick, and strongly bound externally with iron, the heat being sufficient to destroy supports passing through it. It is sufficiently large to contain a small forest of upright flattened pipes about ten feet high, with an internal cavity of about four by seven or eight inches, the thickness of the metal being about an inch. These are maintained at a red heat, the blast through them preventing their destruction. They stand upon two large pipes or cylinders about a foot in diameter, and from twelve to fifteen feet long, with a single row of apertures, (*a*, *d*, fig. 4,) and one or more (*b*, *c*) large enough to admit of a double row of apertures. Over the neck of each aperture, a detached collar is placed, into which a pipe is firmly cemented, and the heads of two pipes on adjoining cylinders are similarly connected by an auxiliary pipe forming a semicircular or gothic arch, as represented in section in the upper part of the figure. The blast entering the first cylinder at *a*, meets a partition near the middle, and has to pass through the seven openings and pipes across the arched heads into *b*, and so on to *d d*, when it passes in the opposite direction to its place of exit at *g*, whence it descends to the twiers. The partitions are not in the middle of the cylinders, because by the time the air has passed half through them, it requires more room on account of its expansion.

Fig. 4.

The operations and general results of smelting iron with anthracite, may be given at a future period.

ART. VIII.—*Notes on some Ferns of the United States;* by Professor KUNZE of Leipzic, 1846.—(Communicated by Dr. G. ENGELMANN.)

THE plants of this family prefer the climate of ocean-islands, more particularly within the tropics; the number of species is very limited on the large continents, especially in cold or temperate latitudes. We observe the same fact in the United States; the ferns of which are not numerous, though it is supposed that in the western and southern parts of the union, several may yet be discovered. Several species new to the flora of the United

States have been communicated to me; their description, and some further notes on some North American ferns, are here offered to the botanists of the Union, who will oblige me exceedingly by communicating ferns, not known to me, and thereby assist my investigations on this family.

The most complete enumeration yet known to me is that of Nuttall's, (1818,) and the largest supplement has been furnished by Hooker (Flora Bor. Am., 1840). Many other data may be gleaned from numerous journals and other works, to collect and arrange which will be the task of some American botanist; I here offer merely some notes on the distinction of nearly related ferns, on some additional localities, and a few special remarks, in which I follow Nuttall's arrangement.

Equisetum.—I have nothing to add to A. Braun's and Engelmann's memoir in this Journal, vol. xlvi.

Lycopodium.—*L. Selago*, L., found in Greenland, on the mountains of New England (E. Tuckerman, Jr.), and on rocks at the falls of Broad River, North Carolina (Rugel!).—*L. alopecuroides*, L., on meadows between Quincy and Aspalaga, Florida (Rugel!). An elongated form densely covered with small leaves was collected on Lake Tamony, Florida, by Rugel!—A similar elongated variety is *L. inundatum*, L. *β. Bigelovii*, Tuckerm.! (*L. Carolinianum*, Big., *L. Bigelovii*, Oakes and Tuck.!) from Plymouth, Mass. (Tuckerman!), and from Covington, Louisiana (Drummond!).—*L. annotinum*, L. β. Spach Monogr. (*L. pungens*, Desv., L. annotinum, β. montanum, Tuckerm.! L. sabinæfolium, Beck, non Mich. fide Tuckerm.) has been found, not only in Newfoundland and Labrador, but also on the White Mountains of New Hampshire (A. Gray! and Tuckerman!).—*L. dendroideum*, Mich. (*L. obscurum*, L.) has been found as far south as the Smoky Mountains of Tennessee (Rugel!).—*L. Chamæcyparissus*, A. Braun,* nearly related to *L. complanatum*, L., but probably well distinguished, grows also on the Chivi Mountains, Cherokee County, North Carolina (Rugel!).—*L. lucidulum*, Mich., one and a half feet high, New England, (Tuckerman!) of common size on the Black Mountains, North Carolina (Rugel!).—*L. rupestre*, L., is widely distributed in America and Africa, and from California to Mexico and Peru. Beyrich has collected it in the Southern States, and Rugel on the Broad river Mountains, North Carolina.—Nuttall's supposition, that *L. albi-*

* Note by A. Braun.—*L. Chamæcyparissus* is preserved in Wildenow's herbarium from Canada, sent by Richard under the name of *L. complanatum*. *L. complanatum* of the North American authors belongs mostly to *L. digitatum*, (Dillen.) A. Braun; it is questionable whether the true Linnean *L. complanatum*, has been found in North America; a specimen collected in Kamtschatka by Ermann cannot be entirely identified, as it shows no fructification. *L. sabinæfolium* is a very doubtful species of this section. To judge from a specimen in Willdenow's herbarium, I take it to be an alpine form of *L. Chamæcyparissus*.

dum might be only a variety of *L. apus* or *apodum* has lately been confirmed.

Ophioglossum.—American specimens of *O. vulgatum* are not distinct from European ones.—A small species with an elliptical acute leaf as long as the spike, collected by Beyrich at Ebenezar, probably belongs to *O. nudicaule* (*O. ellipticum*, H. and Grev.)—A specimen of *O. bulbosum*, Mich., or more properly *O. crotalophoroides*, Walt., collected by Drummond in Louisiana and communicated by A. Gray, agrees exactly with *O. tuberosum*, Hook. from Talcahuano.—*O. pusillum*, Nutt., is entirely unknown in Europe and has not been mentioned by Greville and Hooker. Bot. Misc., iii.

Botrychium.—The different species still require to be more accurately distinguished. *B. gracile*, Pursh, has been united with *B. virginicum* by Greville and Hooker. (l. c.) *B. dissectum*, Muhl., is unknown to me.

Osmunda.—A. Gray has already proved the identity of *O. Claytoniana*, L., with *O. interrupta*. *O. spectabilis*, W., and *O. regalis*, L.; cannot be separated any better. Nuttall has already pronounced them "scarcely distinct."

Polypodium.—More correct observations are required regarding the species which resemble *P. vulgare*, L. *P. vulgare*, β. *americanum*, Hook., (*P. virginianum*, L.,) differs from the European form by a narrower and more elongated frond, narrower lobes separated by wider sinus, the lowest being longer or at least not shorter than the following ones, and the sori being always nearer the margin than in the European plant. I have not met with any American specimens entirely agreeing with the true *P. vulgare* of the old world.—*P. Scouleri*, H. and Grev., Ic. Fil. 56, is incorrectly united with the very distinct *P. Californicum*, Kaulf., in Hook. Fl. Bor. Am. *P. intermedium* is unknown to me; it appears to approach *P. Cambricum*, Desv., the original form of *P. Cambricum*, L., and of the gardens, a common fern about the Mediterranean Sea, but may constitute a separate species.—*P. incanum*, L., appears to belong exclusively to the southern states, I have seen specimens from Louisiana (Flügel!), and from Louisiana and Florida (Rugel!).*—*Polyp. connectile*, (Mich.,) not distinguishable from *P. Phegopteris*, L., extends as far north as Newfoundland and Labrador.—*P. Dryopteris*, L., was sent to me from Labrador.—*P. calcareum*, Sm., widely differing from the last, is enumerated by Hooker; I have not seen any American specimens of it.

Nothochlæna *dealbata*, Kunze, (*Cheilanthes dealbata*, Pursh, ii, 675, Nuttall, ii, 253, *N. pulchella*, Kze., in Mohl and Schlechtend., Bot. Zeitg., 1843, No. 37,) must be introduced here. This

* Grows as far north as on the Wabash in Indiana.—*Engelm.*

species is nearly related to *N. nivea*, though essentially distinct. I have only seen specimens obtained from the Berlin botanical garden, but Nuttall's and Pursh's diagnoses do not permit a doubt about the identity of the species. I would not have looked for it under *Cheilanthes*.*

WOODSIA.—I cannot distinguish *W. rufidula*, Beck, (*Nephrodium*, Mich.,) from *W. ilvensis*, Br. The species varies, with ovate, acutish, elongated, obtuse or rounded fronds. Specimens from New York, sent by Prof. A. Gray, attain the height of six inches.—*W. glabella*, Br., Hook. Fl. Bor. Am. i, 237, is a very distinct species.

PHYSEMATIUM.—*Ph. obtusum*, Hook. Fl. B. Am. ii, 259. Hooker in Spec. Fil. i, 62, very properly unites *Aspidium obtusum*, W., and *Woodsia Perriniana*, Hook. and Grev., though under the name of *Woodsia obtusa*. This fern extends from the northeastern states to North Carolina, Missouri and Texas.

ASPIDIUM.—I have so far seen no specimens of *A. cicutarium*, Spreng., from the United States.—Hooker refers *A. Filix mas*, Pursh, to *A. Goldianum*, H. and Grev., whether correctly or not, I cannot decide; but I have seen the true *A. Filix mas* from Newfoundland.—*A. molle*, Sw., appears to be unknown as an inhabitant of the United States; I have seen specimens from Louisiana, (Ludwig in Herb. Lucæ!), Alexandria, Louisiana, (Hale!) limestone rocks near Aspalaga, Florida (Rugel!), and banks of streams near Houston, Texas (Lindheimer in Herb. A. Braun!).—*A. Thelipteris* and *A. Noveboracense*, Sw., are declared by Hooker, Fl. Bor. Am., to be "quite identical." I cannot subscribe to this opinion. The latter species, Schk., t. 46, appears to me to be distinguished from the former by a shorter stipe, by the circumference of the frond being more narrowed upwards and downwards, by thinner texture, by narrower and ciliate segments of the pinnæ, and by entire veins (Presl therefore arranges both species in different sections of his genus *Lastrea*). I have seen *A. Noveboracense* from New York (Halsey), Pennsylvania, (Pœppig), Arkansas (Beyrich), and North Carolina (Rugel).—I have seen no North American specimen of *A. cristatum*, Sw.—The identity of *A. spinulosum*, Sw., *A. dilatatum*, Sw., *A. dumetorum*, W., and *A. intermedium*, W., as different forms of one species, cannot be doubted any longer. A peculiar variety of *A. spinulosum* occurs in the northern latitudes and on the mountains of the Southern States, which must be studied more closely in its native localities, as it may prove to be a distinct species. I have specimens of this form from Newfoundland, (La Pylaie,) Greenland, and Labrador,

---

* *Nothochlæna sinuata*, Kaulf. Enum. Fil. 135. Kunze, t. 65. (*Acrostichum sinuatum*, Sw. Syn. Fil. *Gymnogramma sinuata*, Presl.) so far only known as a Mexican and Peruvian species, has been found by M. Lindheimer on the Guadaloupe river in Texas.—*A. Braun.*

(Breutel and Kurr,) New England mountains, sterile (Tuckerman), and from the highest tops of the Black Mountains, North Carolina, (Rugel). Cultivated specimens have been communicated to me from the botanical garden of St. Petersburg, (Dr. Fischer as *A. spinulosum americanum*,) and from that of Berlin. The lowest pair of the mostly opposite pinnæ is *ascending* and *curved upwards*, and has a *different direction from the other pinnæ*. The pinnulæ are more deeply pinnatified, with more and sharper teeth than in the common form; *those of the lowest pinnæ, especially near the base, are much elongated downwards*, by which these pinnæ assume a very irregularly triangular shape. The sori are nearer the middle nerve. The stipe is thickly covered with brown or redish paleæ. If this form should eventually prove to be a distinct species, the name of *A. campylopterum* would be appropriate.—*A.* (*Polystichum*) *Lonchitis*, Sw., also in Greenland (Wormskiold).*—*A.* (*P.*) *aculeatum*, to which Hooker (Fl. Bor. Am. ii, 261,) joins even *A. vestitum*, Sw., though undoubtedly incorrectly, and *Nephrodium setigerum*, Presl, which I do not know, appears to include different species, which I think ought to be separated. But Hooker states that the plant of the Rocky Mountains and the Pacific coast is intermediate between *A. lobatum* and *A. angulare*, and is identical with *A. aculeatum* of his British flora. All the American specimens which I have seen were communicated by Mr. E. Tuckerman, as collected on the mountains of New England. They evidently belong to *A.* (*P.*) *Braunii*, Spenn. Fl. Frib., which, therefore, is also an American plant. The different species which usually have been confounded under the name of *A. aculeatum* have been elucidated by me in a memoir, which is not yet published. I have thus far seen *A. Braunii* only from Baden and Saxony, and from New England. Prof. Braun states that it has also been observed in Norway: it is cultivated in the botanical gardens of Leipzig and Berlin.—I have to add here a new and well distinguished species of the United States.

A. (*Polystichum*) *Ludovicianum*, Kunze: fronde tenuiter coriacea, glabra, oblongo-lanceolata, bipinnata; pinnis (alternis) remotis, oblongo-acuminatis, patenti-erectis inferioribus petiolatis; pinnulis basi adnatis decurrentibus, sterilibus ovato-oblongis acutiusculis serrulatis subsinuatis, fertilibus e basi inæquali subauriculata leviter falcatis lanceolato-oblongis grosse sinuato-dentatis, infimis pinnatifidis, laciniis dentibusque 1–raro 2–sorophoris, obtusis; costulis subtus convexis; soris magnis, convexis, centro ab indusio badio leviter impressis; rhachibus partialibus marginatis, universali stipiteque stramineis, rufo-paleaceis.

In Louisiana legit Ludwig (Herb. Luceanum!). Colitur in horto botanico Berolinensi (vid. specimen!).

* It likewise occurs on the shores of Lake Superior.—A. Gr.

A fine species, which cannot be confounded with any one known to me; in habit it approaches somewhat to *A.* (*Nephr.*) *marginale;* it is 1–2 feet high; the circumference of the entire fertile pinnulæ varies from lanceolate to oblong; the veins are repeatedly furcate and the upper branch rarely: also the following bear the sori; the sterile branches of the veins end just before reaching the margin only slightly thickened.

ONOCLEA.—*O. obtusilobata*, Schk., according to Hooker's opinion, a variety of *O. sensibilis*, and

STRUTHIOPTERIS *Pennsylvanica*, W., which the same author declares to be synonymous with *S. Germanica*, W., are not well known to me. An examination of specimens in the royal herbarium of Berlin, inclines me to the same opinion. The genus *Rhagiopteris*, Presl, is founded on fertile specimens of *Onoclea*, mixed with sterile ones of an *Aspidium.**

ASPLENIUM.—*A. pinnatifidum*, Nutt., appears to be a rare species.†

Rugel has collected a variety with sharply and irregularly incise-toothed lobes, on rocks of the southern declivity of the Broad River mountains, North Carolina. It is distinguished from *A. rhizophyllum* by its free, not anastomosing veins, and apparently also by never being proliferous from the tip. Mr. Shuttleworth states that *A. rhizophyllum*, *β. pinnatifidum*, Barton, in Eaton, Manual, ed. 5, 120, is the same plant.

A. trichomanoides, Michx., fronde coriacea, glabra, lineari-lanceolata, brevi-acuminata, basi longe attenuata, pinnata; pinnis sessilibus (oppositis), divergentibus, trapezio-oblongis, obtusis, inferioribus deflexis subcordatis sensim abbreviatis, omnibus subaveniis, margine cartilagineo repando-crenatis; soris breviusculis, margine approximatis; rhachi stipiteque brevi basi paleaceis, rhizomate brevi, horizontali, radicoso.

This species, so well distinguished from its nearest relatives, has been much mistaken. Michaux's diagnosis and his habitat "Carolina" permit no doubt but that the plant collected in Georgia and Tennessee by Beyrich, and about Dandridge, Tennessee, by Rugel, and described above from their specimens in my herbarium, is the same as Michaux's. Michaux (Fl. Bor. Am. ii, 265) refers to two figures: 1. Plukenet (Almag.), p. 152, (Phytogr.) t. 287, f. 2; [Michaux's citation is not exactly the same, but these are Kunze's words and figures,] and 2. Morrison, p. 567, part. xiv, t. 2, f. 12. var. minor. The latter figure, though rude, represents tolerably well the plant in question, but the former must remain doubtful, for the pinnæ are represented as being auriculated

* As was pointed out in a notice of Presl's Pteridographia, in this Journal, vol. xxxix, p. 174.—A. GR.

† Grows also on sandstone rocks near Mine la Motte, in southern Missouri.—*Engelm.*

above and below. Swartz, in his Synopsis, p. 79, and 272, refers Michaux's plant, together with the quotations, to *A. polypodioides;* but he seems to have had some other plant in view, in drawing up his description, perhaps a form of *A. ebeneum*, or to have mainly considered Plukenet's figure; as he says, *pinnæ basi utrinque obtuse auritæ*, and as he leaves out Michaux's words, "*fructificatione lineis brevissimis*," and as he says in the description, "sori lineares, brevissimi, ad latera costæ utrinque puncta Polypodii mentientes, ætate confluentes." Schkuhr has only considered *A. ebeneum*, and has figured it as *A. trichomanoides*, tab. 73. The largest specimens of the true plant, seen by me, are only six inches high, while Swartz mentions his as being 1–2 feet high, nor did I ever see the sori confluent. *A. trichomanoides* of the English gardens is nothing but *A. Trichomanes*. As Swartz's alteration of Michaux's name is entirely gratuitous, the latter must be restored to this species.

A. melanocaulon, W. and *A. Trichomanes*, are united by Hooker, nor can I satisfactorily distinguish them. *A. montanum*, W., which is considered a rare plant, has been collected in abundance in N. Carolina, by Rugel, and in Georgia, by Beyrich.* *A. Adiantum nigrum*, Michx., belongs here. I have not seen any American specimens of the true *A. Filix fœmina;* it appears to be represented by *A. Michauxii*, Spr. (*A. Filix fœmina*, Mich., *Aspid. angustum*, W.), and by *A. Athyrium*, Spr. (*Aspid. asplenioides*, W.), the latter extends as far north as Labrador and Newfoundland. Both these species, which are certainly well distinguished, are thrown together by Hooker. The Mexican *A. Michauxii*, Mart. and Gal., is a distinct species which I have named, *A. Martensi*. My *A. Sibiricum* (*Aspid. crenatum*, Sommerfelt) may yet be discovered in arctic America.

Pteris.—*P. pedata*, of the North American Flora, I have not as yet seen, so I am unable to say to which of the lately distinguished species it may belong, probably to *P. geraniifolia*, Raddi. *P. atropurpurea* as well as *P. gracilis*, must be referred to the genus *Allosurus*. *P. caudata* of the United States, is not the true Linnæan plant which is common in South America, and the West Indies, and is distinguished by the nodose base of the rhachis, as has already been stated by J. Agardh, Monogr. Pterid. 49, but a variety of *P. aquilina*, L., Schk., t. 96. b., peculiar to North America, which Desvaux, Prodr., Fil. p. 303, has distinguished under the name of *P. latiuscula;* and which ought to be more closely studied. It occurs more or less hairy.

Allosurus.—(*Cryptogramma*, Br.) *A. gracilis*, Kaulfuss, *Pteris*, Mich., is nearly related to *A. crispus*, though distinct. I have

* And even as far east as Hillsboro', North Carolina, by the Rev. Mr. Curtis. A. Gr.

received numerous fine specimens of it from rocks, New York, by Dr. Knieskern. *A. acrostichoides*, Pr., is unknown to me; and Hooker is probably correct in referring it to *A. crispus.*

Vittaria.—Not having compared any North American specimens, I am unable to say whether they belong to the true *V. lineata.*

Blechnum.—*B. boreale* is a *Lomaria.*—*B. serrulatum*, Mich., I have only from South America.

Adiantum.—*A. Capillus*, diffused over almost the whole globe, is also not rare in the southern U. States, where Beyrich collected it (the label does not give the exact locality); Dr. Engelmann sent it from the Hot Springs of Arkansas; Rugel from Aspalaga, Florida; and according to E. Tuckerman, it is also found in Alabama.

Cheilanthes.—I refer to this genus Buckley's *Pteris Alabamensis*,* and namé it *Ch. Alabamensis.* It is a very distinct species, which has also been collected by Rugel on French Broad River, Tennessee, and is preserved in Shuttleworth's herbarium from Capville, Upper Georgia; it is now also cultivated in the Leipzic botanic garden. It resembles *Ch. micromera*, Sw.; and my *Ch. Linkiana* (*Ch. micromera*, Link), *Ch. vestita*, Sw. (*Nephr. lanosum*, Mich.), appears to be common in the southern states. I have seen specimens collected by Beyrich near Augusta, Georgia; by Leibold on the western frontiers of Arkansas; by Duerinck in Missouri, in Carolina, (Schweinitz,) and on the Broad River Mountains, North Carolina, by Rugel. *Ch. tomentosa*, Link, (Fil. Spec. h. bot. Berol, p. 65, raised from Mexican spores, now common in European gardens, is new for the flora of the United States. Rugel collected a few specimens with the former in North Carolina, and Prof. A. Gray has sent me specimens from Tennessee under the name of *Ch. vestita.* Cultivation does not alter it in the least. It is quite probable that some of the numerous species of Mexico may yet be discovered in the southern states.† *Ch. dealbata*, Pursh, is a *Nothochlæna*, (see above.)

Dicksonia.—Michaux's name, *Nephr. punctilobulum*, not as commonly spelled, *punctilobum*, has the priority (1803); Schkuhr's name, *Dicks. pubescens*, was published 1809, and Willdenow's, or rather Muhlenberg's mss. name, *Polypod. pilosiusculum*, dates only from the year 1810. Desvaux has founded his genus *Litolobium* (not *Sitolobium*), Prodr. 262, on this species; but the peculiar characters are not sufficient to warrant a generic separation, and I refer with Hooker this plant again to *Dicksonia*, and name

---

* This Journal, 1843, p. 177.

† On the calcareous rocks of the Hot Springs of Arkansas, I collected together with *Ch. vestita*, a second species, which Prof. A. Braun considers identical with the West Indian *Ch. microphylla*, Sw.—*Engelmann.*

it *D. punctilobula.* I have specimens from the West Indies, (Ryan,) Tennessee and North Carolina, (Rugel!) Ludwig collected in Louisiana a fern, specimens of which I received from Lucæ's herbarium, and which resembles very much *D. punctilobula;* but it has more acutely dentate segments, rhachis and veins below, sparsely covered with short hairs, very large sori without any trace of an indusium, which is still plainly distinguishable even in fully mature specimens of *D. punctilobula.* It is impossible to decide about this plant without examining younger specimens, which I hope botanists of the Southern United States will be induced to do. It may possibly be a peculiar *Polypodium?* Muhlenberg's specimen in Willdenow's herbarium, is plainly *D. punctilobula.*

CYSTOPTERIS.—*C. fragilis* has been sent by Dr. Engelmann from Missouri, (rocks on the Merrimac Springs.) The specimens sent from Labrador by Kurr and Breutel,—from the Broad River Mountains, North Carolina, by Rugel,—those from Pennsylvania and New England, seen by me, all belong to *C. tenuis,* Schott, which appears to be well distinguished from *C. fragilis,* and not a variety of it, as Hooker states; the distinguishing characters remain constant in cultivation. *C. bulbifera,* Bernhardi, grows also near Painted Rock, below the Warm Springs in North Carolina, (Rugel!)

HYMENOPHYLLUM.—I have not yet seen any North American specimens.

ISOËTES.—Prof. A. Braun has published his investigations on this genus in Flora or Bot. Zeitung, 1846, No. 12.* I have only to add to this valuable paper, that *I. lucustris* has been communicated to me by Mr. E. Tuckerman from New England. The mention made of an *Isoëtes* from California, is based on a mistake of Bory's, who speaking of *I. flaccida,* put California for Florida. *I. flaccida* has only an apparent affinity with *I. longissima,* Bory; the spores of this last are large brown, with membranaceous margin, minutely and sparsely farinaceous.

MARSILEA.—I am acquainted with three North American species: *M. vestita,* H. and Gr., common on the Columbia River in Oregon, collected by Douglas and by Geyer; *M. uncinata,* A. Braun, collected by Dr. Engelmann on the banks of the Arkansas, and by Beyrich on the Washita in Arkansas; and a third species found by Drummond in Louisiana, the fruit of which I have not seen.†

---

* A translation has been published in this Journal, ii ser., iii, p. 52, January, 1847.—E.

† Compare Notes on Marsileæ, in this Journal, ii Ser., iii, p. 55, Jan., 1847. Drummond's plant, mentioned by Kunze, is doubtless *M. macropoda,* Engelm., in this Journal, l. c., described from specimens collected by Lindheimer near the Matagorda Bay in Texas. *M. macropoda:* stipitibus supra basin petioli ortis pluribus (2–5), basi connatis, receptaculo ter quaterve longioribus, erectis; receptac-

SALVINIA.—I have not seen this plant from the United States.

AZOLLA.—*A. microphylla*, Klfs., from California, is certainly distinct from *A. caroliniana*, though Hooker unites them. The latter species was collected by Drummond about New Orleans.

ART. IX.—*On the Beneficent Distribution of the Sense of Pain;* by Mr. G. R. ROWELL.

Read before the Ashmolean Society of Oxford, 3d May, 1847, and communicated by the Author, to the Edinb. New Phil. Jour., vol. xlii, p. 385, from which it is here cited.

HAVING had, in my youth, an aversion to animal food, from an idea that it was cruel to destroy life for the purpose of obtaining it, I have been led by that feeling, and a few rather extraordinary circumstances which have come under my notice, to pay some attention to the effects produced by injuries to various animals; which investigation has caused such a complete change in my opinions on the use and distribution of the sense of pain, that, so far from considering it an infliction, I now believe it to be one of the most necessary senses we possess; that, like all other senses, it is given to animals in as great a degree as it is necessary and useful to them; that no animals have a greater sense of pain than is necessary for the preservation of the class to which they belong; that those which are designed for food, suffer little when killed, in comparison to what other animals would feel from the same infliction; and that some are totally devoid of the sense of pain.

---

ulo ascendente, oblique securiformi versus basin angustato, margine superiori minore, inferiori magis convexo, lateribus compresso; rhaphide brevi, dente inferiori obtuso divergente, superiori vix ullo; receptaculo coriaceo indurato, fusco-atro, cicatricibus concoloribus scabrato, paleis angustis persistentibus tecto; soris utrumque decem; foliolis flabelliformibus, margine arcuatim excisis, apice integris, utrumque albo-pilosis.

Very distinct from the other North American Marsileæ, it approaches an undescribed species from New Holland, *M. Drummondii*, A. Braun, MSS., nearer than any other. What I formerly called *stomata*, (vide this Journal, l. c.,) I find now to be nothing but the *cicatrix*, or the place of insertion of the paleæ. In the other North American species: these scars have a red margin, which is wanting in *M. macropoda*.

A fourth species is *M. mucronata*, A. Braun, collected by Geyer in the Northwestern Territory, (this Journal, l. c.)

A fifth has been collected, 1837, by T. Lindheimer in Western Texas, on the upper waters of the Guadaloupe River.

Marsilea tenuifolia, Engelm. MSS.: stipitibus singulis e basi petioli ortis, receptaculo dimidio brevioribus; receptaculo ascendente, oblique obovato, margine superiore vix convexo subrecto, lateribus compresso; rhaphide brevi, dentibus approximatis superiore inferiorem paulo superante; paleis brevibus, adpressis, sparsis, cicatricibus rubro-marginatis; soris utrumque 9–10; foliolis angustis oblique lanceolatis, apice oblique truncatis, inæqualiter dentatis, parce adpressi pilosis.

Nearly related to *M. mucronata* and *M. vestita;* but distinguished by the shorter stipe, more erect fruit, and shape of the leaflets.—*A. Braun.*

In submitting this paper to the consideration of the Ashmolean Society, I beg to state distinctly, that I do not pretend to any knowledge of anatomy, but have been led to my conclusions by what appears to be the effect of injuries upon different animals. I do not attempt to assign any cause for the difference of the amount of pain, whether it be that the nerves are less sensitive, or less numerons in some classes than in others, or whether it is owing to the want of reflecting faculties, but only to show that there is such a difference.

I do not know that there is any thing new in the opinions I advance; but as I have had more than ordinary opportunities of witnessing the effect of wounds on some classes of animals, I submit this paper, believing that the consideration of the subject is calculated, in the highest degree, to excite feelings of gratitude and admiration of the merciful designs of Providence; and as the discovery of the use of the vapor of ether has recently brought the sense of pain under the consideration of this Society, I hope the paper will be in some degree interesting.

There can be little doubt that the sense of pain is of the first importance to man, to guard and warn him from injury. The skin is very sensitive, the body being thus enveloped in a membrane susceptible of the slightest injury, while the heart, lungs, brain, and other vital internal parts that are thus guarded, are almost insensible; but although the lungs are, in a great degree, insensible of pain during consumption, they are extremely sensible of the impurities of the air, thus guarding against the inhalation of anything injurious. As the hands, and especially the fingers, are very liable to injury, the sense of pain is great in those parts; and I believe there may be more real pain from a gathering in the finger, than from very many of the most fatal complaints. The exterior coating of the eye is extremely sensitive; while the back and interior portions of that organ are almost insensible. The sense of pain in the mouth guards the throat, and in the stomach is a warning against our eating anything that is injurious. Rheumatic pains are bad; but how many more fatal cases would arise from colds, &c., if man was not warned by pain and inconvenience of the bad effects upon his constitution of sudden changes of temperature.

One of the best ways to judge of the value of anything, is to consider how we could do without it; and it will be well to do so in the present case. Thus, if a man had not the sense of pain, he might sit by a fire, and in his absence of mind, put his foot upon it, and soon find himself *minus* that useful member; he might have lime blown into his eyes, and thus loose his sight if not warned by the pain; in fact, there would be no end to his dangers if not possessed of that useful monitor, which guards him from injury, and is a check to his excesses. There may be pains and sufferings, the use of which it may be difficult to see; but I would rather attribute this to a want of knowledge, than believe that the rule which holds good in so many cases does not hold good in all. In fact, the beneficial use of the sense of pain to man is so evident, and has been pointed out so long since in Paley's Natural Theology, that I should not have said anything upon the point, but that I considered it necessary for the elucidation of my subject, as regards its uses and distribution among the lower classes of animals.

Before I enter farther upon the subject, it will be necessary to consider what may be taken as a *proof* of pain; convulsions are considered by many as a sign of suffering, but I believe it is generally allowed by the medical profession that the opinion is erroneous: the cry of animals cannot always be depended on as indicative of pain, which is proved by the noise a pig will make when taken hold of. It is also necessary to make allowance for the struggling under restraint which is natural to all wild animals. The only criterion to decide the question is to consider what is the effect of mutilations on the health of animals, and how far such injuries interfere with their usual habits and appetites.

I will now state a few cases, to show that injuries, apparently the most dreadful, have but little effect on many of the brute creation.

The first case which forcibly took my attention, was seeing a horse that was feeding by the side of the road between St. Clement's and Headington hill, have its leg broken by a coach-wheel passing over it just above the fetlock joint; the poor beast showed evident signs of pain at the moment, the bone being dreadfully crushed, and protruding in parts through the skin. A number of persons collected around, but no one liked to dispatch it, and on their standing aside, so that it might get out of the way of things passing, the moment the horse got to the side of the road it began grazing, showing no other sign of pain than holding up the injured leg.

Another case is that of a post-horse, which was going along the road between Botley and Ensham, about twelve years since, when it came down with such violence that the skin and sinews of both the fore fetlock joints were so cut that on its getting up again the bones came through the skin, and the two feet turned up at the back of the legs, the horse walking upon the ends of the leg bones. The man who was with it would not consent to its being killed till he had informed his master, (who, I believe, was Mr. Masters of Staple Hall Inn, Witney;) the horse was therefore put into a field by the road side, and was found the next morning quietly feeding about the field, with the feet and skin forced nearly half way up the leg bones, and where it had been walking about, the holes made in the ground by the leg bones were three or four inches deep.

A similar accident once happened to a coach-horse, the property of the late Mr. Costar of Oxford; it was found, when the coach stopped to change horses, to have dislocated the fetlock joints, and from the worn appearance of the ends of the leg bones, must have run a considerable distance along the road in that state.

I do not lay much stress on this case, as it is not very surprising that a spirited horse, in harness with others, should continue running under such circumstances; but in the former case, there was nothing to excite the horse but its hunger, and if the pain had been equal to what such a dreadful injury would seem to indicate, it would probably, if in ever such a famished state, have gone upon its knees to feed, rather than upon the injured parts.

It is curious to observe the apparent indifference with which some animals will devour parts of their own bodies. I once kept tame dormice, and, in shutting the cage door, accidentally caught the tail of one of them, when it squeaked out and left the skin of about two thirds of its tail sticking to the door. Whether the cry was caused by pain or fear, I cannot decide; but it went about the cage for a few minutes apparently rather uneasy, it then took hold of its tail with its paws and eat all the injured part, and then seemed as well as ever.

Rats will often eat their tails when in confinement, if kept short of food; and the habit of eating their own tails is not uncommon amongst the monkey tribe. I know a person who used to dip the end of his monkey's tail in tobacco water to keep it from being eaten, and some of the monkeys in the London Zoological Garden may at times be seen enjoying themselves in this way; but from whatever cause this propensity may arise, I believe it is never indulged in by the monkeys with prehensile tails; their tails seem to be too useful to be so wantonly disposed of, and I have no doubt are therefore possessed of a much greater share of the sense of pain.

A few years since, the Quarterly Review, in a notice of the Dean of Westminster's work on the bones found in the cave at Kirkdale, stated that an old hyena kept in the Jardin des Plantes at Paris, had its leg broken, when one night it bit off the leg at the broken part, and eat it.

The emasculation of large cattle seems a very barbarous operation, the parts being cut with hot instruments; yet I saw an aged bull after undergoing that operation, walk away very unconcernedly, and then after grazing for about half an hour, he lay down and chewed his cud apparently quite comfortable.

Pigs make a sad outcry when being killed, but I believe it is caused by fear and the uncomfortable way in which they are held, rather than by pain. I once saw a large pig which had been stuck, get away from the men who were holding it, and there was not the least cry after it had got out of their hands, although it was bleeding to death; when smaller pigs are killed by sticking them, and then letting them run about till they drop, there is no cry after they are let go; and if stuck skilfully, without taking hold of them, there is no more noise than a mere grunt or squeak, about the same as there would be if the pig had a slight blow with the end of a stick; and I have no doubt that a pig may feel more pain from a heavy blow, than from being killed in the usual manner. When it is considered that the nose of a pig is so very useful to the animal from its habit of routing in the earth, and may therefore be very sensitive, it does seem probable that the opinion is correct, that a pig feels more pain from having a ring put through its nose, than in being killed.

I have stated these cases to shew that the pain felt by brutes is much less than would be felt by man under similar injuries. My object is to shew the probability, that as the sense of pain is not so necessary or useful to brutes, they have it in a less degree.

In the next class of animals to which I shall allude, that is, rabbits and hares, I will endeavor to shew that the use of the sense of pain is, in a great degree, or almost completely, superseded by other senses, and that their sense of pain is very trifling, compared to that of most other quadrupeds. There can be little doubt that, although so very prolific, very few rabbits or hares in a wild state die of old age, as they are the food of a large class of beasts of prey. Foxes, wild-cats, martins, pole-cats, stoats and weasels, could not exist without them; they are their natural prey, against the least of which the rabbit or hare has no means of defense when once caught; therefore the sense of pain would be of no use to them, either to warn them from danger or to cause them to exert themselves to escape; but a slight examination of the form of both rabbits and hares, will shew that they have other means of defense: their eyes are not placed in the front of the head as in beasts of prey, but on the side of the head, very prominent, so that they are enabled to see before, behind, and all around them; their ears also can be turned this way or that way to catch the slightest sound, added to which, they have a degree of timidity which keeps them always on the alert.

With regard to their sense of pain, it is well to know that a hare never, or very seldom, cries out when shot, even if she receives her death-wound, if she can run a few yards and hide herself; but if her legs are broken, or she is in any way stopped from running, even if caught in a net, which can give her no real pain, she utters most piteous screams; when followed by dogs, her screams always begin before they have actually caught her, and it is worthy of notice that she is much more readily dispatched than perhaps any other animal of her size.

Rabbits resemble hares in this respect, as they utter no cry when wounded, but will do so from fear; if run down by a stoat or weasel, they always cry out when the enemy gets within two or three yards of them, and are generally so terrified that they lie down and are caught; therefore the cry in this case is evidently from fear.

I one day disturbed a rabbit which ran away in so singular a manner that I followed it, and saw that the flesh had been eaten away from the back of the head to the top of the shoulders; the sight was so sickening, that I turned away, thinking the poor creature could not live many minutes. About two hours afterwards, I went with a view to pick up and examine the rabbit, and when I came to the spot, was surprised to see it jump up and run away as before; the person who was with me ran after it, the rabbit ran into a bush and he caught it. Now, although the poor thing was so injured, there was no cry when I first disturbed and ran after it, or when it was disturbed and followed the second time, but the moment it was caught it began to cry out, showing that fear could excite a cry which all its sufferings could not do.

When rabbits are caught in traps, if not taken out in a short time they are almost sure to escape, either by breaking away by force from the trap, and tearing off the leg, or by biting the leg off. These traps are made to clasp very strongly, but to prevent escape as far as possible, they are made purposely not to close nearer than about the eighth of an inch, and the teeth are rounded so as not to cut; but rabbits are so indifferent to pain that I have seen their legs left in traps with the sinews attached to them, just as the sinews are drawn from the fowl's legs previous to cooking, and yet although the bone is so broken, and the muscles and sinews torn apart in this manner, it seems to have little or no effect on the health of the animal.

I have seen them caught after having recently lost a leg, and to all appearance, in as good health, and as fat, as if nothing had happened to them. A short time since, I saw a rabbit caught which had but one leg, having lost one hind-leg apparently some time, and the two fore-legs very recently, but although the poor animal had been obliged to go along as it could with its one leg and the bare stumps of the others, it was in good condition and healthy.

Rats will bite off their legs in a similar way, and escape; but I do not know of any animal which is strictly a beast of prey, or rather a hunting animal, that will do so. I have never known a cat, polecat, or such animals do it, although they may sometimes lose a leg in a common trap which shuts close and is apt to cut; and I have lately known a fox found in a wood in a dying state, from starvation, with a trap on its leg, an incumbrance that a rabbit would have been free from in a very short time.

These facts, will, I believe, bear me out on the point, that the sense of pain is for the preservation of animals, by compelling them to take due care of themselves, and that no animal has a greater share of the sense of pain than is necessary for the preservation of the class to which it belongs. The loss of a leg must be a great inconvenience to any quadruped, but rabbits or rats may still procure food without it; even the case before alluded to of the hyena, does not tell against it, as the hyena does not get its food by swiftness of foot alone, nor is its foot the weapon of attack, as with the cat tribe; but if a fox, wild-cat, polecat, or any animal of that description, loses its leg, it is a great chance if it does not die of starvation, unless its prey be very plentiful; therefore, as the legs are of so much importance to these animals, they seem to be endowed with a sense of pain in proportion to their usefulness, as a guard for their preservation.

From the ease and indifference with which crabs and lobsters will throw off their claws, when under the influence of sudden fright, or when their claws are injured, it is evident that their sense of pain from mutilation must be very little; and, according to the argument I have advanced, it may be asked, of what use can the sense of pain be to any of the crustaceous tribes? They are coated in armor sufficient to protect them from all minor enemies, and if they get into the power of an enemy strong enough to crush through their shells, of what use can the sense of pain be to them then? But they shew signs of great pain when thrown into boiling water, and I see no reason why they may not be insensible to pain from mutilations, and yet be sensible, in a high degree, to pain from extreme changes of temperature; for, as there are no bounds to prevent their ranging over all parts of the sea, it is probable that a sense of temperature is necessary to them, and many other animals also, to keep them to those parts of the world which they are formed to inhabit. It may also be useful to keep them to those parts and depths in the sea that are necessary for their young to arrive at maturity.

From the observation of Sir Humphry Davy, and others well acquainted with the habits of fish, it is very probable that the sense of pain in many of them is very trifling; and when we consider the fecundity of the cod, and many other fishes, the number of eggs deposited by a single cod-fish in one season (according to Leuenhœck, upwards of nine millions), and bear in mind, that unless these fish more than double their numbers annually, that of the myriads of fishes that are hatched from these eggs, not more than three or four, on an average, can arrive at the same maturity as the parent fish, the others being all destroyed at different stages of their growth, being the food of other animals; it does seem probable that there is a similar dispensation of mercy to them, as I have endeavored to shew there is to rabbits and hares.

Many cases may be brought forward to shew the absence of pain in insects. I have seen a wasp eat a fly almost immediately after a portion of its own abdomen had been cut off; I have also seen a cockchafer crawling and eating on a hedge after its abdomen had been emptied of the viscera, probably by some bird. It is well known that a dragon-fly will eat freely for a considerable time while confined by a pin through its body; and every one who has collected entomological specimens, must know the difficulty in killing some of the larger moths. But as this paper is already much longer than I originally intended, I shall say no more on this point, as the remarks on the subject in the introduction to Kirby and Spence's Entomology are very generally known.

It may be well to reflect for a moment on the constant slaughter that is going on among the lower class of animals. The number of flies eaten by a single pair of swallows and their young must be immense.

I once observed a rather extraordinary illustration of the law of nature to eat and be eaten. I kept in a glass globe a variety of the smaller aquatic animals, such as the larvæ of the dragon-fly, &c., and one day introduced among them a few of the common water newts and water beetles, one of which was the Dytiscus marginalis. The dragon-flies had been living upon the animalculæ, &c., the newts attacked and devoured the dragon-flies. The next morning I found one of the newts lying at the bottom of the vessel half-eaten, and, while looking on, saw the ditiscus attack another newt. Not wishing to have them all destroyed, I took the ditiscus out of the water, and put it in the sunshine a few minutes, when it flew away, and had not gone more than thirty or forty yards when a sparrow flew after and caught it. This constant destruction of life would be fearful to contemplate, if there is truth in the quotation so often made, that "the poor beetle that we tread upon, in corporal sufferance finds a pang as great as when a giant dies."

April 19, 1847.

Art. X.—*On the Absorption of Carbonic Acid Gas by Liquids;* by Prof. W. B. Rogers, and Prof. R. E. Rogers, University of Virginia.

Since the experiments of Dalton and Henry of Manchester, and the more elaborate researches of Saussure on the absorption of carbonic acid and other gases by various liquids and solids, this branch of enquiry seems to have been regarded by chemists as in a great degree exhausted, and unlike most of the researches of that earlier day, has failed to command any extensive re-investigation.

The experiments forming the subject of the present paper, extend over a part only of the ground occupied by those of Saussure, but although confined to the absorption of carbonic acid, they embrace many liquids not referred to in his enquiries, or in the similar but less varied observations of Dr. Henry. We believe that they furnish much more accurate results than the simple but rather rude methods used by these experimenters could be expected to afford. Besides a great number of results obtained with different liquids and solutions at 60°, they include in the case of water a series of determinations at *various stages of temperature*, from 32° to 100°.

Apart from the general value which in a scientific sense must always attach to the determination of exact numerical constants in subjects of this kind, there are points of the present enquiry which claim attention from their bearing upon certain other branches of research. It will be seen, for example, in the sequel, that the absorption of carbonic acid gas by sulphuric acid at ordinary temperatures, is far greater than chemists have hitherto suspected, and that the processes in which this gas, before being estimated, is made to pass through or over a considerable volume of sulphuric acid, may lead to errors which although hitherto unnoticed, are too important to be overlooked.

In a paper, *on the analysis of the carbonates*, published in the American Journal of Science in 1844, we called attention to the fact, that in using sulphuric or hydrochloric acid for decomposing the carbonates, the resulting solution or mixture always retains an amount of carbonic acid too great to be neglected in accurate research, and that this gas cannot be expelled without the use of *a continued boiling heat*. Some experiments undertaken in the hope of ascertaining precisely the absorbent power of these acids and solutions, led us into the more extensive field of enquiry, of which we propose now to embody the results.

Availing ourselves, at first, of the simple methods employed by Dalton, Henry and Saussure, we found that with all care in the manipulation and in applying the proper corrections, we were unable to attain consistent and reliable results.

In operating with a graduated tube over mercury, as was practised by Dalton, and by Saussure for the more absorbent liquids, the great slowness of the absorption in many cases, rendered it impossible to determine, even after some days, whether the action was still in progress or had ceased, and the form of the apparatus made it unsafe and almost impracticable to apply that *brisk and continued agitation*, which is the only means of greatly expediting the absorption. With some liquids, such as sulphuric acid, the penetration of the gas is so extremely slow, that without this mechanical aid, weeks of exposure would probably be necessary to complete the absorption. Yet by continued and thorough shaking for thirty minutes, this result is attained so perfectly, that no prolonged exposure afterwards indicates a continuance of the absorption. The importance of attending to this point in constructing an apparatus for experiments in absorption, is evident from the fact that while by our observation, which occupied generally less than thirty minutes, sulphuric acid of common density was found to absorb 98 per cent. of its volume of the gas, Saussure's experiments, which continued for one or more days, make the absorption only 45 per cent.

The difficulty and uncertainty of the method above mentioned, is moreover increased by the necessity of restoring the instrument to the standard temperature before measuring the absorption, and of taking account of the change of barometric pressure in the interval. To these objections must be added the errors of measurement due to the weight of the column of liquid above the mercury, as well as the large diameter of the tube in which it was necessary to operate, and lastly, the consideration that this method is inadmissible where we are operating with liquids, which like nitric acid and many saline solutions react with mercury.

Results as little satisfactory attended our trials with the other process of Saussure. In this mode of operating, which he adopted in cases where the absorption was small, the liquid and gas are brought together in a well stopped bottle, and after continued agitation for some time, the absorption is measured by removing the stopper in an immersed position. But here, besides the difficulty of making the absorption in a precise manner, we encounter a more serious objection in the fact, that the rarefaction of the remaining gas causes the absorption to cease before reaching the full amount proper to an undiminished pressure. This evil may, it is true, be rendered insignificant in cases where the absorption is slight, by using as Saussure did, a volume of gas many times greater than that of the liquid; but with carbonic acid, such a procedure would in most cases call for so large a volume of gas as greatly to increase the errors arising from a slight variation of temperature during the experiment, while it would augment the difficulty of securing the coincidence of temperature required.

In the syphon formed apparatus used by Dr. Henry, the flexible tube beneath, facilitates the experiment by enabling the operator to apply agitation to the wider limb containing the gas and liquid, but the results are exposed to error from the dilation of the flexible connection and from the effects of concussive compression caused by shaking a large mass of mercury with the gas and absorbent liquid. Of course, this method is inapplicable where the liquid reacts upon the mercury.

From what has now been stated, it will we think be apparent that the modes of experimenting on this subject, used by the distinguished chemists referred to, were not adapted to an accurate determination of the absorbent power of liquids. To be capable of precise results, the absorbing apparatus must fulfill the following conditions:—

First. It must provide means for maintaining the temperature uniform throughout the experiment.

Second. It must maintain the tension of the gas unaltered.

Third. It must afford means for rapid and continuous agitation of the liquid with the gas.

Fourth. The tube in which the absorption is measured by the mercurial column, must be apart from the vessel in which the absorption occurs, and the mercury must not be introduced into that vessel.

In view of these requisites we were led, after many unsatisfactory trials with other arrangements, to the form of apparatus represented in the accompanying diagram, (see next page,) which, besides greatly expediting the experiments, affords uniform and consistent results seldom varying in successive trials, to the extent of one per cent., and which is equally applicable to all liquids.

Absorption Apparatus.—This consists of a gasometer A, plunged in a large wooden reservoir B, containing water to the level indicated in the figure, adjoining which is a smaller but taller reservoir C, of glass, also containing water. In the latter is immersed, in a fixed vertical position from the strong frame above, a syphon-shaped measuring tube with a finely graduated scale between the limbs. A horizontal arm of thick barometer tube extending from the top of this, is united by a short gum-elastic joint, with a similar tube which bends down over the edge of the frame and is inserted below into the actual opening of the absorption flask D. Cylinder thermometers graduated to tenths of a degree are placed in the gasometer, large and small reservoir, and flask. [Figure 2 is a larger view of the flask.]

The main reservoir, charged as indicated in the figure, contains five thousand six hundred cubic inches of water, the smaller one, of glass, six hundred cubic inches, and the gasometer three hundred cubic inches. The large volume of water in the reservoirs, serves to maintain an almost absolute uniformity of temperature in the flask and measuring tube during the experiment. The capacity of the flask usually employed by us, is 6·2 cubic inches. The measuring tube is read to $\frac{1}{200}$th of a cubic inch.

A long winding leaden tube serves to conduct the gas from the gasometer to the flask in the process of charging the latter, and being plunged in the water of the large reservoir, secures us against any variation of temperature in the gas, which might arise from the reaction of the materials in the gasometer. The gas will thus in all cases have the temperature of the main res-

Fig. 2.

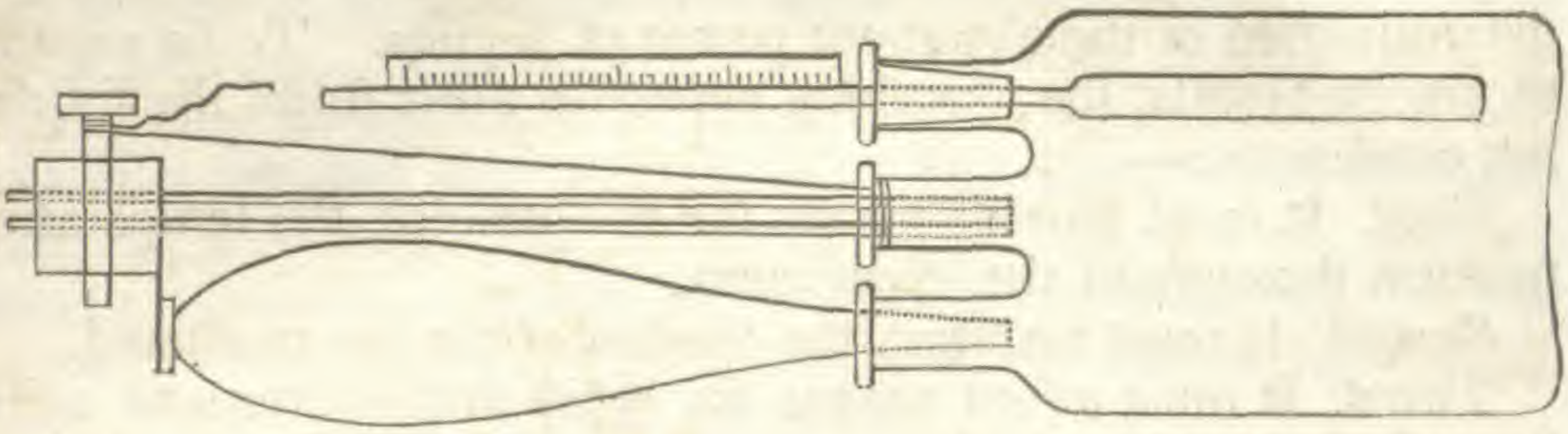
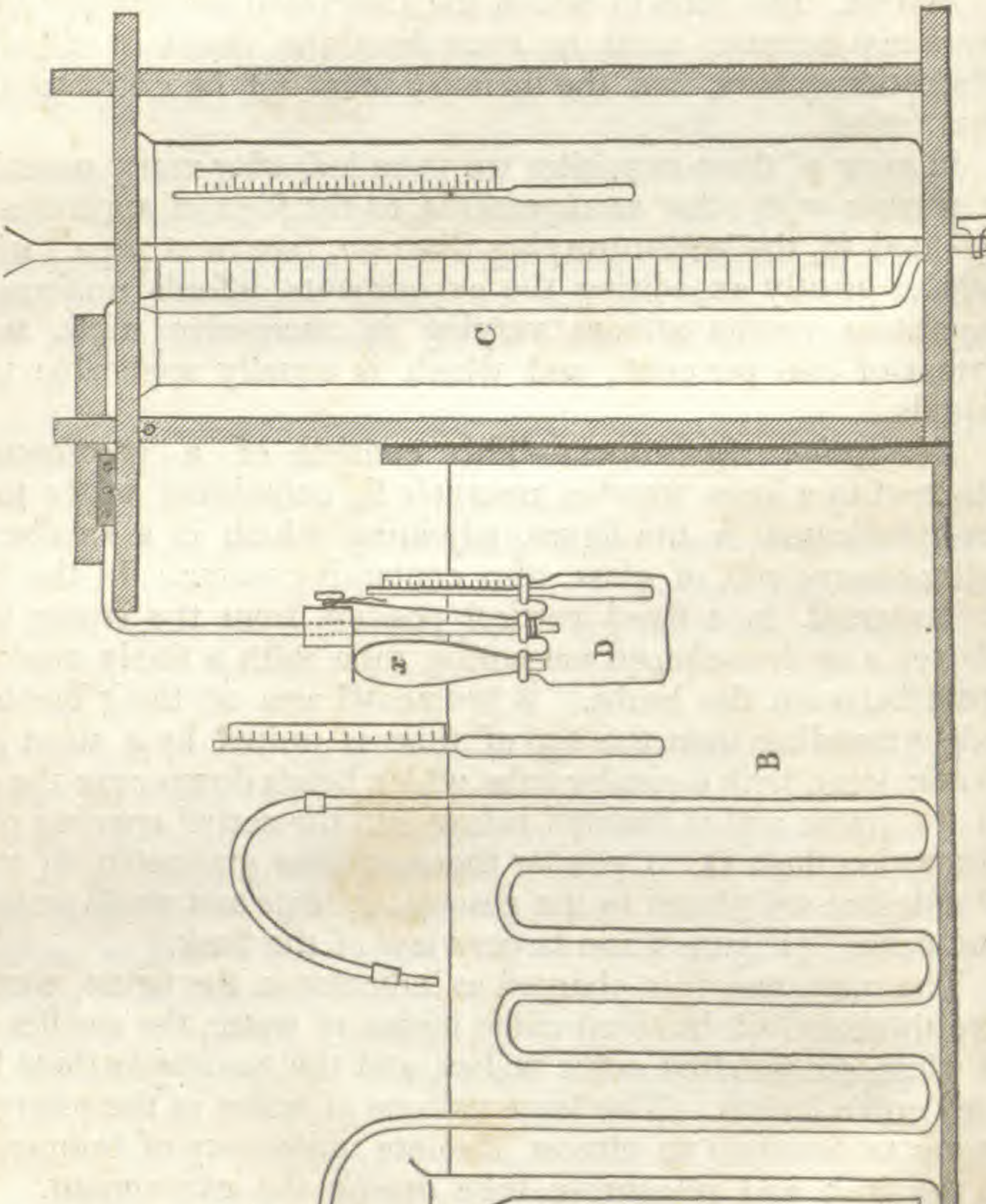


Fig. 1.



ervoir, when conveyed into the flask. The end of this tube is mounted with a close cork and smaller glass tube, to be placed in the near opening of the flask when the gas is to be passed into the latter and the measuring tube.

Connected with the flask is a movable vessel x, adapted by accurate grinding to the mouth of the former, and designed to contain the liquid whose absorbent power is to be determined. This *unit bottle* as we will call it, has its opening below contracted to about *one-eighth of an inch*, so that when filled with the liquid and connected in an inverted position with the flask, as in the diagram, *the liquid is in no danger of flowing out.* When thus inserted in its proper position, it is confined in place by the strong pressure of a steel spring, attached to the central tube of the flask, and which by a revolving motion is then brought to press by a leather cushion upon its upper end. This secures the juncture at the stopper perfectly air-tight during the active agitation of the flask.

The central tube is in like manner ground to an air-tight joint at its insertion into the flask, and the connection is forcibly secured by a strong cord wrapped around the neck and then passed around a screw peg inserted in a wooden block which is firmly cemented to the tube above. To avoid all chance of leakage at this and the junction of the unit bottle with the flask, a very delicate coating of tenacious cement made of beeswax, rosin and tallow, is applied to the upper part of the ground surface. This from its very minute amount, and its removal from the gas in the interior, is incapable of exercising any appreciable absorbent effect. Indeed we have found that even with a large mass of this cement placed in the flask, the effect is quite insignificant.

The flask suspended by the horizontal part of the tube just described, hangs, when in its natural vertical position, at such depth as to immerse about half the length of the unit bottle. The agitation is given by a hooked rod which embracing the central neck, is moved to and fro longitudinally, and causes the flask to swing as rapidly as the operator pleases, the axis of motion being the part of the horizontal tube which is external to the flexible joint, and lies upon the wooden frame near its end. The rest of the horizontal tube is connected with the measuring tube, and firmly attached, along with the latter, to the horizontal bar of the frame. This slides up and down upon the vertical supports, and can be adjusted to a proper position by the movable pins seen in the figure, immediately beneath it, or can be lifted off, carrying the measuring tube and flask. To secure the axis tube from lateral motion during the shaking, a wooden block descends by a hinge over the flexible joint and this tube, and embracing them in a longitudinal groove retains them in place.

The stop-cock at the bottom of the measuring tube is used for adjusting the level of the mercury in the two limbs at the beginning of each experiment, and for removing the mercury which is poured in through the funnel above, to maintain the columns at the same height during the progress of the absorption.

It will be seen from the figure, that while the flask and measuring tube are both constantly immersed as the experiment is going on, and are thus kept at an invariable temperature, the connecting tube, between the two levels of water, is necessarily out of the liquid, and must be influenced by the temperature of the ambient air. The capacity of this exposed part of the tube was found to be very nearly $\frac{2}{10}$ths of a cubic inch, the expansion of which for 1° is equal to $\frac{1}{2600}$ cubic inch. As the temperature of the apartment seldom differed from that of the apparatus by more than some four or five degrees during our experiments, the entire error would be within $\frac{1}{500}$th of an inch, while as before mentioned, the smallest reliable reading of the measuring scale is $\frac{1}{200}$th cubic inch. It has therefore been thought useless to attempt any correction for the temperature of this part of the enclosed gas.

Mode of Manipulating.—From the description just given of the several parts of the apparatus, the general method of operating with it will be readily inferred, and but few words need be added on this head.

Bringing the entire apparatus to the required temperature, (60° in most of our experiments,) the unit bottle, charged with the liquid to be used, is hung in the large reservoir, to attain exactly the same temperature. The back of the gasometer pipe is inserted in the flask air-tight, and a brisk stream of carbonic acid is suffered to flow through the apparatus for five minutes. Some mercury is now poured by a long funnel into the measuring tube to arrest the current. The flask being raised so as to lay bare the mouth, the cork is withdrawn, and at the same moment, while the stream of gas is pouring out and overflowing from the flask, the unit bottle is secured in the opening and fastened by the spring above. After swinging the flask down to its vertical position, the level of the mercury in the measuring tube is carefully adjusted, and the agitation is now commenced. The liquid at first descends only by drops, but soon begins to flow more rapidly. The vibratory movement of the flask is of that sudden kind which effectually brings the gas and liquid into intricate contact—and the absorption rapidly proceeds. Two operators are necessary in conducting the experiment, one to keep up the shaking, and the other to supply the outer limb of the measuring tube with mercury as the column on the other side ascends.

With water, we have found the absorption to be completed in about five minutes. The oils, dense saline solutions and sulphuric acid, require a longer time, but even with the last named substance which is one of the most sluggish in its action, the absorption reaches its limit in less than thirty minutes.

Purity of the Carbonic Acid.—The gas used in our experiments was supplied by the reaction of dilute hydrochloric acid and fragments of calc spar, contained in the self-regulating apparatus figured in the preceding diagram. For sometime, after charging the vessel with water and acid, the gas evolved contains a marked proportion of atmospheric air, derived from the air originally present in the water, and which is slowly disengaged as the carbonic acid is absorbed by the liquid. This admixture with air was found to continue until the solution became well charged with the gas, and this result, in the ordinary use of the apparatus, was very slowly attained. To hasten the saturation, and thus bring the materials into a condition to furnish unmixed gas, the action of the acid liquid on the carbonate was renewed at short intervals, by opening the stop-cock of the reservoir, and in this way in a few hours the gas evolved was almost absolutely exempt from atmospheric air.

At the commencement of each set of experiments, a specimen of the gas, two cubic inches, was passed into a tube over mercury and tested by a moist fragment of caustic potash. When the contents of the reservoir were in a proper condition, the residuum of unabsorbed gas in this experiment was a *mere globule*, rarely more than $\frac{1}{20}$th of an inch in diameter, and therefore indicating from $\frac{1}{15000}$th to $\frac{1}{30000}$th of gaseous impurity.

Thus assured of the almost total absence of atmospheric air in the gas supplied under these conditions, our next precaution was to determine the degree of purity it retained, when transferred, as in our experiments, by simple displacement into the flask and measuring tube. For this purpose a V shaped tube, eighteen inches in each leg, with a stop-cock at the bend, was attached temporarily to a flask like that of the absorbing apparatus, and was charged by allowing a stream of CO_2 to pass through the vessel and tube steadily for five minutes. The stop-cock of the tube was then closed, the open end stopped with the finger, and the tube detached and inverted over mercury. The contents were now examined in the usual way with caustic potassa. In a number of such trials, made at different stages of our investigation, we found the amount of residual gas to range from about $\frac{1}{4000}$th to $\frac{1}{8000}$th of the entire volume employed. In the absorption apparatus, the charge of gas is probably less, and certainly not more contaminated with atmospheric air than in the trials just mentioned, and can therefore involve no sensible error from this source.

It remains to ascertain how far the CO_2, escaping from the gasometer, might be mingled with *hydrochloric acid.* The presence of this impurity was deemed so probable, that in our first experiments, a small vessel containing nitrate of silver was interposed in the current of issuing gas. Finding no milkiness to arise in the time required for the experiment, we prolonged the trial to a period of several hours, during which a stream of gas from the gasometer was passed in bubbles through the nitrate. But no precipitate was formed. This result, many times repeated, sufficiently attests the absence of *hydrochloric acid from the gas.* It is important, however, to remark, that using a *much larger proportion* of hydrochloric acid with the water of the reservoir, distinct traces of this substance may be detected in the issuing gas, and to remove all chance of error, therefore, after each new charge of acid, the gas was carefully tested by transmission through the solution of nitrate of silver.

Of the Hygrometric State of the Gas.—Excepting in the experiments on sulphuric and some other acids, the gas was transmitted through the long submerged tube into the flask, *without desiccation.* This course was rendered necessary by the fact, that in repeated trials, with gas previously dried and saline solutions, there occurred an irregular expansion of the gaseous volume in the first stage of the action, which did not show itself when the undried gas was used. Such an enlargement, due evidently to the rise of aqueous vapor into the dry space in the first moments of the agitation, being of variable amount according to the solution used, would form a serious obstacle to the exact measurement of the absorption.

In the case of the sulphuric acid and other bodies referred to as exceptions, this would not take place. On the contrary, the *presence* of aqueous vapor in the gas would here involve other errors, due to the absorption of the vapor by the liquid, or to the heat disengaged by their reaction.

The drying of the gas being thus prohibited in a great majority of the experiments, it became important to ascertain whether the carbonic acid, coming from the gasometer, was *saturated* with vapor, as in this case, from the *observed absorption of the moist gas*, it would be easy to compute the *amount of dry gas* which had actually disappeared.

For this purpose, the acid solution in the gasometer was allowed to continue its action until it became *entirely neutral.* A measured volume of the gas was then passed *very slowly* through a long drying tube of chlorid of calcium, previously counterpoised. By preliminary trials with an additional smaller tube, similarly charged, it was ascertained that scarcely a trace of moisture escaped absorption in the long tube. Before the second weighing of the latter, it was freed from carbonic acid by aspiration, the smaller tube being attached to prevent the entrance of atmospheric moisture. In repeated experiments thus performed, the weight of vapor contained in the gas was found to correspond closely with that proper to the temperature and a state of saturation. In other words, *the vapor mingled with the gas was at its maximum tension.* As in its neutral state, the liquid of the gasometer contained most dissolved matter, it was to be inferred that the effect upon the tension of the vapor rising from it would then be most perceptible, and that therefore in the working condition of the apparatus, the saturation of the vapor could not be less, although it might be a small fraction more. Similar experiments with the gas under these conditions gave us, however, the same results. We concluded, therefore, that the dissolved matter in the gasometer, is not in sufficient quantity to produce a sensible modification of the tension of the aqueous vapor evolved, and that in all our experiments, *we may assume the gas to be saturated with vapor proper to the temperature at which we operate.*

Of the Correction for Moisture.—This being deduced from the pressure of the atmosphere and the vaporous tension jointly, requires a record of the barometer for each experiment. By the equal adjustment of the columns in the measuring tube, the entire tension of vapor and gas together, is the same at the close as at the beginning of the experiment, and is measured by the height of the barometer. The tension of the vapor remains unchanged, because it is vapor of saturation, and is condensed into water in proportion as the gaseous space contracts in the progress of the absorption. If therefore V represent the *apparent absorption*, or the volume which has disappeared, and v the volume of dry gas in V, estimated under the full atmospheric pressure; and if p denote that pressure, in other words, the height of the barometer, and f the tension of the vapor proper to the temperature, we have $v = \mathrm{V} \cdot \frac{p-f}{p}$.

It is important to remark, that the tension of the gas under which this absorption takes place, is $p-f$, and not p, and that in tabulating the results, the corrected absorption should refer to *the actual pressure of the gaseous atmosphere* in the flask, and not to the entire atmospheric pressure.

From experiments upon the absorption of carbonic acid gas at *various pressures* by water, Dr. Henry, as is well known, was led to infer that equal volumes are absorbed at all pressures, or what is the same thing, that the quantities of gas absorbed are exactly proportioned to the pressures. This very simple law, if true, would render the correction for moisture superfluous. For in that case, the volume absorbed at the pressure $p-f$, would equal the volume absorbed at p. Thus V, the *apparent absorption*, that is, the volume disappearing at the pressure p, consisting partly of gas and partly of vapor, would be precisely the same as the volume of dry gas alone which would disappear at the same pressure. But further experiments are, we think, needed, to determine with precision the law of absorption as dependent on pressure, and in the mean time, the law of Henry can only be looked upon as approximately true. From observations on this subject in which we have lately been engaged, and which we hope to continue, we have been led to infer that, in comparing widely variant pressures, there is a marked departure from this law.

Although therefore, from the small difference of gaseous pressure (that between p and $p-f$) in our experiments, we believe that no sensible error could be introduced by applying the law of Dr. Henry to the results, we have thought it proper in reporting them, to state the volume of dry gas absorbed and the reduced pressure, as well as the apparent absorption and entire barometric pressure.

Having now presented all the details of our mode of operating, and of the precautions and corrections we have used, we proceed to give an account of the results, treating of them in the following order:

I. Of the absorption by water.

II. Of that by sulphuric and other acids, and by other unmixed liquids.

III. Of that by various saline aqueous solutions.

I. *Absorption of Carbonic Acid by Water.*—The water used in these experiments, as well as in making the solutions employed in others to be described hereafter, was prepared by careful distillation in a copper vessel. Its purity was such, that several cubic inches evaporated in a platinum capsule, gave no indication of alkaline matter to the most delicate test paper, and when entirely volatilized, left scarcely a trace of residuum. Before being used, it was briskly boiled for half an hour, quickly transferred to a well stopped bottle, and when sufficiently cooled, exposed to the exhausting action of a good air-pump. The bottle was then suspended in the large reservoir, to bring it to the proper temperature, before the charge was introduced into the flask.

The absorption was seen to begin as soon as the first drop descended from the flask, and with brisk agitation, the process was completed in about five minutes after the liquid was brought in contact with the gas. To satisfy ourselves that no further absorption would occur, we repeatedly prolonged the agitation to fifteen or twenty minutes, allowed the apparatus to rest, and again resumed the shaking, but without producing any appreciable change in the column of the measuring tube.

Although, from the purity of the gas used, the closeness of the apparatus, and the care with which it was charged with gas, we had no reason to apprehend *any dilution* of the CO_2, yet as such a change would cause the absorption to terminate short of the saturation of the liquid proper to an unmixed atmosphere of the gas, experiments were made to determine if any further absorption was caused by a renewal of the charge. This was done by removing the flask, driving a stream of CO_2 into the bottle, closing the orifice by an air-tight stopper, readjusting the levels, and submitting the liquid to further agitation. Repeated trials at 60°, gave no indications of additional absorption. We would therefore regard our results as furnishing a nearly accurate measure of the absorption of carbonic acid by pure water.

These results, together with the conditions under which the observations were made, are comprised in the following table.

Table of the Absorption of Carbonic Acid by Water, from 32° *to* 212°.

No. of Ex.	Temp. of CO_2 & HO.	External thermometer.	Barom. $=p$.	App. abs. by 100....HO.	Mean of app. abs. $=V$.	Mean abs. of dry CO_2 $=v$.	Tension of gas $=p-f$.	Abs. V reduced to 60°.
1	32°	54°	29·48	166·				
2	32	54	29·48	166·5	166·25	165·08	29·28	175·72
3	40	55	29·46	142·5				
4	40	55	29·46	142·	142·25	140·8	29·21	147·94
5	50	55·5	29·46	119·5				
6	50	55·5	29 46	120·5	120·	118·44	29·1	122·27
7	60	64·5	29·42	100·5				
8	60	64·5	29·42	100·2				
9	60	64·5	29·42	100·5	100·4			
10	60	65	29·25	100·5				
11	60	65	29·25	100·8	. .	98·5	28·82	100·5
12	60	65	29·25	100·5				
13	60	65	29·25	100·5	100·6			
14	70	72	29·21	85·5				
15	70	72	29·21	85·5	85·5	83·36	28·48	83·86
16	80	75	29·51	71·				
17	80	75	29·51	71·5	71·25	68·75	28·5	68·60
18	90	80·5	29·54	60·5				
19	90	80·5	29·54	61·2	60·85	57·78	28·18	57·50
20	100	80·5	29·54	54·5				
21	100	80·5	29·54	54·	54·25	49·83	27·68	50·39

On comparing the second and third columns in the above table, it will be seen that, in the observations from 50° to 80° inclusive, the temperature of the contiguous air in no case differed from that of the apparatus by more than 5°·5. Hence during the few minutes occupied in each experiment, the temperature even of the smaller reservoir experienced only a very slight and quite unimportant change, amounting in none of the experiments to as much as *one-tenth* of a degree. In the experiments at 40°, it was found easy to maintain a uniform temperature by a few fragments of floating ice, and in those at 32°, the use of a large amount of ice in both vessels, preserved the temperature entirely unchanged. The observations at 90° and 100°, were attended with a slight cooling in the small reservoir, which however, in no case exceeded one degree, an amount too small to produce any measurable change in the mercurial column.

The above table presents we believe the first systematic series of observations on the comparative absorption of CO_2, by water at different temperatures, yet made known. The experiments of Dalton, Henry, Manchester and Saussure, were made almost exclusively at 60°. The only results, referring to other temperatures, which we have seen numerically noted, are one by Cavendish at 55° and one by Henry at 85°. According to Cavendish the absorption by one hundred volumes of water at 55° is one hundred and sixteen. In Henry's experiment the same volume of water at 85°, is said to have absorbed eighty-four volumes of the gas. The latter result departs very widely from the mean of our experiments at 80° and 90°, which is about sixty-six volumes instead of eighty-four. The experiment seems to have been made with little care and merely to test the effect of a higher temperature upon the amount of absorption. The number obtained by Cavendish in his observation at 55°, corresponds more nearly with our results, which, taking the mean of the experiments at 60° and 50°, would be about one hundred and ten, instead of one hundred and sixteen, the number which he has given.

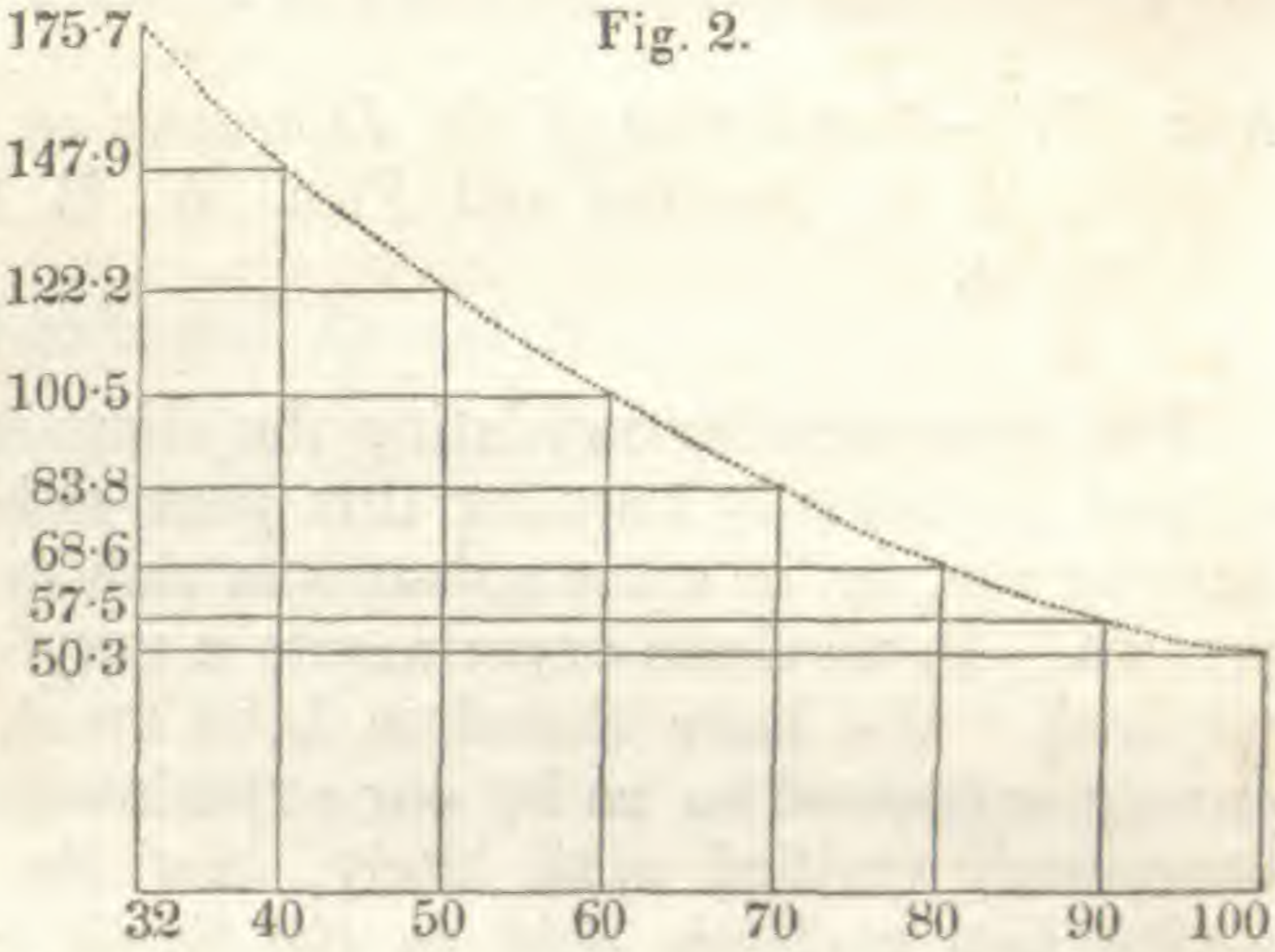
In the more numerous and important experiments at 60°, the observed absorption as given by Saussure, is one hundred and six, by Henry, one hundred and eight, and by Dalton, one hundred. The two former present a marked excess over our result, the latter agrees with it very closely. The larger absorption obtained by Saussure and Henry, is we think explained by their mode of conducting the experiment. We have found that when a column of mercury is shaken briskly in a tube containing water and carbonic acid, the water is made to absorb a larger volume of the gas than is proper to the normal pressure. The concussive movement, violently compresses the gas at each vibration, and the additional quantity which in these circumstances is promptly taken up by the water, is very slow in separating after the quiescent pressure has been restored.

Referring to the arrangement of the preceding table, it will be seen that the numbers in the 7th column express the absorption, reduced to volumes of dry gas and to the density corresponding to p in the 4th column. The obvious formula for this has already been explained. The numbers in the 8th column, represent the actual tension of the gas under which the absorption took place. These two columns give the direct experimental relation of the absorption of dry gas with the tension of the same. But assuming Henry's law to be correct, and in the present case it can involve no sensible error, this relation would be equally expressed by the corresponding numbers in columns 4 and 6. Thus while it is clearly proved, from the observations at 50°, that under the pressure $29{\cdot}1 = p - f$, 118·4 volumes of dry gas are absorbed, it would also be true that under the pressure $29{\cdot}46 = p$, 120 volumes of dry gas would be absorbed, for $p : V = p - f : v$.

It is further evident that admitting this law, all the numbers (p) in the column of barometric heights may be reduced to one standard number, as for example 30 inches, without at all changing the volume of V. Thus at 50° while one hundred and twenty volumes are absorbed under a pressure of 29·46 inches, one hundred and twenty volumes will also be absorbed at a pressure of 30 inches, the latter volumes being denser than the former in the proportion of 30 to 29·46.

The last column of the table represents the values of V, contained in column 6, after they have been *reduced to the common temperature* 60°. These numbers therefore indicate the relative *quantities or weights* of carbonic acid absorbed at the temperatures recorded.

Fig. 2.



The relation of the absorption to the temperature is simply pictured in the accompanying diagram, where the temperatures are measured in the horizontal, and the corresponding absorptions in the vertical direction.

It will be remarked that this curve approaches the horizontal axis less rapidly, as the temperature rises, so that, for example, the absorption is greatly more diminished in passing from 40° to 60°, than in passing from 60° to 80°, and still more than in passing from 80° to 100°. This would lead to the inference that at temperatures much above 100°, we should find the absorption still quite considerable.

To satisfy ourselves on this point, we made repeated experiments at 150° and 212°, by passing a stream of gas from the pipe of the gasometer through a measured quantity of water, maintained by a peculiar lamp arrangement, at the proposed temperature. The pipe being withdrawn while the temperature was continued, any floating carbonic acid was removed from the surface of the liquid by a blast of air, and a solution of baryta was then added. In the water at 150°, a very copious precipitate was formed. This was separated by filtration under a vessel kept full of hydrogen gas to prevent the absorption of atmospheric carbonic acid by the precipitant, and the weight of the carbonate determined by the method of double filters.

By this procedure, 14·5 cubic inches of water at 150°, gave 3·51 grs. of carbonate of baryta, which corresponds to 11·4 *volumes of carbonic acid gas for one hundred volumes of liquid.*

In the water at 212°, a precipitate was also formed, but the amount although sufficient to produce a very obvious cloudiness, was too small to be readily estimated. We propose however to determine its quantity accurately hereafter. In this experiment the liquid was in active ebullition, while the stream of gas was passing, and continued to boil for a few seconds after the removal of the gas pipe.

It is thus clearly proved that water is capable of absorbing carbonic acid, in sensible quantity, while it is actually boiling under ordinary pressure.

(To be continued.)

Art. XI.—*Oxydation of the Diamond in the Liquid Way;* by Prof. R. E. Rogers and Prof. W. B. Rogers, University of Virginia.

The processes for oxydating the diamond, hitherto described, consist in actually burning this gem either in the open air, in oxygen gas, or in some substances rich in oxygen, as nitrate of potassa. In all these experiments a very elevated temperature is required. We have therefore been much interested by the discovery suggested to us by our experiments on graphite, but not completely verified until lately, *that the diamond may be converted into carbonic acid in the liquid way and at a moderate heat, by the reaction of a mixture of bichromate of potassa and sulphuric acid*, in other words, *by the oxydating power of chromic acid.*

The method of proceeding is much the same as in the oxydation of graphite, as described by us in the May number of this Journal; but the progress of the action is slower.

To succeed in the experiment, it is necessary to reduce the chips of diamond to *a very fine powder*, by trituration with repeated portions of pure siliceous sand in an agate mortar. A single grain weight of the gem will suffice for several experiments. In our repeated trials we have generally used less than half a grain, and we have obtained unequivocal proof of oxydation, by the evolved carbonic acid, when using less than $\frac{2}{10}$ths of a grain.

The apparatus employed, is in the main, identical with that used in the analysis of graphite, but the Liebig tube is in this case replaced by a vessel containing lime water.

Precautions are necessary to correct a slight error arising from the evolution of a minute amount of carbonic acid from the bichromate and sulphuric acid, caused by the presence of a trace of organic matter or of carbonate in the former.

Operating on half a grain of diamond, we have in a first process obtained half a grain of carbonate of lime, and using the residuary matter have continued the oxydation, until at length the amount of carbonic acid evolved approached nearly to that due to the entire weight of the diamond. In these experiments, the carbonic acid evolved by the bichromate and sulphuric acid is first expelled from the apparatus, by a particular mode of conducting the operation.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *Researches on the Latent and Specific Heat of Bodies*; by C. C. Person, (Compt. Rendus, t. xxiii, p. 162; Pogg. Annalen, lxx, p. 300.)—Person gives the following as his results on latent heat :—

Substances.	Melting point.	Latent heat for unit of weight.
Tin, ...	235° Cent.	14·3
Bismuth, ...	270 "	12·4
Lead, ...	320 "	5·15
Zinc, ...	423 "	27·46
D'Arcet's alloy$_2$, Pb Sm_2 Bi_3, .	96 "	5·96
Fusible alloy, Pb Sn_2 Bi, . .	145 "	7·63
Phosphorus, ...	44·2 "	4·71
Sulphur, ...	115 "	9·175
Nitrate of soda, ...	310·5 "	62·98
Nitrate of potash, ...	339 "	46·18
Phosphate of soda, PO_5 2Na O24HO,	364 "	54·65
Chlorid of calcium, Cl Cao+6Ho, .	28·5 "	45·79
Yellow bees' wax, ...	62·0 "	43·51

If we examine this and the following table, we see that the latent heats do not follow the order of the temperature, and that they are not, also, inversely as the atomic weights, as was supposed. But they are related to the fusing points and specific heats as

$$(160+t)\delta=l,$$

where t is the fusing point, l the latent heat, and δ the difference between the specific heats in the solid and liquid form. This relation may be expressed by the following proposition:—*To obtain the latent heat, the difference between the two specific heats must be multiplied by the number of degrees between* – 160° *Cent. and the melting point.* The latent heats calculated by this formula agree pretty well with those observed.

The following are his results on specific heat :—

Substances.	Temperatures between which the specific heat was observed.	Specific heat.
Tin, ...	340° and 240° Cent.	0·061
Bismuth, . . .	370 " 280 "	0·035
Lead, ...	440 " 340 "	0·039
D'Arcet's alloy, $PbSn_2B_3$,	300 " 136 "	0·036
do. . . .	136 " 107 "	0·047
do. . . .	80 " 14 "	0·060
do. . . .	50 " 12 "	0·049
Fusible alloy, $PbSn_2Bi$,	330 " 143 "	0·046
Phosphorus, . . .	100 " 50 "	0·212
Sulphur, . . .	147 " 120 "	0·235
Nitrate of soda, . .	430 " 330 "	0·413
Nitrate of potash, . .	435 " 350 "	0·344
Phosphate of soda, .	79 " 44 "	0·758
do. . . .	2 " –20 "	0·454
Chlorid of calcium, .	127 " 100 "	0·519
do. . . .	100 " 60 "	0·628
do. . . .	60 " 31 "	0·358
do. . . .	28 " 4 "	0·647
do. . . .	2 " –20 "	0·406
Yellow bees' wax, .	102 " 66 "	0·54
do. . . .	58 " 42 "	0·72
do. . . .	42 " 26 "	0·79
do. . . .	26 " 6 "	0·52
do. . . .	2 " –20 "	0·39
Ice, ...	0 " –30 "	0·505

This table of the specific heats shews that they are nearly the same in the solid and liquid form for metals. The differences belong to the classes of those produced by change of temperature, and not by a change of the state of aggregation. This equality appears at first sight to upset his formula; but in reality it does not do so, if we consider the formula in its physical sense, and not as an empirical one.

2. *Note on the means of testing the comparative value of Astringent Substances for the purpose of Tanning;* by ROBERT WARINGTON, Esq., (Phil. Mag., xxxi, 150, from the Proceedings of the Chemical Society.)—Having been frequently called upon to examine the value of astringent substances imported into this country for the purposes of tanning, such as valonia, divi-divi, sumac, cutch, &c., I am induced to believe that the detail of the manipulation adopted may not be without interest to some of the members of the Society. As the manufacture of leather was the object of the purchaser of these materials, gelatin was selected as the basis for the estimation of their comparative value; and after several trials with various kinds of natural and manufactured gelatin, such as varieties of isinglass, glue, patent gelatin, &c., the finest long staple isinglass was found to be the most constant in its quality and least liable to undergo change.

With this therefore the test solution was prepared, of such a strength, that each division, by measure in the ordinary alkalimeter tube, should be equivalent to the one-tenth or one-fourth of a grain of pure tannin, and thus the number of divisions used would indicate the proportion of available tannin or substance precipitable by gelatin contained in any specimen. A given weight of the sample under trial was then infused in water, or if necessary the astringent matter extracted by boiling, and the clear liquid precipitated by the test solution until no further deposit occurred.

It was necessary in the course of this operation to test at intervals a portion of the solution under examination, to ascertain the progress of the trial; and this, from the nature of the precipitate, was attended at first with some little difficulty: paper filters were inadmissible from the quantity of the solution they would absorb, and thus introduce a source of extensive error; subsidence rendered the operation very tedious. The plan I have adopted is as follows:—a piece of glass tubing, about twelve inches in length and about half an inch internal diameter, is selected, and this has a small piece of wet sponge loosely introduced into its lower extremity, and when it is wished to abstract a part of the fluid under investigation for a separate testing, this is immersed a few seconds in the partially precipitated solution; the clear liquid then filters by ascent through the sponge into the tube, and is to be decanted from its other extremity into a test glass; if on adding a drop of the gelatin solution to this a fresh precipitate is caused, the whole is returned to the original bulk, and the process proceeded in, and so on, until the operation is perfected; this method of operating is facilitated by conducting the examination in a deep glass. After a few trials the manipulation will be found extremely easy, and in this way considerable accuracy may be arrived at.

3. *On the Manufacture of pure Sulphuric Acid;* by Aug. A. Hayes, M.D., Assayer to the State of Massachusetts, (communicated for this Journal.)—In the arts, the rapid extension given to refined operations, has led to the consumption of pure chemical products. Applications of such substances as were formerly only in the hands of accurate chemists, are now of daily occurrence in manufacturing. The want felt for pure sulphuric acid, has to a certain extent been supplied by the Nordhausen acid; but aside from a higher price restricting its consumption, the manufacture is foreign to this country.

Without entering into scientific details, I shall describe an economical process which I have carefully studied and by which the pure acid, used in my laboratory, has long been obtained.

In the manufactories of sulphuric acid, the weaker acid from the lead chambers is concentrated in lead pans, usually to the density of 1·76, and transferred without cooling to the platinum alembics for further concentration.

The modification commences with the hot acid, and it may be supposed to contain sulphurous acid, hydrochloric acid, hyponitric acid, arsenous acid, oxyds of iron and lead, alumina, lime, soda and organic matter, although the acid obtained from the combustion of Sicily sulphur, is rarely thus impure. On adding to the hot acid sufficient nitrate of potash, or soda, to destroy the organic matter, the brown color disappears and the fluid becomes colorless. The addition of $\frac{1}{300}$ of sulphate of ammonia, removes the remaining hyponitric acid; much of the hydrochloric acid has been removed by the nitrate, and sulphurous and arsenous acids carried to their highest stage of oxydation. The oxyds present, aid the further purification; by continuing the concentration to 1·78, a trifling addition of oxyd of lead is made, but it is essential to the success of the process that this point of density be reached. The fluid must now be cooled in deep vessels of lead, the temperature of it being gradually reduced to 32° F., and allowed to become perfectly clear. The clear part must then be run into shallow lead vessels so placed that they may be refrigerated to 0 Fahr. As the whole acid has nearly the hydrate composition of SO_3+2HO, it would form by repose a solid crystalline mass. In ordinary cases, the regular crystals form solid masses, which are allowed to increase, till one-half the bulk of the fluid has assumed the solid state, when the remaining liquor is rapidly removed, the crystals broken up and washed with some acid resulting from the crystals of a former operation.

When crystallized in this way, nearly all the contamination which can be detected, arises from the fine granular sediment of anhydrous sulphates and arseniates of iron and lead, mixing with the crystals from careless washing. These substances are deposited in the cooling, but more abundantly in the course of the crystallization of this acid. The crystals melted in lead kettles which have been recently washed with ordinary sulphuric acid, afford an acid nearly pure, and if required in the concentrated state, may be transferred directly to the platinum alembic, melted and boiled. For the most delicate researches, the crystals must be melted in glass, or stone-ware, recrystallized out of contact with metals or dust, leaving one-half or one-third of the acid in a fluid state. If the subsequent use of the acid does not require the removal of the water, which is very rarely the case, the crystals being a perfectly definite hydrate when fluid, enable us to weigh and apportion the quantity of real acid with great precision.

In the laboratory, when used for cases of difficult decomposition, it may be added to the crystallized bisulphate of potash, mixed with the substance to be acted on, and the whole brought to any state of dryness in the platinum utensils employed in such operations.

All the acid from which the pure acid has been abstracted, may be used for generating nitric, or hyponitric acid in the manufacture of sulphuric acid. The manufacture may best be carried on during the winter months, and the crystals obtained, stored, or melted.

This hydrate is remarkable for the regularity and great size of its crystals. They are oblique four sided prisms, and often present faces of twelve by sixteen inches. Their capacity for heat is also surprising; small parcels exposed at the mean temperature of 46° F., melt with extreme slowness.

Lowell, Mass., April 28th, 1848.

II. Mineralogy and Geology.

1. *On the Wave of Translation in connexion with the Northern Drift*; by W. Whewell, D.D., F.G.S., (Lon. Quart. Jour. Geo. Soc., Aug. 1847.)—The great geological problem of the "Northern Drift" has been attacked in various ways; and the diffusion of Scandinavian rocks and northern detritus over a vast area in the northern part of Europe has been ascribed to various kinds of natural machinery. Of late, a large part of this operation has been attributed to "Waves of Translation," produced by the sudden upheaval of the bottom or shore of the sea. This view is advocated in the 'Geology of Russia' by Sir Roderick Murchison.* There are some very simple numerical calculations which belong to this subject, and which may throw some light on the probability of such a theory. These calculations must necessarily be hypothetical as to their quantities, but as to their quantities only; and even these will be capable of correction by a more careful survey of the facts. For the mathematical doctrine on which they proceed is rigorously true, and does not depend upon any hypothetical view of the structure of the masses which we have to deal with. Mr. Scott Russell tells us that the wave of translation may be regarded as a mechanical agent for the transmission of power, as complete and perfect as the lever or the inclined plane. Assuming this property of the wave of translation as a basis, I shall point out some of the results of its operation in the case now to be considered.

It has been stated to the Geological Society, that, by supposing the sudden elevation of a submarine district, there is no difficulty in accounting for a current of twenty-five or thirty miles an hour at the bottom of the sea, as a consequence of the "wave of translation." In making this assertion, I think it has not been sufficiently considered that what is thus called a "current," is really a *transient* motion for each point of the bottom of the water. The great wave is *solitary*; the fluid *before* and *behind* it is *at rest*; and the particles move *only while* the wave is passing over them. Therefore the effect of such a wave upon loose materials immersed in the fluid would be only one of two :—*either* it would carry a *single* mass along with it, giving to it its own velocity,—*or* it would give a *transient* motion to a series of masses in succession, as it passed over each, moving each but a small distance. A single wave of translation cannot explain the situation of a long line of masses *each* of which is moved through a *great* distance.

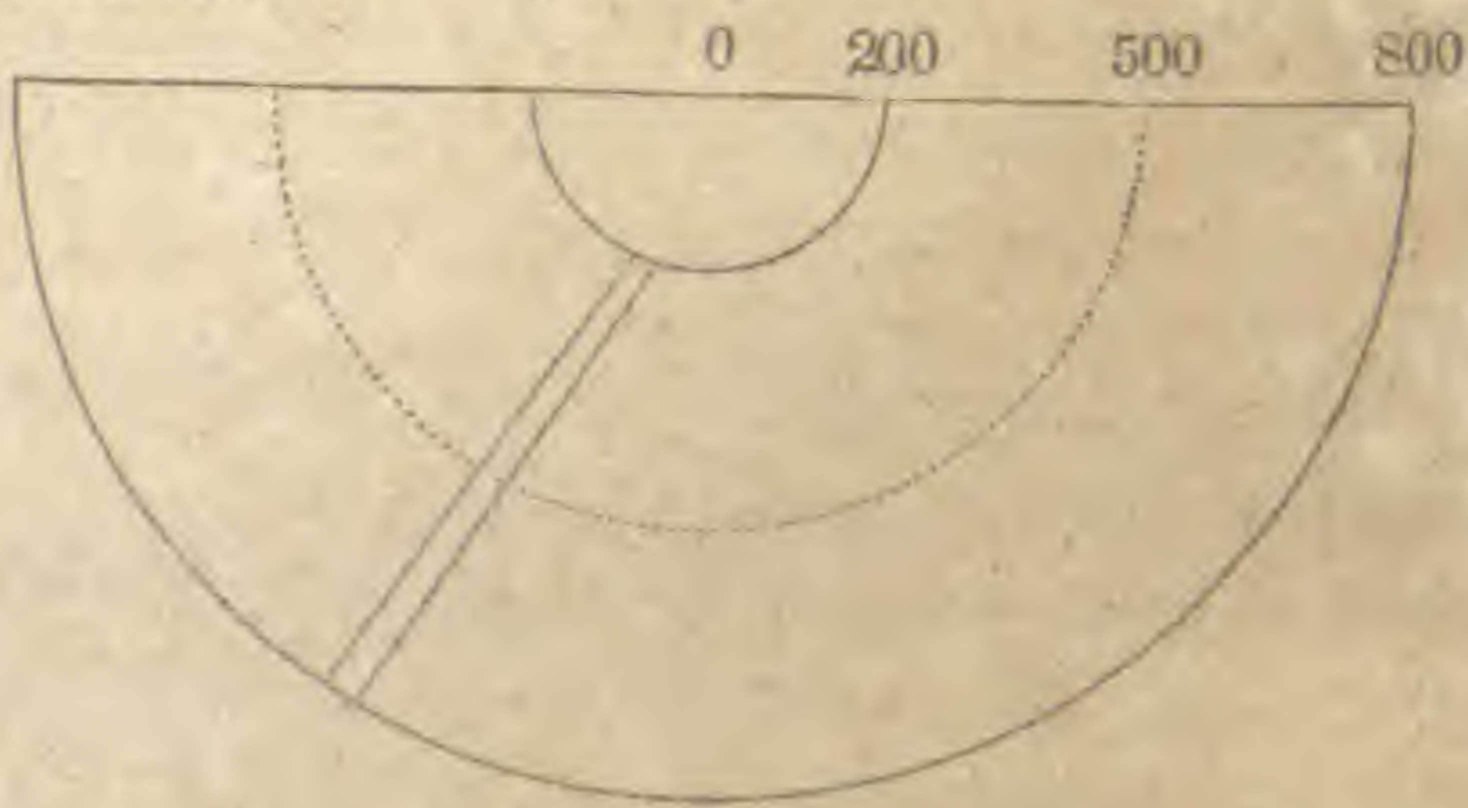
If indeed we suppose a *series* of waves of translation each produced by a sudden elevation, or by some other paroxysmal action, we may obtain a greater effect. In the operation of such a battery, each shock would be transmitted through the water by means of the wave, and would do its measured work; and by accumulating such processes, any amount of result may be mathematically accounted for.

In whatever manner we frame the hypothesis in order to account for the "Northern Drift," the same mathematical equality, between the

* Also at an earlier date in the Memoirs of Profs. W. B. and H. D. Rogers, published in the Trans. Assoc. Amer. Geol. and Nat., 1840–42, and in this Journal.—Eds. Am. Jour.

work done and the force exerted, will hold, as if the effect had been produced by any other mechanical power :—whether the waves be one or many, great or small. And as the amount of the work done in transporting the northern drift from its parent rocks (supposing their place known) to its present position, may be calculated upon assumed numerical bases, we may test the theory of the wave of translation, by thus calculating the amount of sudden elevation which it necessarily supposes. The numbers which I shall assume may be grossly erroneous; but the result being attained, can easily be corrected by changing it in proportion to the alteration which ought to be made in any of the numerical elements.

In the 'Geology of Russia' it is stated that the northern drift occupies a space 2000 miles long and 400 to 800 miles wide. If all the materials were derived from one centre, we might, as a general approximate view, suppose the area to be circular, with a radius of 800 miles; or rather, semicircular, the northern half being for the most part cut off. But if we suppose this semicircle of 1600 miles diameter to be extended to a length of 2000, by taking the *Scandinavian chain* for the source of diffusion instead of a *single centre*, the distance travelled by each mass will be the same as in the supposed circle, which we may therefore make the basis of calculation.



Within the circle of 800 miles radius, I will take an inner circle of 200 miles radius, and I will consider the drift as occupying only the annular space between these two circles.

The *mean* distance from the centre of the annulus lies along a circle of which the radius is 500 miles. I will first consider places at this mean distance.

I must necessarily make some supposition about the mass of the materials which compose the drift. Let it be supposed that, at this mean distance from the centre of diffusion, every square mile, on an average, contains as much drift as would cover it entirely to the depth of one hundredth of a foot. This is equivalent to supposing that there is on each mile, a patch of drift, one-tenth of a mile square and one foot deep; or a ridge or "trainée" of drift, one-tenth of a mile long, one-hundredth of a mile broad, and ten feet deep. It is easy to see that the supposition might be put in innumerable other forms; and by comparing these with many observed facts, some average result might perhaps be obtained.

Supposing this result to be, as I have said, that on every mile there is an average depth of one hundredth of a foot, I shall, for the sake of easy calculation, call this $\frac{1}{500000}$ of a mile (instead of $\frac{1}{528000}$). And thus, on every square mile of ground, at the mean distance from the origin, there is $\frac{1}{500000}$ of a cubic mile of drift.

I will suppose the mean specific gravity of this material to be three times that of water. When the materials are immersed in water, the effective gravity will therefore be twice that of water.

The horizontal force which it requires to move a body along a surface on which it rests, depends on the form of the body, its texture and that of the surface, and other circumstances : but I think we may suppose that it would require a force and pressure of at least one-fourth the weight of the mass moved, to propel rocks and loose materials along the bottom of the sea.

This being assumed, it will require a force (pressure) equal to the weight of half a cubic foot of water to move a cubic foot of drift ; and so, for any other quantities. And to move $\frac{1}{500000}$ of a cubic mile of drift, will require the weight of $\frac{1}{1000000}$ of a mile of water, acting as a pressure.

Now this mass of drift, which is found on an average mile at the mean distance, has travelled 500 miles from the centre. And the laboring force which has carried it through this space, in whatever way it has acted, must be equivalent to the product of the moving pressure and the space through which it has acted ; that is, it must be equivalent to the weight of $\frac{1}{1000000}$ of a mile of water, multiplied into 500 miles.

This is the same as $\frac{1}{2000}$ of a mile of water, multiplied into one mile ; or one mile of water multiplied into $\frac{1}{2000}$ of a mile of elevation.

That is, one cubic mile of water rising through $\frac{1}{2000}$ of a mile (or about 2½ feet) would supply the power necessary to carry the drift which occupies one average mile at the mean distance from the centre of distribution.

Instead of one cubic mile of water, we may take a square of ten miles, $\frac{1}{100}$ of a mile deep ; and this mass rising through $\frac{1}{2000}$ of a mile, will produce the effect now spoken of.

Taking any radius drawn from the centre of the annulus, the part of this radius which lies on the annulus is 600 miles. On each of these 600 miles, we suppose drift to rest. Each portion of drift has travelled a different distance from the centre. But at each different distance from the centre, there may be a different quantity of drift upon the average ; the quantity probably decreasing as we recede from the centre. Let us suppose, for the sake of calculation, that the quantity diminishes exactly *in proportion* as the distance increases ; so that at the distance of 200 and 800 miles, the quantities on a square mile are as four and one respectively.

On this supposition, the laboring force requisite to carry the drift which lies on each square mile of the same radial line, would be the same. It would take the same laboring force to carry $\frac{1}{1000000}$ of a mile through 500 miles (the mean radius), as to carry $\frac{1}{400000}$ through 200 miles to the inner edge of the annular space ; or $\frac{1}{1600000}$ through 800 miles, to the outer edge of the annulus. In each case, the amount of force requisite would be, as before, the weight of $\frac{1}{2000}$ of a mile of water, raised through one mile.

Here the laboring force requisite to carry the drift to the whole of the 600 miles which lie along this radius, would be $\frac{6}{20}$ or $\frac{3}{10}$ of a mile of water raised through one mile ($600 \times \frac{1}{2000} = \frac{6}{20} = \frac{3}{10}$).

Now taking the whole semi-annulus, the length of the mean semicircle, of which the radius is 500 miles, is about 1500 miles.

Hence if we suppose the radical tracts a mile wide just spoken of to make up the semi-annulus, the force requisite to distribute the whole mass of drift will be $1500 \times \frac{3}{10}$, or 450 cubic miles of water raised through one mile.

Now though these radial tracks do not make up the annulus, being too broad within the mean distance and too narrow beyond it, this excess and defect balance each other; and therefore we arrive at the conclusion that 450 cubic miles of water raised a mile high would produce an effect equivalent to the dispersion of the whole body of northern drift.

But we may put this result in a shape more readily conceivable. It is equivalent to 4500 cubic miles of water raised through a space of $\frac{1}{10}$ of a mile; or again, to a body of water 45,000 miles in surface and $\frac{1}{10}$ of a mile deep, raised through $\frac{1}{10}$ of a mile. If then we suppose a sea-bottom 450 miles long and 100 miles broad, which is $\frac{1}{10}$ of a mile below the surface of the water, to be raised to the surface by paroxysmal action, we shall have the force which we require for the distribution of the northern drift, on the numerical assumptions which have been made. And this is true, whether we suppose the elevation to have taken place at once, or by repeated operations, so long as they are paroxysmal. We shall have the requisite force, for instance, if we suppose this area to be elevated by ten jerks of 50 feet each, fifty jerks of 10 feet each, or by the same 500 feet any how divided into sudden movements. And as we diminish the area elevated, we must increase the total amount of elevation in the same proportion, so as to retain the same ultimate product of water paroxysmally elevated through a certain space. In all these cases, we shall have a machinery, which, operating through waves of translation, will produce the requisite effect. And if any of our data be held to be erroneous;—the area occupied;—the amount of matter in the drift;—the amount of friction or tenacity to be overcome in propelling it;—the law of its diminution in quantity as we recede from the centre of distribution;—the final result will have to be proportionally diminished or augmented.

It may be asked whether, since the paroxysmal elevation may thus be reduced into successive smaller elevations, the same result would not follow if it were so reduced as to become, not paroxysmal, but gradual, and even insensible: for, it may be said, mechanical power retains its amount however much it be thus distributed through time, and divested of the character of extraordinary violence. And to this I reply, that no action except such as is of a paroxysmal character could produce the effect. This impossibility depends upon the nature of the effect to be produced. The friction of the bottom which supports the drifted materials, and the tenacity of the masses, are to be overcome: and the peculiarity of such resisting forces is this;—that except the force which acts be sufficient to overcome these resistances, it produces no effect, and is altogether lost. If we push at a mass resting on the ground, with a force insufficient to move it, the force which we exert is wasted, and disappears from all calculations which suffer force to be preserved and transferred into the change produced. A very small elevation, even if sudden, would produce a wave of translation which would pass over all the large masses, and leave them unstirred; and the wave would disappear without producing any such effects as we are here endeavoring to account for.

And thus, the great mass of northern drift, inasmuch as no considerable part of its transfer can be accounted for by any minute causes or languid operations of water, is an irresistible evidence of paroxysmal action; and of action in a scale which may be judged of from the conclusion at which we have arrived:—an elevation of 45,000 square miles of sea-bottom through 500 feet. And this conclusion is equally certain, whether or not we suppose the machinery employed in the distribution of this mass from the centre to be waves of translation. For the proposition that the laboring force expended in the transit of this mass of materials must be equal to the force exerted, and that this force must be exerted in such portions as, at every step, to overcome the friction and tenacity of the masses of rock, shingle, and other detritus moved, is equally true, whatever be the machinery employed. As no gradual or minute action could move the masses in question through a yard of space, no accumulation of such action, through any amount of time, could distribute the masses through the great distances which the northern drift has traversed, and spread them over the vast spaces which that formation occupies. The distribution of the northern drift belongs to a period when other causes operated than those which are now in action.

Postscript.—Perhaps it may throw some light upon the subject to remark that a wave of translation differs little from a "debacle" according to the notions of earlier speculators. A wave of translation is a *debacle* conceived according to the more exact notions to which modern science has led. Or rather, since a *debacle* was generally conceived as a vast torrent sweeping over the land, arising from the emergence of a submarine area, or some such cause, we may say that a *wave of translation*, in such cases as we have considered, is *a debacle travelling along the sea* after it has been shot off the land.

2. *On the Slow Transmission of Heat through loosely coherent Clay and Sand;* by James Nasmyth, Esq.; communicated in a letter to Leonard Horner, Esq., P.G.S., (Lon. Quart. Jour. Geo. Soc., Aug. 1847.)—When I lately had the pleasure to see you at the foundry, on drawing your attention to what appeared to me a remarkable example of the low capability of mineral substances for conducting heat, I was much gratified to find that you agreed with me in considering that the instance in view had an important bearing on several interesting geological questions, especially those relating to the theory of the central heat of the earth.

At your request I have much pleasure in sending you a statement of the instance in question, under the impression that it may chance to prove of some interest as an illustration of what may yet exist in respect to the state of the interior of the globe, as regards its high temperature.

The case, you will remember, was that of a large plate-iron pot, containing eleven tons of white-hot melted cast-iron—a temperature so high as to be quite beyond all thermometric certainty, but well-known to be the highest intensity of furnace heat, being quite equal to that of welding hot iron.

This vast mass of white-hot melted cast-iron, you will remember, stood in the pot for upwards of twenty minutes, and but for a thin coating of clay and sand of about half an inch thick, would have soon melted the bottom and sides of the pot.

This half-inch thickness of mineral substance, however, was quite sufficient to prevent the conduction of the heat to the exterior; so completely so, that after this vast mass of hot iron had remained for upwards of twenty minutes in the pot, you could place your hand on the side of the vessel without feeling any inconvenient degree of heat; and, as I mentioned to you, so slowly and imperfectly does this thin lining of half an inch of clay and sand permit the heat to pass outwards, that the entire mass might rest there till it became cool ere the outside of the pot would have reached a temperature high enough to carbonize wood in contact with it, the radiation from the outside carrying away the heat as *fast* as the *slow* conducting power of the clay and sand lining transmits it.

So striking an instance of the low conducting power of such substances is not frequently met with, and it appears to me that it is calculated to remove some of the doubts occasionally expressed respecting facts which indicate a high temperature in the interior of the earth. If half an inch of mineral matter thus intercepts the communication of so high a temperature as that of a mass of eleven tons of white-hot cast-iron, what may not two or three hundred miles of similar substances effect, in preventing the central heat of the earth from developing its action beyond a very moderate extent towards the surface? If this reasoning be correct, it tends to show that there may exist below the crust of the earth, a mass of fluid molten matter which at depths of two or three hundred miles may have a temperature transcending all our ideas of high heat, the only indications of which, at the surface, are afforded by volcanos, hot springs, and that regular increase of temperature as we descend towards the interior found in deep mines, or by deep borings.

There are many other instances of this nature which I could bring forward, as exhibiting the remarkable non-conducting power of clay; many such examples are every day before the eyes of our manufacturers who have to do with furnaces where intense heat is employed. The fire-brick lining of such furnaces is only from 4½ to 9 inches thick, and yet while the heat within is as high as our furnace powers will carry it, the hand may be placed outside without suffering any inconvenience.

3. *On the Changes of the Vegetable Kingdom in the different Geological Epochs;* by M. Adolphe Brongniart, (Edin. New Phil. Jour., Jan. 1848; from L'Institut, No. 714, p. 280.)—The changes which have taken place in the nature of living beings, since their first appearance on the globe till the period when the surface of the earth, having assumed its present form, has been covered by the creation which now occupies it, constitutes one of the most interesting departments of geology: it is the history of life and its metamorphoses.

The progress of modern geology presents to us the surface of the globe becoming renewed many times since the period when life first appeared upon it, under the influence of Creative Power. At each of these modifications—every time that a great bed of mineral matter covered a portion of the earth's surface, or a shaking of the crust of the globe wrinkled this surface, and produced new chains of mountains, the living beings which inhabited our earth, destroyed and buried in these sedimentary deposits, were replaced by a new creation more or less different from the preceding.

It would be a difficult task at this moment to fix precisely the number of these successive creations of animals and vegetables; but science is every day leading us nearer to this result, although it requires more detailed facts to enable us to reach it.

At certain epochs, however, great changes in the physical state of our planet have been followed by modifications equally great in the nature of the beings which inhabit it.

These are the very decided changes which alone deserve our attention in the present instance; for, on the one hand, they shew us each of the two organic kingdoms passing through varied forms, of which the different degrees are of great interest, owing to the remarkable order in which they succeed each other; and, on the other, the nature of the beings which correspond to each of these great geological periods, may afford us most valuable indications respecting the physical state of the earth, and its climate, at these different epochs, illustrative of the history of the formation of our globe.

From the most remote historical times, the vegetables inhabiting our globe have undergone no change. This is proved by the comparison of grains and plants preserved in the tombs of Egypt, with those which now grow in that country.

On the contrary, the plants of the latest geological periods,—those which occupied the earth before the last revolution of its surface, and whose remains are enclosed in the deposits named tertiary formations, —differ very considerably from such as now grow in these same places. They are, in general, species no longer existing in a living state, and their differences, relatively to the plants now living on the same ground, are greater as they occur in the more ancient beds of these tertiary formations. The most recent indicate a climate differing little from that of temperate Europe; the most ancient announce a warmer climate than now occurs in that region.

But in all these beds, which are very recent when compared with the other parts of the crust of the globe, we find vegetation, as a whole, agreeing in all its principal features with the mass of the vegetable kingdom which still inhabits the surface of the earth; there are the same classes, the same natural families, often the same genera. The general characters of this extinct vegetation are the same as those of the existing vegetation, and we might suppose ourselves merely transported to another quarter of the globe. Viewed as a whole they are the same; the details only are different.

But if, on the contrary, we descend more deeply into the layers composing the earth's crust, and go back to the more ancient periods of the creation; if we consider the vegetables preserved in the formations named secondary, which have preceded those of which we have spoken by many ages, we shall find the vegetable kingdom reduced to a much less considerable number of those natural groups which we name families or classes.

This variety of form and aspect, which gives such a charm to the existing vegetation, did not then exist; and, to characterize in a word the vegetable kingdom of those remote periods, we may say that the plants composing it, much less varied and numerous than those now covering our ground, were all deprived of what constitutes their greatest ornament, namely, those flowers with brilliant envelops which belong to almost all the plants of our period. All the vegetables of the first geological periods were in fact analogous to our firs and ferns, whose habit and elegant foliage form all their beauty.

In these ancient times of geological history, we may farther distinguish two great periods; the one nearest our own times, during which terrestrial vegetation, almost entirely limited to three families, the ferns, Coniferæ, and Cycades, presented only species so far analogous in their most essential characters to those now existing, that they may be easily classified in the natural families I have just named; the other, more ancient, to which the vegetables belong that have produced great deposits of coal, and numerous remains of which accompany beds of this combustible. The latter recede much more widely from actually living forms, enter with more difficulty into known families, evidently constitute other families altogether distinct from those of our actual creation, families whose existence was not prolonged beyond this first geological period.

The singular organization and great dimensions of these first inhabitants of our soil, have long thrown much obscurity over the great classes of the existing vegetable kingdom. Every day, however, the study of them is advancing, and now we can no longer doubt that these gigantic vegetables, so remarkable by their extraordinary forms and by their structure, constitute special families, allied, however, to the ferns and Coniferæ; (that is to say, belonging to the great divisions of vascular cryptogams, and gymnospermous phanerogams.)

In conjunction with many true ferns, often arborescent, and with some Coniferæ, very different from those of our climate, these vegetables must have formed vast forests growing on a turfy soil, produced by their detritus, and to which our coal owes its origin.

Thus, briefly to recapitulate; during the earliest periods of the creation of living beings, the vegetable kingdom was composed only of plants belonging to the two classes of that kingdom distinguished by the simplest structure. These plants had then special forms, were of considerable dimensions, and the greater part constituted families now extinct.

At a later period, these two great classes still continued to exist alone on the earth, but their forms approached more to those which they present in the present vegetation; the families peculiar to the most ancient epochs were already destroyed, and the numerous and varied families which were to appear in the tertiary epoch did not yet exist.

Lastly, during this latter period, vegetation assumes characters analogous to those it now presents. The more perfect vegetables, known by the name of angiospermous phanerogams, appeared in great numbers, and the vegetable kingdom is not distinguishable from that now existing but by characters of detail, or by differences analogous to those which diversities of climate still produce on the earth.

If we now compare the vegetables of the families which, like the ferns and Coniferæ, have been perpetuated during all the geological periods, from the most ancient up to the present, we perceive that such as belong to the most remote creations, are most allied to the plants of those families which now inhabit regions of the earth having a climate very different from our own; and that such, on the contrary, as we meet with in the most recent beds, become more analogous to the species which still grow in these same countries, as the geological period to which they belong approaches nearer our own.

Every thing, therefore, proves, on the one hand, that the different vegetable creations which have succeeded each other on the globe have become more and more perfect; on the other hand, that the climate of the surface of the earth has been greatly modified since the earlier times of the creation of living beings up to the commencement of the present epoch.

4. *Geology and Topography of the Isthmus of Panama;* by EVAN HOPKINS, C.E., F.G.S., (Mining Journal, April 8, 1848; translated from the Bogotâ Gazette of the 9th Sept. 1847.)—By reference to a prepared plan, it will be observed that the Cordillera of mountains, forming the chain of union between the two Americas, is curved in the shape of an arc on the Isthmus of Panama—the convex side faces the north, the easterly portion runs in a south-eastern direction towards Darien, and the south-west prolongation extends to the shores of the Pacific, from whence it again takes a westerly turn towards Veragua. The westerly part of the curve, between the rivers Trinidad and Gorgona, is broken, and the continuity of the chain interrupted by the oblique intersection of the River Chagres. Towards the north-east, between the sources of the Boqueron and San Blas, the chain forms a broad mass of great elevation, and sends out numerous lateral branches, from which the rivers Chagres, Pequeni, and Boqueron take their origin, and also the Cascajal, which runs to the north. The old road to Portobello, which I took on crossing the Isthmus the second time, follows along the Boqueron principally on the bed of the river, owing to the rocky and precipitous nature of the banks, until numerous and deep waterfalls over basaltic rocks, which exist near its source, render it necessary to leave the river, and travel along the steep sides of the surrounding mountains. The heads of this river consist of various branches, one of which arises from the break existing in the Cordillera, at an elevation of 700 feet, where the road across the mountain is carried; and from the same point another stream runs to the north into the River Cascajal. In consequence of the great convolutions of this river, and the rugged and rocky nature of its bed, a day and a half was formerly spent in ascending it by boats from the point of union of the Pequeni to half its extent. The river and the road being synonymous terms in this route, our road continued descending as before, but rather in the waters of the Cascajal than along its banks, over the hard, slippery, sharp, and broken edges of the primary slates that traverse it, until we came to within a short distance of Portobelo. The great difficulties and obstructions, caused by inundations, which attend this route, and the choice made of such a direction, are a strong proof that the Spaniards found insuperable obstacles to the formation of a good road between Portobello and Panama.

From the pass in the mountain above alluded to, towards the west, the chain is divided into numerous longitudinal branches; one proceeds from Portobelo, and terminates abruptly in the vicinity of this port, with an elevation of 600 feet; the central branch falls towards the bay of El Limon, and the southern branch forms the limit of the River Chagres, up to the mouth of the Trinidad, varying from 400 feet to 900 feet in height, and having a few peaks of still greater elevation. The space comprised between these three principal ridges is full of a multitude of smaller ones, which form the channels of the rivers Agua Lucia, Gatun, Aqua Clara, which fall into the Chagres, and of the Grande, Guanche, and Buenaventura, which discharge themselves into the Atlantic.

The gold washings of Santa Rita are situated on the central branch, between the rivers Clara and Grande. From the summit of the central Cordillera, at Santa Rita, (which was the direction of my third journey across the Isthmus,) a commanding view is obtained of the chain, from the elevated point of separation to the east, as far as Portobello, and, on the other side, of the whole length of coast of the Atlantic, as far as Chagres, and from hence to the Cordillera, in the vicinity of Cruces.

Reflecting on this elevated and dense mass of mountains, which intervene between Portobello and Panama, deeply furrowed by so many rivers, we are led to appreciate the difficulties of undertaking to construct any thing resembling a commodious road, diagonally from Portobello. I examined the Cordillera in the rear of Portobello; and it appears feasible to open a mule road on the summit of the external ridges, crossing the rivers near their sources, and gradually descending along the top of the south side, towards Cruces, or any other convenient point on the River Chagres. The peones sometimes follow this direction, which is called the new road, and it is, doubtless, preferable to that of the Boqueron. The distance from Portobello to Panama, in a direct line, is about 40 miles; by the Boqueron, including the turnings, 60; by the top of the Cordilleras, including deviations and turns, 58; from Chagres, along the River Gorgona, 42, and from Gorgona to Panama, 19=61; from the Bay of Limon, along the east bank of the Chagres, by Gorgona, to Panama, 35 miles. The last is the most direct and shortest road, and the one which appears to me to present fewer obstacles than any other to the formation of a railroad across the Isthmus. The Bay of Limon is equally the only port, besides Portobello, adapted to this purpose, on the Atlantic coast, within the described limits.

The corresponding part of the principal chain to the south of the Chagres, near Gorgona, is divided into a number of conical mountains; but, further on, towards the centre of Trinidad, they unite into a cordillera, of an average elevation of 500 feet. The space between this chain and the river of Trinidad is composed of marshy flats and isolated pyramidal mountains. An opinion prevailed, that there existed an almost uninterrupted level from the junction of the Trinidad with the Chagres, and that a canal could be easily cut in this direction, which would simply require locks (*represas*) at each extremity; but this allusion has been destroyed by Senor Garella, chief engineer of the royal corps of miners, who examined this portion of the Isthmus, and informed his Government, that it would be necessary to construct 33 locks (*represas*) and a large tunnel, to effect this object between the two seas. Assuredly, the great obstacles presented by the locality to an undertaking of this nature, place such a plan out of the question—so gigantic a work as a canal for vessels, which would require so much capital and time, must be left to a future generation, when the commerce and prosperity of this portion of the globe shall justify such an undertaking. The time has, nevertheless, arrived, when public attention should be directed to some practical end, as the traffic between the two seas across the Isthmus is on the increase, and, consequently, some immediate and important improvement is required to facilitate the transit.

The surface between Gorgona, Cruces, and Panama, gradually, and with gentle undulations, slopes towards the Pacific, and is covered with various groups of conical hills, decomposed rocks, colored clay, sand, and loose stones. A section, from the mouth of the River Chagres to Chonera, presents a very gradual ascent, as far as the marshy land near the base of the Cordillera of Trinidad, then a rapid ascent of 450 feet, followed by a corresponding fall to the Pacific. A section, from the center of the mines (*Ensenada de minas*) at Panama, shows a succession of deep undulations as far as Gorgona, and from thence a gradual fall to the coast. Another section, from Portobello, begins with a rapid ascent from the port; it then follows the turns of the rocks and falls of the rivers Grande and Gatun, amounting to an elevation of 1000 feet, and concludes with a rapid descent to the River Chagres. A diagonal section, from the mouth of the Chagres, along the river, as far as Gorgona, and from thence to Panama, embraces the lowest point of depression between the two seas; the highest point in this section is between the River Grande, and the Obispo, which does not exceed 150 feet; consequently, with regard both to level and distance, this line offers greater attractions and facilities than any in another direction, for making an easy and comparatively cheap communication across the isthmus.

Notwithstanding the want of a port at Chagres, and the excellency of the port of Portobello, the first place is made use of, and is at present the only profitable point for the transit. As there is little or no coasting trade (*comercio costonero*) worth mentioning, nor any internal trade, the ports are necessarily rendered dependent on the facilities offered by the localities for the purposes of internal transit: this is the reason why Chagres has deprived Portobello of its shipping, and caused it to be almost abandoned. There ought to be some prospect of increase in the internal resources—*i. e.*, in the production and consumption, and not merely in the transport, to justify the formation of any thing better than a good mule-road from Portobello to the south of the great chain. A good mule-road would answer for passengers, money, and light articles; but it would not serve the general purposes of commerce, as it would probably increase the expenses and delays, and would be more exposed to deterioration than the present road; it would increase the advantages of shipping, but it would add to the cost of transit; whereas, what is required, is to give increased facility to the transit, in order to secure the advantages and pre-eminence of this route by the isthmus; the shipping would necessarily increase, and ways and means would be found to provide commodious ports, or rather to improve the existing ones for their reception.

It appears to me that this great question, of improving the communication between the two seas, ought to be considered as a *sine qua non* by the Government, and that every reasonable stimulus ought to be given, by removing commercial restrictions, in order that the work may be undertaken with the probability of its being completed without delay. It is sure to be executed some day, therefore the sooner it is taken in hand the better. The advantages that it would cause to be derived by the western coast of New Granada, independent of the isthmus, would be immense.

The geological character of the isthmus is very simple, and is easily examined. With the exception of the schistose channel, which crosses it in the meridian of the Boqueron and the granitic line between Pequeni and San Blas, the whole is composed of porphyritic and hornblendic rocks, which gradually pass from one to the other, and run in large layers, more or less, in a northerly direction. The schistose rocks are largely developed in the Boqueron and the Cascajal, and the laminated structure of the hornblendic rocks is well defined, their inclination varying from east to west, according to the contortions and other disorders arising from the lateral pressure in the mountains enclosing them. The predominant ingredients are visible in the mass, and give rise in the rock to numerous colors, as black, green, blue, white, brown, and bright red.

From this part of the chain to the west, the mass is hornblendic, but subject to the usual variations in its structure, alternating between porphyry, greenstone, and basalt, conformably to the changes in the relative proportions of hornblende and feldspar. There is a great deficiency of silica in these rocks; quartz in crystals, veins, or masses, is rare ; lime is equally scarce, but iron is very abundant, and exists in different degrees of oxydation. These rocks are very susceptible of decomposition, particularly when iron is the predominant ingredient ; large fragments of decomposed rock, containing globular pieces, which resist ulterior decomposition, are numerous, and constitute the principal superior masses of the isthmus.

This sort of spherical exfoliating decomposition, until scarcely a vestige of the original rock is perceptible, is common enough in the granites and porphyries of the Andes, and the fissures are also frequently found filled with a species of efflorescence of black ferruginous sand; and when this is auriferous, the gold is found mixed with iron. In the course of time, the pieces scale, and the masses crumble ; and, being gradually carried by the rains to the cavities and valleys, secondary deposits are formed of marl (*greda*), sand, conglomerate, or gravel, which, in these warm climates, are soon consolidated into compact beds.

The town of Panama is situated on secondary argillaceous deposits, in layers and fragments of comparatively recent date, and very strongly impregnated with iron. A great part of the upper portion of these deposits to the depth of several inches on the sea shore, is composed of oyster-shells and red sand ; interstratified, are found soft seams of aluminous white magnesia, and likewise some yellow and grey layers, appropriate for building—some of which are sufficiently soft *in situ*, but become harder by exposure to the sun. The green and blue varieties, which are found of different degrees of hardness, are susceptible of rapid decay, owing to the absence of siliceous, or calcareous, matter in the original compound, to form a cement for binding together the sedimentary deposits. Lime for building is a marine production, obtained principally from shells ; and, in consequence of the excess of phosphate, and the absence of silicate of lime, and pure argillaceous sand, there is great difficulty in obtaining a good composition for works exposed to the action of water, or hydraulic lime. Even to make lime for ordinary purposes, the utmost care is required to wash the saline matter from the shells; if this be neglected, the lime is spoiled, and does not easily bind. The foregoing secondary deposits—those of Barbacoas—the white argillaceous deposits between Cruces and El Pequeni and Caimitello, are all the secondary rocks I have seen. There are a few calcareo-aluminous rocks, interstratified with feldspathic deposits, near St. Juan, but, correctly speaking, they are not deserving of notice. The lime on the shores of the Atlantic, and likewise the building-stone, is obtained exclusively from the coral rocks, which so beautifully and exuberantly vegetate on the hornblendic shore of Portobello. The town and fortifications of Portobello are entirely built of coral, and they appear very durable. The persons who have hinted at the existence of limestone and freestone quarries, in the Isthmus of Panama, must have been mistaken, and were evidently unacquainted with the geological position of these rocks The question will now naturally arise—where are we to procure materials for a road in a country where there is so absolute a deficiency of these requisite articles? because, in case of either improving the present mode of transit, by means of an ordinary road, or making a road for carts and horses, in both cases it will be requisite to prepare the localities intended for the reception of cattle and construction of bridges.

Gravel, or hard and rough stones, can be obtained from the decomposed basaltic rocks; the friable sandstone must be rejected, being unfit to make a hard and durable surface; which, by means of a cart-road, can easily be conveyed to any part of the line, and with much greater economy than by the ordinary road. It will be necessary to make the bridges high and wide over the Gatun and the Chagres, which can only be effected by means of timber, judiciously combined with wrought-iron, constructing them on the principle of *obra de legadura*—the sketches of which, including the road and quay (*muelle*) of Panama, will be forthcoming in due time, together with an approximative calculation of the cost. In case the medium line should not be determined on for the ordinary road cutting, and constructing dykes and bridges, the advantages of a carriage-road over a mule-road would be trifling. In reality a *soft* road, embracing a number of useless ascents, and following the undulations of the precipitous hills, would be inferior to a good mule-road. It is important to consider this point attentively beforehand, to avoid the mistake of supposing that a mule-road, converted into a carriage-road, would produce the anticipated advantages. If the gradients are well executed, it is a feasible project to construct a railroad (*ferro carril*) from the Bay of Limon along the eastern bank of the Chagres—and this can be performed with a moderate outlay, the transit performed in nine or ten hours, and merchandise transported with celerity, and at an insignificant cost; one horse on a railroad (*ferro carril*) will do the work of six on an ordinary road; the casual and necessary expense will be less, and the best materials could always be procured, owing to the great facility of transport.

The foregoing observations have reference to the transit from sea to sea; they have no connection with those provincial works and improvements which are being carried on, and which are so much required to facilitate the traffic between different parts of the country.

Mines.—There are no metalliferous veins in the Isthmus of Panama within the limits above described. Notwithstanding that, generally speaking, the porphyritic hornblende is auriferous, the gold is very sparingly disseminated; and, in the absence of lodes, or fissures, in the rocks, no natural concentration takes place; and, consequently, the precious metals cannot be obtained until the rock is decomposed, and the gold partially concentrated in pools, by the agency of the rains. The inhabitants of these auriferous districts are well acquainted with the places in which the gold is collected; they are also expert washers; notwithstanding, in consequence of the small quantity of gold obtained, and the excessive labor required to remove the accumulation of stones, they seldom gain more than 4 rials a-day—rather less than more; and yet, in the face of repeated misfortunes, they are so infatuated with this work, that they are unwilling to abandon the labor of searching for gold, in order to direct their energies to a more certain and profitable occupation. Sometimes rich pools (*pozos*) are found—this is reported to have taken place at Santa Rita and Pequeni; these fortunate casualties serve to keep alive the interest felt, and, when they occur, they generally occasion the loss of much useful capital and labor, by the excitement produced, and the consequent search for gold lodes; which mistaken notion is fostered by the supposition that all minerals, or metals, must proceed from lodes; under the same erroneous impression, poor gold lodes are worked—their only merit consisting in vague traditional reports, that some rich deposits had been formerly discovered in the vicinity. The gold washings are commonly called "mines," and the term *mine* leads to the supposition of the existence of metallic veins, on account of the vague signification given by miners to metalliferous deposits. The gold-washers give the name of *lode* to all the small seams of ferruginous deposits, though they may be widely different in their character from true *lodes;* and, consequently, persons entering into these ruinous speculations, who are unacquainted with their nature by practical experience, are deceived; and, unfortunately, the elementary books on these subjects, instead of giving information, add to the confusion—and thus it happens, that capital is frequently thrown away on useless speculations The gold washings of Santa Rita and Pequeni are the product of decomposed auriferous rocks; and the gold is, as it always happens, of much purer quality and better standard than that obtained from lodes. The decomposed deposits of Santa Rita and Pequeni, situated on elevated Cordilleras, are very unfavorably placed for water; the present washings are limited to the portions washed by the rains during the rainy season.

I have found a few specimens of hepatic iron in Pequeni, and great quantities of the peroxyd and protoxyd of iron; but as these can be of no service in this part of the world, it is unnecessary to dilate thereon; it is also useless to allude to the presence of silver, the descriptions already given being sufficient for the purpose.

Very fine trees are to be seen on the banks of the Gatun, especially of the species called cedar. Having crossed the isthmus three times, I penetrated, on foot, through forests and rivers, and have been exposed to heavy rains, day and night, without suffering in health. I have no reason, therefore, to consider it as unhealthy as it is reported to be.

The population appears small and inadequate for the purpose of public works; but I have been assured laborers can be procured from some parts of the interior. I am, however, of opinion that, if any important works are undertaken, an additional and more effective set of hands would be indispensable.

5. *Geology and Mineralogy of the Malay Peninsula*, (Mining Journal, April 22, 1848.)—The little that is known of the physical geography and geology of the peninsula of India, renders the most general information of the greatest interest. The knowledge of this immense tract, extending over 83,000 geographical square miles—the interior of which is almost untrodden ground, at least to European foot—must depend on future exploration; but any information, even of its coast line and adjoining islands, is of importance, and tends to incite to further observation. Its western coast is remarkable for the great number of islets which skirt it; a broad and almost uninterrupted belt extends along all the western side of the isthmus. Some of these are remarkably bold and imposing—such as the Johore Archipelago, and the Redang Islands. The concave southern half embraces the Island of Singapore; and an archipelago of several hundred miles, stretching south-east by south, marks that the peninsular zone has not yet wholly sunk beneath the sea, and attests how nearly a junction with Sumatra has been accomplished. Most of the Islands are bold; and one of them (St. Matthew) rises to the height of 3000 ft. The isthmus itself is occupied by numerous high hill ranges, which have the same general southerly direction. Along the sea borders, considerable tracts of flat alluvial land occur, the best known of which is the large plain of Tenesarim. From Junk-Ceylon to the Langkawi group, the coasts of the main land and Islands exposed to the full force of the Bengal Sea, are broken, and frequently rocky and precipitous. The high and perpendicular limestone rocks, with their deep excavations, pillared with colossal stalactites and with their summits crowned with dense forests, present the most magnificent scenery. The Island of Penang is a bold mountain mass, rising in some of its northerly summits to the height of nearly 3000 ft., and contrasting nobly with the broad and beautiful plain which lies opposite to it, on the main land. Geologically, the peninsula may be considered, when divested of its alluvial fringes, as one continuous belt of mountains and hills, separated from the Hindu-Chinese region in lat. 13° 30′ north. We find that the broad tract, stretching eastward towards Siam, Cambodia, Cochin-China, with which the peninsular zone is amalgamated, is not a uniform elevated continental mass in which the peninsula merges, as the straits of Malacca lapse in the Sea of Bengal. The zone of elevation continues uninterruptedly—the western border being a broad sheet of alluvium; beyond this alluvium, another elevated zone occurs, succeeded by a second tract of alluvium, which again is bounded by a third elevated belt. How far to the north these great alluvial plains extend, and how much the northern limit of the Malay Peninsula has been pushed south by the gradual filling up of the northern part of the Gulf of Siam, we have no authentic knowledge. The rocks are principally plutonic; but considerable masses of sedimentary rocks oc-

cur, consisting of limestones, sandstones, common clays, and shales. In the famous tin island (Banca) the prevailing stratified rocks are clays and sandstones. In many cases plutonic action has indurated the superincumbent strata, converting sandstones into compact siliceous rocks and clays, and conglomerates into schist and other hard crystalline forms. In Malacca are several thermal springs. This fact, combined with some proofs of recent upheaval, leads to the surmise that it still retains the character of a rising region—a surmise which its proximity to Sumatra countenances.

Metals.—The tendency to the production of metalliferous ores at and near the junction of plutonic and sedimentary rocks, which has been observed in many countries, might have led us to anticipate a large share of metallic riches for the peninsula. In reality, it probably abounds in some ores far beyond conception.

Iron ores are every where found, and in the south they exist in vast profusion. In some places the strata have been completely saturated with iron; and here the bare surface of the ground, strewed with blackish scoriform gravel and blocks, presents a strange contrast to the exuberant vegetation of surrounding tracts, appearing as if it had been burned and blasted by subterranean fires. Much of the ordinary forms of ironmasked rocks, which are so common, and so little regarded for their metallic contents, that in Singapore they are used to macadamize the roads, contain often nearly 60 per cent. of pure metal.

The whole length and breadth of the peninsula, there can be little doubt, abounds in tin ore. The uniformity, we might almost say unity, of its plutonic character, warrants the inference that ores, found plentifully in many different and and distant localities where they have been sought for, exist also in the intermediate tracts which have not yet been examined. At the two extremities of the peninsular zone of elevation, Junk-Ceylon and Banca, tin sand is diffused in such quantity that its collection has never had any other limit than the number of persons employed in it. In Junk-Ceylon and Phunga, under a barbarous government, about 13,000 piculs are annually dug out of the soil. In Banca, under a European government, but without any improvement on the usual Chinese mode of excavating, washing, and smelting, the production has increased from 25,000 piculs, in 1812, when it was a British possession, to 60,000 piculs.

At numerous intermediate localities throughout the peninsula tin is obtained; and when we consider the despotic, rapacious, and, too often, remorseless character of the native governments, the consequent failure of all attempts to introduce European or Chinese capital and system into the tin mining, and the robberies and massacres which, from time to time terrify and scatter the little communities of needy Chinese in whose hands it has remained, the wonder is, that so much metal should find its way to the market. In the Siamese countries north of Kedah, and in Kedah itself, which has been so long in a state of anarchy, it is sparingly extracted. From Perak 9000 piculs per annum was formerly exported, but the produce has now greatly diminished, owing to the miserable state of the country. Sálángor and the adjacent inland states yield about 1000 piculs. The eastern countries from Kalatan to Pahang yield about 11,000 piculs. The present produce of the whole peninsula, including Sinkep and Linga, the only two islands of the Johore Archipelago where it is now sought for, is probably above 40,000 piculs. The produce for many years past has ranged between that quantity and 30,000. The peninsular range, therefore, including Banka, yields upwards of 100,000 piculs, so that it equals, or exceeds, that of Cornwall (6000 tons), and may be expected to increase steadily.

Seeing that tin is procured in all parts of the peninsula where it is sought for, and, in proportion to the enterprise and labor which are devoted to the search, we may consider the entire zone as a great magazine of tin. It is, in fact, incomparably the greatest on the globe. Johore might have seemed to offer an exception to the apparent universality of the distribution of oxyd of tin, if its geological affinity to Banca, the fact of tin having from time to time been found in several places, and for many years having been got in considerable quantity in Malacca, had not afforded the strongest presumption that its want of inhabitants and government was the cause of its nonproductiveness. The last eighteen months, however, have placed the matter beyond doubt, and given a striking proof at once of the metallic fertility of the country, and of the little attention which this branch of industry has hitherto met with in the British settlements. In 1845, Malacca, an integral part of Johore, and having the same geology as the rest of the country, produced about 450 piculs of tin. In the succeeding year the interest of some Chinese of capital was excited in the subject, and more vigorous and extensive operations were commenced. In 1846 above 1400 piculs were procured, the greater part from 39 pits in one valley. In 1847 the produce appears to have been from 4000 to 5000 piculs. In 1848 it will probably rise to between 5000 and 7000 piculs, for the government tithe upon it for the year has been rented for the unprecedented sum of 8190 Sp. dollars ; the revenue from this source having been, in the two preceding years, $1020 and $3345 respectively.

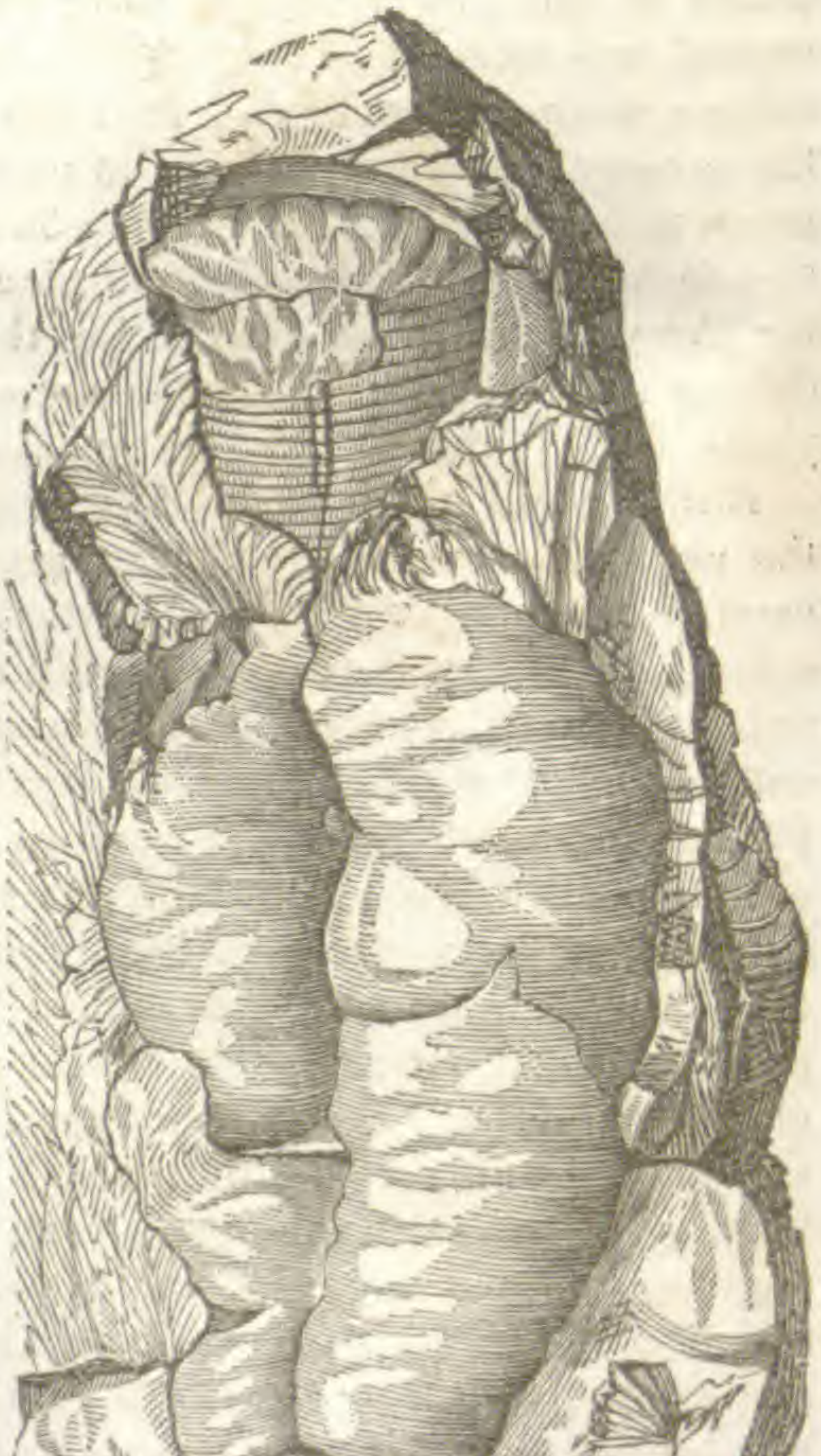
Nothing can better show how entirely the metalliferous character of the peninsula has escaped the mining enterprise of private European capitalists, than the fact, that in the Island of Singapore, where we have a line of junction between plutonic and sedimentary rocks, of above 20 miles in length, where tin was found in former years in at least two localities—and where the same iron ore, with which it is associated in Banca, abounds both in the igneous and aqueous rocks—no interest has ever been awakened in the subject. In the peninsula and Banca, tin has hitherto been procured by digging pits in alluvial tracts where the ore is found, generally intermixed with quartz particles, in a state resembling sand, varying from fine to coarse, and may properly be considered stream ore. Large specimens are found with the ore, adhering to, and partially invested with, quartz. We are not aware that it has ever been actually seen in the solid rock in the peninsula, but in Banca it is found associated with iron ore in veins in the granite. A Dutch writer also describes whole layers as occurring in some mountains, which consist partly of granite, but in the centre principally of layers of sandstone and quartz, in which iron ore also appears. In the more purely granitic mountains, it seems to have been observed in quartz at the junction of the granite, with the iron-veined sandstone strata. In the Isthmus of Krá, it has also been found at the junction of sandstone and granite. In Cornwall, it appears to be dependent on granite.

The finest ores of Banca yield as much as 80 per cent. of metal—the common sorts from 40 to 60. The quality of the peninsular ores has not been ascertained so carefully; we are not aware that more than 70 per cent. have been ever obtained.

We have dwelt, at some length, on tin, because it is the principal natural production of the peninsula, which derives from the fact of its being the greatest stanniferous tract in the world—an importance, economically, which has never been sufficiently appreciated. The existence of tin in Banca was unknown until 1709, when it was accidentally discovered. Now its produce doubles that of the peninsula, although the latter has a surface 18 times larger. The reason is not a mineralogical one: it is because in Banca the Chinese are stimulated, furthered, and protected, by a strong government which directly interests itself in their operations.

Gold is found in the peninsula, but whether from inferiority of enterprise, or natural deficiency, not in such abundance as in those parts of the adjacent countries of Sumatra and Borneo, where it is systematically dug for. The present annual produce is probably about 20,000 ozs. In all the larger specimens which we possess, or have seen, it is disseminated in small particles, and streaks, in quartz. Like the tin ore, it has not been seen in the undisintegrated state. Copper, silver, and arsenic, have been detected in Banca, but apparently in small quantities.

6. *On an Impression of the Soft Parts of an Orthoceras.*—The accompanying figure represents a specimen from a bed of shale alternating with compact limestone, near Cincinnati, Ohio, described by Mr. J. G. Anthony in the Quart. Jour. of the Geological Society, 1847, p. 256. Mr. Anthony observes, that the Orthocerata of the locality were associated with numerous fossils of the "Hudson river group," and they were remarkably well preserved, the Lingulæ being erect, as if entombed in the position in which they lived; the trilobites unusually perfect. On the Orthocerata, he remarks, that they frequently measured over three feet in length. "They all appeared more or less compressed, as if by the weight of the superimposed strata, and their diameter when thus flattened was frequently over six inches. The surface was often coated with a black substance, like paint; where this was removed, it appeared rough, almost like shagreen. My attention was however particularly drawn towards the



smaller specimens, each of which was enveloped in a sac, an appearance which I had never before noticed in connexion with these remains. This sac was of an oval form, about twice the diameter of the enclosed Orthoceratite, enveloped its whole length, was like it flattened, and had a longitudinal depression through its entire length. Upon seeing it, the idea was at once suggested that here was a solution of the question, never before determined, with regard to the form and texture of the body of the Orthoceratite. Though very widely distributed through various strata, yet the soft parts have been so completely destroyed by time and circumstances, that no discovery of them had been hitherto made, by which even a surmise could be formed of the organization of the animal. * * * From the present discovery, we may reasonably suppose that they were furnished with a fleshy body, like the Sepia of the present day and its kindred cephalopods, or perhaps like the Belemnite of the antediluvian creation with its accompanying ink-bag. If they were provided with this latter apparatus, might not the black coating so common upon them be a deposit from that dark liquor?" * *

We have received a communication on Mr. Anthony's paper, from Mr. James Hall of Albany, who takes the ground that what is represented as due to the soft parts of the Orthoceras, is a result of concretion about the fossil. He mentions and figures numerous examples of similar appearances about fossils of various kinds, Orthocerata and others, which are nothing but a result of a concretionary structure; and states that such forms are most common in the fine soft shales. The striated surface and bilobate form are common in the New York specimens. Moreover, it is doubted that the "soft parts" could become petrified, or retain their form sufficiently during the decay which immediately follows death to give it to the enclosing material.

7. *Effect of Fusion on the Density of Rocks.*—In the last volume, p. 258, some facts are given relative to the change of density in different siliceous minerals, in consequence of fusion and their assuming a vitreous state. Delesse has experimented upon this subject, and gives the following table containing the diminution of density for the different rocks mentioned: (Jour. de Pharm. et de Chem., xiii, 68.)

Granites, quartzose porphyry and granitoid rocks,	9 to 11 per ct.
Syenitic granite, syenite, - - - - -	8 to 9 "
Red, brown, green porphyry, with or without quartz, and having a base of albite, oligoclase, andesite,	8 to 10 "
Diorite and dioritic porphyry, - - - - -	6 to 8 "
Melaphyre, - - - - - - - - -	6 to 7 "
Trachyte, - - - - - - - - -	4 to 5 "
Ancient volcanic rocks and basalt, - - - -	3 to 4 "
Modern volcanic rocks and lavas, - - - -	0 to 3 "

8. *Talus Slopes.*—In the chains of the Vosges and Jura, Leblanc found no talus exceeding an inclination of 35°. This slope, he observes, is most rigorously, the inclination of the diagonal of a cube. The density of the material has no effect on the slope, as the avalanches of snow and fall of rocks take the same slope. Some rough rocks, as trachyte and sandstone debris, may form a declivity of 37° to 39°. A talus of 42° to 45°, is not one of stable equilibrium.

9. *Burra Burra Copper Mine, South Australia.*—The Burra Burra Copper Mine, is the most remarkable one in South Australia. A correspondent of the Mining Journal, (No. 651,) makes the following remarks:—"You are aware that the property consists of 10,000 acres (the remaining 10,000 belonging to the Princess Royal Company), divided into 2,464 shares, of 5*l.* each, paid up; or, 12,320*l.* capital. *Two* dividends, of 2*l.* 10*s.* per 5*l.* share (or 50 per cent.), have been paid in July, by which the whole of the original has been returned; a *third* dividend, of 5*l.* per share, or 100 per cent., has just been declared; and, probably, every month or six weeks will see a similar one! The merchants have lately established a sort of market for the purchase of the ore from the different mines as it arrives at the port. Hitherto, the banks would only advance 6*l.* or 8*l.* per ton, even on the best ore. Now, the merchants, who, from the flourishing state of trade, have large remittances to make to their constituents in England, and would otherwise have to pay a premium to the bank for bills of exchange, purchase the ore from the mining companies on the following plan;—parties are now, from experience, able to give a pretty fair guess as to the probable metallic contents of a heap of ore; the Burra Burra Company thus sell 100 tons, for instance, to A. B., guaranteeing that 100 tons at 20 per cent.; A. B. takes an average of the price of metal, from two or three of the last Swansea sales, and says, for that heap, I will give you such a standard; another merchant will, perhaps, raise a little on it—so that virtually, the only price settled here and paid for, is the price of the copper metal; the merchant running the risk of profiting or losing by a rise or fall of the metal by the time the ore arrives at Swansea. Should the heap, when sold, be found in Swansea to contain 25 per cent., instead of 20 per cent., then A. B. makes good the difference to the company. In the other case, of a less produce, the mine makes good the difference to A. B. The arrangement suits both parties. A. B. saves premium on bills of exchange, and makes a commission on sale of ore in England. The mine instead of having to wait twelve or eighteen months for the net proceeds, being formerly only allowed to draw barely enough to pay for the prime cost of ore, now is enabled to divide profits as fast as the ore is delivered at the port."

In another part of the same number of the Mining Journal, we read—"it appears that, in about eighteen months, these mines have yielded the extraordinary amount of 9841 tons of rich copper ore—so rich, that its total value amounted to 150,000*l.* The original purchase money of the mines, together with the costs of working, from September, 1845, to March, 1847—the year and a half in question—is something under 75,000*l.*, which has been wholly repaid to the shareholders, in two dividends, of 50 per cent. each; and the directors are about to declare another dividend of 100 per cent. We make no comment whatever on this extraordinary statement. We suppose it to be without a parallel in the whole history of mining successes. A large part of the ore has arrived at Swansea for smelting, another portion is on its way, and a remnant of some 1600 tons will be forwarded to this country, or America, with as little delay as possible."

10. *Histoire des Progrès de la Géologie de* 1834 *à* 1845; par Le Vicomte D'Archiac. Publiée par la Société Géologique de France,

sous les auspices de M. LE COMTE DE SALVANDY, Ministre de l'Instruction Publique. Tome Premier. *Cosmogonie et Géogenie, Physique du Globe, Géographie Physique, Terrain Moderne.* 680 pp., 8vo. *Paris*, 1847.—In a science advancing with the rapidity of geology, a work like the one before us, giving a review of its progress for a period of years, is of great value to science. The laborers in the field are scattered over the whole civilized world, and these publications are in many languages.

The difficulty of commanding the works issued, is especially felt in America, where libraries in science are slowly supplied with European publications, particularly the Transactions of the various learned societies of different countries. Moreover, few have the time requisite to study and digest thoroughly the publications within reach. M. d'Archiac has done an invaluable service to geologists, in his labors. The work is divided into chapters and sections. Each chapter contains a fair and interesting review of the subject of which it treats, and is followed by a list of publications. The following are the subjects treated of in this, the *first* volume: 1. Cosmogony.—2. Geogeny—constituting the *First Part.—Second Part:* 1. Size of the Earth, Irregularities of Surface and Density.—2. Interior temperature of the globe.—3. Meteorology.—4. Terrestrial magnetism and electric currents within the earth.—5. Physical Geography.—6. Orography and Relief of the Continents.—7. Hydrography.—8. Continental Depressions.—*Third Part:* On Modern Deposits and Phenomena upon the Earth's surface—1. Atmospheric and Terrestrial products.—2. Aqueous and Glacial products.—3. Lacustrine and Fluviatile Deposits.—4. Vegetable and Animal productions of these deposits.—5. Marine Deposits.—6. Organic productions of the last.—*Fourth Part:* Phenomena originating beneath the Earth's Surface.—1. Gaseous, Bituminous and Saline.—2. Mineral and Thermal Waters.—3. Volcanic products.—4. Earthquakes.—5. Elevations and Subsidences.

This volume is to be followed by a *Second* on the Diluvial or quaternary and tertiary strata; a *Third* on the secondary and intermediary or Transition strata—and a *Fourth* on Primary rocks, Palæontology, Theories of Elevation, Subsidence, Veins, and Metamorphism, Analysis and Structure of rocks, Artesian wells, Meteorites, Selenology, together with a Bibliographical Supplement, a review of the bibliographical statistics of each country, and a list of authors cited in the four volumes.

The work should be in the hands of all interested in geological science.

III. BOTANY AND ZOOLOGY.

1. *Gutta Percha.*—The tree affording the gutta percha, of which an imperfect description was given in our last volume, p. 438, has been referred to the new genus *Isonandra*, of Wight. Dr. Wight described two species, to which M. A. De Candolle has added two others referred hitherto to Sideroxylon. W. J. Hooker calls the species affording the gutta percha, *Isonandra gutta.*

2. *On the Eyes of the Balanus;* by Dr. LEIDY, (Proc. Acad. Nat. Sci., Jan. 11, 1848, p. 1, vol. v.)—Dr. Leidy remarked, that the existence of eyes in the perfect condition of the Cirrhopoda, has been denied by all anatomists up to the present time, but its presence in the larva or imperfect stages is very generally acknowledged. Several years since, having received some living specimens of *Balanus rugosus* adhering to an oyster, he submitted them to dissection, in the course of which, he noticed upon the dark purple membrane which lines the shell and muscular columns running to the opercula, on each side of the anterior middle line, a small, round, black body, surrounded by a colorless ring or space of the membrane, which, upon submitting to a low power of the microscope, he found to be an eye, composed of a vitreous body, having nearly two-thirds of its posterior part covered by pigmentum nigrum, and attached to a nervous filament, which he afterwards traced to the supra-œsophageal ganglia. The presence of this organ in other species or genera, he had not yet had an opportunity of determining.

3. *A comparison between Sterna Cantiaca*, Gm., *of Europe, and Sterna acuflavida*, Nobis, *hitherto considered identical with S. Cantiaca, and a description of a new species of Wren;* by Dr. CABOT, (Proc. Bost. Soc. Nat. Hist., Nov. 17, 1847, p. 257.)—The following measurements from adult, full-plumaged specimens were given:

American.	Millimetres.	European.
Bill along ridge, ...	49	57
" " gape, ...	64	75
From the nostril to the point of the bill, . .	36	41
Length of nostril, ...	6	9
Length of lower mandible along the centre, (measuring to the feathers,)	41	47
Length of do. do. along the side, do. do. . .	51	62
Width of bill at commencement of feathers, .	8	7½
Depth of do. do. do.	11¼	12½
Length of wing from flexure, ...	290	317
Length of tail to tips of lateral feathers, . .	136	149
Length of tarsus, ...	25	28
Middle toe without the claw, ...	18	21
Middle claw, ...	7½	9
Inner toe with claw, ...	17	20
Outer do. do.	21	26
Thumb, ...	6½	8½

Besides these differences in the measurement of parts not subject to change from improper stuffing, &c., we find that the coloring differs in some very important particulars. In the American bird the yellow is strictly confined to the tip of the bill, and the line of union of the yellow and black is perpendicular and unbroken, whereas in the European bird the yellow runs up to the inner edge of the symphysis on the under side of the lower mandible, and almost as far on the upper edge; and on the upper mandible also, it extends both on the edges and on the ridge much higher than in the American bird. The primaries are much darker in the American bird than in the European, and the white line which runs along the inner edges and forms their tips in the European bird, disappears in the American before it gets within half an inch of the tip; besides being much narrower. There are also some important differences in form. The projecting point at the symphysis on the under side of the lower mandible is more marked in the American than in the European bird. The claws of the European bird are larger and much more arched than those of the American. The bill of the European bird is much narrower in proportion than the American, and is more bent.

The specimen of *S. acuflavida* in his collection was procured at Tancah, on the coast of Yucatan, on the 25th of April, 1842, and is mentioned in the appendix of Mr. Stephens's Incidents of Travel in Yucatan, under the name of *S. Boysii.*

Troglodytes albinucha, a new species of Wren.

	Millimetres.
Total length,	140
Length of wing from flexure,	58
" tail,	51
" head and bill,	38
" bill along the ridge,	17
" bill along the gape,	22
Width of bill at feathers,	$3\frac{1}{4}$
Depth " "	$3\frac{3}{4}$
Length of tarsus,	20
" middle toe with the claw,	22
" inner toe " "	15
" outer toe " "	16
" thumb " "	17

The bill is bent from the base to the tip. The claws are much curved and very sharp. The head, back, and upper sides of the wings and tail, brown; a line of white, with black or dark brown intermixed, passes over the eye, and meets with a similar line, which passes under it, and they form a patch on the sides of the neck extending round to the nape. Chin, throat, and breast white; flanks and abdomen light yellowish brown, darkest near vent. On the rump are some white and dark brown or black spots intermixed with the brown of the rest of the back. Under tail-coverts, the outermost, and outer webs of next three tail-feathers, and outer edges of first and second primaries, barred with white or yellowish white, and dark brown or black. There are many black bars running across upper side of wings and upper tail-coverts. The four middle tail-feathers are brown, with many black spots. The upper mandible is dark horn color; the under mandible is the same at its tip, but is almost white on the under side and at base. The fourth and fifth primaries are longest and the first is shortest.

The specimen from which the description was taken was the only one observed, and was procured near Yalahao, in Yucatan, April 6th, 1842.

4. *Notice of a fractured and repaired Argonauta argo;* by C. B. Adams, Professor, &c. in Amherst College.—The familiar examples of the repair of the shells of Mollusca are interesting, since they illustrate the mode of growth of the shell.

We have before us examples in which the whole of the last whorl has been destroyed and reproduced. On account of the extraordinary relations subsisting between the animal and the shell in the genus Argonauta, a fractured and repaired shell possesses more than usual value.

In the collection of shells in the cabinet of Amherst College, is an individual of the Argonauta argo, which appears to furnish an additional argument in support of the opinions which are based on the researches of Madame Power. In this shell a portion has been broken out near the middle of the left side, and not far from the sinus of the aperture. The opening was of a semilunar form, about 1¾ inches long, with an average breadth of half an inch. A new deposit of testaceous substance, together with a broken fragment, has closed the opening in the rude manner common in the shells of Mollusca.

But the most extraordinary circumstance is this; that a fragment, which was broken out in the accident which befel the animal, now constitutes two-thirds of the repaired portion, and that the originally inner surface is now the outer surface, as is evident from its concavity, style of undulation, and texture. It is also nearly at right angles to its original position. These facts show that the piece was totally detached from the shell by the accident.

We apprehend that a case could scarcely occur, especially in a shell moving in water, except in consequence of the functions now ascribed to the vela of the Argonaut. These once-reputed sails, performing the less poetic function of clasping and enveloping the shell, prevented the loss of the large fragment.

It is obvious also that the new deposit of testaceous matter, was secreted from the part of the animal within the shell, and not from the vela, since the edges of the original shell around the fracture appear exclusively on the outside.

Since none but the original inhabitant of the shell could repair it, the case described is corroborative of the opinion, that the animal usually seen in these shells is the original owner.

5. *Description of a Species of Haliotis, supposed to be new;* by C. B. Adams, Prof. &c. in Amherst College, (communicated for this Journal.)

Haliotis ponderosa: H. t. magnâ, ovatâ, crassissimâ, convexâ; striis incrementi magnis, irregularibus; rugis concentricis, irregularibus, subnodosis; spirâ elevatâ, subterminali; foraminibus quatuor, magnis; externè rubrâ, intùs maculis plurimis rubris viridibusque iridescente.

Shell ovate, convex, ponderous, with coarse unequal incremental striæ and concentric ridges (not folds), and a few broad low tubercles on the ridges; spire elevated, subterminal; four perforations open, the inner one very large; exterior surface brick red; inner surface elegantly iridescent with innumerable shades of delicate red, purplish red, and green.

Length 8½ in.; breadth 6⅝ in.; depth within 3⅛ in.

Comparison with the well known *H. rufescens*, Swains., will render a figure unnecessary. A large specimen of Swainson's shell before me, has exactly the same superficial dimensions, but is only 2⅛ inches deep. *H. ponderosa* is nearly or quite destitute of the spiral waves of *H. rufescens*, is of a darker red without, wants the red inner margin of the outer lip, and within has the clouds of iridescent colors remarkably small and numerous, while in *H. rufescens* they are remarkably large. It is more ponderous than any Haliotis which we have seen, weighing 2 lbs. 2 oz. avoirdupois.

Zoological Museum, Amherst College. Hab. —— ?

Not finding this species in Reeve's very complete and excellent monograph, I have ventured to describe it as new.

IV. Astronomy.

1. *Lord Rosse's Telescope*, (Lond. Athenæum, April 8.)—At the meeting of the Dublin Royal Academy, March 17, 1848, Dr. Robinson gave an account of the present condition of Lord Rosse's telescope. Dr. R. found that the speculum (whose figure, as he had formerly stated, was not quite perfect) as well as a duplicate one, had been polished by the workmen; and as he apprehended no difficulty in the process, it was repeated. An unexpected difficulty however occurred, which made much delay, till Lord Rosse discovered the cause. The success of the operation requires that it be performed at the temperature of 55°. In winter this must be obtained by artificial heat,—which however increases the dryness of the air, so that the polishing material cannot be kept on the speculum. In this case the surface is untrue, and gives a confused image. This was verified by the hygrometer, and remedied by a jet of steam so regulated as to keep the air saturated with moisture. The result was immediate; and at the first trial the speculum acted so well, that it was unnecessary to try any further experiments. Three additions had been made to the telescope: 1. The movement in right ascension is given from the ground by machinery intended to be connected with a clock movement which is in progress. 2. To obviate the difficulty of finding objects, an eye-piece of large field and peculiar construction is connected with a slide, so that it can be replaced by the usual one in an instant. It magnifies 208 times, and employs nearly four feet of the speculum, the same as Herschel's 40-feet; thus giving the power of trying what that instrument might show. 3. The micrometer is peculiar,—a plate of parallel glass, with a position-circle attached. Light admitted at its edge cannot escape at the parallel surfaces except they be scratched, and a scale of equal parts engraved on one of them with a diamond—luminous in a field absolutely black. The exceedingly unfavorable state of the weather subsequently prevented much from being done; in fact, there was but one good night, the 11th ult. In the moon he observed the large flat bottom of the crater covered with fragments, and satisfied himself that one of the bright stripes which have been often discussed, had no visible elevation above the general surface. In the belts of Jupiter, streaks like those of Pyrrhus's cloud were seen; and the fading of their brown color towards the edge, is evidence that they are seen through a considerable and imperfectly transparent atmosphere. A similar shade in the polar regions, where little cloud is to be expected, seems to indicate that the brighter bands are cloudy regions, and the more dusky show the body of the planet. Several nebulæ were examined, and as formerly all were resolved. That of Orion is most remarkable. Even

before the mirror was perfect and in bad nights, the part of it which presents the strange flocculent appearance described by Sir John Herschel, is seen to be composed of stars, with the lowest power, 360. But Dr. Robinson's eye required 830 to bring out the smaller stars, amongst which these are scattered. Having seen them and known the easier parts, they were seen with the 3-feet and 500. * * * * Another interesting object is the planetary nebula, *h.* 464, situated in the splendid cluster, *Messier* 46, and probably a part of it. It is a disc of small stars uniformly distributed, and surrounded by the larger. *Messier* 64 is a singular modification of the annular form seen obliquely. The opening seems black as ink, and at its margin is one of those interior clusters of bright stars so often noticed before. But the most remarkable nebular arrangement which this instrument has revealed, is that where the stars are grouped in spirals. Lord Rosse described one of them (*Messier* 51) in the year 1845; and Dr. Robinson found four others on the 11th, of which he exhibited drawings, *h.* 604 (seen by Herschel as a bi-central nebula), *Messier* 99, in which the centre is a cluster of stars. *Messier* 97 looks with the finding eye-piece like a figure 8, but the higher powers show star-spirals related to two centres, appearing like stars with dark spaces around them,—though probably high powers in a fine night would prove them to be clusters. Another fact deserves to be noted from its bearing on Struve's *Etudes d'Astronomie Stellaire.* In that admirable book, among other curious matters, he infers that the eighteen-inch telescope of Herschel penetrated into space only one-third of what was due to its optical power. He explains this by supposing the heavenly spaces imperfectly transparent. In computing the limit, however, he assumes that the Milky Way is in its greatest extent "unfathomable by the telescope." Dr. R. however chanced to observe it when it is deepest at 6–4, and is certain that its remotest stars were very far indeed within the limit of the six-feet, and very much larger than those of the nebula of Orion.

2. *New Planet*, (Lond. Athenæum, May 6, 1848.)—A new planet was discovered by Mr. Graham, at Markree, Ireland, April 25, 1848. It appeared like a star of the tenth magnitude; R.A. $14^{h} 55^{m}$, S. declination 12° 32′; daily motion in R.A. $1^{m} 7^{s}$ retrograde. It is supposed to belong to the group between Mars and Jupiter.

3. *Supposed new Star*, (ibid.)—A new star of the fifth magnitude in the constellation Ophiuchus, was noticed at Mr. Bishop's Observatory, London, April 28, 1848. No star has been previously recorded in the position of this. It is in a line joining *eta* and 20 *Ophiuchi*, rather nearer to the latter; R.A. $16^{h} 51^{m} 1^{s}$, S. decl. 12° 39′. It is some degrees distant from the place of the famous object seen by Kepler in 1604.

4. *On the opinion of Copernicus with respect to the Light of the Planets;* by Prof. De Morgan, (Phil. Mag., xxxi, p. 528.)—The common story is, that Copernicus, on being opposed by the argument that Mercury and Venus did not show phases, answered that the phases would be discovered some day. The first place in which I find this story is in Keill's Lectures. It is also given by Dr. Smith, in his well-known Treatise on Optics, by Bailli, and by others. But I cannot find it mentioned either by Melchoir Adam or Gassendil, in their biographies of

Copernicus; nor by Rheticus, in his celebrated *Narratio*, descriptive of the system of Copernicus; nor by Kepler, nor by Riccioli, in their collections of arguments for and against the heliocentric theory; nor by Galileo, when announcing and commenting on the discovery of the phases; and, what is most to the purpose, Müler, in his excellent edition of the great work of Copernicus, when referring to the discovery of the phases of Venus, as made since, and unknown to, Copernicus, does not say a word on any prediction or opinion of the latter.

This story may then be rejected, as the gossip of a time posterior to Copernicus. If we try to examine what the opinion of Copernicus on this matter really was, a point of some little curiosity arises. It depends on one word, whether he did or did not assert his belief in one or other of these two opinions,—that the planets shine by their own light, or that they are saturated by the solar light, which, as it were soaks through them. I support the affirmative: that is to say, I hold it sufficiently certain that Copernicus did express himself to the effect that one or the other of these suppositions was the truth.

If we take the first edition of the work *De Revolutionibus*, which was printed from the manuscript furnished by Copernicus himself, there is little doubt about the matter. There are but two passages which bear or can bear upon the question. The first is in the *ad lectorem*, in which the writer (Osiander, though even Delambre make him Copernicus) asks whether any one acquainted with geometry or optics can receive the Ptolemaic epicycle then used to explain the motion in longitude of Venus? But the meaning of the allusion to optics is explained in the next sentence, by a reference (and by no means a fortunate one) to the changes of apparent diameter of Venus derived from the epicycle; changes which, as they made the perigean diameter more than four times as great as the apogean, were assured to be falsified by common experience. The second passage is the one on which this discussion must turn. In book i, chap. x, after noting that some had heretofore believed Mercury and Venus to come between the earth and sun, he mentions the difficulty arising from the absence of the remarkable phase, which we now call the transit over the sun's disc. He describes the opinion just mentioned favorably, referring, not to his own view, but to that of those others who had held it. This is not an uncommon idiom: persons advocating an unpopular opinion are very apt to describe the maintainers of it in the third person, though themselves be of the number. But when he comes to describe what he takes to be the necessary consequences of the opinion, he lapses into the first person as follows:— "Non ergo fatemur in stellis opacitatem esse aliquam lunari similem, sed vel proprio lumine, vel solari totis imbutas corporibus fulgere, et idcirco solem non impediri . . . . ."

These are the words of the first edition (Nuremberg, 1543). That Copernicus could have answered any objection, either by word or writing, is impossible, since he drew his last breath within a few hours of the time when, not able to open it from weakness, he saw the first printed copy. The second edition (Basle, 1566) is usually said to have been edited by Rheticus. The reason of this is that the name of Rheticus appears in the title-page. But this appearance only arises from the *Narratio*, &c. of Rheticus being added to the edition; and it is only the description of this edition which brings Rheticus into the title-page. There is no mark whatever of his having been the editor; and as the work was printed at Basle, where I cannot find that Rheticus ever sojourned, and as the latter was deeply engaged at the time in his enormous trigonometrical calculation, some proof of his editorship must be given before it is admitted. As the point is of importance, I will notice, that unless Rheticus had made some stay at Basle, it is very unlikely he should have edited a work printed there. He did not edit the first edition, only because it was found convenient to print it at Nuremberg instead of at Wittemberg; and it was accordingly entrusted to Osiander. Now, if ever there were a connexion between two men, and between one of them and the book of the other, which made it desirable and even necessary that the first should edit the second, it was the case of Rheticus and the first edition of the *De Revolutionibus*, &c.; and yet no arrangement could be made by which the sheets printed at Nuremberg could be revised at Wittemberg. It is very unlikely, then, that Rheticus should have edited the second edition, when, as far as we know, a similar impediment existed.

The third edition by Müler (Amsterdam, 1617), has no authority as to the text above that of the second.

Now both the second and third editions change the word *fatemur* into *fatentur*, thus causing Copernicus to throw the opinion in question upon his predecessors, instead of directly making it his own. Not that it would be conclusive, even if the emendation were adopted: for, as I have said, Copernicus is evidently speaking with approbation of the opinions which he describes; and it would be difficult to say why *comperiunt* or *putant* in one sentence should imply approbation, and *fatentur*, in the next, should be at least disavowal, if not disapprobation. If Rheticus, who knew the mind of Copernicus better than any one, had been the editor, I can conceive that stress ought to be laid upon the change of the first into the third person as an emendation; that is, I should be somewhat staggered by Rheticus having thought it necessary to make such an alteration.

But, Rheticus not being in the question, as I think, for the reasons given above, the next best authority on an opinion of Copernicus is Galileo. Now the latter, in speaking of the phases of Venus, expressly attributes to Copernicus the maintenance of one of the two alternatives,—that the planet is either self-luminous or perforated by the solar rays. Of these alternatives, he says, in his letter to Velser (Works, vol. ii, pp. 88, 89), "Al Copernico medesimo convien amettere come possibile, anzi pur come necessaria una delle dette posizioni." And that such was the opinion of Copernicus is also assumed by the writer of the note on the *Sydereus Nuncius* in the volume just mentioned, and by others, even down to our own time; as by Mr. Drinkwater Bethune, in his life of Galileo. In fact, with the exception of the unsupported story mentioned at the beginning of this paper, there is nowhere, that I can find, any thing against my conclusion. And it is to be remembered, that Copernicus nowhere shows any of that acumen in matters of physics, apart from mathematics, which has often enabled the cultivators of the former to make steps more than proportionate to their knowledge of the latter. Ptolemy, the great promotor of the old theory, and Copernicus, its destroyer, were both mathematicians in a peculiar sense; Ptolemy being far the more sagacious in questions of pure experiment. Their grounds of confidence are mathematical; and Copernicus, in particular, dares to face his own physics (for there is no reason to suppose he was beyond his age in mechanical philosophy) with reasons drawn entirely from probabilities afforded by mathematics.

There is much reason to regret the practice of associating with the names of those who have led the way in great discovery the glory which is due to their followers. The disadvantage is twofold. In the first place, it introduces into the history of science an index error of from one to two centuries; secondly, those who come to inquire are disappointed to find that they must lower their opinion of great men, and are perhaps led to do it to a greater extent than justice requires. Our usual popular treatises speak of Copernicus as if, besides himself, he had in him no inconsiderable fraction of Kepler, Galileo, Newton and Halley. What is a person to think who comes from these histories to actual investigation, when he finds in Copernicus himself the immovable *centrum mundi* (only reading sun for earth) of the Ptolemaists, their epicycles, and a suspicion, at least, of the solid orbs?

5. *Solar Parallax.*—A Report was submitted to Congress in April last, with reference to setting on foot an expedition to the most southern available position on the western Continent, for the purpose of making observations on the planet Venus during the period of her retrograde motion: these observations are to be conjoined with similar observations at the Observatory in Washington city, with a view to determining, more accurately than has hitherto been done, the solar parallax. The plan emanated from Dr. Gerling of Marburg, well known for his astronomical and geodetical labors, and was communicated by him in a letter to Lieut. Gilliss, dated April 17, 1847, in which he earnestly seeks for the coöperation of American astronomers. The correspondence on the subject between Dr. Gerling and Lieut. Gilliss, addressed by the latter to the Chairman of the Committee of Naval Affairs of the House of Representatives, was made the basis of the Report. The object is one worthy of a national expedition. The Report states that in 1769, Dr. Rittenhouse, under the patronage of the government of Pennsylvania, made observations on the transit of Venus that were of great value. The subject is therefore already connected with the history of American science, under the auspices of government patronage.

V. Miscellaneous Intelligence.

1. *Memoire sur les Temperatures de la Mer Glaciale à la surface, à de grandes profondeurs, et dans le voisinage des Glaciers du Spitzberg;* par Ch. Martins, Membre de la Commission Scientifique du Nord. (Extrait des Voyages en Scandinavie, en Laponie, et au Spitzberg de la Corvette la Recherche, Geographie Physique, ii, 279. Paris, 1848.—The following are the results of these valuable researches, as laid down by the author. They relate to the temperature of the sea near the icebergs in the two bays of Spitzberg.

1. In the month of July and August, the surface temperature, although very near the freezing point, is always above it.

2. From the surface to a depth of seventy meters (about 76½ yards), the temperature is sometimes increasing and sometimes decreasing.

3. Below seventy meters to the bottom, it is always decreasing.

4. The decrease between the surface and the bottom is not a uniform rate, but goes on accelerating with the depth.

5. Between the surface and seventy meters in depth, the temperature is never below zero (freezing point).

6. Below seventy meters, the temperature of the bed covering the bottom is below zero.

7. The mean temperature of this bed is $-1°{\cdot}75$ Cent., and consequently it is above that of the maximum density and freezing point of salt-water.

8. These facts are easily explained, if we consider that the maximum density and the point of congelation of sea-water are several degrees below zero, and if also we regard the complex, intermittent and variable intensity, caused by the solidification of the surface during winter, the icebergs, floating ice, the tides and currents.

These results, M. Martins continues, are fertile in applications to the physics of the globe. We learn from the fact of the temperature increasing in April and May, that in winter the surface cools more than the bottom, and that consequently the formation of *ground ice*, common in fresh-water lakes, is here impossible. Scoresby and Ross ascertained by direct trials that no ground ice exists, and farther brought up living animals in many instances.

As the temperature of the surface of the sea in July and August, near the glaciers, is above zero (Cent.), it is easy to understand their constant destruction and the formation of floating ice. These glaciers, moving slowly from the land into the sea, for the same reason, melt on reaching the water, and are borne on its surface. At low tide, as the waters retreat, the interval between high and low water is well seen in the glacier; at the same time it becomes broken, or overturned, and thus floating ice is produced. The largest glaciers were seventy-six meters high, and furnished floating masses ten meters in elevation; but generally the detached portions break to pieces and produce what is called *brash*, or *drift ice*.

In Baffin's Bay, on the contrary, the glaciers advance into the sea without being melted. John Ross has described and figured a glacier, to the north of Cape Dudley Digges, which advanced 1800 meters (5906 feet) beyond the shore. The floating ice, consequently, is often higher than the mast of a ship, and the masses are well called *icebergs*, or mountains of ice. As the part above water is about one-eighth of the whole thickness, these bergs have been described as 72, 113, and even 180 meters in depth.

The height of the floating ice is a consequence therefore of the thickness of the glacier, and the shore and bottom temperature of the sea. Upon the coast of Spitzberg, washed by the warm waters of the Gulf Stream, the floating ice is small, whilst in Baffin's Bay, where there is no such stream, the temperature of the surface of the sea is almost always below the freezing point, and the glaciers advance into the sea, sliding along its bottom, without much diminution at base.

2. *Indurating Building Materials*, (Mining Journal, April 15, 1848.)—Our attention having been called to an advertisement of Mr. Hutchinson's indurated stone, &c., we were induced to visit the office, and among the extraordinary discoveries of the present day, by which materials of the most humble pretensions in works of art are rendered of the utmost utility—the most refractory substances made to bend to the power of scientific research, and many productions, which have for ages been thrown away as useless, brought into most extensive usefulness—we know of none by which a more extraordinary, not to say magical metamorphosis is effected, than the operation patented by Mr. Wm. Hutchinson, by which plaster of Paris, Bath, Caen, and other soft stone, chalk, wood, pasteboard, and, in fact, any other material, is rendered hard as metal, receiving the most brilliant polish, and made absolutely imperishable from atmospheric action, vermin, &c. The purposes to which this patent can be applied are innumerable. The first idea of the patentee was the induration of the softer and more common, and almost useless, stones for the purpose of paving; but so complete was his success, that he soon took a loftier view; and has rendered the operation, not only applicable to all common purposes for which stones and slates are used in building—such as paving, both internal and external, window-sills, cisterns, fittings of dairies, &c.—but now applies the operation to all the higher works of art. Plaster of Paris casts, of the most elaborate designs, in bust, relievos, architectural ornaments, fonts, and ornamental flooring for churches, trellis work for balconies, ornamental inkstands, &c., are rendered imperishable by the operation of the elements, and hard and tough as metal. Sculptors who may so choose, may work in Bath or Caen Stone, or even chalk, and the production will be rendered superior to marble; and in all these operations the finest edges of the cuttings are preserved, and not a chisel mark is lost.

In inspecting specimens of Mr. Hutchinson's works, we were shown a slab, of soft fine sandstone, from Tonbridge Wells—so soft, that it might be rubbed into powder by the hand—rendered hard as granite, and rung like a bell; numerous plaster of Paris ornaments and busts, metamorphosed into bronze, granite, and party-colored marbles—drain, water and gas pipes, made from Bath stone, chalk, or paper, hard as granite, and polished internally like marble; in fact, the results of the operations are most extraordinary. The water-pipes, and prepared sheets for roofing, will be found most economical, both in first cost and in wear and tear; in fact, they can be rendered at a cost which comes far below any other description of material which has yet been introduced for these purposes; the sheets would also be highly applicable for railways, and many other public engineering uses. We recommend the attention of the engineers, architects, sculptors, builders, &c., to this interesting patent, which, we feel assured, will prove of great public utility. Mr. Hutchinson has also a model of a stone-sawing machine, which performs its work most perfectly by hand labor—entirely superseding steam machinery.

Works are already established in London, Caen in Normandy, and at Tonbridge Wells, in Kent. The patents, works, &c., are divided into twelve shares, of 3000*l.* each—two-thirds of the value to form the working capital, and the original proprietors retaining four shares. Parties will be treated with for the remaining eight shares.

3. *Coal in Chili*, (Mining Journal, Feb. 12.)—We have, on various occasions, alluded to the mineral resources of Chili, which stand pre-eminent among the republics of South America. Lately, several extensive coalfields have been discovered between Valparaiso and Santiago, but one in particular, belonging to an English firm, a short distance from the port of Valparaiso, is likely to prove a most valuable speculation, as it is being worked, and the coal equal to that of Newcastle, which can be delivered at the rate of 4*s.* per ton, whilst but a short time ago none could be obtained at a less price than 2*l.* to 2*l.* 10*s.* Several miners have arrived out there from the north of England and from Australia, at high wages; and as the parties who have got the property and concessions, are chiefly British, and strongly patronized by the government, there is little doubt that these seams will be worked on a large scale, as native laborers (*peones*) may be obtained at a very low rate. To the progress of steam navigation in the Pacific, the facility of obtaining coal in Chili, will be a most important advantage; but to mining adventurers it will be the means of greatly developing her mineral resources, by the establishing of steam-engines, furnaces and smelting-houses, on the spot, instead of sending the ore to Europe to be reduced; roads are being cut in every direction, and water conveyance will be easy of access in the interior.

4. *Metallurgical Industry of Bohemia*, (Mining Journal, Feb. 12.)—It appears, by a paragraph in the *Prussian Gazette*, that metallurgical industry has, within the last few years, made considerable progress in Bohemia. Although at present there are not more than fifty establishments in operation, these have produced 470,000 quintals of metal in the course of one year, valued at 2,000,000 thalers (280,000*l.*) This quantity, it is stated, is very little below the entire production of the provinces of Silesia, the Rhine and Westphalia, where strenuous endeavors have been made to push this branch of business. The mineral resources of Bohemia are described to be most extensive; and, according to the statement quoted, have scarcely yet been properly developed.

5. *On the Jordan and Dead Sea;* by the late Lieut. MOLYNEUX, of H.M.S. Spartan, (Athen., Apr. 1.)—On the 20th of August last, Lieut. Molyneux landed at Acre, taking with him three volunteer seamen and an interpreter; and having hired camels, horses, and attendants, he started early the following morning with the ship's dingey *en route* to Tiberias. For the first two hours the road was excellent. On nearing the village of Abilin its character altered; the country became hilly, and some awkward passes were encountered. The village of Taran was reached the same night, after ten consecutive hours of travelling. On the following day the party arrived at Tiberias, where they encamped outside the walls of the town and near the edge of the lake. Immense herds of camels were seen feeding in different directions. From the hills overlooking Tiberias the prospect was magnificent;—Djebel Sheikh, smothered in clouds, was distinctly seen to the left, bearing N.N.E.; in front were the blue waters of Tiberias, surrounded by fine ranges of hills; and to the left of Djebel Sheikh the white ruins of Safed.—On the 23d, they embarked on the lake, which is described

as being of greater size than is generally laid down;—from Tiberias to the eastern shore not less than eight or nine miles, and from the entrance of the Jordan on the north to its exit at the south end, eighteen miles: the latitude of the northern extremity of the lake is 32° 49′ 9″, about 3½ miles to the south of the point usually marked. The Jordan is described as shallow, and crossed by numerous weirs, which greatly obstructed the passage of the boat. In many places it might have been crossed by stepping from stone to stone without wetting the shoes; its waters are muddy and full of fish; its course tortuous in the extreme, and some waterfalls were found. Great reluctance was manifested by the natives towards the purposed descent of the river, and every possible obstacle thrown in the way. The Sheikhs demanded in some cases exorbitant sums for permission to pass through their provinces; and altercations, annoying and incessant, were generally terminated by a display of fire-arms, and the threat to shoot them unless they allowed the party to proceed.—On the 3d of September, Lieut. Molyneux embarked on the Dead Sea. The breeze gradually freshened, till there was quite enough sea for the dingey: steering about south by west, large patches of white frothy foam were several times passed; and as the sea got up there was heard a most unusual noise, something like breakers a-head. At 2 A.M. on the 4th, considering they must be approaching the south end of the sea, they hauled to the wind and stood over towards the western mountains; and at daylight were about five miles from the peninsula. From Ras el Feshkah to the north, nearly down to the peninsula to the south, the mountains on the western side rise, almost like a perpendicular wall, to a height of 1,200 or 1,500 feet. The peninsula is connected with the main land by a low neck, so that at a distance it would be considered an island. Having arrived at what was thought to be the deepest water, soundings were obtained at 225 fathoms; the arming of the lead was clear, with some pieces of rock-salt attached to it. Two other casts of the lead were taken at different times; one gave 178, the second 183 fathoms, with bluish mud or clay. The water throughout the Dead Sea is of a dirty, sandy color, resembling that of the Jordan; it is extremely destructive to everything that comes in contact with it, particularly metals, and produces a very unpleasant, greasy feel when allowed to remain on the skin; it has also a very obnoxious smell. At noon on the 5th they returned to the tent whence they embarked, thoroughly done up and thankful for having escaped. Every thing and body in the boat was covered with a nasty shiny substance from the water; iron was corroded and looked as if covered with coal tar. No fish or any living thing was found in the water of the Dead Sea. A broad strip of white foam running nearly north and south throughout the whole length of the sea was observed, not commencing where the Jordan empties itself, but some miles to the westward; it appeared to be constantly bubbling and in motion, and over this, on both nights, was a white line of cloud far above the surface. Having disembarked, the dingey was secured upon the backs of two camels, and the party proceeded to Jerusalem,—within the walls of which town entered the boat of a British ship-of-war. Lieut. Molyneux returned by way of Jaffa; and died shortly after his return to his ship.

6. *Level of the Caspian and Dead Seas.*—The Caspian Sea, according to A. Erman in 1836, is 84 meters (266 feet) below the level of the Black Sea. The Scientific Commission from the Russian government in 1837, found it 101·2 feet (English). M. H. de Hell has concluded from a barometric leveling, that the difference of level between the Caspian and Sea of Azof, is only 18·304 meters. From the geodesic results of Sabler and Sowitsch, M. Hell deduced 33·7 meters, and afterwards 27, as the difference of level. From the same observations, Humboldt obtained 81·4 feet (English).

M. Cailler (1839) deduced from the observations of Bertou (1837 and 1839), Moore and Beet (1837), and Schubert (1837), as a mean, that the Dead Sea is depressed 185 meters below the Mediterranean. Bertou placed it at 419·6 meters. David Wilkie (in 1842) found the depression 365 meters; Lymonds, 427 meters; Rusegger (1841) 434 meters. Delcros (1843) derives from all the observations, that 426·3 meters is the amount of depression. Moore and Beck sounded 300 fathoms in the Dead Sea without finding bottom.—*D'Archiac Hist. Geol.*

7. *Cremastochilus in Ant Nests;* by S. S. HALDEMAN.—Our ant nests are similar to those of Europe, in harboring various insects. Among these are Aphis, Coccus, Batrisus, Hister, Hetærius, and the singular genus of Lamellicornia mentioned above. About the end of April, I found beneath a flat stone, in a cavity occupied by a large flavous species of ant, a living *Cremastochilus variolosus*, but laid no stress upon the occurrence, as I supposed it to be accidental. On the 16th of May, I took three individuals of *C. Harrisii* together, under similar circumstances, and kept them alive for twelve days. On the 25th of May, I found a second individual of *C. variolosus*, in an ant's nest. The locality is a southern hill slope covered with Castanea, Pinus mitis, Acer, Carya, and Kalmia, the soil siliceous. The genus is extremely rare; although tolerably successful in collecting, and my residence is near the locality, these are the first living individuals I have seen. In confinement they burrow beneath the earth in which they are placed, the head, from its peculiar form, being well adapted for this purpose.

The genus Chelifer is also found in ant nests, where it is probably attracted by the immature Thysanura which occur there; but I recently found nine individuals apparently parasitic, lodged near the extremity of the abdomen, beneath the wings and elytra of a living *Alaus oculatus*, the early stages of which are passed in ash trees.

8. *Meteor;* by D. D. PHARES, A.M. (from a letter dated Whitesville, Miss., May 8, 1848.)—On the night (Saturday) of the 15th ultimo, a brilliant meteor was seen to start a little west of north, and more towards the east, disappearing with a loud noise like that of a six pounder. It was described by those who saw it as appearing several inches in diameter, with a train several feet long. Persons in every part of this county saw it and heard the explosion. It was so bright as to cause opaque objects to cast a shadow even in the moonshine. I can hear of no part of the meteor being found.

9. *Common Salt.*—The amount of common salt in all the oceans, is estimated by Schafhæutl at 3,051,342 cubic geographical miles. This would be about five times more than the mass of the Alps, and only one-third less than that of the Himalaya. The sulphate of soda

equals 633,644·36 cubic miles, or is equal to the mass of the Alps. The chlorid of magnesium, 441,811·80 cubic miles; the lime salts, 109,339·44 cubic miles. The above supposes the mean depth to be but 300 meters, as estimated by Humboldt. Admitting with Laplace, that the mean depth is 1000 meters, which is more probable, the mass of marine salt will be more than double the mass of the Himalaya.

10. *Geological Map from Soundings.*—In a communication from Lieut. M. F. Maury, U.S.N., we learn that the proposition to construct a geological chart of our coast from the "records" of soundings, or the use of the *troll*, was suggested by him to the "National Institute" in December, 1840, thus anticipating Lieut. Bache.* The idea is not a novel one abroad. Lieut. Bache's proposition included beyond this, the constructing of the chart by glueing on, in its proper order, the material collected.

11. *Science at Cambridge.*—Hon. Abbott Lawrence has made a second donation of $50,000 to the Department of Science in Harvard University.

12. *Expedition in search of Sir John Franklin.*—This Expedition, under Sir James Ross, has left England. It consists of two vessels, the Enterprise and Investigator, the first of 470 tons and the latter of 420, which are built as strong as wood and iron can make them, with due reference to their sailing qualities. A launch is attached to each ship fitted with screw propellers, which are to be worked with steam, and will make on an average seven miles an hour.

VI. Bibliography.

1. *Researches on the Chemistry of Food and the motion of the juices in the animal body;* by Justus Liebig, M.D. Edited from the manuscript of the author, by William Gregory, M.D., and from the English Edition, by Eben N. Horsford, A.M., Rumford Professor in the University at Cambridge. Lowell, D. Bixby & Co. 1848, 12mo., pp. 219. —Prof. Horsford has conferred an acceptable service in promptly bringing out this edition of the last work of the great chemist whose name it bears. The title fully indicates the topics of discussion—which it is needless to say are handled with a master's hand. Some of the new views on the flesh fluids and upon endosmosis have already been presented to the readers of this Journal. (See vol. v, p. 415.) The two separate topics named in the title are the subject of distinct discussion under two heads, and form in fact two separate treatises. The volume will be eagerly sought by all chemists and physiologists, and it is not easy to say to which class it is most important.

2. *Carices Americæ Septentrionalis Exsiccatæ*, edidit H. P. Sartwell, M.D. Part I. Penn Yan. 1848.—Dr. Sartwell is well known as one of our most zealous botanists, and has long paid great attention to the vast and intricate genus Carex, as the rich collections which he has for many years so liberally distributed among botanists abundantly testify. His name is indissolubly associated with the genus in all our

* See page 318 of last volume.

current works and Floras. Wishing at length to distribute his admirable dried specimens of Carices in a more systematic way, he has prepared and published a choice series of specimens, seventy in number, with printed tickets and title-page, under the appellation given above. We understand that the sets are not on sale,—for no sum which they would be likely to command would afford any pecuniary compensation for the time and pains bestowed upon them,—but are intended for distribution among his botanical correspondents. Having been favored with a copy of this valuable *work*, the writer wishes to record his sense of the value of such well-authenticated specimens to all students of Carices—and they are many—and to state that the specimens are remarkably beautiful and complete. Several represent peculiarly rare and interesting species, such as *C. dioica*, which Dr. Sartwell discovered in this country. *C. scirpoidea*, *C. Willdenovii* and its near allies *C. Steudelii* and *C. Backii; C. Sartwellii*, *C. decomposita*, *C. Crus-corvi*, *C. alopecoidea* of Tuckerman, *C. Fraseri*, *C. tenuiflora*, *C. sychnocephala* of Carey, the recently detected American representative of *C. cyperoides*, *C. Liddonii*, *C. torta*, of Boott, *C. salina*, *C. flacca*, *C. livida*, and *C. Crawei*.

Trusting that Dr. Sartwell will continue this publication so as to furnish similar fine specimens of all our Carices, we suggest the propriety of adding the name of the collector to the ticket,—a point of the more importance since the loose specimens are likely to be distributed in herbaria apart from the title page,—and also of printing the habitat with sufficient fulness to indicate clearly the place intended. A. GR.

3. *Statistics of Coal;* the Geographical and Geological Distribution of Mineral Combustibles or Fossil Fuel, including also notices and localities of the various Mineral Bituminous substances employed in the Arts and Manufactures, illustrated by numerous Maps and Diagrams, embracing four official reports of the great Coal-producing Countries, the respective amounts of their Production, Consumption and Commercial Distribution in all parts of the World, together with their Prices, Tariffs, Duties and International Regulations, accompanied by nearly 400 Statistical Tables and eleven hundred analyses of Mineral Combustibles, with incidental statements of the Statistics of Iron Manufactures derived from authentic authorities; prepared by RICHARD COWLING TAYLOR, Fellow of the Geol. Soc. London, etc., 754 pp. 8vo. *Philadelphia*, 1848.—The extent of the above work as regards whatever pertains to coal either scientifically or economically, is evident from the above title: and it is a sufficient guarantee for its completeness and accuracy on all points on which it touches, that it received before publication the highest and most unqualified praise at one of the meetings of the American Association of Geologists and Naturalists, which was followed by a general subscription for copies of the work. An examination of the volume, now that it has appeared from the press, gives us a still higher opinion of the talents and industry of its author, and the great value of his labors. It meets the wants of those economically interested in coal mines, by its various detailed information and statistics on mines at home and abroad; and the geologist finds a fuller account of the scientific history of coal deposits than is met with elsewhere in any single volume. On a large map of the world the coal regions

of the globe are well exhibited, and details of those of different countries are presented with singular distinctness on the special maps for the purpose. As an example of the thorough plan of the work, we mention the principal topics under the head Great Britain :— Area of Great Britain—Population—Money, Weights, Measures—Coal-fields, and their influence on her prosperity—Annual production of Coal—General Shipments from the places of production—Table of amount conveyed to London—Source of the same, from 1832 to 1845—average prices—British import and export duties on coals—Effect of the Remission of the British Tariff duties on Coal in 1845—General Exportation—Royalties, Tribute, Rent or Galeage in the English Coal-fields—Mining Leases in Newcastle Coalfield—Area, &c. of 51 Coal-fields of Great Britain. Then follows a scientific account of different coal regions, commencing with the Culm or Anthracite formation of Devonshire. To these are added tables showing the exportation of Iron and Steel ; annual production of iron in Great Britain, European states, America, &c. Moreover a map shows to the eye the positions of all the coal regions. The same extensive plan is adopted for other countries, and carried out in a manner for which no one could be better prepared than Mr. Taylor.

4. *Indicis Generum Malacozoorum Primordia*, etc., conscripsit A. N. HERRMANNSEN, Dr. med. Cassel, 1846, vol. i, pp. 636, 8vo. Vol. ii, 1847. To be completed in about ten numbers of which eight have appeared, five forming the first volume.—This may be regarded as a companion to the Nomenclator Zoologicus of Agassiz. Like that work, it is an alphabetical list of the genera, &c. in conchology ; with etymologies, dates, authorities, and references : but these last are given more fully, and a very extensive synonymy is given under such names as require it. The genera Conus, Oliva, and Cypræa occupy two pages each ; Exogyra occupies a page, Helix eight pages, and Ostrea three pages. In general, however, each page contains from five to ten genera. When a citation is made at second hand, an asterisk is added and a later author cited. This, like the Nomenclator zoologicus, is an indispensable work to all who wish to be acquainted with the present condition of the science, and the extent to which aberrant species have been the types of distinct genera by the older authors. It gives, moreover, the extent of the various families according to the views of the principal authors, citing the genera which are supposed to be included. The genera are printed in a heavy face small or lower-case type, and the authority follows in small capitals, *without a point between*, a plan adopted by Agassiz, Stephens, Curtis, G. R. Gray, Doubleday and others. Amyot and Serville, place no point only when the name is followed by the original authority. If the authority is regarded as a genitive case, the point is improper. The original authority should be in *italic*, after the manner of Agassiz and the English, who have the credit of systematizing these things. S. S. H.

5. *Principles of Zoology, touching the Structure, Development, Distribution and Natural arrangement of the races of Animals, living and extinct, with numerous Illustrations.* For the use of Schools and Colleges. Part I, Comparative Physiology ; by LOUIS AGASSIZ and AUGUSTUS A. GOULD. 216 pp., 12 mo. *Boston*, 1848. Gould, Ken-

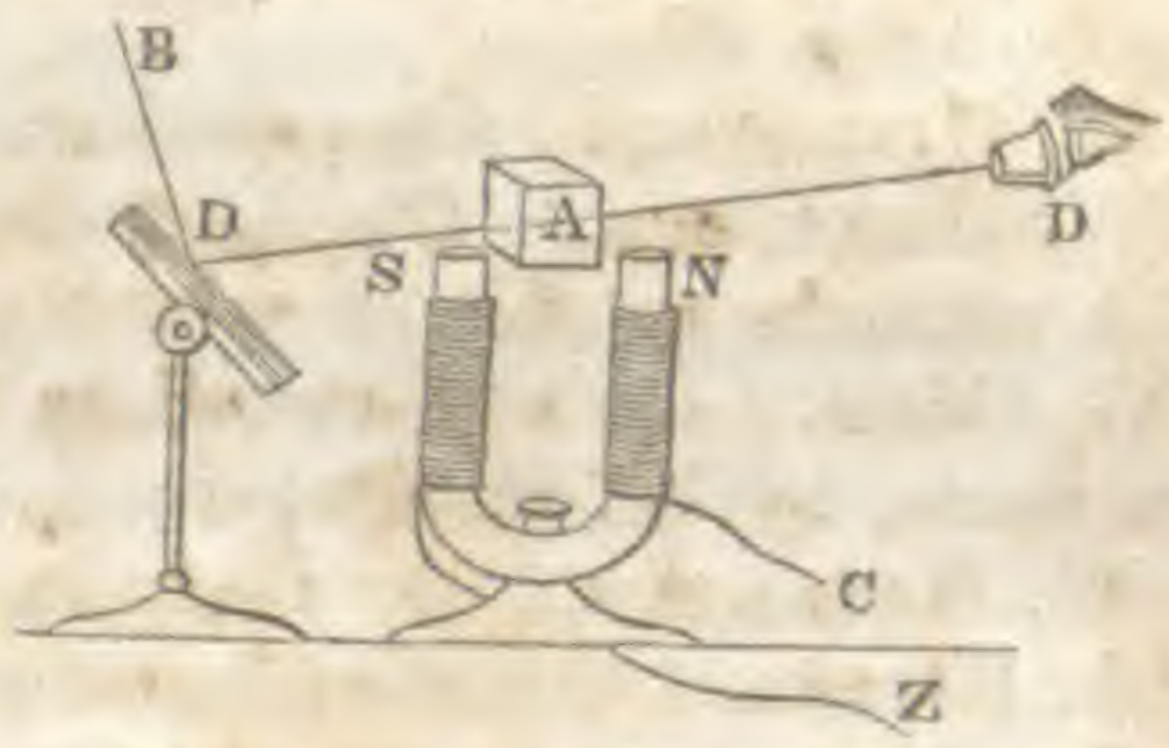
dall and Lincoln.—A work emanating from so high a source as the Principles of Zoology, hardly requires commendation to give it currency. The public have become acquainted with the eminent abilities of Prof. Agassiz through his lectures, and are aware of his vast learning, wide reach of mind, and popular mode of illustrating scientific subjects. In the preparation of this work he has had an able coadjutor in Dr. A. A. Gould, a frequent contributor to the Transactions of the Boston Society of Natural History, and at present engaged upon the Department of Conchology for the publications of the late Exploring Expedition. The volume is prepared for the *student* in zoological science ; it is simple and elementary in its style, full in its illustrations, comprehensive in its range, yet well condensed and brought into the narrow compass requisite for the purpose intended. We annex a brief mention of its main topics, deferring a fuller notice to our next number.

Chap. I. The Sphere and fundamental Principles of Zoology.
II. General Properties of Organized Bodies.
III. Functions and Organs of Animal life.
IV. Of Intelligence and Instinct.
V. Of Motion, (apparatus and modes.)
VI. Of Nutrition.
VII. Of the Blood and Circulation.
VIII. Of Respiration.
IX. Of the Secretions.
X. Embryology. (Egg and its Development.)
XI. Peculiar modes of Reproduction.
XII. Metamorphoses of Animals.
XIII. Geographical Distribution of Animals.
XIV. Geological Succession of Animals, or their Distribution in Time.

6. *Observations on the Temple of Serapis at Pozzuoli near Naples;* by CHARLES BABBAGE, 42 pp., 8vo.—This very valuable memoir was read before the Geological Society of London in 1834, but has been withheld from publication by the author, until May of the past year, when it appeared in the Journal of the Geological Society. A full abstract has however been before the public, and the general facts have become a constituent part of most treatises on Geology. The author, after presenting his observations with clearness and philosophical precision, considers next the action of expansion by heat as a cause of change of level : and in conclusion dwells upon the effect which an accumulation of material on the bottom of an ocean would have on changing the position of isothermal lines at depths beneath. If the temperature increase 1° for every 60 feet of descent, an addition of 5000 feet of material will raise as much above its former position, the line of a given temperature below. This accession of heat upward is urged as a means of metamorphic changes, and of various effects of igneous action. The volume closes with a supplement containing "Conjectures concerning the Physical condition of the surface of the moon." The large craters of the moon's surface are compared to Lagoon Islands, when the water of the ocean is removed. Besides other considerations it is an insurmountable objection to the hypothesis, that the lagoons seldom exceed 35 fathoms in depth, and the majority are still shallower. The Southern maldives, among the largest and deepest in the world, have but 60 fathoms of water in the lagoon.

7. *Elements of Natural Philosophy; being an Experimental Introduction to the Study of the Physical Sciences;* by Golding Bird, A.M., M.D., F.R.S., F.L.S., &c. &c. With three hundred and seventy-two illustrations. From the revised and enlarged third London edition. 12mo. pp. 402. Philadelphia: Lea & Blanchard. 1848.—The deservedly popular Elements of Natural Philosophy by Dr. Bird, have passed through three editions in London since their first appearance in 1839; and it is an acceptable service that the enterprising American house have performed in renewing the present edition. We observe in the chapters on Polarization, the following notice of Dr. Faraday's researches on diamagnetism, which we copy for the benefit of our readers:—

One of the most interesting contributions to science, for which we are indebted to Dr. Faraday, is the discovery of the excitement of a molecular change in certain forms of glass, water, alcohol, oil, and other substances when under the influence of the magnetic and electric forces, sufficient to cause the rotation of a polarized ray. To show this with the magnet a piece of flint-glass, A, or much better, a heavy slip of fused borate of lead 2 inches square and 0·5 inch-thick, is placed between the poles N S of a powerful electro-magnet, so that the line of force may pass through its length. A ray of light BD is polarized in a vertical plane by reflexion from a piece of blackened glass D, and passing through the glass A is examined at D through a Nichol's prism. So long as the bars N and S are not magnetic, the ray is transmitted or extinguished as usual during the revolution of the prism. Let this be turned so that the ray is darkened, and connect the wires C Z with the battery, the bar instantly becomes magnetic and the ray becomes visible. It will be necessary to revolve the prism to the right to extinguish the ray which has, under the influence of the developed magnetism, been made to revolve. If the north pole be next the observer, the ray will revolve to the right, but if this position be reversed, it will revolve to the left.



When a glass tube is filled with water and placed in the axis of a long helix of wire traversed by a current from a battery of ten pairs of plates, the water assumes a similar rotatory power over a rectilinearly polarized ray, turning it to the right or the left, according to the direction of the current, the ray always revolving in the direction in which the positive current traverses the wire of the helix. When a wide tube of glass is filled with water and the helix traversed by the current immersed in it, the water in the centre of the helix will alone exert any action on a transmitted polarized ray, that lying between the exterior of the coil and the side of the tube having no rotatory power. A piece of borate of lead glass placed in the helix acquires a similar power. Thus by the magnetic and electric forces, Dr. Faraday communicated temporarily to glass the rotatory power naturally possessed by quartz, and to water and other fluids the power proper to syrup and oil of turpentine.

8. *An Introduction to the study of Meteorology;* by DAVID P. THOMSON, M.D. 8vo. Blackwood & Sons, London.—We are informed by a letter dated Wrenbury, Nantwich, March 3, 1848, that Dr. Thomson's Treatise on Meteorology is in press and will soon appear.

9. *Naturwissenschaftliche Abhandlungen*, gesammelt und durch Subscription herausgegeben, von WILHELM HAIDINGER. Erster Band. Subscriptionsjahr vom 1 Juli, 1846, bis 1 Juli, 1847. Pr. 15 fl. C. M. 475 pp., 4to, with 22 plates. Wien (Vienna), Aug., 1847.—This volume of scientific memoirs is published by subscription, the list being headed by his majesty the Emperor of Austria. It is prepared under the able direction of W. Haidinger, well known by his various mineralogical publications, and his English translation of Mohs's Treatise on Mineralogy. It contains the following memoirs.

W. HAIDINGER. On the Pleochroism of Amethyst: p. 1.

F. W. ROSSI. New Species of Arachnida in the K. K. museum. p. 11.

FR. R. v. HAUER. On fossil Cephalopoda from Bleiberg in Carinthia: p. 21.

S. REISSEK. On Endophytes of the cells of plants: p. 31.

H. ST. LOBARZEWSKI. New species of Leafy Musci from the Carpathians: p. 47.

W. HAIDINGER. On pseudomorphs imitative of stone-salt: p. 65.

W. HAIDINGER. On Aspasiolite, as pseudomorphic of Cordierite, with remarks on Metamorphism: p. 79.

G. GÖTH. On a Hailstorm in Steiermark. p. 93; with remarks on the same, by W. Haidinger: p. 96.

W. HAIDINGER. On Hauerite: p. 101.

A. PATERA. Chemical examination of Hauerite: p. 107.

FR. R. v. HAUER. On the Caprina Partschii: p. 109.

V. STREFFLEUR. Phenomena of Ebb and Flow, under the influence of the Rotation: p. 115.

W. HAIDINGER. On the varying colors of faces of Crystals: p. 143.

B. KNER. On the Cephalaspis Lloydii and C. Lewisii of Agassiz: p. 159.

K. PRÜFER. On the Crystalline form of Lazulite:* p. 169.

J. PETZVAL. On the linear Integration of Differential equations: p. 177.

FR. R. v. HAUER. New Cephalopoda from the Sea of Marmora: p. 257.

K. E. HAMMERSCHMIDT. Description of a Species of Oxyuris: p. 279.

J. v. PETTKO. Geological sketch of the District of Kremnitz: p. 289.

A. v. MORLOT. On Dolomite and its relation in origin to Calc spar: p. 305.

F. SIMONY. Meteorological Observations: p. 317.

A. LÖWE. On the Arsenical Nickel of Schladming and Prackendorf: p. 343.

---

* The author shows that the form is *oblique* rhombic, and gives fine figures and many measurments.

Fr. R. v. Hauer. On the Fossils of Korod in Siebenbürgen: p. 349.

J. Barrande. On the Brachiopoda of the Silurian Rocks of Bohemia: p. 357—475; with nine crowded quarto plates.

10. *Berichte über die Mittheilungen von Freunden der Naturwissenschaften in Wien.* This Bulletin is from the "Friends of Science" in Vienna, and is published under the direction of M. W. Haidinger. A second volume was issued in 1847, including proceedings from Nov., 1846 to June, 1847.

L. C. Beck: Botany of the United Stetes, new ed. 1 vol. 12 mo. *New York*, 1848.

J. Liebig: Researches on the chemistry of Food, and the motion of the Juices in the Animal Body. Amer. ed. *New York*, 1848. 50 cts.

E. G. Squier and E. H. Davis: Ancient Monuments of the Mississippi Valley, comprising the results of extensive original surveys and explorations; 4to, with numerous elegant illustrations. In the press, *New York*. Published by the Smithsonian Institution.

H. E. Strickland & A. G. Melville: The Natural History and Osteology of the Dodo solitaria, and other extinct birds of the islands Rodriguez, Mauritius, and Bourbon.—In course of Preparation.

Menke and Pfeiffer: Zeitschrift für Malakozoologie, iv. Jahrg. 1847. (12 Nummern) gr. 8. 1 *Thlr.* 15 *sgr.*

E. F. Glocker: Generum et specierum mineralium secundum ordines naturales digestorum Synopsis. 8 maj. cart. *Halle.* 2 *Thlr*. 10 *sgr.*

J. Fournet: Metamorphose der Gesteine, nachgeweisen in den westlichen Alpen; 1 taf., gr. 8. *Freiberg.* ⅔ *Thlr.*

C. F. Rammelsberg: Drittes Supplement zu dem Handwörterbuch der chem. Th. der Mineralogie. *Freiberg.* 1 *Thlr.*

C. Freisleben: Von vorkommen der Silbererze in Sachsen. *Freiberg.* 2 *Thlr.* Also die Sachs· Erzgänge in localer u. Systemat. Reihenfolge, 3 hefte 2 *Thlr.* 15 *gr.* Von vorkommen der Gold und Quecksilbererze in Sachsen. 24 *gr.*

B. Cotta: Geognost Karte von Thuringen. Secs. 2 and 3, imp. fol., 15*s.* 6*d.*; Secs. 1–3, 24*s.* 6*d.*

L. Gmelin: Handbuch der Chemie, 4th edit., 8vo.

Millon: Elemens de Chimie organique, comprenant les applications de cette science à la physiologie animale; 2 vols., 8vo. 15*s.*

Ronquainal: Le globe terrestre reconnu vivant ou physiologie de la terre. 8vo. 3*s.* 6*d.*

W. Sartorius von Waltershausen: Physich.-geograph. Skizze von Island, mit besond. Rücksicht auf vulkan. Erscheinungen. 8vo. 2*s.* 6*d.*

F. G. W. Struve: Etudes d'Astronomie stellaire; la voie lactée sur la distance des étoiles fixes. 8vo. 4*s.*

J. Pelouze & E. Fremy.—Cours de chimie générale, with an atlas of 46 plates. *Paris*, 1848.

Ouvrages sur le Bresil.

Spix and von Martius: Reise in Brasilien, in den Jahren 1817–1820, with an atlas of 40 plates of views, and 8 charts, besides two sheets of music. 3 vols., 1388 pp., and an additional volume on Geography, 40 pp.; 1823–1831. Edition Velin Imperial in fol., 285 *frs.*; in 4to, 216 *frs.*

Martius: Die Physiognomie des Pflanzenreiches in Brasilien. 1824. 2*frs.*

——: Die Thiere und Pflanzen des tropischen America. 1837. 9*frs.*

——: Von dem Rechtstande unter den Urein wohnern Brasiliens. 1832, 4to, with an ethnographic chart. 7*frs.*

Partie Zoologique.—*J. Wagler* and *J. B. de Spix*: Serpentum brasiliensium species novæ, &c., in small folio, new edition of plates, 1838–1840. 108*frs.*

Avium species novæ, &c.; 2 vols. in small folio; i, pp. 90, 104 col. plates; ii, pp. 85, 118 plates; 568*frs.*

J. B. de Spix: Species novæ Lacertarum; in small folio, 26 pp. and 28 colored plates. 76*frs.*

J. B. de Spix: Species novæ Testudinum et Ranarum, &c., folio, 53 pp., with 39 colored plates. 98*frs.*

J. B. de Spix, L. Agassiz and *C. F. P. de Martius*: Selecta genera et species Piscium, &c., in small folio, 138 pp., 96 colored plates. 1827. 249 *frs.*

Spix, Wagner, Schrank and *von Martius*: Testacea, &c., in small folio, 36 pp., 29 colored plates. 1827. 54 *frs.*

Perty and von Martius: Delectus Animalium articulatorum, &c., in small folio, pp. 224, 40 colored plates. 1830–1834. 164 *frs.*

PARTIE BOTANIQUE.—*Von Martius:* Nova genera et species plantarum, &c., 3 vols. in small folio, with 300 colored plates. 798 *frs.*

Von Martius: Icones Plantarum Cryptogamicarum, 1 vol. in small folio, 138 pp. and 76 colored plates. 1827–1834. 249 *frs.*

——— *:* Specimen Materiæ Medicæ Brasiliensis. Specimen I. Emetica; in 4to, with 9 plates. 1824. Pr. 7 *frs.*

Unger and *Mohl:* Palmarum genera et species, &c. 1823–1845. 220 plates. 1164 *frs.*

Von Martius: Flora Brasiliensis, sive enumeratio plantarum, &c. Fasciculi i–ix, 281 *frs.*

——— : Systema Materiæ Medicæ Vegetabilis brasiliensis, 1843. 8vo. 4 *frs.*

PROC. ACAD. NAT. SCI. PHILAD., iv, No. 2; Ap. 11, 1848. p. 36. Habits of some African Reptilia; *T. S. Savage.*—Ap. 25. p. 40. Generation of the Virginian Opossum; *J. Bachman.*—p. 47. A new genus and species of Fossil Ruminantoid Pachydermata (Merycoilodon Culbertsonii), with a plate; *J. Leidy.*

PROC. AMER. PHIL. SOC., PHILAD., vol. v, No. 40.—April 7, 1848, p. 51. A letter on Neptune; *Prof. Peirce.*—p. 16. On the projection of a star during occultation upon the disk of the moon; *S. S. Haldeman.*—April 21, p. 20. Excess of male births diminished by cholera; *Dr. Emerson.*—p. 20. Ephemeris of Neptune; *S. C. Walker.*

MEM. OF THE SOC. GEOL. DE FRANCE, 2d Ser., Tome II.—First and second parts. On the cretaceous formation southwest, north, and northwest of the central plateau of France (with 3 folded plates of views and sections; *D'Archiac.*—Geological position of the *Macigno* deposits in Italy and southern France; *L. Pilla.*—Observations on the Etrurian formation (with 1 plate); *L. Pilla.*—Geology of the vicinity of Bayonne; *S. P. Pratt.*—Fossils from the Nummuline beds of Bayonne (with 5 plates); *D'Archiac.*—On the geological constitution of the Sancerrois, or northern part of the department of Cher (with 2 plates); *V. Raulin.*—Age of the freshwater formation of the eastern part of the basin of the Gironde (with 1 folded plate of sections); *J. Delbos.*—On the fossils of Tourtia (with 13 plates); *D'Archiac.*

ANN. DES SCI. NAT. Paris. OCTOBER, 1847. Arvicola nivalis; *C. Martins.*—Fossil mammalia of Southern France; *P. Gervais.*—Fossil mammalia of Montpelier; *P. Gervais* and *Marcel de Serres.*—Organization of the Genus Galeodes, a type among the Arachnida; *E. Blanchard.*—Connection between the pigment of the hair and of the iris and the faculty of hearing in certain animals; *Dr. Sichel.*—On the Brachiopoda; *A. d'Orbigny.*—On the Gutta Percha and the plant yielding it; 193.—Eight species of Allium, mostly Algerian; *J. Gay.*—New plants from Bolivia; *J. Reney.*—Cellulose, is it the basis of all vegetable membranes; *H. Mohl.*—NOVEMBER, 1847. On the Brachiopoda (continued); *A. d'Orbigny.*—Organization of the Vermes (continued); *E. Blanchard.*—On Cellulose (continued); *H. Mohl.*—On the origin of adventitious buds; *A. Trécul.*—On the pith of ligneous plants; *A. Guillard.*

ARCHIV FÜR NATURGESCHICHTE, *Berlin*, THIRD HEFT, 1847. On the Naiads, &c.; *F. H. Troschel.*—On insect larves; *W. F. Erichson.*—Review of publications on mammalia and birds for the year 1846.—FIRST HEFT, 1848. On the process of subdivision in the egg of snails; *F. Müller.*—Natural history of the "Blasenwürmer" (Cysticercus tenuicollis, etc.); *R. Leuckart.*—Two new species of Helminthes; *R. Leuckart.*—On peculiar air canals in the Velella and Porpita; *A. Krohn.*—New Annelida; *E. Grube.*—Orchestia Euchorus and Gryphus, new species from the Baltic; *F. Müller.*—On the mode of increase in the Chlorogonium euchlorum, Ehr.; *J. F. Weisse.*—On the species of Ctenomys; *A. Wagner.*—Letter on an original figure of the Didus ineptus of Roland Savery, in the Gemälde-Gallerie in the Belvidere at Vienna; *L. J. Fitzinger.*—On the Buds of Upper California; by *W. Gambel*, with remarks by *J. Cabanis.*

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XII.—*On the Indian Archipelago.**

THE first and most general consideration, in a physical review of the Archipelago, is its relation to the continent of Asia. In the platform, on which the largest and most important lands are distributed, we see a great root which the stupendous mass of Asia has sent forth from its southeastern side, and which, spreading far to the south beneath the waters of the Indian and Pacific Oceans, and there expanding and shooting up by its plutonic and volcanic energy, has covered them, and marked its track with innumerable islands. That there is a real and not merely a fanciful connexion between the Archipelago and Asia is demonstrable, although, when we endeavor to trace its history, we are soon lost in the region of speculation. So obvious is this connexion that it has been a constant source of excitement to the imagination, which, in the traditions of the natives and in the hypotheses of Europeans, has sought its origin in an earlier geographical unity. Certainly, if, in the progress of the elevatory and depressing movements which the region is probably undergoing even now, the land were raised but a little, we should see shallow seas dried up, the mountain ranges of Sumatra, Borneo, and Java become continental like those of the Peninsula, and great rivers flowing not only in the Straits of Malacca, whose current early navigators mistook for that of an inland stream, but through the wide valley of the China Sea, and by the deep and narrow Strait of Sunda into the Indian Ocean. Thus the unity would become geographical, which is now only geological. That the great

* From the Journal of the Indian Archipelago and Eastern Asia, for July, 1847.

platform from which only mountains and hills rose above the sea level, till the materials drawn from them by the rains were rolled out into the present alluvial plains, is really an extension of the Asiatic mass, appears evident from the facts, amongst many others which require a separate geological paper for their discussion, and would be less readily appreciated by the general reader, —that its direction, as a whole, is that which a continuation of southeastern Asia, under the same plutonic action which produced it, would possess; the mountain ranges which form the latter sink into it irregularly in the lines of the longitudinal axes; —in one zone, that of the Peninsula, the connexion is an actual geographical one;—the Peninsula is obviously continued in the dense clusters of islands and rocks, stretching on the parallel of its elevation and of the strike of its sedimentary rocks, from Singapore to Banka, and almost touches Sumatra, the mountain ranges of which are, notwithstanding, parallel to it;—Borneo and Celebes appear to represent the broader or eastern branch of the Indo-Chinese Peninsula, from which they are separated by the area of the China Sea, supposed to be sinking; and finally, nearly the whole Archipelago is surrounded by a great volcanic curve rooted in Asia itself, and the continuity of which demonstrates that the platform and the continental projection with which it is geographically connected are really united, at this day, into one geological region by a still vigorous power of plutonic expansiveness, no longer, to appearance, forming hypogene elevations, but expending itself chiefly in the numerous volcanic vents along the borders where it sinks into the depths of the ocean.

Whether the present platform ever rose above the level of the sea and surrounded the now insular eminences with vast undulating plains of vegetation, instead of a level expanse of water, we shall not here seek to decide, although we think that Raffles and others who have followed in his steps too hastily connected the supposed subsidence with the existing geological configuration of the region, and neglected the all-important evidence of the comparative distribution of the living flora and fauna, which seems to prove that the ancient southern continent, if such there was, had subsided before they came into existence. No conclusive reasons have yet been adduced why we would consider the islands of the Archipelago as the summits of a partially submerged, instead of a partially emerged, continent. But whether it was the sinking of the continent that deluged all the southern lowlands of Asia, leaving only the mountain summits visible, or its elevation that was arrested by the exhaustion of the plutonic energy, or the conversion of its upheaving into an ejecting action, on the opening of fractures along the outskirts of the region, before the feebler action there had brought the sea bed into contact with the atmosphere, the result has been to form an expanse of shallow seas and islands elsewhere unequalled in the world, but perhaps not greater in proportion to the wide continental shores, and the vast bulk of dry land in front of which it is spread out, than other archipelagos are to the particular countries, or continental sections, with which they are connected.

The forms and positions of these islands bear an older date than that of any limited subsidence or elevation of the region after its formation. They were determined by the same forces which originally caused the platform itself to swell up above the deep floor of the southern ocean: and it was one prolonged act of the subterranean power to raise the Himalayas into the aërial level of perpetual snow, to spread out the submarine bed on which the rivers were afterwards to pile the hot plains of Bengal, and to mould the surface of the southern region, so that when it rose above, or sunk into the sea to certain levels, the mutual influences of air and sea and land should be so balanced, that while the last drew from the first a perennial ripeness and beauty of summer, it owed to the second a perennial freshness and fecundity of spring. Hence it is, that in the Archipelago, while the bank of black mud daily overflowed by the tides is hidden beneath a dense forest, and the polypifer has scarcely reared its tower to the sea's surface before it is converted into a green islet, the granitic rocks of the highest plutonic summits and the smoke of the volcanic peaks, rise from amidst equally luxuriant, and more varied, vegetation. Certainly, the most powerfully impressive of all the characteristics of the Achipelago is its botanical exuberance, which has exercised the greatest influence on the history and habits of its human inhabitants, and which, as the most obvious, first excites the admiration of the voyager, and from its never growing stale, because ever renewing itself in fresh and changeful beauty, retains its hold upon our feelings to the last.

When we enter the seas of the Archipelago we are in a new world. Land and ocean are strangely intermingled. Great islands are disjoined by narrow straits, which, in the case of those of Sunda, lead at once into the smooth waters and green level shores of the interior from the rugged and turbulent outer coast, which would otherwise have opposed to us an unbroken wall more than two thousand miles in length. We pass from one mediterranean sea to another, now through groups of islets so small that we encounter many in an hour, and presently along the coasts of those so large that we might be months in circumnavigating them. Even in crossing the widest of the Eastern seas, when the last green speck has sunk beneath the horizon, the mariner knows that a circle drawn with a radius of two days' sail would touch more land than water, and even that, if the eye were raised to a sufficient height, while the islands he had left would reappear on the one side, new shores would be seen on almost every other. But it is the wonderful freshness and greenness in which, go where he will, each new island is enveloped, that impresses itself on his senses as the great distinctive character of the region. The equinoctial warmth of the air, tempered and moistened by a constant evaporation, and purified by periodical winds, seems to be imbued with penetrating life-giving virtue, under the influence of which even the most barren rock becomes fertile. Hence those groups of small islands which sometimes environ the larger ones like clusters of satellites, or mark where their ranges pursue their course beneath the sea, often appear, in particular states of the atmosphere, when a zone of white quivering light surrounds them and obliterates their coasts, to be dark umbrageous gardens floating on a wide lake, whose gleaming surface would be too dazzling were it not traversed by the shadows of the clouds, and covered by the breeze with an incessant play of light and shade. Far different from the placid beauty of such scenes is the effect of the mountain domes and peaks which elsewhere rise against the sky. In these the voyager sees the grandeur of European mountains repeated, but with all that is austere or savage transformed into softness and beauty. The snow and glaciers are replaced by a mighty forest, which fills every ravine with dark shade, and arrays every peak and ridge in glancing light. Even the peculiar beauties which the summits of the Alps borrow from the atmosphere are sometimes displayed. The Swiss, gazing on the lofty and majestic form of a volcanic mountain, is astonished to behold, at the rising of the sun, the peaks inflamed with the same rose-red glow which the snowy summits of Mount Rosa and Mount Blanc reflect at its setting, and the smoke wreaths, as they ascend from the crater into mid-air, shining in golden hues like the clouds of heaven.*

But serene in their beauty and magnificent as these mountains generally appear, they hide in their bosoms elements of the highest terrestrial sublimity and awe, compared with whose appalling energy, not only the bursten lakes and the rushing avalanches of the Alps, but the most devastating explosions of Vesuvius or Etna, cease to terrify the imagination. When we look upon the ordinary aspects of these mountains, it is almost impossible to believe the geological story of their origin, and if our senses yield to science, they tacitly revenge themselves by placing in the remotest past the era of such convulsions as it relates. But the nether powers though imprisoned are not subdued. The same telluric energy which piled the mountain from the ocean

* M. Zollinger in describing Mount Semírú in Java, notices this singular resemblance to the mountains of his native country.

to the clouds, even while we gaze in silent worship on its glorious form, is silently gathering in its dark womb, and time speeds on to the day, whose coming science can neither foretell nor prevent, when the mountain is rent; the solid foundations of the whole region are shaken; the earth is opened to vomit forth destroying fires upon the living beings who dwell upon its surface, or closed to engulf them; the forests are deluged by lava, or withered by sulphureous vapors; the sun sets at noonday behind the black smoke which thickens over the sky, and spreads far and wide, raining ashes throughout a circuit hundreds of miles in diameter; till it seems to the superstitious native that the fiery abodes of the volcanic dewas are disemboweling themselves, possessing the earth, and blotting out the heavens. The living remnants of the generation whose doom it was to inhabit Sumbawa in 1815 could tell us that this picture is but a faint transcript of the reality, and that our imagination can never conceive the dreadful spectacle which still appalls their memories. Fortunately these awful explosions of the earth, which to man convert nature into the supernatural, occur at rare intervals; and though scarcely a year elapse without some volcano bursting into action, the greater portion of the Archipelago being more than once shaken, and even the ancient granitic floor of the Peninsula trembling beneath us, this terrestrial instability has ordinarily no worse effect than to dispel the illusion that we tread upon a solid globe, to convert the physical romance of geological history into the familiar associations of our own lives, and to unite the events of the passing hour with those which first fitted the world for the habitation of man.

We have spoken of the impression which the exterior beauty of the Archipelago makes upon the voyager, and the fearful change which sometimes comes over it, when the sea around him is hidden beneath floating ashes mingled with the charred wrecks of the noble forests which had clothed the mountain sides; but, hurried though we are from one part of our slight sketch to another, we cannot leave the vegetation of this great region without looking upon it more closely. To recall the full charms, however, of the forests of the Archipelago,—which is to speak of the Archipelago itself, for the greater portion of it is at this moment, as the whole of it once was, clothed to the water's edge with trees,—we must animate their solitudes with the tribes which dwell there in freedom, ranging through their boundless shade as unconscious of the presence of man, and as unwitting of his dominion, as they were thousands of years ago, when he did not dream that the world held such lands and such creatures.

When we pass from the open sea of the Archipelago into the deep shade of its mountain forests, we have realized all that, in

Europe, our fancies ever pictured of the wildness and beauty of primeval nature. Trees of gigantic forms and exuberant foliage rise on every side; each species shooting up its trunk to its utmost measure of development, and striving, as it seems, to escape from the dense crowd. Others, as if no room were left for them to grow in the ordinary way, emulate the shapes and motions of serpents, enwrap their less pliant neighbors in their folds, twine their branches into one connected canopy, or hang down, here loose and swaying in the air, or in festoons from tree to tree, and there stiff and rooted like the yards which support the mast of a ship. No sooner has decay diminished the green array of a branch, than its place is supplied by epiphytes, chiefly fragrant Orchidaceæ, of singular and beautiful forms. While the eye in vain seeks to familiarize itself with the exuberance and diversity of the forest vegetation, the ear drinks in the sounds of life which break the silence and deepen the solitude. Of these, while the interrupted notes of birds, loud or low, rapid or long-drawn, cheerful or plaintive, and ranging over a greater or less musical compass, are the most pleasing, the most constant are those of insects, which sometimes rise into a shrill and deafening clangor; and the most impressive, and those which bring out all the wildness and loneliness of the scene, are the prolonged complaining cries of the únkas, which rise, loud and more loud, till the twilight air is filled with the clear, powerful and melancholy sounds. As we penetrate deeper into the forest, its animals, few at any one place, are soon seen to be, in reality, numerous and varied. Green and harmless snakes hang like tender branches. Others of deeper and mingled colors, but less innocuous, lie coiled up, or, disturbed by the human intruder, assume an angry and dangerous look, but glide out of sight. Insects in their shapes and hues imitate leaves, twigs and flowers. Monkeys, of all sizes and colors, spring from branch to branch, or, in long trains, rapidly steal up the trunks. Deer, and amongst them the graceful palandoh, no bigger than a hare and celebrated in Malayan poetry, on our approach fly startled from the pools which they and the wild hog most frequent. Lively squirrels, of different species, are everywhere met with. Amongst a great variety of other remarkable animals which range the forest, we may, according to our locality, encounter herds of elephants, the rhinoceros, tigers of several sorts, the tapir, the bábirúsa, the orangútan, the sloth; and, of the winged tribes, the gorgeously beautiful birds of paradise, the loris, the peacock, and the Argus pheasant. The mangrove rivers and creeks are haunted by huge alligators. An endless variety of fragile and richly colored shells not only lie empty on the sandy beaches, but are tenanted by Pagurian crabs, which, in clusters, batten on every morsel of fat seaweed that has been left by the retiring waves. The coasts are fringed with living rocks of beautiful colors, and shaped like stars, flowers, bushes and other symmetrical forms. Of multitudes of peculiar fishes which inhabit the seas, the dugong, or Malayan mermaid, most attracts our wonder.

Before we leave this part of our subject, we would assure any European reader who may suspect that we have in aught written too warmly of the physical beauty of the Archipelago, that the same nature which, in the West, only reveals her highest and most prodigal terrestrial beauty to the imagination of the poet, has here ungirdled herself, and given her wild and glowing charms, in all their fullness, to the eye of day. The ideal has here passed into the real. The few botanists who have visited this region declare, that from the multitude of its noble trees, odorous and beautiful flowers, and wonderful vegetable forms of all sorts, it is inconceivable in its magnificence, luxuriance and variety. The zoologists, in their turn, bear testimony to the rare, curious, varied and important animals which inhabit it, and the number and character of those already known is such as to justify one of the most distinguished of the day in expressing his belief, that "no region on the face of the earth would furnish more novel, splendid, or extraordinary forms than the unexplored islands in the eastern range of the Indian Archipelago."

Hitherto we have faintly traced the permanent influence of the physical configuration of the Archipelago in tempering the intertropical heat, regulating the monsoons, determining the distribution of plants and animals, and giving to the whole region its peculiar character of softness and exuberant beauty. But when its rock foundations were laid, the shadow of its future human, as well as natural, history spread over them. Its primal physical architecture, in diminishing the extent of dry land, has increased the variety in the races who inhabit it; while the mineralogical constitution of the insulated elevations, the manner in which they are dispersed throughout its seas, and all the meteoric and botanical consequences, have affected them in innumerable modes. Again, as we saw that the platform of the Archipelago is but an extension of the great central mass of Asia, and that the direction of the subterranean forces had determined the ranges of the land, so we find that its population is but an extension of the Asiatic families, and that the direction of migration was marked out by the same forces. But, separated by the sea from the great plains and valleys of the continent, having the grand routes of communication covered by mountains and dense and difficultly penetrable forests, the Archipelago could not be peopled by hordes, but must have owed its aborigines to the occasional wandering of small parties or single families. The migrations from one island to another were probably equally limited and accidental; and the small and scattered communities in such as were inhabited, must for a long period have remained secluded from all others, save when a repetition of similar accidents added a few more units to the human denizens of the forests.

We cannot here attempt to retrace in the most concise manner the deeply interesting history of the tribes of the Archipelago, so exciting from the variety of its elements, and its frequent, though not impenetrable, mystery. We can but distinguish the two great eras into which it divides itself:—that, at the commencement of which some of the inhabitants of the table-land of Asia having slowly traversed the southeastern valleys and ranges, a work perhaps of centuries, appear on the confines of the Archipelago, no longer nomades of the plains but of the jungles, with all the changes in ideas, habits and language which such transformation implies, and prepared by their habits to give rise, under the influences of their new position, to the nomades of the sea;—and the second era, that, at the commencement of which the forest and pelagic nomades, scattered over the interior and along the shores of the island of the Archipelago, in numerous petty tribes, each with some peculiarities in its habits and language, but all bearing a family resemblance, were discovered in their solitudes by the earliest navigators from the civilized nations of the continent.

The ensuing, or what, although extending over a period of about two thousand years, we may term the modern history of the Archipelago, first exhibits the Klings from southern India,—who were a civilized maritime people probably three thousand years ago,—frequenting the islands for their peculiar productions, awakening a taste for their manufactures in the inhabitants, settling amongst them, introducing their arts and religion, partially communicating these and a little of their manners and habits to their disciples, but neither by much intermarriage altering their general physical character, nor by moral influence obliterating their ancient superstitions, their comparative simplicity and robustness of character, and their freedom from the effeminate vanity which probably then, as in later times, distinguished their teachers. At a comparatively recent period, Islamism supplanted Hinduism in most of the communities which had grown up under the influence of the latter, but it had still less modifying operation; and amongst the great bulk of the people, the conversion from a semi-Hindu condition to that of Mahomedanism was merely formal. Their intellects, essentially simple and impatient of discipline and abstract contemplation, could as little appreciate the scholastic refinements of the one religion, as the complex and elaborate mythological machinery and psychological subtleties of the other. While the Malay of the nineteenth century exhibits in his manner, and in many of his formal usages and habits, the influence which Indians and Arabs have exerted on his race, he remains, physically and morally, in all the broader and deeper traits of nature, what he was when he first entered the Archipelago; and even on his manners, usages and habits, influenced as they have been, his distinctive original character is still very obviously impressed.

We cannot do more than allude to the growth of population and civilization in those localities which, from their extent of fertile soil or favorable commercial position, rose into eminence, and became the seats of powerful nations. But it must be borne in mind, that, although these localities were varied and wide-spread, they occupied but a small portion of the entire surface of the Archipelago, and that the remainder continued to be thinly inhabited by uncivilized tribes, communities, or wandering families.

Prevented, until a very recent date, by stubborn prejudices and an overweening sense of superiority from understanding and influencing the people of the Archipelago, the European dominations have not directly affected them at all; and the indirect operation of the new power, and mercantile and political policies which they introduced, has been productive of much evil and very little good. While, on the one hand, the native industry and trade have been stimulated by increased demand and by the freedom enjoyed in the English ports, they have, on the other hand, been subjected by the Portuguese, English and Dutch, to a series of despotic restraints, extending over a period of three hundred years; and, within the range of the last nation's influence, continued, however modified, to this hour: which far more than counterbalance all the advantages that can be placed in the opposite scale.

The effect of the successive immigrations, revolutions and admixtures which we have indicated or alluded to, has been, that there are now in the Archipelago an extraordinary number of races, differing in color, habits, civilization and language, and living under forms of government and laws, or customs, exhibiting the greatest variety. The same cause which isolated the aborigines into numerous distinct tribes and kept them separate,—the exuberant vegetation of the islands,—has resisted the influence, so far as it was originally amalgamating, of every successive foreign civilization that has dominated; and the aboriginal nomades of the jungle and the sea, in their unchanged habits and mode of life, reveal to their European contemporary the condition of their race at a time when his own forefathers were as rude and far more savage. The more civilized races, after attaining a certain measure of advancement, have been separated by their acquired habits from the unaltered races, and have too often turned their superiority into the means of oppressing, and thereby more completely imprisoning in the barbarism of the jungles, such of them as lived in their proximity. So great is the diversity of tribes, that if a dry catalogue of names suited the purpose of this sketch, we could not afford space to enumerate them. But, viewing human life in the Archipelago as a general contemplation, we may recall a few of the broader peculiarities which would be most likely to dwell on the memory after leaving the region.

In the hearts of the forests we meet man scantily covered with the bark of a tree, and living on wild fruits, which he seeks with the agility of the monkey, and wild animals, which he tracks with the keen eye and scent of a beast of prey, and slays with a poisoned arrow projected from a hollow bambú by his breath. In lonely creeks and straits we see him in a small boat, which is his cradle, his house, and his bed of death; which gives him all the shelter he ever needs, and enables him to seize the food which always surrounds him. On plains, and on the banks of rivers, we see the civilized planter converting the moist flats into rice-fields, overshadowing his neat cottage of bambú, níbong and palm leaves, with the graceful and bounteous cocoa-nut, and surrounding it with fruits, the variety and flavor of which European luxury might envy, and often with fragrant flowering trees and shrubs which the greenhouses of the West do not possess. Where the land is not adapted for wet rice, he pursues a system of husbandry which the farmer of Europe would view with astonishment. Too indolent to collect fertilizing appliances, and well-aware that the soil will not yield two successive crops of rice, he takes but one, after having felled and burnt the forest; and he then leaves nature, during a ten years' fallow, to accumulate manure for his second crop in the vegetable matter elaborated by the new forest that springs up. Relieved from the care of his crop, he searches the forests for ratans, canes, timber, fragrant woods, oils, wax, gums, caoutchouc, gutta-percha, dyes, camphor, wild nutmegs, the tusks of the elephant, the horn and hide of the rhinoceros, the skin of the tiger, parrots, birds of paradise, argus pheasants, and materials for mats, roofs, baskets and receptacles of various kinds. If he lives near the coast, he collects fish, fish maws, fish roes, slugs (trepang), seaweed (agaragar), tortoise-shell, rare corals and mother-of-pearl. To the eastward, great fishing voyages are annually made to the shores of Australia for trepang. In many parts, pepper, coffee, or betel-nut, to a large extent, and tobacco, ginger, and other articles, to a considerable extent, are cultivated. Where the *Hirundo esculenta* is found, the rocks are climbed and the caves explored for its costly edible nest. In different parts of the Archipelago the soil is dug for tin, antimony, iron, gold, or diamonds. The more civilized nations make cloths and weapons, not only for their own use but for exportation. The traders, including the Rajahs, purchase the commodities which we have mentioned, dispose of them to the European, Chinese, Arab, or Kling navigator who visits their shores, or send them in their own vessels to the markets of Singapore, Batavia, Samarang, Manilla, and Macassar. In these are gathered all the products of the Archipelago, whether such as the native inhabitants procure by their unassisted industry, or such as demand the skill and capital of the European or Chinese for their cultivation or manufacture; and amongst the latter, nutmegs, cloves, sugar, indigo, sago, gambier, tea, and the partially cultivated cinnamon and cotton. To these busy marts, the vessels of the first maritime people of the Archipelago, the Bugis, and those of many Malayan communities, bring the produce of their own countries, and that which they have collected from neighboring lands, or from the wild tribes, to furnish cargoes for the ships of Europe, America, Arabia, India, Siam, China, and Australia. To the bazaar of the Eastern Seas, commerce brings representatives of every industrious nation of the Archipelago, and of every maritime people in the civilized world.

Although, therefore, cultivation has made comparatively little impression on the vast natural vegetation, and the inhabitants are devoid of that unremitting laboriousness which distinguishes the Chinese and European, the Archipelago, in its industrial aspect, presents an animated and varied scene. The industry of man, when civilization or over-population has not destroyed the natural balance of life, must ever be the complement of the bounty of nature. The inhabitant of the Archipelago is as energetic and laborious as nature requires him to be; and he does not convert the world into a workshop, as the Chinese and the Kling immigrants do, because his world is not like theirs, darkened with the pressure of crowded population and over-competition, nor is his desire to accumulate wealth excited and goaded by the contrast of splendour and luxury on the one hand and penury on the other, by the pride and assumptions of wealth and station, and the humiliations of poverty and dependence.

While in the volcanic soils of Java, Menangkabaú and Celebes, and many other parts of the Archipelago, population has increased, an industry suited to the locality and habits of each people prevails, and distinct civilizations, on the peculiar features of which we cannot touch, have been nurtured and developed; other islands, less favoured by nature, or under the influence of particular historical circumstances, have become the seats of great piratical communities, which periodically send forth large fleets to sweep the seas, and lurk along the shores of the Archipelago, despoiling the seafaring trader of the fruits of his industry and his personal liberty, and carrying off, from their very homes, the wives and children of the villagers. From the creeks and rivers of Borneo and Johore, from the numerous islands between Singapore and Banka, and from other parts of the Archipelago, piratical expeditions, less formidable than those of the Lanuns of Sulu, are year after year fitted out. No coast is so thickly peopled, and no harbor so well protected, as to be secure from all molestation, for where open force would be useless, recourse is had to stealth and stratagem. Men have been kidnapped in broad day in the harbors of Pinang and Singapore. Several inhabitants of Province Wellesley, who had been carried away from their houses through the harbor of Pinang and down the Straits of Malacca to the southward, were recently discovered by the Dutch authorities living in a state of slavery, and restored to their homes. But the ordinary abodes of the pirates themselves are not always at a distance from the European settlements. As the thug of Bengal is only known in his own village as a peaceful peasant, so the pirate, when not absent on an expedition, appears in the river, and along the shores and islands of Singapore, as an honest boatman or fisherman.

When we turn from this brief review of the industry of the Archipelago, and its great internal enemy, to the personal and social condition of the inhabitants, we are struck by the mixture of simplicity and art, of rudeness and refinement, which characterizes all the principal nations. No European has ever entered into free and kindly intercourse with them, without being much more impressed by their virtues than their faults. They contrast most favorably with the Chinese and the Klings in their moral characters; and although they do not, like those pliant races, readily adapt themselves to the requirements of foreigners, in their proper sphere they are intelligent, shrewd, active, and, when need is, laborious. Comparing them even with the general condition of many civilized nations of far higher pretensions, our estimate must be favorable. Their manners are distinguished by a mixture of courtesy and freedom which is very attractive. Even the poorest while frank are well-bred, and, excluding the communities that are corrupted by piracy or a mixture with European seamen and low Chinese and Klings, we never see an impudent air, an insolent look, or any exhibition of immodesty, or hear coarse, abusive or indecent language. In their mutual intercourse they are respectful, and while good-humored and open, habitually reflective and considerate. They are much given to amusements of various kinds, fond of music, poetry and romances, and in their common conversation addicted to sententious remarks, proverbs, and metrical sentiments or allusions. To the first impression of the European, the inhabitants, like the vegetation and animals of the Archipelago, are altogether strange, because the characteristics in which they differ from those to which we are habituated, affect the senses more vividly than those in which they agree. For a time the color, features, dress, manners and habits which we see and the languages which we hear are those of a new world. But with the fresh charms, the exaggerated impressions also of novelty wear away; and then, retracing our steps, we wonder that people so widely separated from the nations of the West, both geographically and historically, and really differing so much in their outward aspect, should, in their more latent traits, so much resemble them. The nearer we come to the inner spirit of humanity, the more points of agreement appear, and this not merely in the possession of the universal attributes of human nature, but in specific habits, usages, and superstitions.

What at first seems stranger still is, that when we seek the native of the Archipelago in the mountains of the interior, where he has lived for probably more than two thousand years secluded from all foreign influence, and where we expect to find all the differences at their maximum, we are sometimes astonished to find him approximating most closely of all to the European. In the Jakún, for instance, girded though his loins are with *terap* bark, and armed as he is with his sumpitan and poisoned arrows, we recognize the plain and clownish manners and simple ideas of the uneducated peasant in the more secluded parts of European countries; and when he describes how, at his merry-makings, his neighbors assemble, the arrack tampúi flows around and the dance, in which both sexes mingle, is prolonged, till each seats himself on the ground with his partner on his knee and his bambú of arrack by his side, when the dance gives place to song, we are forcibly reminded of the free and jovial, if rude, manners of the lower rural classes of the West. Freed from the repellant prejudices and artificial trappings of Hindu and Mahomedan civilization, we see in the man of the Archipelago more that is akin than the reverse to the unpolished man of Europe.

When we turn to the present political condition of the Archipelago, we are struck by the contrast which it presents to that which characterized it three or four centuries ago. The mass of the people, it is true, in all their private relations, remain in nearly the same state in which they were found by the earliest European voyagers, and in which they had existed for many centuries previously. But, as nations, they have withered in the presence of the uncongenial, greedy and relentless spirit of European policy. They have been subdued by the hard and determined will of Europeans, who in general have pursued the purposes for which they have come into the Archipelago without giving any sympathy to the inhabitants. The nomadic spirit, never extinguished during all the changes which they underwent, had made them adventurous and warlike when they rose into nations. But now, long overawed and restrained by the power of Europeans, the national habits of action have, in most parts of the Archipelago, been lost, or are only faintly maintained in the piratical expeditions of some. Their pride has fallen. Their living literature is gone, with the power, the wars, and the glory which inspired it. The day has departed when Singapore could be invaded by Javanese,—when Johore could extend its dominion to Borneo on the one side and Sumatra on the other,—when the fleets of Acheen and Malacca could encounter each other in the Straits to dispute the dominion of the Eastern Seas,—when the warrants of the Sultan of Menangkabaú were as potent over the Malayan nations as the bulls of Rome ever were over those of Christendom,—when a champion of Malacca could make his name be known all over the Archipelago,—and when the kings of the Peninsula sent their sons, escorted by celebrated warriors, to demand the daughters of the emperors of Majapahit in marriage. The Malayan princes of the present day, retaining all the feudal attachment and homage of their subjects, and finding no more honorable vent for the assertion of their freedom from restraint and the gratification of their self-will, have almost everywhere sunk into indolent debauchees and greedy monopolists, and, incited by their own rapacity and that of the courtiers who surround them, drain and paralyze the industry of their people.

Art. XIII.—*On the Anomalies presented in the Atomic Volume of Sulphur and Nitrogen; with remarks on Chemical Classification, and a notice of M. Laurent's Theory of Binary Molecules;* by T. S. Hunt, of the Geol. Commission of Canada. (In a letter to one of the Editors.)

The similarity of functions enjoyed by oxygen and sulphur, is now generally recognized by chemists. It is known that sulphur may replace oxygen, equivalent for equivalent, and produce combinations which are referable to the same type and often isomorphous with the oxygen compounds. It is unnecessary to recall instances of this; the parallelism of the oxyds and sulphurets of the metals is perfect, and in the sulphates and hyposulphites of soda, two salts identical in form and in the amount of crystal-water, we have the same formula, with the exception that sulphur in the second replaces an equivalent of the oxygen in the first. The sulphate is $SNa_2 O_4$, and the hyposulphite $SNa_2 (O_3 S)$. The researches in organic chemistry have still farther established this relation, and shown that oxygen with sulphur, selenium and tellurium, constitute a natural group.

Chlorine, iodine and bromine, and nitrogen, phosphorus and arsenic, constitute two analogous groups. Besides their power of replacing each other, it is found that elements thus related have generally the same atomic volume, and their vapors consequently the same combining measure.

If with the French chemists we divide the equivalents of hydrogen, chlorine and the metals by 2, and write the formula of water, H_2O or H_4O_2, their combining volumes will be the same as that of oxygen. But if we look at the volume of sulphur, we find an exception to this rule: the specific gravity of its vapor is 6·654, while that of oxygen gas is 1·1057. Taking the combining volume of oxygen as unity, that of sulphur is $\frac{1}{3}$, and while the volume of the atom of oxygen (= the atomic weight divided by the density) is represented by 7·2354, that of sulphur is found to be 2·4045. This fact with a similar one in the history of nitrogen, has long been an unexplained difficulty in the way of admitting that the combining volumes of all the elements should be identical.

In an attempt towards a system of chemical classification, some suggestions have arisen which will, I think, enable us to explain satisfactorily this apparent anomaly. Rejecting the ordinary ideas of electro-negative and electro-positive relations, as not only baseless but erroneous in their tendency, I consider with MM. Gerhardt and Laurent, that each class of compounds is derived from a normal species or primitive type by successive substitutions. This idea I have endeavored to extend both by the formation of new classes, and by enlarging our views of substitutions.

In considering such combinations as SO_2 and SeO_2, which contain three equivalents of the elements of the oxygen group, it was necessary to admit a normal species which should be a polymere of oxygen, and be represented by O_3=(OOO). The replacement of one equivalent of oxygen by one of sulphur, would yield sulphurous acid gas (OOS), and a complete metalepsis would give rise to (SSS). The first compound is probably the *ozone* of Schönbein, which the late researches of Marignac and de la Rive have shown to be in reality only oxygen in a peculiarly modified form, since pure dry oxygen gas, by the action of the electrical spark, acquires the peculiar odor and chemical properties which distinguish ozone. The most characteristic of these are, its peculiar odor and its power of discharging vegetable colors, in both of which is seen such a close resemblance to sulphurous acid gas, as at once to suggest a similarity.

If we regard sulphur in the form which is known to us, as having the composition (SSS), and consisting of three equivalents combined in one, the density of its vapor is no longer an anomaly, as the sulphur-vapor is condensed to one-third of its normal bulk, and its equivalent number being $16\times3=48$, its atomic volume is 7·2135, or the same as that of oxygen gas. The difficulty is completely solved in a manner which is accordant with well-admitted principles.

In connection with the similarity between ozone and sulphur here advanced, it is worthy of notice that the odor of sulphur when warmed or rubbed, which is similar to, and often confounded with that of sulphurous acid gas, although really distinct, is strikingly like the odor produced by the electrical discharge; indeed this last, which is now known to be due to the formation of ozone, is universally described as a sulphurous smell. Such resemblances as this may seem trivial; but when we consider the close likeness between the odors of chlorine, bromine, iodine and their compounds with each other, on the one hand, and those of phosphorus and arsenic on the other, we are constrained to admit that the effects produced by these bodies on the nerves of smell, have an intimate and as yet but imperfectly understood relation to their chemical properties.

As to selenium, I am not aware that the density of its vapor has ever been determined, but from that of the solid it appears probable that it as well as tellurium has a triple molecule. The compound described as Se O may belong to a type which is seen in anhydrous sulphuric acid (SO_3), in which case its formula will be ($Se_2\ O_2$), but from its volatility and pungent odor, it is perhaps referable to the previous form, and will then be ($Se_{\frac{3}{2}}\ O_{\frac{3}{2}}$); hybrid combinations* of this sort are not unfrequent.

In the other exception referred to, we find that while the density of the vapors of arsenic and phosphorus is such that their volume is identical with that of oxygen, nitrogen gas is represented by two volumes, taking oxygen as unity; and that consequently while the calculated atomic volumes of gaseous phosphorus and arsenic are 7·2, that of nitrogen gas is 14·4 –; in other words, its state of condensation is only one-half that of the others.

It has already been suggested that elementary nitrogen is probably unknown to us, and that the gas which is left when the oxygen is removed from the atmosphere, is an amid whose formula is (NN), corresponding like all similar combinations to four volumes; the equivalent of nitrogen being taken at 14, while that of oxygen is 8. Two equivalents of nitrogen being thus expanded to four volumes, the density is of course just one-half of that which corresponds to the normal one, and multiplying the observed density by 2, we find that the real specific gravity of gaseous elementary nitrogen should be 1·944; its combining volume identical with that of oxygen, and the volume of its atom, like that of phosphorus and arsenic, 7·2. If it existed in the

* By *hybrids*, M. Laurent has designated a class of compounds, which to the atomistical chemist present no small difficulties. Such as these, are many combinations of the mineral kingdom where three or four metals may exist in varying proportions in a sulphuret, (e. g. $S(Cu\,F\,Zn)_2$,) or as carbonates in $CO_3(Mg\,Fe\,Ca)_2$. The proportions of these are often so variable, as to give rise to the most improbable formulas in attempting to represent them after the Berzelian system of notation. The consideration of such cases as these has induced M. Laurent to admit in these hybrid combinations, "a divisibility of atoms to which he assigns no limits." (See this Journal, ii ser., iv, 405, v, 405, Gerhardt on the Atomic Volume of some Minerals of the Regular System, and Laurent on Silicates.)

same state of condensation as solid phosphorus, its specific gravity would be 790, water being 1000.

M. Laurent in a late valuable memoir,* has made some very important suggestions as to chemical classification, which if properly carried out, will enable us ere long to reduce the immense number of combinations to a few simple and well defined types. Water (H_2O) he not only regards as the primitive type of all the oxyds (M_2O) and (M^{β}_2O), of the hydrates (MH)O, compounds like (KZn)O, and the corresponding sulphur compounds H_2S, M_2S, (MH)S, but going still farther, reduces the alcohols to the same form. Spirit of wine, which is a monobasic *saline*† compound capable of changing an equivalent of hydrogen for one of metal, e. g. $C_2(H_5K)O$, is made the type of the *vinic acids*, in which the *bibasic salt* water has one of its atoms of hydrogen replaced by the elements of alcohol *minus* an equivalent of hydrogen and one of oxygen, while hydric ether corresponds to the *neutral* compounds of the bibasic acids, in which both equivalents of hydrogen are replaced by the same elements. Thus $C_2H_6O - HO = Et$, we have—

Water, ...	H_2O.
Alcohol, ...	$(HEt)O = C_2H_6O$.
Ether, ...	$Et_2O = C_4H_{10}O$.

It appears to me that this view is susceptible of still farther extension and that we may include in the same type all those saline combinations (acids) which contain oxygen. For example, the hypochlorites are represented as having the formula Cl O,MO = Cl MO_2, or in the French notation (Cl M) O, the acid being then (Cl H)O, a monobasic acid which corresponds to water in which Cl replaces H. The so-called anhydrous hypochlorous acid of M. Pelouze, obtained by the action of dry chlorine upon oxyd of mercury, is the result of a complete substitution. In the same manner nitric acid (NHO_3), is a monobasic salt corresponding to water in which NO_2 is substituted for H; the capacity of the elements NO_2 to replace H is abundantly exemplified in the modern history of organic compounds. We have then,

---

* Recherches sur les combinaisons azotés, Ann. de Ch. et de Phys. for November, 1846.

† As the words *salt* and *saline* are several times used in this article, in an acceptation somewhat different from the ordinary one, it may be well to observe, that with M. Gerhardt I designate as a salt any compound which contains hydrogen replaceable by a metal, or the metallic derivatives of that compound; *saline hydrogen* is that replaceable hydrogen. I have sometimes used for convenience the term salt, meaning the hydrogen salt as synonymous with acid, which indeed it is in the ordinary acceptation of the latter. It is time however that the name acid as a generic one, were banished from the science, and that it were restricted merely to sensible qualities, for hydrate of potash, water, sugar and alcohol are as really hydrogen salts as nitric, sulphuric or phosphoric acids—while many compounds possessing *acid reactions*, are chemically indifferent.

Water, ...	(HH)O.
Hypochlorous acid, ...	(Cl H)O.
Hypochlorites, ...	(Cl M)O.
Nitric acid, ...	((NO_2)H)O.
Nitrates, ...	((NO_2) M)O.

As an application of this idea to bibasic compounds, sulphuric acid(SH_2O_4) is to be regarded as water in which SHO_3 replaces H, thus ((SHO_3)H)O. As the replacing elements contain an equivalent of hydrogen which is saline, the acid is bibasic. When the hydrogen in SHO_3 is replaced by a metal we have a class of acid sulphates as ((SKO_3) H)O. The complete replacement of hydrogen in the original type gives rise to $(SHO_3)_2O = S_2H_2O_7$, which is the Nordhausen acid commonly represented by $2SO_3$, HO. This latter compound as M. Gerhardt has shown corresponds to the anhydrous bisulphate of potash.

The tribasic acids may equally be reduced to the same type if we conceive the elements which replace one equivalent of hydrogen to be bibasic instead of indifferent or monobasic. Phosphoric acid PH_3O_4 is ((PH_2O_3)H)O.

The primitive saline type is then essentially bibasic, and is presented in its most elemental form in water, while the simplest type of the monobasic salt which is a derivative of the last, is found in hypochlorous acid.

The ideas above announced show that it is possible to develop some connection between a series of compounds hitherto regarded as widely distinct from each other, and may lead us to hope that the time is coming when a new day will dawn upon the science.

M. Laurent proposes a view of elementary bodies that shall divide them into two classes, which he designates as

the monasides,			and the diodides.		
O	C	Si	H	H	N
S			Metals,	Cl	P
Se				Br	As
Te				I	Bo
				Fl	

The vertical groups represent those bodies which are equivalent to each other and may be again divided into isomorphous groups. These elements may exist in any number of equivalents in organic bodies, but the sum of those of the second group, in accordance with his well known law,* will always be divisible by

* As this important law which was first fully announced in the essay of M. Laurent, before quoted, may not be familiar to all our readers, we translate entire that portion of his memoir. "M. Gerhardt has endeavored to show that in a regular notation, the number of atoms of each element ought to be a pair, and that moreover in those combinations which do not contain azote, the number of atoms

two. The reason of this will appear if we conceive the equivalents of the elements like those of their compounds, to be represented by 2 volumes; we have then,

Oxygen, . . .	O_2 . . .	. 200·0
Hydrogen, . .	H_2 . . .	12·5
Chlorine . . .	Cl_2 . . .	. 442·0
Hydrochloric acid, .	HCl	
Water, . . .	H_2O	
Carbonic acid, .	CO_2	

"The molecules of hydrogen, of chlorine and indeed all the diodides, are formed of two atoms which constitute a *homogeneous combination*, (HH), (Cl Cl), (MM), etc. These in the presence of each other can undergo a double decomposition or mutual substitution and form a *heterogeneous combination*."

$$\text{“}(HH)+(Cl\,Cl)=(HCl)+(Cl\,H)$$
$$(MM)+(Cl\,Cl)=(MCl)+(Cl\,M).$$

---

of hydrogen should be divisible by 4. In searching to explain the introduction of azote into organic bodies, I have been led to complete the rule of M. Gerhardt and to apply to azotized compounds the following proposition. '*In all azotized substances, represented by* 4 *volumes, the sum of the atoms of hydrogen and azote is always a multiple of* 4.'

From this proposition the following corollaries are deducible:

1st. If the hydrogen becomes 0, the number of the atoms of azote is a multiple of 4.

2d. If the azote becomes 0, the number of the atoms of hydrogen is a multiple of 4.—(Gerhardt.)

3d. If the organic substance contains phosphorus or arsenic in place of azote, the same rule is observed.

4th. The halogen bodies (Cl, Br, I,) may be substituted for the hydrogen, but the sum of the azote, the hydrogen and the halogen bodies is still a multiple of 4; it results from this that an organic substance cannot combine with two, six or ten volumes of chlorine, bromine, etc.

5th. The metals which form oxyds (R_2O) corresponding to water (H_2O), also replace hydrogen, and observe in their combinations the same rule.

6th. The metals of the oxyds, R_4O_3 (R_2O_3 in the ordinary notation), do not replace hydrogen, equivalent for equivalent; and it follows that in all the combinations which correspond to these oxyds, the sum of the atoms of hydrogen, of the metals, of azote, etc., is not divisible by 4."

"In a notation which corresponds to two volumes, the preceding numbers must be divided by 2. On account of the simplicity of the formulas, I give preference with M. Gerhardt to this second notation. Our two propositions then unite into the following.

In all organic substances, the sum of the atoms of the hydrogen, azote, phosphorus, arsenic, the metals and the halogen bodies, ought to be divisible by 2."

In regard to the truth of this law, it is to be remarked that among the hundreds of combinations where our position and equivalent is well determined, there is not a single exception, and that the few apparent ones principally among the organic alkaloids, have nearly all been explained by new and carefully conducted analyses, which have shown in their formulas a perfect conformity.

The fifth corollary may be made to include the sixth, by a simple hypothesis, which M. Laurent has proposed in the *Revue Scientifique*. As M_4O_3 corresponds to $3H_2O$, and consequently M_4 to H_6, it is obvious that $M_{\frac{2}{3}}=H$; and regarding the metals in these oxyds as uniting in two-thirds of their ordinary equivalents, they will no longer be exceptions, but will be included in the fifth corollary. See this Journal for Sept., 1847." (Review of Gerhardt.)

"The molecules of the monasides may also divide in two, but the half of the molecule does not necessarily require a complementary half to form a combination. This half can unite itself with an entire diodide. (HH)+(HH)+(OO)=(HH)O+(HH)O, or with an entire monaside, (CC)+(CC)+(OO)=(CC)O+(CC)O, or with the half of a monaside, (CC)+(OO)=(CO)+(CO)."

"If instead of taking one volume for some bodies, two for others and four for others as is ordinarily done; or if in place of taking with M. Gerhardt one volume for simple bodies and two for compounds, we represent all bodies whether simple or compound by one volume, we have a much more regular notation and one which taken in connection with the preceding ideas, enables us to represent the formulas of all bodies, without employing fractional numbers."

"We admit that each molecule of the simple bodies is at least divisible into two parts which we designate atoms; the molecules can only be divided in case of combination, we have then

Oxygen, . .	$O_2=200{\cdot}0$ . .	2 vol.
Hydrogen, .	$H_2= 12{\cdot}5$.	1 vol.
Water, . .	$H_2O=112{\cdot}5$ . .	1 vol.
Hydrochloric acid,	$HCl=227{\cdot}0$.	1 vol.

"Each letter O, H, Cl represents a demi-volume or demi-molecule or one atom. The formula of all these bodies indicates immediately the condensation. In no case do I change the notation of M. Gerhardt.

"The *atom* of M. Gerhardt represents the smallest quantity of a simple body *which can exist in a combination.* My *molecule* represents the smallest quantity of a simple body which can be employed to *effect a combination*, a quantity which is divided into two parts by the very act of combination. For example, Cl can enter into combination, but to effect this it is necessary to employ Cl^2. I admit then with M. Ampère the double decomposition of chlorine by hydrogen and the divisibility of atoms; I admit moreover for hybrids, a divisibility to which I assign no limits."

"From my propositions a curious consequence is deducible; M. Gerhardt has remarked that it is impossible that the nitric and chloracetic acids can contain water, because the formulas of these three bodies are NHO_3, $C_2HCl_3O_2$ and H_2O. It will be seen that this difficulty is not avoided by adopting the ordinary formulas, $N_2O_5+H_2O$ and $C_4Cl_6O_3$, H_2O, for it will then be necessary to represent water by H_4O_2."

"I believe that we may go farther and not only say that the hydrogen is not combined with oxygen, in the nitric acid, but that it is combined with azote, the two atoms of these bodies being complementary to each other.

Taking one volume which for the simple bodies represents one molecule or two atoms:

Oxygen, ...	$(OO)=1$ vol.
Hydrogen, ...	$(HH)=1$ vol.
Chlorine, ...	$(Cl\,Cl)=1$ vol.
Hydrochloric acid, ...	$(HCl)=1$ vol.
Hypochlorous acid, ...	$(Cl\,H)O=1$ vol.
Chloric acid, ...	$(ClH)O^3=1$ vol.
Phosph. Hydrogen, ...	$(PH)(HH)=1$ vol.
Hypophosphites, ...	$(PH)(HM)O_2=1$ vol.
Phosphites, ...	$(PH)(MM)O_3=1$ vol.
Phosphates, ...	$(PM)(MM)O_4=1$ vol.
Acetic acid, ...	$C_2(HH)(HH)O_2=1$ vol.
Acid chlorinated, . . .	$C_2(HH)(HCl)O_2=1$ vol.
Acid bichlorinated, . .	$C_2(HH)(Cl\,Cl)O_2=1$ vol.
Acid trichlorinated . .	$C_2(HCl)(Cl\,Cl)O_2=1$ vol."

This last hypothesis I present as one of the deductions of the author from his views, but it seems to me hardly warranted. The following application of the idea of the binary arrangement of atoms to the explanation of the affinities exhibited by bodies in the *nascent state*, is very beautiful and ingenious.

"If we place together two free molecules of bromine and hydrogen (BB′) and (HH′), the affinity of B for B′ and of H for H′ will perhaps be sufficient to oppose the combination of B and B′ with H and H′, but if only B and H were present, these two atoms not having to overcome any affinity would readily combine. This is what takes place, for example, if hydrogen is in the nascent state, as when we decompose hydrochloric acid by a metal, for we have $HCl+M=ClM+H$, which tends to reconstitute itself into a binary molecule by combining either with bromine or another molecule of hydrogen." "With sulphuric acid SH_2O_4 and a metal, the reaction is the same and the hydrogen is nascent or atomic, for it first forms an acid salt, eliminating H and not (HH); when the acid salt is formed, the second atom will be in its turn disengaged."

The binary molecule of the metals, hydrogen, chlorine, bromine, &c., will be seen to be the type of an immense number of combinations embracing the various alloys and amalgams, the hydracids like hydrochloric acid and their corresponding salts and such compounds as Cl Br and Cl I. The compound represented by ICl_5 is referable to a triple molecule of these elements represented by H6 or (HHHHHH); to this same type belong the perchlorids of antimony, arsenic and phosphorus, while the corresponding trichlorids form a double molecule. In all of these it will be observed that the molecular composition is preserved inviolate, all of the inorganic compounds into which the second group of elements enter, furnish a sum of atoms divisible by 2. In the oxygenized bodies on the contrary, we have a type which is composed of three atoms. M. Laurent's law is thus seen to be equally applicable to other compounds, than those denominated organic.

I have thrown out a few ideas suggested by this memoir of M. Laurent, and have at the same time pointed out the basis upon which it appears to me a true natural system of chemical classification can be founded. Imperfect as they are, I hope they may not prove unworthy of the consideration of scientific men, and tend to forward the progress of chemical philosophy.

Art. XIV.—*Upon the Influence of Color on Dew;* by Prof. John Brocklesby.

In those beautifully accurate experiments, from which Dr. Wells derived his theory of dew, the influence of various material properties, in determining the amount of moisture deposited upon bodies, under like exposures, is clearly and satisfactorily unfolded. We are however left to regret, that this sagacious observer did not illustrate the effect of *color*, by a full course of experiments.

This subject indeed was not entirely omitted. In four out of five experiments, made with parcels of black and white wool, alike in size and weight, he discovered that the former had gained a little more dew than the latter; but as the fibres of the white wool were somewhat coarser than those of the black, he accounts for the entire difference in the quantities of moisture from this circumstance alone.

At another time he exposed a piece of pasteboard covered with white paper, and close to this a second piece, similar in every respect to the first, covered with paper blackened with ink. In the morning he beheld hoar-frost upon both the cards, but the black surface appeared to have gained a greater quantity than the white. A doubt however rose in the mind of the observer upon this point, inasmuch as from the contrast of color the amount of hoar-frost might have been apparently greater upon the dark than upon the light surface even when no real difference existed* in favor of the black.

Influenced by certain views in regard to the effect of the chemical constitution of bodies in modifying radiation, Dr. Welles pursued this inquiry no farther.

The subject here rested until the year 1833, when Dr. Stark of Edinburg instituted a series of experiments to determine the influence of color upon heat, odors and dew.† Two experiments

---

* This appearance I have frequently observed, when the amount of dew upon the white *exceeded* that upon the black.

† In 1835, Prof. Bache of the University of Pennsylvania, investigated the influence of color upon the radiation of non-luminous heat. His experiments were

only were made upon the latter. Four parcels of wool of different hues were provided—viz: black, dark green, scarlet and white; each weighing 10 grains. On the night of the 13th of January, the first, and the last two were exposed upon the leads of a house, and a few nights afterwards all the colors were subjected to the same exposure. The results were as follows:

		Grains.
First Experiment,	The Black gained	32
	Scarlet "	25
	White "	20
Second Experiment,	The Black gained	10
	Dark Green "	9·5
	Scarlet "	6
	White "	5

These investigations are considered by the author as decisive of the point in question; and as establishing the fact, that dark and sombre hues are more favorable to the deposition of moisture, than those which are light and brilliant.

These deductions, however, appear to me inconclusive, for several reasons. First, because in this research the utmost delicacy of investigation is required, and it is almost, if not absolutely impossible, even with the nicest care, to guard against the operation of known causes, which, unless entirely excluded, will produce a perceptible difference in the results.

Now we are not informed by Dr. Stark, either in respect to the uniformity of fibre in the wool employed, or as to the size of each parcel. A dissimilarity in either particular would cause a difference in the amount of dew deposited. Moreover, on a subject like this, it is manifestly unphilosophical to infer a general law from two experiments.

With the view of satisfying my own mind upon this point, I made, during the summer of 1846, a number of experiments, the details of which are presented in the following pages.

The material employed for the collection of moisture was fine flannel. Having procured a white strip of an even texture, I cut it into six portions, and caused five to be dyed, each of a different ent color; viz., red (redwood), yellow (quercitron), green (fustic and indigo), blue (indigo), black (logwood). These six pieces, apparently all equally napped, were next cut to exactly the same size, and weighed in a delicate balance. A want of uniformity in weight was detected to the extent of a few grains. This source of error I endeavored to remove, by placing upon the

---

far more numerous than those of Dr. Stark, and the results he obtained entirely opposite.

I regret that I did not enjoy the pleasure of perusing his highly instructive paper upon this subject, until my experiments were closed.

different portions of flannel, shreds of the same material, texture, and color, until the weights were equalized; and before every experiment this precaution was taken, the same shreds as far as possible being always employed. By so doing uniformity in weight was attained, without increasing the extent of exposed surface; except what was due to the thickness of the shreds. And the effect of this is rendered inappreciable, since it is obvious that its slight influence in increasing the amount of dew is checked, and probably annihilated by two opposing causes.

For the shred being raised by its thickness above the surface of the larger piece, partially shelters the contiguous threads of the latter, and thus in a very minute degree arrests their radiation, and diminishes their quantity of deposited moisture. Still further, as the thickness of the flannel is doubled where the shreds are placed, there here exists, comparing such spots with those not so covered, twice the quantity of matter under very nearly the same exposed surface: a circumstance which would retard the diminution of temperature, and the contraction of dew. I therefore judge that these antagonist influences may be regarded in their effects as neutralizing each other, and that no sensible increase or diminution, in the amount of dew contracted, can result from the superposition of the shreds as above detailed. I thus obtained a uniformity in material weight, effective surface, fibre, and with the exception of a very small variation, in texture; for I attribute the variations in the weight of the several colored pieces to the greater density of some of the threads in one flannel, compared with those of another. The only known difference then existing was color.

The place of exposure was a plot of closely shorn turf in the midst of a garden, removed from trees and buildings. In six out of the eleven experiments, detailed in table A, the flannels were placed upon the turf itself, and in the remaining five upon a smooth board, elevated upon blocks of wood, six or seven inches above the turf. In every case the pieces were arranged side by side, without any regard to color in their collocation, and the investigation was conducted mostly on tranquil nights; so that the variations in the deposition of moisture, arising from a body being placed to the windward or leeward of another, were thereby avoided.

Table of Averages.

	Average gain in 11 experiments.	Do. in the first four.	Do. in the second four.	Do. in the last four.	Do. in the last three.
	grs.	grs.	grs.	grs.	grs.
White, . . .	39·27	47·50	39·	30·25	28·66
Yellow, . .	38·73	47·25	38·25	29·75	28·
Red, . .	37·27	46·	37·25	27·50	25·66
Green, . .	37·09	44·37	37·	29·12	27·50
Black, . .	36·14	43·25	36·62	27·75	26·
Blue, . .					25·17

1st Exp.	2d Exp.	3d Exp.	4th Exp.
Yellow, White, Black. Red. Green.	Red, Yellow, White. Green. Black.	Yellow. White. Red. Black. Green.	White. Red, Yellow. Green. Black.

5th Exp.	6th Exp.	7th Exp.	8th Exp.
White. Yellow. Red, Green. Black.	Yellow, Red. Green, Black, White.	White. Yellow. Black. Green, Red.	Yellow, White. Green. Red, Black.

9th Exp.	10th Exp.	11th Exp.
White. Black, Red, Yellow. Green. Blue.	White, Green, Yellow. Black. Blue. Red.	White. Yellow. Red, Green. Black, Blue.

Table A.

	1st.—July 9th.			2d.—July 10th.			3d.—July 11th.		
	Exposed surface.	Dry weight.	Dew gained.	Exposed surface.	Dry weight.	Dew gained.	Exposed surface.	Dry weight.	Dew gained.
	inches.	grs.	grs.	inches.	grs.	grs.	inches.	grs.	grs.
Red, . . .	17·5	52	58	17·5	52	47	17·5	53	32
Yellow, . .	"	"	61	"	"	47	"	"	34
Green, . . .	"	"	57·5	"	"	46	"	"	28
Black, . . .	"	"	59	"	"	41	"	"	29
White, . . .	"	"	61	"	"	47	"	"	33

	4th.—July 14th.			5th.—July 15th.			6th.—July 17th.		
	Exposed surface.	Dry weight.	Dew gained.	Exposed surface.	Dry weight.	Dew gained.	Exposed surface.	Dry weight.	Dew gained.
	inches.	grs.	grs.	inches.	grs.	grs.	inches.	grs.	grs.
Red, ...	17·4	53	47	17·4	51	53	14·85	42	46
Yellow, . . .	"	"	47	"	"	54	"	"	46
Green, . . .	"	"	46	"	"	53	"	"	44
Black, . . .	"	"	44	"	"	52	"	"	44
White, . . .	"	"	49	"	"	58	"	"	44

	7th.—July 21st.			8th.—July 24th.			9th.—July 28th.		
	Exposed surface.	Dry weight.	Dew gained.	Exposed surface.	Dry weight.	Dew gained.	Exposed surface.	Dry weight.	Dew gained.
	inches.	grs.	grs.	inches.	grs.	grs.	inches.	grs.	grs.
Red, ...	14·85	44	17	14·85	42	33	14·85	44	18
Yellow, . . .	"	"	18	"	"	35	"	"	18+
Green, . . .	"	"	17	"	"	34	"	"	17·5
Black, . . .	"	"	17·5	"	"	33+	"	"	18
White, . . .	"	"	19	"	"	35	"	"	19+
Blue,* . . .	. .	. .	. .	. .	. .	. .	"	"	17

	10th.—July 29th.			11th.—Aug. 4th.		
	Exposed surface.	Dry weight.	Dew gained.	Exposed surface.	Dry weight.	Dew gained.
	inches.	grs.	grs.	inches.	grs.	grs.
Red, . .	14·85	42	28	14·85	44	31
Yellow, . .	"	"	34	"	"	32
Green, . .	"	"	34	"	"	31
Black, . .	"	"	30	"	"	30
White, . .	"	"	34+	"	"	33
Blue, . .	"	"	28·5	"	"	30−

* On account of an unavoidable delay, the blue surface was not procured, until most of the experiments had been made.

With the view of discovering, whether these varying results were the legitimate effects of color alone, unconnected with other causes ; I cut a piece of fine, evenly wove, yellow flannel into four portions, and prepared them in the same manner as in table A. I thus obtained as far as possible, uniformity in every discernible particular. The place of exposure was the same, and the like precautions observed, as in the first series of experiments. The following are the results of four trials, the first two being made upon the grass, the last two upon the elevated board.

TABLE B.

	July 15th.			July 17th.			July 21st.			July 24th.		
	Exposed surface.	Dry weight.	Dew gained.	Exposed surface.	Dry weight.	Dew gained.	Exposed surface.	Dry weight	Dew gained.	Exposed surface.	Dry weight.	Dew gained.
	inches.	grs.	grs.	inches.	grs.	grs.	inches.	grs.	grs.	inches.	grs.	grs.
R, . .	12·3	24	33	12·3	24	33	12·3	25	12	12·3	24-	23+
S, . .	"	"	33	"	"	34	"	"	12	"	24-	23+
T, . .	"	"	33	"	"	31	"	"	11-	"	24	23
U, . .	"	"	33	"	"	26	"	"	11	"	24	24

Average of four experiments:

	grs.
R, ...	25·25
S, ...	25·50
T, ...	24·50
U, ...	23·50

By recurring to table A, it will be seen, that the amount of dew gained by the yellow and white is greater than that acquired by the black, both in the general and particular averages, and when single experiments are compared, the gain of the yellow exceeds that of the black in every case ; the highest being one-seventh of the quantity deposited upon the yellow. In like manner the white preponderates over the black in ten out of eleven instances, and in the eleventh their gain is alike. The greatest gain, being one-eighth of the moisture contracted by the white. The green possesses likewise an advantage over the black in every average ; but the red does not ; while in the comparison of single experiments they follow no law, at one time falling below the black, and at another ranging as high as the white and yellow.

The average of the blue is the least of all in the last three experiments, and sinks below the black in every instance in respect to the quantity of deposited moisture. The results of this investigation point to conclusions at variance with the commonly received opinions in regard to the radiation of heat as modified by color, and are directly opposed to the experiments of Dr. Stark. But are these variations in the amount of dew contracted, to their *full extent*, the legitimate effects of difference in color ? The details given in table B, throw light upon this question.

Notwithstanding every precaution to obtain uniformity in all essential particulars, the four exposed surfaces contracted unequal quantities of dew; the difference between the extreme averages being 25·5 grs. − 23·5 grs. = 2 grains in four experiments. The difference of the extremes in the first, second, and last four experiments, as given in table A, is as follows:

	grs. grs.
First four, ...	47·5 −43·25=4·25
Second four, ...	39· −36·62=2·38
Last four, ...	30·25 − 27·50=2·75

From this it is obvious, that the differences in the amount of deposited moisture, developed in the first course of experiments, were not fully due to the influence of color. Latent causes also conspired to produce these discrepancies, and the extent of their influence is eliminated by the second series of experiments. If this is represented by the difference between the extreme averages, and this quantity subtracted from the corresponding differences in table A, the remainder are represented by the following weights, 2·25 grs., ·38 grs., ·75 grs.; residual phenomena, which may be attributed, either to the influence of color, or considered as the sum of those errors of experiment, to which all human investigations are subject.

In table B, it will be observed, by comparing R, S, T, and U, with each other in the several experiments, that the amount of moisture deposited follows no rule, each surface in its turn ranging from the highest to the lowest point of the scale. Such fluctuating results must be the effects of predominating inconstant causes. The same fact is discovered, as before stated, in the first series of experiments, upon comparing together the red, green, and black. Here if color has any effect, it is entirely disguised by the prevalence of more potent fluctuating influences. The invariable superiority however, maintained by the yellow and white over the black, indicates the existence of one or more fixed operating causes, not visiting one surface to-night, and another the next; but attached to their own particular surface.

The only assignable, constant causes, exclusive of coloring matter, are the differences in the density of the threads composing the surfaces, (to which allusion has been made,) and color. But the first cause existed in the second series of experiments, and was unable to preserve any regularity in the variations. Moreover, between the black and white even this difference in the density of the thread scarcely existed, inasmuch as the equal surfaces of the black and white weighed very nearly the same, before any shreds were superadded. Under this view of the subject therefore, color alone would appear to have operated in producing the constant differences observed in the amount of deposited moisture as recorded in the first table, had the investigation been confined to the first course of experiment. But the results of subsequent observation, detected this fallacy ; for in the perusal of the following pages it will be seen, that where different coloring matter was employed, the white and yellow maintained no such superiority in the scale of colors. The material of color therefore is not to be disregarded in this enquiry.

In the further prosecution of this investigation, five small pieces of plate glass were procured, cut from the same strip of equal size, their weights being rendered alike by the addition of small fragments from the same plate. They were next painted on one side with water-colors, as follows:

Nos.	Substance.	Color.
1, ...	Gamboge.	Yellow.
2, ...	Prussian Blue and Gamboge.	Green.
3, ...	India Ink.	Black.
4, ...	Flake White.	White.
5, ...	Prussian Blue.	Blue.

In every color the paint was not spread quite uniformly over the surface, it being found impossible to blend the shades into one unvarying tint.

The plates were placed side by side upon a board, and exposed, in the first and second experiments, upon the roof of a house, and in the third upon an open grass plot. After each experiment, if any defect of coloring appeared, the plates were retouched. The results were as follows:

	1st.—Aug. 12th.			2d.—Aug. 13th.			3d.—Aug. 14th.		
	Exposed surface.	Dry weight.	Dew gained.	Exposed surface.	Dry weight.	Dew gained.	Exposed surface.	Dry weight.	Dew gained.
	inches.	pwts. grs.	grs.	inches.	pwts. grs.	grs.	inches.	pwts. grs.	grs.
Yellow, . .	5·06	9 14·5	13·5	5·06	9 14·5	6·5	5·06	9 14·5	6·5
Green, . .	"	" "	13·5	"	" "	7·5	"	" "	6·5
Black, . .	"	" "	12·5	"	" "	7·	"	" "	5·5
White, . .	"	" "	14·	"	" "	5·5	"	" "	7·
Blue, . . .	"	" "	13·5	"	" "	6·5	"	" "	7·

Arranging the colors according to the quantity of dew gained, the following orders are obtained:

1st Exp.	2d Exp.	3d Exp.
White. Yellow, Green, Blue. Black.	Green. Black. Yellow, Blue. White.	White, Blue. Yellow, Green. Black.

The average gain of the several colors, arranged as above, is seen in the annexed scale.

	grs.
Green, ...	9·2
Blue, ...	9·
Yellow, White, ...	8·8
Black, ...	8·3

It is impossible from these results to detect any controlling influence in color, but the fact, that the least amount of moisture was gained by the black, in two cases out of three, and that it holds the lowest rank in the table of averages, is not in accordance with the experiments of Dr. Stark.

Six white pasteboard cards were next taken, belonging to the same pack, and presenting the same extent of surface. They were equalized in weight in the manner before mentioned, and at first painted on one side as follows:

Card.	Substance.	Color.
A, . . .	Vermilion.	Red.
B, . . .	Gamboge.	Yellow.
C, . . .	Prussian Blue and Gamboge.	Green.
D, . . .	India Ink.	Black.
E, . . .	Natural color of the paper.	White.
F, . . .	Prussian.	Blue.

Thus prepared they were exposed on the grass plot, during five nights, upon the same board employed in the last experiments; and after each trial the cards were carefully weighed and equalized. At the close of the third trial, they were each painted on the remaining side, the colors being interchanged in the following manner.—B, red; A, yellow; F, green; E, black; C, blue; and D, being turned over afforded a white ground.

In the fourth and fifth trials, these second surfaces were exposed. The table below presents the results of this investigation.

	1st.—Sept. 3d.				2d.—Sept. 10th.				3d.—Sept. 15th.			
	Exposed surface.	Dry weight.		Dew gained.	Exposed surface.	Dry weight.		Dew gained.	Exposed surface.	Dry weight.		Dew gained.
	inches.	pwts.	grs.	grs.	inches.	pwts.	grs.	grs.	inches.	pwts.	grs.	grs.
A. Red, . . .	12·33	2	23	9	12·33	2	20	10	12·33	2	21	6
B. Yellow, . .	"	"	"	11	"	"	"	11	"	"	"	7
C. Green, . .	"	"	"	11	"	"	"	11	"	"	"	6
D. Black, . .	"	"	"	11	"	"	"	11	"	"	"	6
E. White, . .	"	"	"	12	"	"	"	11	"	"	"	7
F. Blue, . . .	"	"	"	12	"	"	"	12	"	"	"	8

	4th.—Sept. 22d.				5th.—Sept. 24th.			
	Exposed surface.	Dry weight.		Dew gained.	Exposed surface.	Dry weight.		Dew gained.
	inches.	pwts.	grs.	grs.	inches.	pwts.	grs.	grs.
B. Red, . .	12·33	2	23	15	12·33	2	21	31
A. Yellow, .	"	"	"	17	"	"	"	35
F. Green, . .	"	"	"	18	"	"	"	34
E. Black, .	"	"	"	16	"	"	"	33
D. White, . .	"	"	"	17	"	"	"	36
C. Blue, . .	"	"	"	18	"	"	"	36

Colors arranged according to the amount of dew gained:

1st Ex.	2d Ex.	3d Ex.	4th Ex.	5th Ex.	Average.
					grs.
Blue, White.	Blue.	Blue.	Blue, Green.	Blue,	Blue, 17·2
Yellow, Green,	Green, Yellow,	Yellow, White.	Yellow,	White.	White, 16·6
Black,	Black, White.	Red, Green,	White.	Yellow.	Yellow, 16·2
Red.	Red.	Black.	Black.	Green.	Green, 16·
			Red.	Black.	Black, 15·4
				Red.	Red, 14·2

It is seen in the experiments just detailed, that among the different colors the blue and red alone follow an invariable order; the former always occupying the highest and the latter the lowest rank; and that this is true notwithstanding the cards were changed after the third trial: a fact which shows that this law follows the pigment and not the card. But does the law attach to the *color* or the coloring matter. The latter appears to be the case. In Prof. Bache's essay on the influence of color upon radiation, a list is given of twenty-five substances, arranged in the order of their radiating powers. Prussian blue ranks the second, indigo the eighteenth, and vermilion the fifteenth. Prussian blue therefore, radiating more than vermilion, should contract more dew as accords with the fact. But it is evident that this effect is produced by the material of the pigment and not by the color, inasmuch as indigo has a less radiating power than vermilion, and consequently it would give but comparatively little dew. A fact which is shown in Table A, where the blue ranks very low in the scale of colors.

The results developed in these investigations afford no support to the assertions of Dr. Stark, that dark colors are more favorable than light to the deposition of dew; but, to their full extent, lead to the inference that color has no controlling power in this particular.

It is with much satisfaction that I have perceived the results of my humble researches, to accord with those, which Prof. Bache deduced from his elaborate investigations; wherever a comparison could be made. Thus with him I find, that color is not a determining quality in the radiation of non-luminous heat, that vermilion possesses a low radiating power, and that while Prussian blue possesses this property in a very high degree, indigo ranks amid the lowest on the scale. In Prof. Bache's experiments the rate of cooling was the test of the radiating power, in those just detailed, the amount of dew is the criterion. Now, without asserting that the non-influence of color upon radiation is fully established, it is certainly a circumstance worthy of consideration, that two independent modes of analysis have led to the same conclusions.

Art. XV.—*A new Method of extracting Pure Gold from Alloys and from Ores;* by C. T. Jackson, U.S.G.S.

The following method of obtaining pure metallic gold in the form of a spongy mass has been practised by me for several years, and no account of the process has, to my knowledge, heretofore been published. It is very useful to the chemist and to the manufacturer, and is more economical than any other method that I am acquainted with.

After separating the gold from silver by means of a mixture of nitric and chlorohydric acids as is usually done, the solution containing gold and copper is to be evaporated to small bulk and the excess of nitric acid is thus driven off.

A little oxalic acid is then added and then a solution of carbonate of potash sufficient to take up nearly all the gold in the state of aurite of potash is gradually added. A large quantity of crystallized oxalic acid is then added so as to be in great excess and the whole is to be quickly boiled. All the gold is immediately precipitated in the form of a beautiful yellow sponge which is absolutely pure metallic gold. All the copper is taken up by the excess of oxalic acid and may be washed out.

Boil the sponge in pure water so long as any trace of acidity remains, and the gold is then to be removed from the capsule and dried on filtering paper. It may be pressed into rolls, bars or thin sheets, by pressing it moderately in paper. I have made several useful applications of the gold sponge thus prepared, and had a tooth plugged with it in October, 1846, to which purpose it is well adapted.

By moderate pressure, the spongy gold becomes a solid mass and burnishes quite brilliantly.

The jeweller or goldsmith will find spongy gold to be quite convenient when he requires it for a solder, and it is a convenient form of the metal for making an amalgam for fine gilding. I have used it for some years in soldering platina, and prefer it to the filings or gold foil for that purpose. This method of separating fine gold from coarse, is very simple, and cheaper than the usual processes. It is applicable in the separation of gold from ores that may be treated by acids, and is vastly preferable to the method commonly used by chemists and assayers.

When making oxyd of gold for dentist's use, the chemist will find that oxalic acid added to his potassic solution, will at once recover all the gold that is dissolved in an excess of the alkaline solution.* Many other applications of this very simple method will occur to chemists and artisans.

* Much gold is lost by the usual method of preparing the oxyd.

ART. XVI.—*Discovery of Tellurium in Virginia;* by C. T. JACKSON, U.S.G.S.

EARLY in May last, Mr. Knowles Taylor of New York gave me two specimens of native gold, in mica slate rock, from an auriferous vein recently discovered in Whitehall, near Fredericksburg, Va. In one of the specimens I observed a considerable mass of a splendent foliated and sectile mineral, of the color of antimony, which I recognized as an ore of tellurium. The gold was imbedded in a mass of it, and it was also observed to exist disseminated through the rock in shining metallic leaves. On submitting this mineral to analysis, I discovered that it was a *telluret of lead and gold* or *foliated tellurium ore.* In the open glass tube before the blowpipe, telluric acid sublimes, and condenses in the cooler part of the tube in a yellowish white film which melts into drops. A little greyish sublimate also deposits, which is metallic tellurium. The residual matter, cupelled on mica, gave a well characterized glass of litharge, and a minute globule of pure gold. This interesting mineral has not, I believe, been heretofore discovered in the United States, and it is extremely rare in Europe. It had been mistaken for sulphuret of molybdenum, and was considered to be of no value. That error should be corrected, for it is not only valuable as an extremely rare mineral, but since, as I am informed, it occurs in abundance in the Virginia mine, it should be saved and wrought for gold, in the same manner as is practiced in the tellurium and gold mines of Transylvania. It is very easy to expel the tellurium by heat, and then the gold may be obtained by the usual processes of amalgamation by mercury, and discharge of the mercury by heat. Since I detected the tellurium, I have conversed with T. A. Dexter, Esq. of Boston, who has recently visited the mine, and has seen a considerable quantity of this tellurium ore in the vein. He gave me two very well characterized specimens, which he took from the vein in place; so there can be no doubt of its existence in a true auriferous vein.

I announced this discovery at the annual meeting of the American Academy of Arts and Sciences last month.

Boston, June 18th, 1848.

ART. XVII.—*Upon a peculiar kind of Isomorphism that plays an important part in the Mineral Kingdom;* by Professor SCHEERER of Christiania.

(Continued from p. 73.)

II. BORATES.

1. *Datholite.*

NONE of the prior formulæ for datholite agree so well with its composition as that brought forward by Rammelsberg, namely,

$$2\dot{C}a^3\,\dddot{S}i+\dot{B}^3\,\dddot{S}i^2+3\dot{\mathbf{H}}.$$

This formula, however, involves the improbability that the boracic acid is here viewed in the light of a base combined with the silica. This improbability may however be got over by writing the formula as follows: $3[\dot{C}a\,\dddot{S}i+\dot{C}a\,\dddot{R}]+(\dot{R})\,\dddot{S}i$, wherein therefore, $(\dot{R})=3\dot{\mathbf{H}}$.

2. *Botryolite.*

Rammelsberg's formula for this mineral is,

$$2\dot{C}a^3\,\dddot{S}i+\dddot{B}^3\,\dddot{S}i+6\,\dot{H},$$

which admits of conversion to $3[\dot{C}a\,\dddot{S}i+\dot{C}a\,\dddot{B}]+(\dot{R})^2\,\dddot{S}i$.

III. PHOSPHATES.

A. *Phosphates of Iron.*

1. *Vivianite.*

According to Stromeyer's analysis, the vivianite of St. Agnes in Cornwall, consists of phosphoric acid 31·8125, protoxyd of iron 41·2266, water 27·4843=99·8934.

Hitherto all endeavors have been in vain to arrive at a formula that would represent in a satisfactory manner the results of this analysis by so celebrated an analyst as Stromeyer, and which was apparently conducted with such precision. Von Kobell's formula, which gives the closest approximation to the result, $\dot{F}e^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathbf{P}}+8\dot{\mathbf{H}}$, requires a composition of phosphoric acid 28·69, protoxyd of iron 42·38, water 28·93=100·00.

This differs not immaterially from the result of the analysis, and moreover involves a ratio in the quantity of oxygen contained in the base, the acid and the water, which in a compound of so little complicated a nature can hardly be looked upon as probable. On calculating the water in Stromeyer's result as a base isomorphous with protoxyd of iron $(3\dot{\mathbf{H}}=1\dot{F}e)$ which, after the number of proofs we have adduced thereof, we are fully borne out in doing, we obtain an oxygen ratio of 17·47 $\dddot{P}$: 17·53 $(\dot{F}e)$, corresponding with almost mathematical accuracy to the simple formula $(\dot{F}e)^5 \dddot{P}$, and in which formula *base and acid contain equal amounts of oxygen.*

2. *Earthy Vivianite*, from Hillentrup.

This consists, according to an analysis of Brandes, of phosphoric acid 30·320, protoxyd of iron 43·775, water 25·000, alumina 0·700, silica 0·025 = 99·820.

The oxygen ratio deduced herefrom is as follows: 18·60 : 17·38.

Deducting the alumina as a phosphate, the ratio becomes even more nearly 1 : 1, whence we also obtain for this mineral too the formula $(\dot{F}e)^5 \dddot{P}$.

3. *Vivianite*, from Bodenmais.

Vogel's analysis gave, phosphoric acid 26·4, protoxyd of iron 41·0, water 31·0 = 98·4.

If we may rely on the accuracy of this result, it will justify the following formula, $(\dot{F}e)^5 \dddot{P} + 5\dot{H}$.

The oxygen ratio as it may be calculated from the result of

the analysis, is,	14·79 $\dddot{P}$	: 14·00 $(\dot{F}e)$	: 13·58 $\dot{H}$
should be	14·00	: 14·00	: 14·00.

A portion of the water in this mineral is *basic*, another portion exists as a hydrate. The formula thus resulting for the Bodenmais vivianite, is precisely similar to that which we obtain upon converting, on the principle here involved, the formula of the artificially prepared hydrous phosphate of magnesia, which is $\dot{M}g^2 \dddot{P} + 14\dot{H}$, whereby we obtain $(\dot{M}g)^5 \dddot{P} + 5\dot{H}$.

The corresponding artificial salts of the protoxyd of iron and of the protoxyd of manganese, have not as yet been analyzed, but without a doubt the same formula is also applicable to them. It would however be well to submit the Bodenmais vivianite to a further examination in order to ascertain with certainty whether in point of fact its composition is different from that from Cornwall, which as the two minerals agree in their crystalline form is certainly not probable.

4. *Mullicite.*

Thompson obtained for the composition of this mineral, phosphoric acid 26·06, protoxyd of iron 46·31, water 27·14 = 99·51.

The corresponding oxygen ratio is, 14·60 $\dddot{P}$: 14·00 $(\dot{F}e)$: 13·75 $\dot{H}$, which gives as the formula of mullicite $(\dot{F}e)^5 \dddot{P} + 5\dot{H}$, agreeing with Vogel's analysis of the Bodenmais vivianite. The chemical difference between both minerals would consist therefore merely herein, that in the former a smaller quantity of the protoxyd of iron is replaced by water than in the latter.

5. *Vivianite from the Mauritius.*

According to the analysis of Laugier it consists of phosphoric acid 21, protoxyd of iron 45, water 34=100.

From these numbers we can, it is true, surmise no great accuracy, nevertheless they afford an oxygen ratio of $11{\cdot}77\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathbf{P}}$: $10{\cdot}25\,\dot{\mathrm{Fe}}$: $30{\cdot}11\,\dot{\mathbf{H}}$, corresponding approximately to the formula $\dot{\mathrm{Fe}}^5\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathbf{P}}+15\dot{\mathbf{H}}$, according to which the oxygen ratio should be 10 : 10 : 30. In this mineral, therefore, the *whole* of the water appears to exist as a *hydrate*. The formula however admits of being thus written, $(\dot{\mathrm{Fe}})^{10}\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathbf{P}}$, in which case the whole of the water figures as basic.

B. *Phosphates of Copper.*

As oxyd of copper is not isomorphous with magnesia, protoxyd of iron, &c., it of course cannot be assumed that three atoms of water replace one atom of oxyd of copper. From grounds which I will afterwards explain, there is more than a probability that two atoms of water can replace one of oxyd of copper. That less water should be required to replace one atom of oxyd of copper than one atom of magnesia, is sufficiently substantiated by the different basic qualities of these compounds. In calculating the oxygen ratio of the following phosphates and arseniates of copper, it is assumed, as yet hypothetically, that $2\dot{\mathbf{H}}=1\dot{\mathrm{C}}\mathrm{u}$.

1. *Libethenite.*

The crystallized Libethenite consists, according to Berthier's analysis, of phosphoric acid 28·7, oxyd of copper 63·9, water 7·4=100·0. This gives, upon the above supposition, an oxygen ratio of $16{\cdot}08\overset{\cdot\cdot\cdot\cdot\cdot}{\mathbf{P}}$: $16{\cdot}18(\dot{\mathrm{C}}\mathrm{u})$, corresponding exactly to the formula $(\dot{\mathrm{C}}\mathrm{u})^5\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathbf{P}}$, which is the formula of the Cornwall vivianite and of the eathy vivianite from Hillentrup.

2. *Phosphorochalcite.*

Rammelsberg calculated from Lynn's analysis of the phosphorochalcite from Rheinbreitenbach, the formula $\dot{\mathrm{C}}\mathrm{u}^5\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathbf{P}}+5\dot{\mathbf{H}}$, coinciding completely with the formula here adduced for the phosphates. According to the analysis perhaps a portion (though for a certainty but a very small one) of the oxyd of copper may be replaced by water, and the formula in consequence becomes $(\dot{C}u)^5\,\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}+5\bar{H}$, agreeing with the Bodenmais vivianite and mullicite.

3. *Phosphate of Copper*, from Ehl, near Rheinbreitenbach.

This consists, according to Bergmann, of phosphoric acid 24·93, oxyd of copper 65·99, water 9·06 = 99·98, corresponding to the oxygen ratio $13{\cdot}99\,\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}} : 13{\cdot}31\,\dot{C}u : 8{\cdot}05\,\dot{\bar{H}}$; whence we deduce the formula, $3\dot{C}u^5\,\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}+10\,\dot{\bar{H}}$, requiring an oxygen ratio of 13 : 13 : 8·66.

4. *Phosphate of Copper*, from Hirschberg.

According to Kühn, its constituents are, phosphoric acid 20·87, oxyd of copper 71·73, water 7·40 = 100·00; whence we obtain the oxygen ratio,

$$\left.\begin{array}{l} 11{\cdot}69\,\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}} : 17{\cdot}66\,(\dot{\bar{R}}) \\ 11{\cdot}69 \quad : 17{\cdot}54 \end{array}\right\} \qquad (\dot{C}u)^{15}\,\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}{}^2.$$

IV. Arseniates.

As the relative quantities of the peroxyd and the protoxyd of iron have not yet been ascertained with accuracy in scorodite and in pharmacolite, no calculations can be here entered upon with respect to the formula these minerals would receive, by considering their water as a basic constituent.

A. *Arseniates of Earths.*

Picropharmacolite.

The analysis of Stromeyer gives arsenic acid 46·971, lime 24·646, magnesia 3·223, oxyd of cobalt 0·998, water 23·977 = 99·815, corresponding to—

$$\left.\begin{array}{l} 16{\cdot}30\,\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s : 15{\cdot}47\,(\dot{\bar{R}}) \\ 16{\cdot}00 \quad : 16{\cdot}00 \end{array}\right\} \qquad (\dot{R})^5\,\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s,$$

the formula of vivianite, libethenite, and earthy blue iron. Since *pharmacolite* contains no earth but *lime*, it is not to be assumed that any replacement by water is brought into play in that mineral.

B. *Arseniates of Cobalt.*

Cobalt Bloom.

According to Berzelius, its formula is $\dot{C}o^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s+6\dot{\bar{H}}$, which, as protoxyd of iron and protoxyd of cobalt are isomorphous, and as we may make $3\dot{\bar{H}} = 1\dot{C}o$, may be expressed likewise thus, $(\dot{C}o)^5\,\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s$, by which it is rendered analogous to the Cornish vivianite; and the agreement that has been proved by Gustavus Rose to exist between the forms of the crystals of these two minerals, would be thus farther borne out. According to Kersten's analysis of the cobalt bloom from Schneeberg, the formula for this mineral is however, $\dot{C}o^{3}\,\dddot{\mathbf{A}}s+8\mathbf{H}$.

C. *Arseniates of Copper.*

1. *Olivenite.*

Richardson found the crystallized olivenite to consist of—

Arsenic acid, . .	39·9	39·80
Oxyd of copper, . .	56·2	56·65
Water, . . .	3·9	3·55
	100·0	100·00

The mean oxygen ratio from these two analyses is—

$$\left.\begin{array}{l}13{\cdot}83\,\dddot{\mathbf{A}}s : 13{\cdot}04\,(\dot{C}u)\\ 13{\cdot}00 \quad : 13{\cdot}00\end{array}\right\}\quad (\dot{C}u)^{5}\,\dddot{\mathbf{A}}s.$$

This too is the formula of vivianite and of the other minerals cited. It is assumed that $2\mathbf{H} = 1\dot{C}u$.

2. *Euchroite.*

The euchroite from Libethen consists, according to Turner, of arsenic acid 32·02, oxyd of copper 47·85, water 8·80 = 99·67. From this the following oxygen ratio may be deduced, $11{\cdot}47\,\dddot{\mathbf{A}}s : 12{\cdot}00\,(\dot{C}u) : 12{\cdot}01\,\mathbf{H}$, approaching very closely the ratio calculated for phosphorochalcite, and whence may be deduced the formula, $(\dot{C}u)^{5}\,\dddot{\mathbf{A}}s+5\mathbf{H}$. In euchroite however, a larger portion of the water (about one-fourth of the whole amount) plays the part of a base, than is the case in phosphorochalcite.

3. *Copper-foam.*

According to v. Kobell's analysis, the formula of the diverging foliated copper-foam from Falkenstein, is $\dot{C}u^{5}\,\dddot{\mathbf{A}}s+10\mathbf{H}$, not taking into account the quantity of carbonate of lime therein contained, the amount of which approaches 1 atom.

4. *Erinite.*

From Turner's approximative analysis of this mineral, its constituents are arsenic acid 33·78, oxyd of copper 59·44, water 5·01, alumina 1·77 = 100·00. Neglecting the alumina, this gives the following oxygen ratio, $11{\cdot}73\,\dddot{\mathbf{A}}s : 11{\cdot}99\,\dot{C}u : 4{\cdot}45\,\mathbf{H}$, whence may be deduced the formula, $2\dot{C}u^{6}\,\dddot{\mathbf{A}}s+5\mathbf{H}$, or perhaps rather, $3\dot{C}u^{5}\,\dddot{\mathbf{A}}s+5\mathbf{H}$. The former requires an oxygen ratio of 11 : 11 : 5·5,—the latter of 12 : 12 : 4.

5. *Copper Mica.*

The composition of the Cornish copper mica, according to Chenevix, is arsenic acid 21, oxyd of copper 58, water 21 = 100, corresponding to the oxygen ratio, $7{\cdot}29\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathbf{A}\text{s}} : 11{\cdot}70\,\dot{\text{Cu}} : 18{\cdot}67\,\mathbf{H}$, which may be likewise thus expressed, $7{\cdot}29\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathbf{A}\text{s}} : 15{\cdot}00\,\dot{\text{Cu}} : 12{\cdot}07\,\dot{\text{H}}$, representing pretty closely the formula, $2(\dot{\text{Cu}})^{10}\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathbf{A}\text{s}}+15\mathbf{H}$, which requires the oxygen ratio, 7·50 : 15·00 : 11·25.

6. *Lenticular Copper.*

Rammelsberg proposes for this mineral, as analyzed by Chenevix, the formula, $\dot{\text{Cu}}^{10}\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathbf{A}\text{s}}+30\mathbf{H}$, which represents very closely the result of that analysis, and harmonizes well with the formula proposed for the preceding mineral. This formula can be also expressed as follows, $4(\dot{\text{Cu}})^{10}\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathbf{A}\text{s}}+30\mathbf{H}$.

V. Sulphates.

1. *Melanterite.*

According to Mitscherlich, the formula of sulphate of iron is $\dot{\text{Fe}}\,\dddot{\text{S}}+6\mathbf{H}$. According to Graham, on the contrary, it is $\dot{\text{Fe}}\,\dddot{\text{S}}+7\mathbf{H}$. The former formula, taking $3\mathbf{H} = 1\dot{\text{Fe}}$, may be converted to $(\dot{\text{Fe}})^3\,\dddot{\text{S}}$, and the latter to $(\dot{\text{Fe}})^3\,\dddot{\text{S}}+\mathbf{H}$. Since protoxyd of iron and water appear to exist always in sulphate of iron in determinate proportions, the former formula, properly speaking, may be expressed more correctly thus, $\dot{\text{Fe}}^3\,\dddot{\text{S}}+2(\dot{\mathbf{H}})^3\,\dddot{\text{S}}$, and the latter also in the same manner, but with $+\mathbf{H}$.

2. *Epsomite.* (Beudant.)

The formula thereof is $\dot{\text{Mg}}\,\dddot{\text{S}}+7\dot{\mathbf{H}}$, which is convertible to $(\dot{\text{Mg}})^3\,\dddot{\text{S}}+\dot{\mathbf{H}}$, the remarks appended to melanterite being likewise applicable in this case.

3. *Goslarite.* (Haidinger.)

Its formula is $\dot{\text{Zn}}\,\dddot{\text{S}}+7\mathbf{H}$, which is equivalent to $(\dot{\text{Zn}})^3\,\dddot{\text{S}}+\mathbf{H}$.

4. *Bieberite.* (Haidinger.)

The sulphate of cobalt from Bieber consists, according to Winkelblech, of sulphuric acid 29·05, protoxyd of cobalt 19·91, magnesia 3·86, water 46·83 = 99·65. This gives an oxygen ratio of 17·39 $\dddot{\mathrm{S}}$: 5·74 $\dot{\mathrm{Co}}$ and $\dot{\mathrm{Mg}}$: 13·88 $\dot{\mathbf{H}}$, which is convertible to 17·39 $\dddot{\mathrm{S}}$: 17·66 $(\dot{\mathrm{R}})$: 5·88 $\dot{\mathbf{H}}$, in which case it corresponds very closely to the formula, $(\dot{\mathrm{Co}})^3\,\dddot{\mathrm{S}}+\dot{\mathbf{H}}$, which requires an oxygen ratio of 17·64 : 17·64 : 5·88. The formula of the artificial sulphate of nickel, $\dot{\mathrm{Ni}}\,\dddot{\mathrm{S}}+7\dot{\mathbf{H}}$, may be converted in like manner to $(\dot{\mathrm{Ni}})^3\,\dddot{\mathrm{S}}+\dot{\mathbf{H}}$.

Kopp has examined a sulphate of cobalt from Bieber, the composition of which differed from that analyzed by Winkelblech. It is composed of sulphuric acid 19·74, protoxyd of cobalt 38·71, water 41·55 = 100·00, corresponding to the oxygen ratio, 11·82 $\dddot{\mathrm{S}}$: 8·25 $\dot{\mathrm{Co}}$: 12·31 $\dot{\mathbf{H}}$, which is convertible to—

$$\left.\begin{matrix} 11{\cdot}82\,\dddot{\mathrm{S}} : 12{\cdot}00\,\dot{\mathrm{Co}} : 25{\cdot}68\,\dot{\mathbf{H}} \\ 12{\cdot}00 \quad : 12{\cdot}00 \quad : 24{\cdot}00 \end{matrix}\right\} \quad (\dot{\mathrm{Co}})^3\,\dddot{\mathrm{S}}+6\dot{\mathbf{H}}.$$

It would be interesting to ascertain whether this bieberite has the same form of crystal as that examined by Winkelblech, which without a doubt is to be looked upon as the normal salt.

5. *Vitriol.* (Haidinger.)

The formula of sulphate of copper is $\dot{\mathrm{Cu}}\,\dddot{\mathrm{S}}+5\dot{\mathrm{H}}$. Assuming that 1$\dot{\mathrm{Cu}}$ may be replaced by 2$\dot{\mathbf{H}}$, this formula is equivalent to $(\dot{\mathrm{Cu}})^3\,\dddot{\mathrm{S}}+\dot{\mathrm{H}}$. Sulphate of copper by this means receives a formula similar to that of the other sulphates here mentioned, (with the exception perhaps of melanterite,) and this harmony appears to me to bear out the truth of the assumption I have adopted, and this opinion is still farther supported by the formula obtained by calculation for the phosphates and for the arseniates of copper.

6. *Basic Sulphate of Copper.*

The oxygen ratio of this mineral, resulting from Berthier's analysis, is 9·93 $\dddot{\mathrm{S}}$: 13·35 $\dot{\mathrm{Cu}}$: 15·29 $\dot{\mathbf{H}}$, or otherwise by conversion,

$$\left.\begin{matrix} 9{\cdot}93\,\dddot{\mathrm{S}} : 19{\cdot}33\,(\dot{\mathrm{Cu}}) : 3{\cdot}33\,\dot{\mathbf{H}} \\ 9{\cdot}75 \quad : 19{\cdot}50 \quad : 3{\cdot}25 \end{matrix}\right\} \quad (\dot{\mathrm{Cu}})^6\,\dddot{\mathrm{S}}+\dot{\mathbf{H}}.$$

7. *Sulphate of Alumina.*

The formula of sulphate of alumina, both that which occurs native and the artificial, is $\dddot{\mathbf{Al}}\,\dddot{\mathrm{S}}^3+18\dot{\mathbf{H}}$, which expression may be thus written, $2(\dot{\mathrm{R}})^3\,\dddot{\mathrm{S}}+\dddot{\mathbf{Al}}\,\dddot{\mathrm{S}}$. In the artificially prepared pure salt, $(\dot{\mathrm{R}})$ consists entirely of water, whereas in the natural salt, it contains also minute quantities of solid bases isomorphous therewith, as $\dot{F}e$, $\dot{M}g$, &c.

8. *Alum.*

The alum formula, $\dot{R}\dddot{S}+\dddot{\mathbf{Al}}\dddot{S}^3+24\dot{\mathbf{H}}$, is convertible to

$$3(\dot{R})^3\dddot{S}+\dddot{\mathbf{Al}}\dddot{S}.$$

9. *Alum Stone*, or *Alumite.*

Rammelsberg, from Cordier's analysis of the crystallized alumite from Tolfa, attributes to this mineral the formula, $(\dot{K}\dddot{S}+\dddot{\mathbf{Al}}\dddot{S}^3)+3\dddot{\mathbf{Al}}\dot{\mathbf{H}}$, which involves, as it seems to me, an improbability, inasmuch as one portion of alumina and sulphuric acid are therein combined as a neutral salt, while three times this quantity of alumina, in the form of a hydrate, is noways combined with the acid at all. Changing the expression of the formula to $(\dot{R})^3\dddot{S}+\dddot{\mathbf{Al}}^3\dddot{S}^2$, we get rid of the above improbable ratio.

It cannot but be noticed that in the formulæ proposed for the different (neutral) sulphates, 1 atom $\dot{\mathbf{H}}$ is always introduced as water of crystallization, while six atoms $\dot{\mathbf{H}}=2(\dot{R})$, acting the part of a base, are combined with the sulphuric acid. This coincides very well with Graham's well known observation, to the effect that these salts by exposure to heat, yield up six equivalents of water with far greater readiness than they do the seventh equivalent, which is not expelled until the temperature is still farther raised. Graham termed this last "basic water," and the former water of crystallization. According to my view of the matter, this nomenclature would be inverted.*

At the close of these enquiries, to set about enumerating the numerous facts in favor of the notion that water in the mineral kingdom, acts extensively the part of a base, seems to me a use-

---

* Whether in fact in all the sulphates in question the quantities of the 1 : 1 atomic bases ($\dot{M}g$, $\dot{F}e$, $\dot{M}n$, $\dot{C}o$, $\dot{N}i$, $\dot{Z}n$, $\dot{C}u$) are *always* in *definite* atomic proportion to the amount of basic water [as $\dot{R} : 2(\dot{\mathbf{H}})$], a circumstance which, as we have seen, does *not* appear to obtain in other minerals (silicates, phosphates and arseniates), cannot as yet be established for a certainty. But even already from the not unimportant discrepancies observable in the results obtained by various chemists in their analysis of several of these sulphates, it is rendered probable that the ratio between the 1 : 1 atomic bases and the basic water is *variable*. So many other circumstances may however be brought here into play, that no direct proof one way or another is to be sought for therein. This has engaged me to institute a series of experiments directed to the formation of crystallized sulphates in which $\dot{R}$ and $(\dot{\mathbf{H}})$ do *not* observe the definite proportion indicated above. But that such sulphates, if indeed they can exist, are formed only under certain peculiar circumstances, is of itself evident.

less labor, and one which unless entered upon in detail would very likely be imperfect. From all that has been said, it may fairly be held established, That 1 *atom of magnesia, protoxyd of iron, protoxyd of manganese* (probably also) *protoxyd of cobalt, protoxyd of nickel and oxyd of zinc may be isomorphically replaced by* 3 *atoms of water, and that* 1 *atom of oxyd of copper may be similarly replaced by* 2 *atoms of water.* This would be the foundation of a new kind of isomorphism which, contrasted with that hitherto received (monomeric), might be termed *polymeric isomorphism.* There is hardly a doubt but that with time, its application will be found more general.

There occurs to me an opposite remark of v. Bonsdorff, to the effect that in hornblendes $3\dddot{Al}$ are apparently isomorphic with $2\dddot{Si}$, an opinion which is supported by the analogous examples of a similar polymeric replacement mentioned above.*

That polymeric isomorphism is called into play also beyond the region of the mineral kingdom, admits scarcely of a doubt. For the present however, I have no time to follow the subject up beyond its actual limits.

I hold it almost superfluous to remark, that I am far from supposing that *the whole* of the formulæ that I have proposed are the correct ones. For a considerable number of the minerals concerned, especially those with whose composition we are not sufficiently well acquainted, the formulæ are given merely as a suggestion, and further investigation must decide how far I have been correct in such cases as those.

At the conclusion of this article, I may be perhaps permitted to add a few general remarks that appear to me to be of some importance, and which are more or less closely connected with the subject in hand.

1. *Remarks upon the Zeolites.*

Among all the minerals to which our attention has been directed, there is not a single one belonging to the zeolites. This group of minerals is distinguished for its amount of water, and is not the less remarkable from *the total absence of magnesia and protoxyd of iron by which it is characterized, the very two bases which so frequently and with such facility are replaced by water.* The 1 : 1 atomic bases most usually occurring in zeolites, are *lime* and *potash,* with regard to which, as far at least as minerals are concerned, in which they play a leading part, it would appear that they are not replaceable by water. Upon endeavoring to treat either in the whole or in part the water contained in zeolites

* It is possible that the minute quantities of $\dddot{Al}$ and $\dddot{Cr}$ in Schiller-spar (which see) may, upon the same principle, admit of a corresponding quantity of $\dddot{Si}$.

as basic water, we obtain generally speaking, either highly improbable formulæ, or at least such ones as offer no reason for preferring them to those already received. In a few instances only, which will be found below, the results that I have obtained, appear to be worthy of notice.

1. *Okenite.*

$\dot{Ca}^3\,\dddot{Si}^4+6\dot{\mathbf{H}}$ may be converted to $3\dot{Ca}\,\dddot{Si}+(\dot{R})\,\dddot{S}+3\dot{\mathbf{H}}$.

2. *Apophyllite.*

$\dot{K}\,\dddot{Si}^2+8\dot{Ca}\,\dddot{Si}+16\dot{\mathbf{H}}$ may be converted to $3\dot{R}^3\dddot{Si}^2+2(\dot{R})^3\dddot{Si}^2$.

$\dot{R}$ here contains $\dot{K}$ and $\dot{Ca}$; $(\dot{R})$ on the contrary, the entire amount of water. According to this formula however, the quantity of water in apophyllite should amount to about 18 per cent, whereas both Berzelius and Stromeyer obtained only from 16 to 17 per cent.

3. *Analcime.*

$\dot{Na}^3\,\dddot{Si}^2,\ 3\dddot{\mathbf{Al}}\,\dddot{Si}^2+6\dot{\mathbf{H}}$ may be converted to

$3[\dot{Na}\,\dddot{Si}+\dddot{\mathbf{Al}}\,\dddot{Si}]+2(\dot{R})\,\dddot{Si}$.

The portion of the formula within the bracket is the formula of labradorite. $(\dot{R})$ here too contains only water.

4. *Harmotome.*

$\dot{Ba}^3\,\dddot{Si}^2+4\dddot{\mathbf{Al}}\,\dddot{Si}^2+18\dot{\mathbf{H}}$ may be converted to

$\dot{Ba}^3\,\dddot{Si}^2+2[(\dot{R})^3\dddot{Si}^2+2\dddot{\mathbf{Al}}\,\dddot{Si}]$.

The bracketed portion of the formula is that of scapolite, amphodelite, &c.

5. *Epistilbite.*

$\left.\begin{matrix}\dot{Ca}\\ \dot{Na}\end{matrix}\right\}\dddot{Si}+3\dddot{\mathbf{Al}}\,\dddot{Si}^3+5\dot{\mathbf{H}}$ may be converted to

$\dot{Ca}^3\,\dddot{Si}^2+2[(\dot{R})^3\,\dddot{Si}^2+2\dddot{\mathbf{H}}\mathrm{l}\,\dddot{Si}^2]$.

The bracketed portion is the formula of Weissite. The oxygen ratio of epistilbite, deduced from Gustavus Rose's analysis thereof, is

$30{\cdot}44\,\dddot{Si} : 8{\cdot}18\,\dddot{\mathbf{H}}\mathrm{l} : 4{\cdot}75\,\dot{Na}$ and $\dot{\mathbf{H}} : 2{\cdot}12\,\dot{Ca}$;

whereas, according to the formula proposed by me, it ought to be

30·44 : 8·69 : 4·35 : 2·17,

agreeing therefore very closely with the ratio deduced from the analysis. $(\dot{R})$ in this formula comprises the entire soda and the whole of the water.

Now though there may be somewhat of a probability that some of the zeolites contain basic water, yet it nevertheless seems characteristic of the *zeolites in general*, that the water which they contain is true water of crystallization.

2. *Remarks upon certain Pseudomorphs.*

Not an inconsiderable number of minerals of the most various chemical and crystallographic character, such as spinel, garnet, augite, feldspar, tourmaline, mica, and so forth, are, as is known, met with converted to all appearance into a substance which, according to the external characters that it presents, is termed either steatite or serpentine. We are not however by any means well informed with respect to their precise chemical nature.

Had not aspasiolite which externally resembles serpentine very closely, been accurately examined by me, nothing would have been more probable than holding those crystals, consisting as they do partly of cordierite and partly of aspasiolite, for *crystals of cordierite, partially converted to serpentine*, by which the number of those peculiar pseudomorphs would have been still farther increased. Now as it is moreover established that the crystals of serpentine met with at Snarum, are by no means pseudomorphs of olivine, the inference will not appear too hazarded that, also in the instance of some other serpentine and steatitic masses, hitherto held to be pseudomorphs, further investigation may lead to precisely analogous results. In spinel, garnet, augite, and so forth, a portion of the 1 : 1 atomic bases may easily occur replaced by water, and without a change in the form of its respective crystal being effected, a mineral be formed in its nature approaching serpentine or steatite. Thus, for instance, spadaite and meerschaum, two minerals allied to serpentine and steatite, have the formula of augite, with the difference only that a portion of their bases is replaced by water, in like manner onkosin has the formula of labradorite, pinguite that of garnet, pyrargillite that of fahlunite,—not to cite other examples.

It is not any ways intended to deny that *true* pseudomorphs are met with wherein the magnesia plays an essential part. It is a long established fact that certain metamorphoses are of very frequent occurrence where water impregnated with carbonic acid has exercised a long continued action upon masses of rock from which, in consequence of its solvent properties, it has withdrawn certain constituents. This water, thus charged with carbonic acid *and likewise with other substances*, appears however in certain cases in its progress downwards, to deposit some of these substances again, or rather *to exchange them for others more easily soluble in water containing carbonic acid*, and by this means to give rise to the formation of a particular kind of pseudomorph. Carbonic acid water containing *carbonate of magnesia* in solution, is capable of this action, being able to withdraw from silicates a portion of their more easily soluble bases, especially potash, and to replace them, at least in part, by *magnesia and water*. A solution of carbonate of magnesia in water impregnated with carbonic acid is, as we are aware, distinguished from similar solutions of the other earths by its *alkaline* reaction, and hence it cannot but exercise a far more energetic action upon silicate-masses than, for instance, a solution of carbonate of lime in water impregnated with carbonic acid, the action of which is acid. In this respect the solutions of the alkaline carbonates will naturally display the most powerful action, but as one can easily see, they never bring about any deposition of substances.* Highly interesting proofs may be seen in Norway (in the neighborhood of Arendal), that such a formation of pseudomorphs as is here touched upon, or one at least resembling it, does in point of fact occur, and upon that I purpose entering upon a future occasion.

3. *Remarks upon certain Petrographic and Geognostic relations.*

When we direct our attention to the formulæ proposed for the micas and the micaceous minerals, it cannot escape our notice that in very many of them the same members occur as in the formulæ for feldspar, as for instance $\dot{R}\dddot{Si}$, $\dddot{\mathbf{R}}\dddot{Si}^3$, $\dddot{\mathbf{R}}\dddot{Si}^2$ and so forth, thus indicating a certain connection between two groups of minerals apparently so distinct, and it is this connection which offers an explanation how it is that these groups of minerals are so very frequently met with associated together in crystalline primary rocks. The feldspars and minerals allied thereto are, however, very characteristically distinguished from the micas and the micaceous minerals, inasmuch as the first have never taken up water into their composition, owing doubtless to their 1 : 1 atomic bases, consisting almost entirely of alkalies which do not admit of the entrance of water, whereas it would find easier access to the micas, which contain magnesia and protoxyd of iron. The formula of the mica from Miask, Monroe, and Karasulik, and probably from many other localities, is, as before mentioned, that of garnet;—the formula of the Abborforss and Sala micas approaches the garnet formula, inasmuch as the members thereof are

* Besides, the solution of carbonate of lime in water impregnated with carbonic acid, cannot well deposit anything else than *carbonate of lime*, either by a diminution of the free carbonic acid, or by taking up into solution other substances more readily soluble, whereby a portion of the carbonate of lime is, of necessity, separated. That carbonate of magnesia, on the contrary, which gives up its carbonic acid more readily, should be thrown down from such a solution rather than silicate of magnesia (and water), is far more probable. Besides, we may conceive that water which, especially in the case of long enduring action, finds its way into so many compounds otherwise constituted may, so to speak, pave the way to the introduction of magnesia, a body, in a certain point of view, isomorphic therewith.

similar though otherwise combined. This would go to explain the circumstance of garnets occurring imbedded in such numerous instances in mica-slate.

In conclusion, I now come to the question put already at the commencement of this paper, how is it then, since aspasiolite and cordierite occur close together, that serpentine is not in like manner associated with olivine? It will be readily conceded that water as well as all the other bases in question, cannot but have been present at the formation of aspasiolite and serpentine, (and indeed of all hydrous minerals, occurring as admixtures in primitive formations. But why was it now that that was taken up by the serpentine mass so *through and through* that not even the smallest portion of olivine could exist, while cordierite took up water only *partially*, and became thereby converted to aspasiolite? Before replying to this question we must revert to the formula proposed for these minerals,

Olivine, $\dot{R}^3\dddot{Si}$. Cordierite, $\dddot{R}\,\dddot{Si}^2+3\dddot{\mathbf{R}}\,\dddot{Si}$.

Serpentine, $(\dot{R})^3\,\dddot{Si}$. Aspasiolite, $(\dot{R})^3\,\dddot{Si}^2+3\,\dddot{\mathbf{R}}\,\dddot{Si}$.

In olivine, 3 atoms of magnesia are combined with only *one* atom of silica; whereas in cordierite, the same quantity is combined with *two* atoms of silica. Now it is evidently easier that a portion of a base should be supplanted by another basic substance in a compound of the former kind (a one-third silicate), than in one of the latter kind (a two-thirds silicate). Even therefore upon this ground it must be easier for water to make its way into olivine than into cordierite. But that water, at the formation of serpentine actually *prevented* a portion of the magnesia from combining in its place with silica, is proved beyond a doubt by this, namely, that in the Snarum serpentine a mineral occurs imbedded in great abundance (hydrotalcite), the constituents of which are *hydrate of magnesia* and carbonate of magnesia. *There can therefore have been no absence of magnesia at the formation of serpentine, and the water, so to speak, have been thus compelled to be taken up by the silica, but the water, in consequence of its basic properties, has in truth* SUPPLANTED *a portion of the magnesia, and* BY THAT MEANS RENDERED EVERY FORMATION OF OLIVINE OUT OF THE QUESTION. The water could not exert a similar influence upon the cordierite mass from not penetrating it so readily, but was principally taken up thereby *where magnesia was wanting*. That this last was the case, or at least that there was no magnesia present in excess, is established by there being in association with the aspasiolite and cordierite neither free magnesia nor any magnesian mineral capable of giving up a portion of the magnesia which it contains. At the commencement of their formation the last thing that could be wanting to cordierite crystals, was naturally cordierite mass saturated with magnesia; but as these crystals increased in size the magnesia that was wanting was of necessity replaced by water. This explains how it is that the *central portion* of the crystals consist of *cordierite*, while *the parts nearer approaching the surface are aspasiolite.* Since *olivine*, as we have seen above, *cannot be called into existence* where water is present, while *serpentine* for its formation *requires* the presence of water, we are naturally led to the inference that all formations in which olivine occurs could at their origin have contained no water, whereas in all those where serpentine is met with, water necessarily must have been present. And in point of fact the rocks in which olivine occurs are not less by their petrographic character than by their position in the series of geognostic formations, distinctly and thoroughly separated from those in which serpentine is met with. The former belong to the basaltic group, the latter to the crystalline primary rocks.

The Chemical Constitution of the Hydrous Carbonates of Magnesia with reference to Polymeric Isomorphism. (From Poggendorff's Annalen, vol. lxviii, p. 376.)

The different compounds of magnesia with carbonic acid and water have hitherto, as we know, been placed in the following six categories: (1.) Triply hydrous two-thirds carbonate of magnesia $=\dot{Mg}^3\ddot{C}+3\dot{\mathbf{H}}$. (2.) Fourfold-hydrous three-fourths carbonate of magnesia $=\dot{Mg}^4\ddot{C}^3+4\dot{\mathbf{H}}$. (3.) Fivefold-hydrous four-fifths carbonate of magnesia $=\dot{Mg}^5\ddot{C}^4+5\dot{\mathbf{H}}$. (4.) Triply hydrous, simple carbonate of magnesia $=\dot{Mg}\ddot{C}+3\dot{\mathbf{H}}$. (5.) Fivefold hydrous, simple carbonate of magnesia $=\dot{Mg}\ddot{C}+5\dot{\mathbf{H}}$, and (6.) Magnesia alba, which was held to be a mixture of several of the above named compounds, more especially $\dot{Mg}^4\ddot{C}^3+4\dot{\mathbf{H}}$ and $\dot{Mg}\ddot{C}+3\dot{\mathbf{H}}$.

Since ascertaining however that, under certain circumstances, water plays a basic part, and this in such a manner that 1 atom $\dot{Mg}$ is replaced by $3\dot{\mathbf{H}}$, the question arises whether the chemical constitution of the whole of these hydrous carbonates, when looked upon in this new point of view, may not become materially modified. The result upon enquiry instituted in this sense, goes to show that the above mentioned compounds, instead of being subdivided under six heads, (the sixth of them consisting itself of compounds incapable of being united under a common formula) may very readily be comprised in two groups.

First Group.

	$\ddot{C}$	$\dot{Mg}$	$\dot{H}$
1. Triply hydrous two-thirds carbonate of magnesia, according to Fritzsche,	32·67	47·23	20·10
2. Magnesia alba, according to Kirwan,	34·	45·	21·
3. Magnesia alba, according to Klaproth,	33·	40·	27·
4. Magnesia alba, according to Bucholz,	32·	33·	35·
5. Triply hydrated, simple carbonate of magnesia, according to Soubeiran, .	31·50	29·58	38·29
6. The same compound, according to Berzelius, ...	31·5	29·6	38·9
7. The same compound, according to Bucholz, ...	30·	30·	40·

The relative quantities of oxygen in these compounds are,

1. 23·73 : 18·28 : 17·87	5. 22·90 : 11·45 : 34·60
2. 24·72 : 17·42 : 18·67	6. 22·90 : 11·46 : 34·62
3. 23·99 : 15·48 : 24·03	7. 21·81 : 11·61 : 35·56
4. 23·26 : 12·77 : 31·15	

Looking upon the whole of the water contained in these salts as basic, so that one atom $\dot{Mg}$ may be equivalent to 3$\dot{H}$, will so modify the ratios of oxygen as stated above, that the oxygen of the magnesia becomes increased by the third part of the oxygen of the water, giving us therefore,

1. $23·73\ddot{C} : (18·28+\frac{1}{3}\,17·87)=24·24\,\dot{Mg}$
2. $24·72 : (17·42+\frac{1}{3}\,18·67)=23·65$
3. $23·99 : (15·48+\frac{1}{3}\,24·03)=23·49$
4. $23·26 : (12·77+\frac{1}{3}\,31·15)=22·82$
5. $22·90 : (11·45+\frac{1}{3}\,34·60)=22·98$
6. $22·90 : (11·46+\frac{1}{3}\,34·62)=23·00$
7. $21·81 : (11·61+\frac{1}{3}\,35·56)=23·46$

The mean of these seven oxygen-ratios of $\ddot{C}$: ($\dot{Mg}$) gives us 23·33 : 23·38.

The quantity of oxygen in the acid is therefore precisely equal to that in the base, and consequently these salts, whose composition is apparently so different, whose quantity of magnesia varies from 47·23 to 30, and whose amount of water ranges between 20·1 and 40, may be brought under the common formula $(\dot{Mg})^2\,\ddot{C}$, and be designated by the general title of *semi-carbonate of hydro-magnesia.* With reference to the causes whence it was brought about that the greater or less portion of $\dot{Mg}$ was replaced by ($\dot{H}$), that is 3$\dot{H}$, it is worthy of remark, that the salt containing the *most water* was formed at a *low temperature* (perhaps between 0° and 10° centigrade), whereas the salt containing the *least water* was formed, with the observance of certain precautions,* at the *boiling point.* This throws out a hint with reference to the possibility of obtaining other salts of magnesia as well, wherein the quantity of water varies.

Second Group.

	$\ddot{C}$	$\dot{Mg}$	$\dot{H}$
1. Fourfold hydrated, three-fourths-carbonate of magnesia, according to Trolle Wachtmeister,	37·66	43·39	18·95
2. The same compound according to Berzelius,	35·70	44·58	19·72
3. Same compound, according to von Kobell,	36·13	44·12	19·75
4. Magnesia alba, according to Berzelius,	36·47	43·16	20·37
5. Fivefold hydrated, four-fifths-carbonate of magnesia, according to Berzelius,	36·4	43·2	20·4
6. Same compound, according to Berzelius,	36·5	42·8	20·7
7. Magnesia alba, according to Berzelius,	37·00	42·24	20·76
8. Magnesia alba, according to Butini,	36·	43·	21·
9. Fivefold hydrated, four-fifths-carbonate of magnesia, according to Fritzsche,	36·22	42·10	21·68
10. Magnesia alba, according to Bucholz,	35·0	42·	23·

The combinations arrived at by the chemists here named, correspond to the quantities of oxygen stated below:

1.	27·38 :	16·80 :	16·85
2.	25·92 :	17·26 :	17·53
3.	26·27 :	17·08 :	17·56
4.	26·51 :	16·70 :	18·13
5.	26·46 :	16·72 :	18·13
6.	26·53 :	16·57 :	18·42
7.	26·90 :	16·35 :	18·48
8.	26·17 :	16·64 :	18·67
9.	26·33 :	16·29 :	19·30
10.	25·44 :	16·26 :	20·47
Mean	26·39 :	16·67 :	18·35

This is an approximation to the formula $\dot{Mg}^4 \ddot{C}^3 + 4\dot{H}$, according to which the oxygen ratio should be 26·39 : 17·59 : 17·59. Apparently, therefore, the water contained in carbonates of magnesia constituted as above, either does not act the part of a base at

* See Gmelin's Handbuch der Chemie, New Edition, vol. ii, p. 224.

all, or does so only to a small extent; possibly the latter may often obtain with regard to some of the salts quoted towards the end of the above group. We have for instance, in the case of salt No. 9, the oxygen ratio 26·33 : 16·29 : 19·30, whereas it ought to be 26·33 : 17·56 : 17·56. Possibly, therefore, in this compound 1·27 $\dot{Mg}$ (that is to say 17·56÷16·29), are replaced by 1·74 $\dot{\text{H}}$ (namely 19·30÷17·56), which would be exactly in the ratio required. On enquiring how it is that in fourfold hydrated three-fourths-carbonate of magnesia, no magnesia, or at least very little, is replaced by basic water, the two following circumstances offer themselves in reply. 1. The ten salts that we have mentioned were one and all, obtained at a *boiling heat.* 2. It must evidently be more difficult (from the reasons which I have entered into in the preceding paper relative to the kindred circumstances applicable to aspasiolite and serpentine) for water to find its way into a *three-fourths*-carbonate than into a *semi*-carbonate and expel from thence a portion of the magnesia.

In addition to the hydrous magnesian carbonates here mentioned, amounting in all to seventeen, which may be ranged in the two groups above described, there are other five that have been analyzed, one of which however may be omitted here inasmuch as prior to its being analyzed (by Dalton), it was dried at a temperature of 100° C. The remaining four are composed as follows:

	$\ddot{C}$	$\dot{Mg}$	$\dot{\text{H}}$
1. Five-fold hydrous simple carbonate of magnesia, according to Fritsche,	25·39	23·70	50·91
2. Magnesia alba, according to Bergmann,	25·	45·	30·
3. Do. do. according to Berzelius,	30·25	36·40	33·35
4. Do. do. according to Fourcroy,	48·	40·	12·

The corresponding proportions of oxygen are—

1. 18·46 $\ddot{C}$: 9·18 $\dot{Mg}$: 45·31 $\dot{\text{H}}$
2. 16·87 : 17·42 : 26·89
3. 21·99 : 14·09 : 29·64
4. 34·89 : 15·48 : 10·68,

while the formulæ resulting therefrom are—

1. $(\dot{Mg})^2\ddot{C}+2\dot{\text{H}}$. 3. $\dot{Mg}^4\ddot{C}^3+8\dot{\text{H}}$.

2. $(\dot{Mg})^2\ddot{C}+3\dot{\text{H}}$, or $(\dot{Mg})^3\ddot{C}$. 4. $3(\dot{Mg})\ddot{C}+\dot{\text{H}}$.

The existence of the second and fourth of these salts must, until established by more accurate experiments, remain a matter of uncertainty. The two compounds alone, the composition of which is ascertained with sufficient precision, are, $(\dot{Mg})^2\ddot{C}+2\dot{\text{H}}$, $\dot{Mg}^4\ddot{C}^3+8\dot{\text{H}}$, the oxygen ratio whereof was,

As obtained,	Should be,
$18{\cdot}46\,\ddot{C} : 18{\cdot}46\,\dot{Mg} : 17{\cdot}47\,\dot{\mathbf{H}}$	$18{\cdot}46\,\ddot{C} : 18{\cdot}46\,\dot{Mg} : 18{\cdot}46\,\dot{H}$
$21{\cdot}99\,\ddot{C} : 14{\cdot}09\,\dot{Mg} : 29{\cdot}64\,\dot{\mathbf{H}}$	$21{\cdot}99\,\ddot{C} : 14{\cdot}66\,\dot{Mg} : 29{\cdot}32\,\dot{\mathbf{H}}$.

The compound $(\dot{Mg})^2\,\ddot{C}+2\dot{\mathbf{H}}$ was obtained from sulphate of magnesia by *cold* precipitation, by means of carbonate of potash *with an excess of sulphate of magnesia;* the compound $\dot{Mg}^4\,\ddot{C}^3+8\dot{\mathbf{H}}$, by the evaporation of a concentrated solution of carbonate of magnesia in water impregnated with carbonic acid at a temperature approaching the *freezing point.*

The principal inference to be deduced herefrom, is as follows. All the hydrated magnesian carbonates hitherto analyzed, when made amenable to polymeric isomorphism, may be ranged in two classes: 1. *Semi-carbonate of hydro-magnesia;* and 2. *Four-fold hydrated three-fourths carbonate of (hydro-?) magnesia.* The salts of the first group, generally speaking, are obtained by precipitation cold, and those of the second group by precipitation at an elevated temperature. In certain exceptional circumstances, in connection especially with a depression of temperature, the compounds of the first class are enabled to take up two atoms more, and those of the second group four more atoms (eight therefore in all) of water of crystallization.

Art. XVIII.—*English Prefixes derived from the Greek;* by Professor J. W. Gibbs.

Many persons well acquainted with Greek fail to derive the full advantage of their knowledge, from not analyzing the Greek compounds found in the English language. To such, it is thought, the following investigation of the force of the Greek prefixes found in English may be of service. An intelligent use of words is certainly desirable for every educated person. Something also may be gained by scientific arrangement.

These prefixes, it should be observed, although sometimes employed as prepositions with their complements, are originally and properly adverbs.

1. *Amphi* or *amphis*, Gr. ἀμφί or ἀμφίς, Æol. ἀμπί, = Sansc. *api*, Lat. *ambi*, *amb*, *am*, *an*, Old Germ. *umpi*, Germ. *um*, Anglo-Sax. *ymbe*, *ymb*, *embe*, *emb*; (connected with Sansc. *ubhau*, Gr. ἄμφω, Lat. *ambo*, Goth. *ba*, both.)

(1.) *on both sides;* as, *amphibrach*, short on both sides, a poetic foot consisting of a short, a long, and a short; *amphisbœna*, moving either way foremost, the name of an animal so moving.

(2.) *about*, *around;* as, Gr. ἀμφιδέω, to bind about. No example occurs in English.

2. *An* before vowels, or *a* before consonants, Gr. ἀν, ἀ, = Sansc. *an*, *a*, Lat. *in*, Germ. *un*, Eng. *in* and *un*; (connected with Gr. ἄνευ, Germ. *ohne*, both signifying *without*;) denoting negation; as, *anarchy*, want of government; *ambrosia*, an imaginary food supposed to confer immortality; *atom*, an indivisible particle; *abyss*, a bottomless gulf.

3. *Ana* before consonants, or *an* before vowels, Gr. ἀνά, ἀν, = Goth. *ana*, Germ. *an*, Anglo-Sax. and Eng. *on*; (connected with Gr. ἀνώ, above.)

(1.) *up*, *upward*; as, *anadromous*, running up; *anagoge*, a leading of the mind upward.

(2.) *over*, *about*; as, *anatreptic*, overturning.

(3.) *back*, *in a contrary direction*; as, *anacamptic*, reflected, turned back.

(4.) *back*, *to the original state*; as, *anatomy*, the dissecting of an animal body into its constituent parts; *analysis*, the separation of a compound body into its constituent parts.

(5.) *back*, *anew*, *again*; as, *anadiplosis*, the use of the same word at the end of one clause and the beginning of another.

(6.) *away*; as, *anachoret*, a hermit, recluse.

4. *Anti*, Gr. ἀντί, = Sansc. *ati*, Lat. *ante*, Goth. *and* and *anda*, Anglo-Sax. *and* and *on*, Germ. *and*, *ant*, *ent*, Eng. *an* in *answer*.

(1.) *before*, *over against*; as, Gr. ἀντίκειμαι, to lie over against. No example occurs in English.

(2.) *against*, *in opposition to*; as, *antipode*, having the feet directly opposite; *antipathy*, opposite feeling. Also as a preposition with its complement; as, *antiasthmatic*, good against the asthma.

(3.) denoting *correspondence*; as, *antitype*, a figure corresponding to its pattern.

(4.) denoting *alternation* or *reciprocity*; as, *antiphony*, alternate or reciprocal singing; *antistrophe*, reciprocal conversion.

(5.) denoting *exchange*; as, *antiptosis*, the exchange of one case for another.

5. *Apo*, Gr. ἀπό, = Sansc. *apa* and *ava*, Lat. *ab*, Goth. *af*, Germ. *ab*, Anglo-Sax. and Eng. *of*.

(1.) *from*, *off*; as, *apocope*, the cutting off of the last letter or syllable of a word; *apology*, a speaking one's self off, a defense in words.

(2.) *away*; as, *apostrophe*, a turning away.

(3.) *out*; as, *apozem*, a decoction; *apologue*, a saying out, a full narration.

(4.) *down*; as, *apoplexy*, a striking down.

(5.) denoting *privation* or *negation*; as, *apocalypse*, an uncovering, revelation.

6. Cata, Gr. κατά.

(1.) *down*, *downwards*; as, *catarrh*, a flowing down.

(2.) *against*, as a preposition with its complement; as, *catabaptist*, one who opposes baptism.

(3.) *upside down*; as, *catastrophe*, a turning upside down, overthrow.

(4.) denoting *distribution*, as a preposition with its complement; as, *catamenia*, monthly courses.

(5.) denoting *perversion*; as, *catachresis*, wrong use.

7. *Dia*, Gr. διά, = Lat. *dis;* (connected with Gr. δύω, Lat. *duo*, Eng. *two.*)

(1.) *in two, asunder, apart;* as, *diæresis*, the resolution of a diphthong.

(2.) *through;* as, *diameter*, a line drawn through the center.

(3.) *thoroughly;* as, *diagnostic*, distinguishing, characteristic.

(4.) *between*, denoting *reciprocity;* as, *dialogue*, conversation between two or more.

8. *Dys*, Gr. δύς, = Sansc. *dus*, Goth. *tus.*

(1.) *badly, with difficulty;* as, *dyspepsy*, difficulty of digestion.

(2.) denoting *want* or *absence;* as, *dysorexy*, want of appetite.

9. *Ec* before a consonant, or *ex* before a vowel, Gr. ἐκ, ἐξ, = Sansc. *wahis*, Lat. *e*, *ex*, Goth. *ût*, Germ. *aus*, Eng. *out.*

(1.) *out;* as, *eclogue*, a selection; *exanthema*, an eruption.

(2.) *away;* as, *eclipse*, a failure.

10. *En*, Gr. ἐν, = Lat. *in*, Germ. *in*, Eng. *in.*

(1.) *in, on;* as, *enclitic*, leaning on.

(2.) *among*, as a preposition with its complement; as, *endemic*, among the people.

(3.) *into;* as, *enallage*, the change of one into another.

11. *Epi*, Gr. ἐπί, = Sansc. *abhi*, Goth. *bi*, Germ. *bei*, Eng. *by.*

(1.) *on, upon;* as, *epigram*, an inscription. Also as a preposition with its complement; as, *epitaph*, an inscription on a sepulcher.

(2.) *to, unto;* as, *epistle*, a writing sent to a person.

(3.) *in addition to;* as, *epilogue*, a conclusion.

12. *Eu*, Gr. εὐ, signifying *well;* as, *euphony*, agreeableness of sound.

13. *Hama* or *a*, Gr. ἅμα, ἁ, ἀ, = Sansc. *sa*, *sam*, Goth. *sama.*

(1.) *together with*, as a preposition with its complement; as, *hamadryad*, a wood nymph, feigned to live and die with its tree.

(2.) denoting *sameness;* as, *adelphic*, relating to brethren, or those from the same womb.

14. *Hyper*, Gr. ὑπέρ, = Sansc. *upari*, Lat. *super*, Goth. *ufar*, Germ. *über*, Eng. *over.*

(1.) *over;* as, *hyperaspist*, one who holds a shield over another.

(2.) *beyond*, as a preposition with its complement; as, *hyperborean*, beyond the north.

(3.) denoting *excess;* as, *hypercritic*, an over rigid critic.

15. *Hypo*, Gr. ὑπό, = Sansc. *upa*, Lat. *sub*, Goth. *uf.*

(1.) *under;* as, *hypothesis*, a placing under, a supposition. Also as a preposition with its complement; as, *hypogeum*, the parts of a building under ground.

(2.) denoting *deficiency;* as, *hyposulphurous*, sulphurous, but having a less quantity of oxygen.

16. *Is*, Gr. εἰς; (connected with Gr. ἐν;) signifying *into;* as, *isagogic*, introductory.

17. *Meta*, Gr. μετά, = Germ. *mit;* (connected with Sansc. *madhya*, Gr. μέσος, Lat. *medius*, Eng. *middle.*)

(1.) *with;* as, *metalepsis*, participation, the name of a figure of speech.

(2.) *after*, of place or time, as a preposition with its complement; as, *metacarpus*, the part after or beyond the wrist; *metachronism*, a placing after the time.

(3.) *over;* as, *metaphor*, a transfer; *metabasis*, a transition.

(4.) denoting *change;* as, *metamorphosis*, a change of form or shape.

(5.) denoting *transposition;* as, *metagrammatism*, a transposition of letters; *metathesis*, a transposition.

18. *Para* before consonants, or *par* before vowels, Gr. παρά, παρ, = Sansc. *parâ*, Goth. *fra*, Eng. *from*.

(1.) *by, along with;* as, *parabole*, a comparison; *paragraph*, something written near; *parathesis*, apposition. Also as a preposition with its complement; as, *paranymph*, a brideman; *parallel*, by or near each other.

(2.) *to, towards;* as, *paraclete*, one that calls upon or exhorts another.

(3.) *beyond;* as, *paraphrase*, an extended explanation; *paragoge*, an addition to the end of a word. Also as a preposition with its complement; as, *parapherna*, what is over and above the dower.

(4.) denoting *error;* as, *paraselene*, a false moon; *paradox*, a false opinion.

19. *Peri*, Gr. περί, = Sansc. *pari*, Lat. *per*, Goth. *fair*, Germ. *ver*.

(1.) *around, about;* as, *periphery*, the circumference of a circle; *periphrasis*, circumlocution. Also as a preposition with its complement; as, *pericranium*, the membrane that invests the skull.

(2.) *near*, as a preposition with its complement; as, *perigee*, point nearest the earth.

20. *Pro*, Gr. πρό, = Sansc. *pra*, Lat. *pro, prae*, Goth. *faur*, Germ. *vor*, Eng. *for*.

(1.) *before*, in place; as, *prostyle*, a range of columns in front. Also as a preposition with its complement; as, *propolis*, something before the city.

(2.) *before*, in time; as, *prodrome*, a forerunner; *prolepsis*, anticipation; *prophet; prologue.* Also as a preposition with its complement; as, *prochronism*, the antedating of an event.

(3.) *before, forth*, in a metaphorical sense; as, *problem*, something set forth or proposed.

21. *Pros*, Gr. πρός, = Sansc. *prati*.

(1.) *unto;* as, *prosthesis*, the addition of a letter or syllable to the beginning of a word; *proselyte*, one that comes over to another sect or party.

(2.) *in addition to;* as, *prosenneahedral*, having nine faces on two adjacent parts of a crystal.

22. *Syn*, before a labial *sym*, before *l syl*, before *z* or a double consonant *sy*, Gr. σύν, συμ, συλ, συ, = Sansc. *sam*, Lat. *con*, Goth. *ga*, Germ. and Anglo-Sax. *ge*.

(1.) *with, in company with;* as, *symbol*, that which compares with something else; *sympathy*, feeling with another; *syzygy*, conjunction.

(2.) *together, in a mass* or *body;* as, *synagogue*, a bringing together; *synthesis*, composition; *syllable*, a taking together of letters.

Art. XIX.—*On a New empirical Formula for ascertaining the Tension of Vapor of Water, at any Temperature;* by J. H. Alexander, Esq.

The formula which the following memoir is intended to expose, is called *new;* because, to the best of my knowledge, it has never been used or suggested hitherto. It is also rightly termed *empirical*, in so far as it is not susceptible of geometrical demonstration, but thus far only; since, in point of fact, it was derived entirely from considerations *a priori* and independent of any experiment or interpolation. Of course, it was compared as soon as possible with the temperature corresponding to the ordinary atmospheric pressure; and after a satisfactory agreement had been found at this point, the accord of the formula with observations at other points, above and below, was regarded as neither accidental nor surprising. The extent and nearness of this accord through a range of experiment more extensive than has hitherto been included in one and the same table, it is the principal aim of the present paper to exhibit, after having shown in few words the reasonableness of the formula and its limits (or rather want of limits) in application; a comparison, then, of the errors existing and admitted in several of the experimental series of the highest authority, with the differences developed at the same epochs by the formula, will indicate the probabilities in favor of the latter, and the nature and amount of its reliability.

It is obvious that the pressure of vapor or steam must be always in proportion to the absolute temperature at which it is produced. But as this temperature is only observable relatively and upon an arbitrary scale, it is necessary, in order to obtain any thing like a measure of the quantity of heat existing, to use the ratio of the whole extent of the scale assumed between the two epochs where the liquid changes its state respectively, to that portion of it (i. e., the number of its degrees) which expresses the existing temperature. Or, what amounts to the same thing, the pressure of steam whose temperature is observed on any scale, is directly as the number of degrees read for the temperature; and inversely, as the whole number of degrees on the same scale between the melting of ice and the boiling of water. With Fahrenheit's scale, calling t the number of degrees at any temperature, the pressure of steam at that temperature must be proportionate to $\frac{t}{180}$. Again, the pressure of steam must be always directly as the absolute heat of conversion, or, as it is otherwise termed, the *latent* heat; expressed, of course, in degrees of the scale assumed. For, the greater the number of degrees for such latent heat, the greater also will be the repulsive force of the heat existing in the steam; which repulsive force may be assumed to be at least a function of the elasticity of the vapor. And as such repulsive force takes effect in part by expanding the medium vaporized; and the greater such expansion, the less will be the remaining elasticity; it follows that the pressure of steam in the ordinary state of an atmosphere, must be also inversely as its increased volume. This increased volume may be taken, from the experiments of Gay-Lussac, at 1695 times that of water at its greatest density. And the latent heat of steam is generally admitted as 990° F.; which number results from the experiments of Clement and Desormes, is not far from the mean of several other observers, and will probably require a very small modification only to be identical with the deduction from a strict theory of volumes applied to vapors generally, in the mechanical relation of the observed effects of heat upon such vapors and the liquids producing them.

So far as we have gone, then, the pressure of steam must be as $\left(\frac{t}{180}+\frac{990}{1695}\right)$. It is here that the empiricism comes in, and dictates the numerical power to which this ratio must be involved, in order to harmonize the progression of the elasticities with the series of the temperature. That the simple ratio will not present such harmony, is manifest; for that would be the measurement, by a lineal scale of equal parts, of central forces which, acting upon *volumes*, might rather be supposed to be in the duplicate ratio of the cube. Such a ratio, equivalent to the sixth power, is in fact what has been taken; and the complete equation becomes then, calling p the pressure:

$$p=\left(\frac{t}{180}+\frac{990}{1695}\right)^6.$$

This index, however plausible upon reflection the reason to justify its adoption might have appeared, was no doubt suggested too, even unconsciously, from the recollection that it had before (though with different factors) served both Young and Tredgold and perhaps others, in approximating the results of experiments. Moreover, it was apparent that the numerical results in English inches from the formula, were altogether an accidental coincidence which, dependent upon the properties of numbers, could not be expected to occur upon the use of any other scale than that of Fahrenheit; unless, indeed, one should adopt the fancy of Mr. Woolf, who supposed that he had discovered an immediate numerical relation between the atmospheric pressure and the pound avoirdupois, in which case the English inch might also claim to be among Natural dimensions. It is, of course, quite possible, by a little artifice among the terms of a formula of this shape and retaining the same index, to produce a series of numbers corresponding to any linear scale. Thus, for instance, substituting Centigrade degrees for those of Fahrenheit, but carrying the denominator of the first term down to the degree at which the pressure becomes, by the formula, zero (which may be presumed to correspond to an absolute negation of heat, and which in fact has to be used with the present formula when it is intended to give the pressure in atmospheres); we obtain pressures expressed in French metres and, through a range of several atmospheres, but little discordant with the results of experiment. In using Centigrade degrees, however, and transforming the equation so as to express atmospheres, the index (6·) gradually diverges from regular multiples; serving to shew what we might otherwise conjecture, that such index is not based upon any general relation in nature. It was, therefore, of less interest for me to weary myself with comparisons of other thermometric and linear scales; it is enough that the formula affords a remarkable coincidence in its own terms with the measures recognized among ourselves.

It is readily seen that the first term is positive as far as 0° of Fahrenheit; for temperatures lower than that, it becomes negative; and there is a point, of course, where the negative value of the first term equals the constant positive value of the second, and the pressure, therefore, as was said just now, becomes itself zero. This point occurs at $-105°·13$; of which it is enough to say, that it is not very far from the lowest degree of heat yet produced, and that long before it is reached the mercurial thermometer becomes useless. Whether there is in the theory of nature (for it is admitted that there is not in fact) such a point as that of the absolute privation of heat, and if so, how it should be reckoned and where placed,—are questions which, although kindred to the matter in hand, are not necessary to the elucidation purposed. Whatever the answers might be, they would not affect the working of a rule which is intended for practicable temperatures; and if it should be objected to the present formula (as it was to the method of interpolation of Dr. Dalton) that it determines a limit which does not exist in nature, or places it where it should not stand, it may be very well replied, that the objection may hold good against the factors without prejudice to the form. It is quite likely that, below 32° F., it is theoretically no longer proper to use in behalf of chilled and freezing vapor, the number (990°) which belongs to boiling steam. But as even here and for nearly 60° below the melting point of ice, the actual formula was not so very discordant from the results of experiment, I had the less motive for modifying or transforming it into a nearer agreement at this unusual temperature.

The determination of a limit of this sort, whether real or assumed, is necessary in converting easily a formula like the present, into one which will shew the pressure in atmospheres;—a method which, as it extricates the results from any dependence on a particular system of weights and measures and thus makes them generally applicable, is of course in any purely scientific investigation, much to be preferred. It is obvious that such a scale of atmospheres or volumes, must start from the degree where the expansions and the tendency to expand (which is *elasticity*), so far as they are due to temperature, are null. The limit that we have found, then, of 105°·13 below 0° Fahr., is such a term; and the distance between that and the other extremity of the scale, or 317°·13, (which is the measure on the thermometer of one atmosphere,) becomes the new denominator to replace the 180° actually used for the pressure in inches of mercury.

In fact, I had expected, in advance, to find the present manometric formula (as it may be termed) becoming a barometric one, by putting it into this shape;

$$p=\left(\frac{t}{317{\cdot}13}+\left(\frac{990}{1695}\right)^2\right)^6.$$

But this did not hold good. Applying it numerically, it results in giving,

For 212°, a pressure of 1·059 atmospheres, equal to 31·68 inches.
And for 322°·38, " 6·263 " " 187·37 "

In both these instances, to agree with the original formula, the numbers representing the atmospheres should have been without fractions. The excess, however, (as is visible,) goes on in a converging series, and by and by disappears altogether; the difference then changing its sign. Even then, it is not much; and at high temperatures, the equation corresponds very nearly with the actual observations. For instance, comparing it with the experiments of Dulong and Arago,

Temp. 335°·3 F. gave a pressure of 7·391 atmos.; by formula 7·478 atm.
" 371°·3 F. " 11·660 " " 11·958 "

Nevertheless, as the object I had in view was not to find an equation that merely fits any particular series of observations, or is exact only for the higher ranges of temperature, I abandoned this theoretical expression; and preferred to deduce a formula for pressure in atmospheres from the original one, in the ordinary analytic way. This results in the alternative expressions—

$$p'=\left(\frac{t}{317{\cdot}13}+\frac{561{\cdot}91}{1695}\right)^6=\left(\frac{t}{317{\cdot}13}+\frac{990}{2986{\cdot}33}\right)^6;$$

either of which may be adopted, according as we prefer to retain in view the factor of the latent heat, or that of the expansion at the unitary atmospheric pressure. In practice, the constant fraction may be substituted by the number 0·33151. For the original formula, the similar constant was carried no farther than *four* places of decimals; in this, where the unit of pressure is thirty times larger, both the attainment of equal precision requires, and the facility of calculation allows, another decimal place to be taken.

These decimal constants might, indeed, have been given in both formulæ at once, instead of the fractional expression from which they originate; were it not that I thought it desirable to preserve those factors which, besides solving the equation, indicate also, in part accidentally and in part essentially, certain elementary relations between pressure and temperature, (or rather certain epochs in those relations,) which are important in the future complete theory of the subject. For example, the denominator (1695) which expresses the number of volumes of steam under the atmospheric pressure and at a temperature of 212°, developed from an unitary volume of water at its maximum density,—shows also the number of atmospheres, the equivalent of whose pressure will, below a certain temperature, prohibit the developement of steam beyond the sphere of said unitary volume. On the other hand, the numerator (990°) gives this limiting temperature; and shows the degree on Fahrenheit's scale, where the force of steam becomes equivalent to 1695 atmospheres. Its density, therefore, would be equal to that of water; if its behavior in other regards were like that of water too, this temperature would be the limit to its useful effect. But as there would most probably still remain the elasticity due to its expansion at that temperature, it does not appear that we are warranted in supposing any such limit.

At this point, 990°, the ratio of the latent and sensible heats, has just inverted itself from what it was under the unitary atmospheric pressure. Then, the former which went altogether towards maintaining the state of vapor, without increasing its apparent temperature, was 5·5 times the latter; now the latter is 5·5 times the former. And from this consideration, flows an easy manner of connecting proportionate volumes and pressure with simple multiples of the increments of heat. But to develope this here, would be to wander from the present aim.

If we go on to suppose the temperature increased until the whole of the latent heat is utilized and becomes sensible, (which occurs at 1170° F.,) we should then have a condition in which steam under a pressure of 4225 atmospheres (by the formula) is reduced to very nearly $\frac{4}{10}$ths of the unitary volume of water to produce it, and has a density (without regard to the expansion from temperature) 2·5 times that of water at its maximum. The expansion due to the temperature, is (with Gay Lussac's factor) 0·975 of the unitary volume; the expansion of water, due to the same temperature (taking its maximum density as occurring at 39°·4 F., its actual expansion as 0·04333 at 212°·F., and its rational expansion as the cube-root of the fifth power of the temperature above the maximum) is 0·99944 of the same unitary volume:—an accord which, considering the possible errors of the experiments, appears to me sufficiently satisfactory.

The equations already given serve to find the pressures in inches of mercury and in atmospheres respectively, when the temperatures are given: to find the temperatures corresponding to given pressure, they become as follows;

$$t = 180\sqrt[6]{p} - 105^{\circ}{\cdot}13\,;$$

where p represents the number of inches of mercury; and

$$t = 307{\cdot}13\sqrt[6]{p'} - 105^{\circ}{\cdot}13\,;$$

where p' stands for the number of atmospheres.

After these preliminaries, may now be presented the comparison of results by the formula and by the experiments of various observers; as is done in the following table. This table is quite extensive; and, for my own sake, rather more so than I desired. But it will be considered that it comprehends the assemblage of the observations of many persons through many years; and it was, besides, to me of an interest that I think will be partaken of by others, to have in one view and without interpolation nearly all the determinations that have been made by actual experiment. In limiting it to statements of this character, I confess I thought at first to restrict its extent, though it appears that there are in fact more experimental data than is generally supposed; and I desired besides to increase its utility beyond the mere comparison with the present formula, by fitting it as a depository for general reference. In this last regard, it may be considered as authentic and reliable.

And yet after all, it does not include the whole of our experimental data. Those of John Henry Ziegler, of Winterthur in the Canton of Zurich, (whose name I give at length because he may be regarded as having led the way in this research,) of Achard, of Schmidt, of Magnus, and of some others whose names escape me at the moment or have failed to come to my knowledge at any time,—either were not accessible to me at all, or only in statements at second or third hand, whose accuracy I had not the means of verifying.

Nor does it contain quite all the results of those observers to whose experiments I had access. To have given every one of each, would have rendered the table, in respect to the present aim, quite enormous. For instance, the several series of Mr. Regnault, the latest experimentalist, exhibit such a luxury of repetition, at temperatures varying very slightly—sometimes only by small fractions of a degree—as almost to outnumber, in themselves alone, all the quotations I have made from others. I exercised, therefore, the discretion of using only those instances which, at reasonable degrees apart, rested upon a number of con-current observations. In general, such concurrences of the same mean temperature, give the mean of *three* observations of pressure; the result for 32° F., is the mean of *forty-seven* recorded pressures. For the experiments earlier than Mr. Southern's, I have usually taken only those whose recorded temperatures were already otherwise in the table. I shall have occasion, however, to speak of each one more particularly, presently.

The difference of apparatus and manipulations necessary for experimenting upon the elasticity of vapor above and below the boiling temperature, has led several of the observers, for convenience or other motives, to confine themselves to one or the other side of this limit; and would render proper, in any discussion of the value and reliability of such observations, an arrangement of them in two distinct tables. But as I have no such aim at present, and as the exemplification of the formula belongs equally to the lowest and highest temperatures, there is no reason for breaking the continuity of the comparison or for presenting the results in more than one table.

The order of the different columns is chronological, according to the dates of execution; or, when that was not known, of publication of the experiments. As in fact each successive observer had, or might have had, the benefit of the experience and precautions of his predecessor, it may be presumed that this order represents too, in a measure, the respective reliabilities of the results. Only the two French series, while they are evidently unrivalled in the extent to which, in opposite directions, they have been carried, are similarly distinguished by the refined elaboration which characterizes every part of the research.

Table of the Pressure of Steam at different Temperatures, calculated and variously observed through a Range of 462 degrees of Fahrenheit's thermometer.

Temp. in deg. of Fahrenheit.	Pressure in inches by Formula.	Pressure in inches of Mercury observed by											
		Regnault. 1844.	Frankl. Inst. 1836.	French Acad. 1829.	Taylor. 1822.	Arzberger. 1819.	Ure, 1818.	Dalton. 1801.	Dalton. 1820.	Southern. 1797–1803.	Betancourt. 1790.	Robison. 1778.	Watt. 1774.
—27·112	0·0066	0·0106	Temperatures read to 0·25 deg.	.	.	.	.	.	.	Extremes of therm'r do not vary more than 0·5 deg.	.	.	Supposes, in 1814, that his Barom'r may have been 0·2 in. *too low*.
—13·	0·0180	0·0205		.	.	.	.	.	.		.	.	
— 4·504	0·0305	0·0284		.	.	.	.	.	.		.	.	
0·	0·0400	.		.	.	.	.	.	.		.	.	
+ 1·706	0·0437	0·0457		.	.	.	.	.	.		.	.	
9·41	0·0664	0·0638		.	.	.	.	.	.		.	.	
17·402	0·0911	0·0941		.	.	.	.	.	.		.	.	
23·702	0·1345	0·1256		.	.	.	.	.	.		.	.	
24·	0·1363	.		.	.	.	0·170	.	.		.	.	
27·626	0·1611	0·1500	.	.	.	.	.	.	.	.	.	.	
32·	0·1956	0·1811	.	.	.	.	0·200	0·200	.	0·16	.	0·0	
36·	0·232	.	.	.	.	.	.	*0·229	0·29	.	.	.	
40·	0·275	.	.	.	.	.	0·250	.	.	.	.	0·1	.
42·	0·298	.	.	.	.	.	.	.	.	0'23	.	.	.
43·25	0·314	.	.	.	.	.	.	0·297	.	.	.	.	.
49·514	0·402	0·366	.	.	.	.	.	.	.	.	.	.	.

Table of the Pressure of Steam, &c.—(Continued.)

Temp. in deg. of Fahrenheit.	Pressure in inches by Formula.	Pressure in inches of Mercury observed by											
		Regnault. 1844.	Frankl. Inst. 1836.	French Acad. 1829.	Taylor. 1822.	Arzberger. 1819.	Ure. 1818.	Dalton. 1801.	Dalton. 1820.	Southern. 1797–1803.	Betancourt. 1790.	Robison. 1778.	Watt. 1774.
50·	0.410						0·360				0·1856	0·2	
52·	0·443									0·41			
54·5	0·487							0·435					
55·	0·496						0·416						0·15
60·	0·596						0·516					0·35	
62·	0·641									0·52			
64·	0·689							*0·597	0·75				
64·976	0·713	0·616											
65·	.						0·630						
65·75	0·732							0·630					
70·	0·849						0·726					0·55	
72·	0·908									0·73			
75·	1·001						0·860						
77·	1·074							0·910			0·7326		
80·	1·184						1·010					0·82	
80·762	1·214	1·055											
82·	1·263									1·02			
85·	1·389						1·170						
88·25	1·538							1·290					
90·	1·623						1·360					1·18	
92·	1·726									1·42			
95·234	1·903	1·673											
96·	1·947							*1·63	1·95				
99·5	2·159							1·820					
100·	2·192						1·860					1·6	
102·	2·323									1·95			
105·	2·531						2·100						
110·	2·915						2·456					2·25	
110·75	2·977							2·540					
112·	3·081									2·65			
115·	3·346						2·820						
120·	3·829						3·300					3·0	
121·244	3·958	3·562											
122·	4 038							3·50		3·57	3·17		
125·	4·367						3·830						
130·	4·969						4·366					3·95	
132·	5·228							*4·60	5·07	4·68			
133·25	5·397							4·76					
135·	5·638						5·070						4·53
140·	6·381						5·770				5·16	5·15	
142·	6·699									6·06			5·46
144·5	7·117							6·45					
145·	7·203						6·600						
150·	8·109						7·530					6·72	
151·124	8·327	7·698											
152·	8·497									7·85			
155·75	9·271							8·55					
160·	10·214						9·600					8·65	
162·	10·685									9·99			
164·	11·174												10·10
165·	11·427						10·800						
167·	11·944							11·25			10·27		11·07
170·	12·752						12·050					11·05	
172·	13·323									12·64			11·95
173·	13·612							*13·02	13·18				
175·	14·209						13·550						12·88
176·416	14·647	14·081											
178·25	15·230							14·60					
180	15·801						15·160					14·05	14·73
182·	16·477									15·91			
185·	17·540						16·900				15·88		16·58
189·5	19·237							18·80					

Table continued.

Temp. in deg. of Fahrenheit.	Pressure in inches by Formula.	Pressure in inches of Mercury observed by Regnault. 1844.	Frankl. Inst. 1836.	French Acad. 1829.	Taylor. 1822.	Arzberger. 1819.	Ure. 1818.	Dalton. 1801.	Dalton. 1820.	Southern. 1797–1803.	Betancourt. 1790.	Robison. 1778.	Watt. 1774.
190·	19·435						19·0					17·85	
195·	21·491						21·100						
198·05	22·839	22·538											
200·	23·731						23·600					22·62	
200·75	24·087							24·0					
202·	24·679												
205·	26·164						25·900						
210·	28·802						28·880					28·65	
211·27	29·500	29·621											
212·	29·915			*29·922			30·	30·		29·8	29·87		
213·	30·48												30·
216·6	32·61						33·40						
220·	34·73				34·95		35·54	*34·99	34·20			35·8	
221·6	35·77						36·70						
222·44	36·33	35·78											
225·	38·07				38·0		39·11						37·
226·3	38·97						40·10						
226·5													38·
230·	41·67				41 51		43·10				44·38	44·5	
230·5	42·04						43·50						
232·	43·17				43·0	44·40							
233·132	44·05	44·75											
234·			43·05										
234·5	45·13						46·80						
235·	45·54				45·50		47·22						44·
238·5	48·41						50·30						47·
240·	49·69				50·0		51·70					54·9	49·
242·	51·44				51·75		53·60						
245·	54·17				54·40		56·34						
245·25			52·12										
245·8	54·93						57·10						
248·25			59·08										
248·5	57·51						60·40						56·
249·	57·99				58·20	59·10							
250·	58·99				59·12		61·90					66·8	
250·25			58·14										
250·3	59·29									59·6			
250·5													58·
251·6	60·60						63·50						
252·662	61·69	63·33											
254·003	63·08			64·14	63·20								
254·5	63·62						66·70						
255·	64·15				64·40		67·25						62·
257·5	66·88						69·80						
260·	69·67				70·12		72·30					80·3	
260·4	70·15						72·80						
262·5													70·
262·75	72·88		73·27										
262·8							75·9						
263·3	73·55	76·15											
264·9	75·47						77·90						
265·	76·44				76·		78·04						
267·	78·08				78·50		81·90						
269·	80·63				81·14		84·90						
269·5			81·51										78·
270·	81·94				82·50		86·30					94·1	
270·86	83·08			85·70									
271·	83·27		82·56										80·
271·2	83·54						88·						
271·346	83·73			85·89									
272·	84·60				85·45			*79·94	88·90				
272·5	85·28												82·

Table continued.

Temp. in deg. of Fahrenheit.	Pressure in inches by Formula.	Pressure in inches of Mercury observed by											
		Regnault. 1844.	Frankl. Inst. 1836.	French Acad. 1829.	Taylor. 1822.	Arzberger. 1819.	Ure. 1818.	Dalton. 1801.	Dalton. 1820.	Southern, 1797–1803.	Betancourt. 1790.	Robison. 1778.	Watt. 1774.
273·7	86·92						91·20						
274·	87·32				88·50	88.8							
275·	88·72				90·		93·48				100·07		
275·5			92·42										
275·7	89·71						94·60						
276·224	90·45	93·86											
277·9	92·86						97·80						
278·			93·81										
278·4	93·60			99·95									
279·5	95·22						101·60				104·91		
280·	95·97				97.75		101·90					105·9	
281·8	98·69						104·40						
283·8	101·79						107·70						
284·5	102·75		110·30										
285·2	103·98						112·20						
287·2	107·25						114·80						
289·	110·23				112·65		118·20						
289 5	111·05		119·02										
290·	111 90				114·50		120·15						
292·3	115·88						123·10						
292·5	116·22		120·60										
293·4	117·81									119·2			
294·	118·87				122·20		126·70						
294·5	119·77		129·11										
295·	120·68				124·15		129·						
295·6	121·76						130·40						
297·1	124·54						133·90						
297·464	125·21	130·79											
298·5			135·8										
298·8	127·72						137·40						
299·5	129·06		142·62										
300·	130·02		136·36		133·75		139·70						
300·6	131·17						140·90						
301·316	132·57			136·85									
302·	133·91		144·33		137;55		144·30						
303·8	137·51						147·70						
304·5	138·93		151·92										
305·	139·92				144·05		150 56						
305·393	140·75			145·15									
305·5			154·28										
306·8	143 65						154·40						
308·	146·19				150·65		157·70						
308·606	147·50			152·80									
310·	150·49				155·		161·30						
310·25	151·03		163·51										
311·4	153·57						164·80						
312·	154·88				159·45		165·50 or 167·						
314·75	161·12		181·23										
319·75	172·99		197·13										
320·	173·61				179·40								
322·	178·56					176·							
325·76	188·21			194·42									
334·50	212·28		240·48										
335·21	214·37			220·69									
337·073	219·84			227·32									
338·75	224·88		248·92										
340·	228·74								231·				
341·798	234·35			242·17									
343·6	240·07									238·4			
345·	244·61		267·62										
346·	247·86		274·										

Table concluded.

Temp. in deg. of Fahrenheit.	Pressure in inches by Formula.	Pressure in inches of Mercury observed by				
		Regnault. 1844.	Frankl. Inst. 1836.	French Acad. 1829.	Taylor. 1822.	Arzberger. 1819.
348·	254·51	.	278·33	.	.	.
350·	261·32	.	290·35	.	.	.
352·	268·35	.	297·36	.	.	.
357·269	287·40	.	.	295·28	.	.
362·66	308·13	.	.	316·35	.	.
368·51	331·99	.	.	†342·51	.	.
371·12	343·12	.	.	348·04	.	.
372·	346·95	.	.	.	.	325·
380·66	386·47	.	.	393·66	.	.
389·345	429·78	.	.	433·83	.	.
395·375	462·20	.	.	467·02	.	.
398·813	481 58	.	.	483·88	.	.
403·043	506·35	.	.	511·31	.	.
403·88	511·43	.	.	514·22	.	.
405·041	518·41	.	.	?516·84	.	.
407·615	534·30	.	.	538·76	.	.
408·407	539·28	.	.	540·85	.	.
410·873	557·56	.	.	553·69	.	.
419 333	611·88	.	.	610·23	.	.
423·257	639·87	.	.	635·95	.	.
425·03	652·93	.	.	644 96	.	.
429·08	683·43	.	.	676·49	.	.
432·	706·12	.	.	.	.	620·
435·227	731·92	.	.	716·13	.	.

Of the earlier observations in the preceding table, I need not say much. Those of Mr. Watt, which he suffered to lie by him for forty years, and, in the caustic phrase of Tredgold, only produced when they had become unnecessary, he was himself dissatisfied with; but as appears upon comparison, with more modesty than reason. I have specially calculated but two or three of his temperatures; and, of the whole sixty-two experiments, have inserted but twenty-two; among which, however, both the limits are to be found. Of his friend Robison's, I have had to calculate none specially; but all happened to find a place in the table. Of Mr. Betancourt's numerous observations which were reported originally in degrees of Reaumur and French inches, I have inserted only those which have been reduced to English scales by Sir D. Brewster for the Edinburgh Encyclopædia.

The experiments of Mr. Southern are, in fact, the supplement of those of Mr. Watt; having been made and reported at the desire of the latter. The numbers will be found to differ, somewhat, from those generally found in professed treatises on the Steam-engine; they are in fact the mean of the actual *observations;* while those usually given, have been selected now from one and now from the other set, and reduced (by himself) to what they might have been, had the pressure at 212° been thirty inches. For the present purpose, it seemed to me proper to state the real, not the possible, result.

Mr. Dalton's experiments were distinct; and are therefore given in distinct columns. The numbers in the earlier column, marked with an asterisk, were not from actual experiment; but by interpolation, according to the method he has himself explained. I have inserted them opposite to experimental numbers in the adjoining column, for the sake of comparison and the benefit of the inference which may flow from the variations. The numbers in the later column were not, in every case, given by his own experiments; but they were accepted by him as authentic, and the most reliable he knew. It is more complimentary to his reputation than to their own research, that compilers of Chemical manuals, even down to the present time, retain among their tables his ancient results whose inaccuracy he himself has recognized. All of his experiments, of Southern's, and of Dr. Ure's, are in the table. To the originals of Mr. Arzberger, I have not had access; but I have found these quoted, in so many authorities and so uniformly accordant that I have not hesitated in recording them. Of the extensive table of Mr. Taylor, whose remarkable accord with the results from the formula I may be allowed to call attention to, I have taken only those epochs of temperature which were already in my table.

The experiments of the French Academy have been already signalized. It is enough to establish their claim to distinction, to say that they were executed by Dulong and Arago; names that have been long since inscribed in the very highest rank of physical philosophers. The numbers found in the appropriate column, are, agreeably to what I have already mentioned as governing me throughout, quantities actually *observed*. The temperatures and pressures generally quoted in the text-books on Steam, as of the French Academy, are not, in fact, what they observed; but what they deduced (in part, by a formula of their own, and in part, by Tredgold's) from the present experimental series. The pressure 29·92 inches corresponding to the temperature 212°, is marked with an asterisk, because it is not expressly declared to have been *observed*. It is the height which is constantly taken in France for the barometric standard, as thirty inches are in England: in the latter assumption, the temperature is rated at 60° F.,—in the former, at 32° F.; and the difference of heights is nearly identical with the difference of expansion at the respective temperatures.

The pressure in this series corresponding to the temperature 368°·51, is also noted with a dagger; it may be presumed to be erroneous, not only because it differs so much from the result by my formula, but because it varies so much and so suddenly from the rate accused by the pressure on either side of it. Nor does it correspond at all with their own formula; calculated by that, the pressure will be 335·87 inches. The error is not, in this instance, of the press; since it makes its appearance in both ways of reckoning, by atmospheres and by metres.

I do not know how to account for another discrepant pressure, corresponding to the temperature 405°·04; which has been indicated by a note of interrogation. On both sides, above and below, the observed pressures are higher than the calculated one; in this instance, it is suddenly lower. It agrees, to be sure, with an independent calculation by the formula of Dulong and Arago, at the temperature; but very manifestly breaks the uniformity or any regular progression of the series. What adds to the difficulty, is that the same observation is given again in another part of the Memoir of the Academicians; but the ciphers do not agree. I have neither altered nor omitted either of these instances; it is obvious that they are not to be used in comparison with the present formula.

The temperatures of the Franklin Institute, which were taken for the composition of the table, come from the second series of their reported experiments. Pressures have been also taken from both the other series, when their temperatures were already in the table; and, adopting this method as a uniform system, I did not allow myself to exclude the anomaly which shews itself between the different series at the temperature of 300°.

Of the experiments of Mr. Regnault, I have already spoken sufficiently.

It is apparent, upon a slight examination of the table, that the calculated pressures do not differ more from the average of the experimental ones, than these experimental ones do among themselves; which is about as much as could be desired to shew the validity of the formula, and the reasonableness of its application, instead of others which are in general merely means of interpolating a particular experimental series. But in order to establish this more clearly, it will be necessary to ascertain more distinctly what the difference is between the results of the formula and those of observation. This difference is, of course, best expressed in the arithmetical scale of temperatures; as I have tabulated it here, upon the maximum deviation in each instance.

	Temperature.		Greatest Differences.	
	Observed.	Calculated.	+	−
Southern's experiments, . .	343·6°	343·09°		0°·51
Dalton's of 1820, ...	340·	340·74	0°·74	
Arzberger's experiments, . .	322·	320·98		1 ·02
Taylor's " . . .	320·	322·34	2 ·34	
French Academy's "	362·66	364·73	2 ·07	
Regnault's " . .	297·46	300·41	2 ·95	

The mean of the sum of these differences, is +1°·09 Fahrenheit; which is the maximum error of the formula, compared with these six series.

It will be observed that I have left out of this comparison, the last observation of the Academy; because it was the very utmost point which the apparatus could carry, and because it might therefore be expected to be affected by the untrustworthiness which forbade the series from being extended farther. I have also neglected the last observation of Arzberger; which, compared with the Academy's, is in error more than 10°,—a deviation sufficient to discredit it entirely. Ure's experiments I have not compared at all; because, if we admit the series just now tabulated, his results are altogether too high. He may, however, be compared with himself, in the two results he has recorded for his last observation. These two different pressures accuse a corresponding difference of temperature of 0°·63 F.; a possible error, not so materially less than what we have found as the maximum that can attach to the formula. The Franklin Institute experiments, which correspond closely with Ure's, I have omitted for a similar reason; they do not profess, even, to read nearer than 0°·25 F. They may, however, for illustration be compared with those of the Academy, as under:

Academy pressure,	145·15 inches;	temp. observed, 305°·39;	temp. calculated, 307°·51.
Institute "	154·28 "	" " 305 ·50;	" " 311 ·73.
Differences,	9·13	0°·11	4°·22

Discounting the *observed* difference from the calculated one, we have left 4°·11 F., as the error of one or the other series; an amount nearly four times that of the formula.

It is manifest that the comparative error of the formula is only approximate; because it is based, in each case, upon only *one* observation instead of upon the combined mean of all the observations or, rather, the mean of the differences at every epoch observed. Also, it can only be called an *error*, upon the assumption of the mean of all the experiments resulting in absolute accuracy; an assumption by no means to be made; for, in general, the utmost that can be done for any experimental series, is to determine the limits of its necessary or accidental errors. Such a research and determination, I have thought the present formula of sufficient interest to warrant. The account, which is in fact the promised and proper conclusion of the present paper, will appear in a future Number of this Journal.

ART. XX.—*Observations on some New England Plants, with characters of several new species;* by EDWARD TUCKERMAN, A.M.

SUBULARIA *aquatica.* This plant has been entirely unknown in this country since its discovery by Mr. Nuttall in the ponds of Paris, Maine, and was sought for unsuccessfully, at Nuttall's station, by Dr. Robbins. In 1844, I was so fortunate as to meet with it growing abundantly, in about a foot of water, in company with Isoëtes lacustris, on the gravelly bottom of Echo Lake, Franconia Notch, N. H. I have not observed it in any other of the numerous ponds of the White Mountains, and it is possibly quite local.

EPILOBIUM *alpinum, β fontanum,* (Wahl.): foliis ovatis denticulatis, *Wahl. Lapp. p.* 98

HAB. About rivulets in the alpine region of the White Mountains, and occasionally descending, along the streams A taller (often 6 to 8 in. high) and stouter plant than the true E. alpinum, with larger ovate leaves, obtuse but tapering above, and always distinctly denticulate.

E. alpinum, γ nutans, (Hornem.): foliis lineari-lanceolatis obtusis obsolete denticulatis, caule paucifloro sparsim crispulo-pubescenti, siliquis cano-pubescentibus. *E. nutans, Sommerf. Suppl. Fl. Lapp. p.* 17, *Fide J. Vahl! E. alpinum, β nutans, Hornem. Fl. Oec. cit. Sommerf.*

HAB. Alpine region of the White Mountains, in rather dry soil, not rare. Always distinguishable by its nodding, commonly solitary flower, and the hoary pubescence of the pods. It appears somewhat nearer than Sommerfelt's plant to E. palustre, and differs in some respects from the description of the Norwegian author, but was recognized as belonging to his species by the excellent northern botanist above cited.

POTAMOGETON. This genus will reward more attention than it seems yet to have received here. Characters of two species, supposed to be undescribed, were given by me in this Journal in 1843, and subsequent investigation has not only confirmed my opinion of the distinctness of these two, but has brought to light several others that seem to be unnoticed by authors. The descriptions which follow, have been made from living plants, in every case. I have similar notes already collected respecting many of our better known species, and hope on a future occasion, to continue these sketches, and perhaps thus acquire suitable material for a survey of the whole genus, as represented with us.

P. pulcher, (Tuckerm.): caule simplici verrucoso; foliis omnibus petiolatis; submersis membranaceis pellucidis, infimis ovalibus spatulatisve superioribus lanceolatis basi acutis apice attenuans acuminatis, multi-nervibus undulatis; natantibus coriacies ovatis, supremis plus minus rotundatis profunde cordatis petiolis subcanaliculatis sæpius longioribus; stipulis elongatis lineari-linguiformibus acutis; pedunculis longiusculis; fructibus recentibus late oblique obovatis lunatis, stylo subapicali mucronatis, dorso tricarinatis, lateribus convexis in faciem acutam declivibus. *P. pulcher, Tuckerm. Obs. in Sill. Journ.*, xlvi, *p.* 38.

HAB. Ponds; Stoneham, Tewksbury, apparently not very common, but abundant where it occurs. *Fl.* May, June. *Fr.* June, July. Stem mostly simple, terete, thick and spongy, conspicuously black-warted, 2–5 feet long. Floating leaves large, attaining to the size of 5 in. by 3½, the uppermost more or less rounded-ovate, deeply cordate, on channelled petioles shorter than the blade; the lower ones oblong-ovate, slightly or scarcely cordate, on elongated petioles; all marked on the under side with very numerous, commonly impressed nerves. Submersed leaves rather distant, membranaceous, inconspicuously many-nerved, the principal ones pellucid, loosely netted veined, lanceolate with an acute base and an attenuate and acuminate tip, undulate-serrate, short-petiolate, 5–8 in. long; the lowest smaller and thicker, more oval, or spatulate, on more elongated petioles. Stipules long, rather acute. Peduncles a little thickened, commonly more than twice as long as the slender spike. Nutlets broad-obovate, the back sharply tricarinate, broadly furrowed between the keels when dry, the middle keel prominent and slightly irregular, the lateral ones less acute, sides convex, sloping to the sharply carinate front, which is produced at the middle. Exocarp thin. Putamen thick, hard. Seed uncinate-convolute. The floating leaves of this Potamogeton have probably been passed over as belonging to P. natans, but the two plants are very different. P. natans is always characterized by its much elongated petioles, the lower of which are so commonly destitute of the blade, that the species has been described as possessing lower leaves without blades. It is very common with us, and near to P. fluitans and P. oblongus, but cannot be confounded either with the present species or the next. The Potamogetons are typically, submersed plants, and their floating leaves become of importance in characterizing the species, only when taken in connexion with the submersed ones. The floating leaves are often merely accessory, and their number is uncertain, the lower ones constantly varying in texture and shape with the character and depth of the water.

P. amplifolius, (Sp. nov.): caule simplici stipulis amplectentibus incluso; foliis omnibus petiolatis; submersis membranaceis pellucidis late lanceolatis basi apiceque acutis plus minus falcato recurvis conspicue 6–8-nerviis undulatis petiolis longiusculis canaliculatis; natantibus coriaceis ovato-s. oblongo-lanceolatis, superioribus petiolis longiusculis plerumque longioribus; stipulis elongatis linguiformibus acuminatis; pedunculis incrassatis; fructibus recentibus oblique obovatis breviter recurvo-rostratis dorso arcuato rotundatis, lateribus convexis in faciem rotundatam declivibus.

HAB. Ponds; Cambridge and elsewhere, very common in New England, and I have seen it from New York. *Fl.* June, July. *Fr.* July, Aug. Stem simple, terete, enclosed by the clasping stipules, 2–5 feet long. Floating leaves oblong-lanceolate, the base often ovate and subcordate, marked on the under side with 6–8 prominent nerves, 3–5 in. long, by 1⅓ to 1¾ in. wide, on channelled petioles, of which the uppermost are mostly shorter than the blade. Submersed leaves delicate, pellucid, broad-lanceolate, acute at each end, more or less recurved and sickle-shaped, 6–8 nerved, obscurely but closely netted-veined, 5–8 in. long, by 1½ to 2 and more in width, on conspicuous, channelled, and in the uppermost, elongated petioles. Stipules long, (the uppermost often 4–5 in.) acuminate, inclosing the stem. Peduncles much thickened, often more than twice the size of the stem, longer than the elongated spike. Nutlets not very obliquely obovate, slightly beaked, rounded on the back. The rather thin exocarp being removed, the back appears *rounded*-carinate, with a sunken line on each side. Putamen thick, spongy. Seed *convolute*-uncinate.

P. lonchites, (Sp. nov.): caule gracili ramoso; foliis submersis membranaceis, superioribus breviter petiolatis reliquis sessilibus, elongatis lanceolato-linearibus basi attenuatis acuminatis nervis 6–8 prominulis omnibus undulatis petiolis supra planis, infimis longe mucronatis s. in subulas rigidiusculas acuminatas abeuntibus; natantibus chartaceis membranaceisve ovatis ovalibus lanceolatisve apice plus minus attenuatis undulatisque petiolis supra planis; stipulis gracilibus lineari-linguiformibus obtusis; pedunculis incrassatis spicis gracilibus triplo longioribus; fructibus recentibus oblique obovatis vix lunatis compressiusculis obsolete tricarinatis rostello brevi truncato terminatis, dorso acutiusculo, lateribus in faciem acutam declivibus.

HAB. Rivers; in the Charles at Newton and Natick. *Fl.* June, July. *Fr.* July, Aug. Stem slender, terete, much branched, elongated, (3–6 feet long.) Submersed leaves lanceolate-linear, tapering at the base, long-acuminate and often a little falcate above, undulate, with 6–8 scarcely prominent nerves, loosely netted-veined, 5–10 inches long by 3–6 lines in width. Floating leaves delicate, papyraceous, or often, and especially the lowest membranaceous, always more or less tapering and waved above, with about 6 prominent nerves on the under side, either shorter and the base more or less ovate (2–3 in. long by about 1⅓ in. wide), or elongated-lanceolate (4–5 in. long by about 1 in. wide), the petioles rather elongated, flat and one-furrowed above. Stipules very slender, shortish. Spikes slender, on elongated, thickened peduncles. Nutlets small, obovate, scarcely lunate, obscurely tricarinate, terminated by a short, truncate beak. This handsome species is extremely abundant in Charles river. Though near to P. heterophyllus of authors, (P. gramineus, Fr., Koch.) it appears to be distinct from my numerous European specimens of that species, as well as from perfectly corresponding American specimens, from the lakes of Western New York, in the Herbarium of Dr. Gray.

P. Claytonii, (Tuckerm.): caule compresso ramoso; foliis submersis membranaceis gramineis elongatis linearibus acutiusculis basi vix attenuatis 5-nervibus sessilibus; natantibus coriaceis crassiusculis angustatis ellipticis obovatisve petiolis breviusculis compressis; stipulis linguiformibus acutis; pedunculis teretibus æqualibus breviusculis; fructibus recentibus oblique obovatis tricarinatis, carina media acuta superne gibboso-alata, lateralibus distinctis obtusis, stigmate subapicali, lateribus convexiusculis, facie carinata. *P. Claytonii, Tuckerman Obs. in Sill. Journ.*, xlv, *p.* 38. *P. fluitans, Pursh! Fl.* 1. *p.* 120. *Bigel. Fl. Bost. edit.* 2. *p.* 63, *e descr. Torr. Fl. U. S. p.* 196, *e descr.*

Hab. Ponds, rivers, and ditches in meadows, common in New England, and extending southward to Virginia! Stem compressed below; branched, in wholly submersed, sterile plants from below, in fertile ones especially from above, and bearing often numerous (8–12) spikes; 2–5 feet long. Submersed leaves grass-like, linear, a little tapering at base, and very slightly so above to the obtusish tip, about 5-nerved, the space between the midrib and the nearest lateral nerves on either hand remarkably cellulose reticulate (as observed by Chamisso, cited below), 5–8 inches long. Floating leaves rather small, thickish, narrowed, tapering to the commonly short petiole, marked on the under side with about 14 inconspicuous, impressed nerves, the petioles compressed, flattish and one-furrowed above. Stipules short. Peduncles of the size of the stem, rather short, often of about the length of the cylindrical spikes. Nutlets obovate, the sharp keel abruptly alate above and sloping suddenly toward the style, lateral keels obtuse, the sides when dry impressed in the middle. Exocarp thickish and as well as the rather thin and hard putamen thickened above. Seed cochleate-convolute. I have found this species in its most perfect state, in which the whole plant is of a bright grass-green, only in ponds. Smaller, more or less fuscescent forms are common in ditches, as well as a wholly submersed, sterile state, with a little of the habit of P. compressus. To the neighborhood of that species, the present one, though its (necessary) floating leaves compel it to assume a very different habit, is probably near. A similar change of habit is seen in the plants with floating leaves, of the next species. Poiret (Enc. Suppl. IV. 534,) under P. heterophyllus, notices a Potamogeton from North Carolina, as possibly a distinct species, which seems from his description to be the present. P. fluitans, e. Americani, Nuttallii, provisionally thus disposed by Chamisso, (Linnæa, 2. p. 226, & t. VI, f. 25,) accords also in every respect with P. Claytonii, except the described and figured orbiculation of the fruit, the base of the nutlets in our plants being always, so far as I have observed, acutish, and the whole outline consequently obovate. The specimen without fruit, from North Carolina, described on the next page of the same memoir, as well as probably that from Pennsylvania, described at the same place, also belong, I think, without doubt, to P. Claytonii.

P. heterophyllus, Pursh, Fl. 2, p. 120, which is included in that part of Pursh's Herbarium that is in my possession, is a plant resembling P. Claytonii, but much smaller and more delicate throughout, explaining thus the citation in the Flora of P. hybridus, Michx., as a synonym of so different a species as the P. heterophyllus of authors. It was noticed as variety β in my former account of the present species, in this Journal, with the remark that it might turn out to be distinct. The stem is extremely slender, branched, and apparently much compressed, about a foot long; the submersed leaves elongated, very narrow-linear, acuminate, sessile, 3-nerved, $\frac{1}{4}$–$\frac{1}{2}$ a line wide and 3–5 inches long; the floating ones (sometimes undistinguishable from the others, or the blade a little widened below the acuminate tip, and the rest of the leaf serving as a petiole) papyraceous, very delicate, lanceolate, with about 10 impressed nerves on the under side, the largest about an inch and a quarter long, by about five lines in width, on elongated, compressed petioles; stipules slender, very long, nerved. The leaves are approximated, with something of a fasciculate aspect. It is found, according to Pursh's Flora, in slow flowing waters of Virginia and Carolina, and his ticket, (upon which "P. hybridus" seems to have been written first, and "P. heterophyllus" afterwards added) records the station "Walker's meadows." The P. hybridus of Barton's Compendium, Fl. Philad. 1. p. 96, is possibly the same plant. Should the fruit confirm its apparent claims to be considered a species, it may not inappropriately take the name of ***P. Purshii.***

P. Spirillus, (Sp. nov.): caule compresso, parte inferiori concavo-convexo, ramoso; foliis submersis membranaceis gramineis cum stipulis connatis basique vaginantibus linearibus obtusis 3-nerviis sessilibus; natantibus subcoriaceis oblongis lanceolatis linearibusve, subtus nervis 3–7 impressis sulcatis, petiolis canaliculatis cum stipulis infra medium connatis; stipulis foliorum submersorum liguliformibus hyalinis laceratis; spicis partis submersæ alaribus capitatis paucifloris brevissime pedunculatis pedunculis erectiusculis compressis clavatis, natantis cylindricis plurifloris longius pedunculatis; fructibus recentibus obovato-lentiformibus compressis subtricarinatis, dorso deorsum curvato alato-carinato dentibus elevatiusculis cristato, carinis lateralibus rotundatis, lateribus sulco cochleato impressis, stigmate faciali sessili, facie rotundata.

HAB. Rivers; common in the Charles and in the Mystic, and also in the Middlesex canal. Stem slender, compressed, and concave-convex below, much branched, 6 to 12 inches long. Submersed leaves delicate, pale-green, grass-like, connate with the stipules and sheathing, linear, obtuse, 1½ in. long, by ½–⅝ lin. wide. Floating leaves coriaceous, oblong lanceolate or linear, the last often a little falcate, furrowed on the under side with 3–7 impressed nerves, half an inch to an inch long and 2–4 lines wide, on channeled petioles 3–5 lines long, which are connate with the stipules, the lower near the middle of the stipules, the upper below it. Stipules of the submersed leaves reduced to short, lacerate ligules. Submersed spikes on very short, erectish, clavate peduncles, 2–6 flowered; spikes of the floating part later, cylindrical, on peduncles half an inch or more in length. Nutlets green, lentiform, and in perfect specimens rendered obovate by the broadly alate-carinate back, which is crested with about 5 prominent, rather distant teeth; the lateral keels rounded: the sides conspicuously cochleate.* Exocarp membranaceous, produced on the back, and forming the wing. Putamen several times thicker, but semitransparent. Seed cochleate. This curious species, which is recognizable by its pale-green color and delicate, grass-like leaves, is more common, in this neighborhood at least, entirely submersed, and perfecting its numerous, few-flowered spikes below the water. The state with floating leaves entirely resembles in habit P. hybridus, from which it differs in its grass-like leaves evidently connate with the stipules, in the attachment of the petioles of its floating leaves to the stipules, in its larger, different nutlets, &c. The following description of the former species, from living specimens, will afford a fuller comparison of these nearly allied plants. P. heterophyllus? Ell. Sk. i, p. 222, seems to accord in many respects with the species above characterized.

P. hybridus, (Michx.): caule compresso striato, ramoso; foliis submersis membranaceis tenuissimis cum stipulis connatis vaginantibusque setaceo-linearibus, apice attenuatis acutis, uninervibus; natantibus subcoriaceis ovalibus lanceolatis linearibusve, subtus nervis 3–7 impressis sulcatis, petiolis planiusculis cum stipulis haud connatis; stipulis nervosis; spicis partis submersæ alaribus capitatis paucifloris pedunculis brevibus clavatis, fructife-

* The spiral impression of the sides of the fruit is its most striking feature when dry, and reminds one of the outline of a small snail-shell, or of Spirorbis nautiloides.

ris plus minus reversis, natantis cylindricis plurifloris pedunculis longiusculis; fructibus recentibus oblique lunato-lentiformibus compressis tricarinatis, stigmate faciali sessili, dorso deorsum curvato anguste alato-carinato dentato, carinis lateralibus acutiusculis plus minus sinuato-irregularibus, lateribus obscurius cochleato-impressis, facie acutiuscula. *P. hybridus, Michx. Fl.* 1, *p.* 101, *e Chamiss. in Linnæa*, 2, *p.* 208. *Kth. Enum.* 3, *p.* 132. *A. Gr. Man. p.* 456. *P. setaceus, Pursh, Fl.* 1, *p.* 120, *non L. P. capillaceus, Poir. Enc. Suppl. iv, p.* 535. *Roem. and Schult. Syst.* 3, *p.* 507. *P. diversifolius, Barton. Comp. Fl. Philad.* 1, *p.* 96. *Torr. Fl. U. S., p.* 197. *P. filiformis, Pursh herb.!*

HAB. Small ponds and plashes; Cambridge, Plymouth, Tewksbury; and extending through the Middle and Southern States. Stem very slender, compressed, striate, shortly and rather distantly branched, about a foot long. Submersed leaves membranaceous, setaceous-linear, connate with the stipules and sheathing at the base, attenuate and acute at the tip, channeled on the upper side, one-nerved, 1–3 inches long. Floating leaves subcoriaceous, a little more oval than in the last, furrowed on the under side with 3–7 impressed nerves, 6–10 lines long by 3–4 wide, on rather flat petioles which are free from the strongly nerved stipules. Peduncles longer than in the last, more or less reversed in fruit. Nutlets minute, half the size of those of the last, very oblique, rounded, compressed, tricarinate, the back narrowly alate, with 6–8 approximate teeth, the lateral keels acute, and often sinuate-toothed when dry, the sides obsoletely cochleate-sulcate. Exocarp very thin, a little produced on the back. Putamen semi-transparent. Seed cochleate. This species, P. Spirillus, and P. Claytonii are peculiar to this country, and, at first sight, are not easily referred to either of the commonly received sections of the genus. They differ from the Heterophylli or Diversifolii of authors in characters much more important than the solitary one (the floating leaves) in which they are considered to agree with them, and shew, as it seems to me, very clearly, that this group cannot be retained in arranging the North American species. P. Claytonii belongs to the Graminifolii, irrespectively of its coriaceous leaves, and the two others mentioned, if they accord with the Heterophylli in their floating leaves, accord at the same time with the Graminifolii in their submersed leaves and inflorescence, and with the Vaginiferi or Coleophylli in the attachment of their leaves to the stipules. This last character is not easily noticeable in P. hybridus, and seems to have escaped attention, but it is conspicuous in the nearly allied P. Spirillus. The arrangement proposed by Fries (Novitiæ, edit. 2, p. 27) for the Swedish Potamogetons, admitting two principal sections, I, of those with submersed leaves broader in the middle (*Plantaginifolii;* in which the *Natantes* or species with simple stems constitute the first tribe, and the *Lucentes* or those with branched stems the second); and II, of those with linear submersed leaves (*Graminifolii;* in which the *Compressi* or species with free stipules are the first tribe, and the *Pectinati* or those with stipules and leaves connate, the second), best includes our American species, and, as is always the case with a natural disposition, sheds light on their difficulties.

Agrostis. In the article in a former volume of this journal to which reference has already been made, an account was attempted, from considerable and authentic materials, of the species of Agrostis formerly considered to constitute the genus Trichodium. The Agrostis scabra there described, is, according to Dr. Gray, (Man. p. 577,) not the *A. scabra* of Willdenow, and is thus without name. As it seems to me distinct from the more southern *A. perennans*, I shall venture to re-instate it, and subjoin, for fuller comparison, a revised description of the other species.

Agrostis campyla, (mihi): culmis e basi geniculato ramoso erectis glabris; foliis lanceolato-linearibus planis striatis scabris vaginis glabris; panicula diffusa ramosa ramis 4–6-verticillatis breviusculis flexuosis patentibus divaricatisve scabris; floribus oblongis acutis glabriusculis, glumis inæqualibus acutis s. cuspidatis carina inferioris sæpius scabra superioris glabra margine scariosis ⅝ lin. longis; palea ovata longiuscula glumam superiorem vix haud æquante acuta glabra. *Agrostis scabra, Tuckerm. Obs. in Sill. Jour., xlv, p.* 44, non Willd. e Gray. *Trichodium scabrum, Muhl. Gram. p.* 61. *Torr. Fl. U. S., p.* 83.

Hab. New England. New York, *Torrey.* Pennsylvania, *Muhl.* A stout, erect grass, with broad, lanceolate-linear leaves, a diffuse panicle with more or less flexuous branches, and *oblong* smoothish florets, the glumes being considerably unequal, and the upper one mostly smooth.

A. perennans, (Tuckerm.): culmis e basi gracili geniculato ramoso erectiusculis procumbentibusque glabris: foliis patulis longiusculis linearibus planis striatis scabris vaginis lævibus; panicula tenui-elliptica demum oblonga laxiuscula ramis verticillatis erectiusculis scabris; floribus lineari-lanceolatis acuminatis, glumis angustatis acutissimis s. cuspidatis carinis scabris circiter lineam longis subæqualibus; palea lineari-lanceolata glumis breviori acuta glabra. *Sill. Journ., xlv, p.* 44. *Cornucopiæ perennans, Walt. Fl. Carol., p.* 74. *Trichodium perennans, Ell. Sk.* 1, *p.* 99, *tab. v, f.* 2. *Agrostis Cornucopiæ, Fraser! in Gent. Mag.* 59, *p.* 873, cum Icone. *Agrostis anomala, Willd. Sp.* 1, *p.* 370. *Trichodium decumbens, Michx. Fl.* 1. *p.* 42. *Muhl. Gram., p.* 60. *T. scabrum, Darlingt. Cest., p.* 54, nec Muhl.

Hab. Carolina, *Fraser!* Pennsylvania, *Darlington!* Southern Ohio, *Sullivant!* A delicate grass, sending up many assurgent, slender culms from the procumbent base. Leaves rather long and lax, narrow, linear. Panicle slender, at length somewhat diffuse. Florets *linear-lanceolate*, acuminate. Glumes narrowed, nearly equal. Palea lanceolate-linear. A plant first brought into notice by Walter, who seems to have had rather extravagant notions of its agricultural value, and afterwards collected and cultivated by Fraser, who published a figure of it in the Gentleman's Magazine, October, 1789, together with a specific character prepared by Dr. Smith. The name proposed by Fraser should perhaps take the place of Walter's, whose account is very imperfect. The principal characters in the above descriptions have been noticed, more or less, by the different authors who have published the species, and seem to be constant in all my specimens.

Ceratoschænus macrophyllus, (Sp. nov.): cymis compositis; spiculis gracilibus patentibus; nuce oblongo-obovata basi acuta compressa lævi, setis filiformibus duplo—stylo persistente subtriplo—breviore; foliis angustatis rigidis glabris culmum superantibus.

Hab. Plymouth, Mass. New Jersey, *Dr. Knieskern!* Found by me at Plymouth in 1839, and distributed afterwards under a provisional name which has not since been taken up by the friend who proposed it. *C. macrostachys*, A. Gr. (Rhynchospora macrostachya, Torr. in Gray Rhynch. n. 14,) of which the present has been considered a state, has closely fascicled, and (especially the axillary ones) somewhat simple cymes; erectish, stout spikelets; broad-obovate (exactly spoon-shaped with the tip truncate) nuts which suddenly taper to the produced base, the bristles more than twice as long, and the style more than four times as long as the nut; and softish leaves which are scabrous on the margins and shorter than the culm. In the species now proposed all the cymes are compound and rather loosely flowered; the spikelets slender and spreading; the nuts oblong-obovate or rather pyriform, tapering evenly to the acutish base, the bristles about twice as long, and the style more than three times as long; the leaves narrowed, rigid, smooth, overtopping the culm. These characters appear to be constant both in the New Jersey and the Plymouth plants, ART. XXI.—*Descriptions of Shells found in Connecticut, collected and named by the late Rev. J. H. Linsley;* by AUGUSTUS A. GOULD, M.D.

SOME months since, specimens of the shells indicated and named by the Rev. J. H. Linsley as new, in his "Catalogue of the Shells of Connecticut,"* and of which he intended subsequently to give full descriptions, were put into my hands by his daughter, with the request that I would examine them, and conclude the work which he commenced so well. I have therefore done so. Some of them, I am well satisfied, had been previously described; others are new. The following are the results of my examination.

ASTARTE MACTRACEA. (No. 71.) Testâ parvâ, solidâ, subtriangulari, sed anticè rotundatâ et ad basim arcuatâ, concentricè costato-undulatâ, inter undas radiatim striolatâ, fulvo-viridi, fusco-radiatâ, apice acuto; areolâ magnâ, profundâ.

Lat. $\frac{1}{4}$, alt. $\frac{1}{4}$ poll.

Fig. 1.

Fig. 2.

Astarte mactracea.

Shell small and solid, nearly quadrant-shaped, the apex acute, somewhat behind the centre, with a divergence of nearly a right angle, the posterior and basal margins regularly curved while the anterior margin is nearly a right line. The surface is undulated with about fourteen concentric, rib-like waves, and is marked between the ribs with very minute, regular radiating striæ. The color is pale yellowish green, with fine pencillings of dusky radiations. The areola is very large, deep and broad.

There is only one valve of this shell, but its characters differ so widely from any described species as to allow no doubt of its being distinct. The figure accompanying Mr. L.'s catalogue is not characteristic, the posterior side being too much excavated.

CYTHEREA MORRHUANA. (No. 85.) This seems to be quite a young and small specimen of *C. convexa*, Say.

UNIO PEQUOTTINUS. (No. 105.) This is undoubtedly a valve of *U. latus*, Raf. (*U. rectus*, Say). It is said to have been found in connection with Indian bones and other articles. As this shell

* See this Journal, vol. xlviii, p. 271.

is a denizen of the streams west of the Alleghanies and of Lake Champlain, its occurrence in this connection may have some bearing upon ethnography.

Fig. 3.

Cyclas truncata.

Cyclas truncata. (No. 82.) Testâ parvâ, tenui, fragili, ventricosâ, sub-equilaterali, transversè rotundato-ovatâ, posticè dilatatâ, et latè subtruncatâ, lineis incrementi confertis et ordinatis striatâ, epidermide olivaceo-corneâ indutâ; umbonibus magnis et perelevatis: dentibus cardinalibus minutis, obtusis; dentibus lateralibus conspicuis, elongatis. Fig. 3.

Long. $\frac{1}{3}$, lat. $\frac{1}{5}$, alt. $\frac{1}{4}$ poll.

Shell small, thin, fragile, inflated, slightly inequilateral, transversely rounded-oval, broadest and somewhat abrupt so as to appear almost truncated posteriorly. Beaks tumid and prominent. Surface finely and regularly striated by the lines of growth. Epidermis pale horn-color, approaching to olive. Hinge teeth obtuse, very minute; lateral teeth elongated and well developed.

This is a well marked species, more similar in its structure to *C. partumeia* than to our other species, but well distinguished by its elevated beaks, narrow and rounded anterior extremity, widened and partially truncated posterior extremity, and by its beaks being placed so much anteriorly as to place it, I doubt not, in the genus Pisidium.

Anodonta Housatonica. (No. 112.) Testâ oblongâ, retrorsum dilatatâ, antrorsum compresso-cuneatâ; margine anticâ rotundatâ, basali arcuatâ, posticâ obliquâ et ad apicem truncatâ, dor-

Fig. 4.

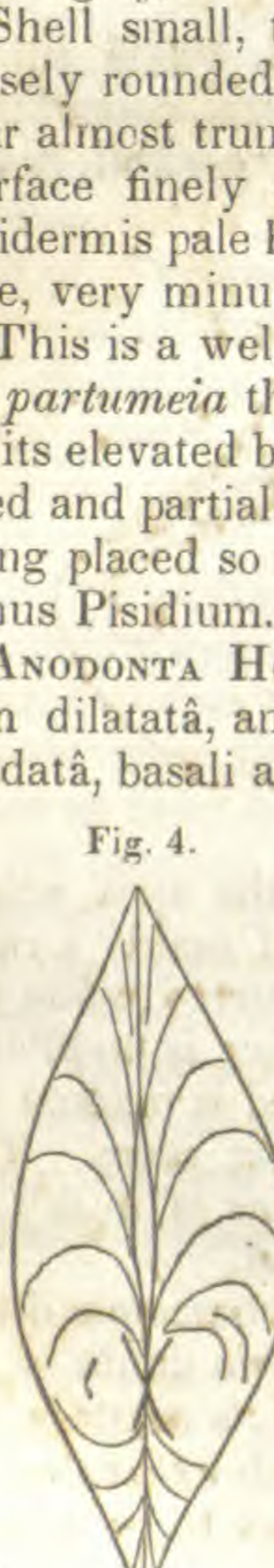


Fig. 5.

Anodonta Housatonica.

sali rectilineari: umbonibus parvis, undulatis, ad trientem anteriorem sitis: valvis posticè tumidis, epidermide nitidâ, fulvo-corneâ indutis: intus lacteâ, salmonaceo-tinctâ; limbo basali posticè incrassato. Figs. 4 and 5.

Long. $3\frac{3}{4}$, lat. $1\frac{1}{2}$, alt. 2 poll.

Shell thin, transversely oblong, somewhat widening backwards, anterior margin rounded, lower margin gently curved, posterior margin oblique, rather broadly truncated at tip, so as to form two angles, hinge margin straight. Beaks very small, undulated, situated at the anterior third. Disc tumid behind the beaks. Epidermis smooth and shining, yellowish green. Viewed from above the shell appears sharply wedge-shaped, the greatest breadth being behind the beaks. Interior bluish-white, with stains of white towards the cavity of the beaks. Anterior basal edge much thickened, as in *A. implicata*.

This shell is especially distinguished from our other species by its great anterior narrowing and compression, its minute undulated beaks, and posterior truncation.

Fig. 6.

Pecten fuscus.

PECTEN FUSCUS. (No. 126.) Testâ parvâ, tenui, rotundato-ovali, convexiusculâ, subequilaterali, costiolis radiantibus filiformibus ad 24, et lineis divaricantibus microscopicis sculptis; auribus subequalibus, postico vix emarginato; colore rubro-fusco. Fig. 6.

Long. $\frac{9}{32}$, lat. $\frac{7}{32}$ poll.

Shell small, thin, somewhat elongated, slightly convex, with about 24 thread-like radiating ribs; the whole surface, viewed with a magnifier, is found to be sculptured with microscopic lines, which curve from the centre towards the sides without reference to the ribs. The ears are nearly equal, the anterior one with three ribs, the posterior one slightly emarginate. Color a dusky red.

I have seen only one valve, which differs from any shell hitherto described, but the characters of the entire shell are of course incomplete.

HELIX TRUMBULLI, (No. 170,) is *Skenea serpuloides*.

LACUNA, (No. 243,) is very imperfect—too much so to justify a description. It appears to be a worn specimen of some Cingula.

Fig. 7.

Fusus Trumbulli.

FUSUS TRUMBULLI. (No. 269.) Testâ subventricosâ, elongato-conicâ, solidâ, lævi, albidâ: anfr. 6 convexis; suturâ impressâ, marginatâ; ultimo sub-angulato: aperturâ angustâ, elongatâ; columellâ sinuosâ, anticè striis volventibus aratâ. Fig. 7.

Long. $\frac{3}{16}$, lat. $\frac{1}{16}$ poll.

A small, rather ventricose and solid shell, scarcely to be distinguished from the following shell. On a close examination it will be found to differ in being rather larger, more ventricose, the last whorl somewhat angular about the middle, with about six well marked furrows revolving about the rostrum, and in having a marginal furrow accompanying the suture; and it is destitute also of the white zones. The columellar portion is also broader, and has a strongly marked projecting angle at the middle. The figure given of it by Mr. Linsley is far too much elongated, and marked with revolving lines not found on the shell.

Fig. 8.

Buccinum zonale.

Buccinum zonale. (No. 281.) Testâ minutâ, solidâ, lævi, fusiformi, pallidè incarnatâ; anfr. ultimo zonâ lacteâ, infra-suturali et alteri mediani cincto: spira conica, acuta, anfr. 6 convexiusculis: apertura angusta, subovali; canali productâ. Fig. 8.

Long. $\frac{1}{6}$, lat. $\frac{1}{12}$ poll.

A small, fusiform, solid, smooth, pale flesh-colored shell, having a white band just below the suture, and another around the middle of the last whorl. Its other characters may be gathered by comparison with those of *Fusus Trumbulli* above given. It resembles *B. lunatum*, Say, and its generic place is somewhat equivocal.

[The figures are magnified four diameters, except 4 and 5, which are reduced one-half.]

Art. XXII.—*Results of Analytical Researches in the Neptunian Theory of Uranus;* by Enoch F. Burr.

The early elements of Neptune have been made the basis of distinct researches in the theory of Uranus. The results were not satisfactory. They failed to recognize in the new planet the sole source of those anomalous movements which have so long perplexed astronomers, or even to interpret them largely without involving conditions entirely at variance with observation.

In the investigation to which allusion was made in the May number of this Journal, we employed the elements of Neptune depending on the period 166·3813 years, and carried the approximation to its effect on the mean longitude of Uranus, as far as terms of the fourth order in eccentricities and inclinations. On account of the near approach to commensurability in the mean motions, the coefficients of some of the inequalities were excessively large, and, consequently, their secular variations very appreciable: but by a suitable disposition of the epoch and some considerations to which we shall have occasion to refer, the necessity of their numerical computation was avoided. The results obtained were not satisfactory. To effect a reduction of the modern residual perturbations two-thirds, a mass was required for Neptune too small to accord with probability.

The time has now come for a revision of the subject. Continued observation has modified essentially the data of investigation. From the discussion of six hundred and eighty-nine observations, Mr. Walker has diminished the period of Neptune by nearly two years, and augmented by 48° the longitude of its perihelion. Its mass has also been determined from a satellite with an accuracy which M. O. Struve regards as definitive and superior to that of the mass of Uranus: thus simplifying the equations and processes by which our ultimate results are derived. That these changes would not affect the nature of our general result, could not be confidently decided anterior to trial. We have, accordingly, again attempted to submit to the test of analysis, the ability of the new planet to supply the defects of the Ephemeris, and now propose to give a concise account of the processes and results to which we have been conducted. As the latter happen to differ essentially from some already before the public, it may be proper to add that the liability to error is very considerable in inquiries involving such varied and extended numerical computations as the present.

In developing the disturbing influence of Neptune, we have aimed at as high a degree of refinement as seemed to us to accord with the present state of its elements. The very considerable change made in the mean motion by the last reduction from the observations, seems to indicate that it is still liable to some modification; and it is evidently useless to gather up all the minute points of the theory until the data have become sufficiently refined to give them significancy and influence.

The fundamental elements employed are the following,

	Uranus, Jan. 1, 1800.	Neptune, Jan. 1, 1847.
Mean Radius Vector, .	19·183305	30·0366
Mean motion, ...	15425″·64	7871″·76
Eccentricity, ...	0·0466108	0·00857741
Long. of Perihelion, . .	167°·30′·24″	48°·21′ ·3″
Long. of epoch, . . .	173°·30′·16″	328°·31′·56″
Inclination, ...	" ·46′·26″	1°·46′·59″
Long. of Ascen. Node, .	72°·59′·21″	130°· 4′·35″

It is important to observe that these elements of Uranus, with a single apparent exception, are substantially those employed by Messrs. Le Verrier and Adams in constructing and testing its ephemeris. Both assume 0·046679 for the eccentricity: but the difference between this value and that which we have adopted is alike unimportant, in the perturbations and the other terms of the equations of condition. Its effect on the principal inequality of long period is about 3″, and only varies from this value by the fraction of a second during the period which has elapsed since 1690, and consequently confounds itself with the correction of the longitude of the epoch. The other term in which its effect is most sensible, is that depending on the difference of the corrections of the longitudes of the epoch and perihelion. There it always oscillates beneath the tenth of a second. The other elements were taken from Bouvard's tables of Uranus, and are the same with those employed by Mr. Adams. He assumed the ancient residual perturbations of Bouvard, and obtained those of modern date by a comparison of his ephemeris, corrected by the equations of Bessel and Hansen, with English and German observations.

We have taken the time of Uranus's mean opposition in 1810 as the epoch of the formulæ. This diminishes the effect of some small errors in the mean anomalies, reduces the numerical value of the periodic and secular variations, and gives the equations the benefit of a changing sign. To this date the above elements have been reduced. In fact, however, it is not necessary to know the elements of Uranus for the epoch with the greatest precision: since all other errors, as well as those due to the influence of the undetected planet, are taken cognizance of by the arbitrary corrections which enter into our final equations. And, indeed, it is easy to see that, with our disposition of the origin of the time, the same may be true of the elements of Neptune. By comparing the planetary eccentricities for 1750 with those for 1800, it will be seen that no one changes its value in the half-century by more than 0·00022; while the variation of most of them is much less. Assume the eccentricity of Neptune to be in error to this amount. The general effect of this error on inequalities of the first order in longitude is,

$$0{\cdot}00022\mathrm{M}\sin . x.$$

Assigning to the general factors their greatest values in the present theory,

$$\mathrm{M}=m'\,1915{\cdot}65$$
$$\sin x=.7946$$
$$4''{\cdot}32=\text{max. effect of the error, using}$$

the mass of Struve. But when M is greatest, the expression has a period of nearly 1338 years, and includes only 0″·71 between its limiting values within the space covered by our equations of condition, and may, therefore, be regarded as included in their constant term. Similarly it may be found that the change in the longitudes of the perihelia of the planets during the fifty years immediately preceding the present century, when corrected for precession, in no case exceeds 17′, and is generally much less. The effect on the preceding inequalities of an error to this amount in the place of Neptune's perihelion is $17'.\mathrm{M}.e'.\cos x$: the greatest value of which in our formulæ occurs in 1715 and is 0″·8 and the subsequent variation of which is 0″·1. The terms of higher orders depending on these errors, as well as those depending on corresponding errors in inclination and longitude of the node, are inconsiderable with respect to the preceding. Hence each of them is either less than the error to which we are probably liable from an imperfect determination of the elements of Neptune, or its period is so great that it may be assumed constant, and merged in the correction of the longitude of the epoch.

In deducing the results which follow, we have availed ourselves of some considerations for abridging the labor. The general formulæ for the perturbations of true longitude have been subjected to the usual condition that the mean longitude and the equation of the centre be the same in the elliptic and in the troubled movement. This enables us to employ the elements given by observation for the epoch. The constants which serve to make the origin of the time the origin also of the perturbations, are not distinctly calculated, but transferred to the equations of condition and determined with their general corrections. A similar disposal has been made of the effects on the inequalities of the secular variations of the elements. For several ages before and after the epoch, these variations may be regarded as changing accurately with the time and all their powers superior to the first be neglected. Hence their effect on the inequalities during the unit of time is correctly represented by $c \frac{\sin}{\cos}(x)$. As it is only appreciable in connection with inequalities of long period, we may regard it as essentially constant during the century and a half of observation and, consequently, confound it with the correction of the mean motion.

It may be well also, in passing, to advert to some of the uncorrected errors and sources of error which we have had occasion to notice. In the 3d volume of the Mecanique Celeste of La Place, by Bowditch, the following corrections should be made. Page 9, for the third term of the formula for the inequalities of the second order in longitude, read

$$\frac{m'}{2} \cdot \mathrm{H} \cdot ee' \sin\left[i\,(n't - nt + \varepsilon' - \varepsilon) + 2nt + 2\varepsilon - \omega' - \omega\right]:$$

page 63, note 2423, for the last term of the development of the first term of R, read

$$\mathrm{M}^{0} \cdot e'^{3} \cdot \cos 3\omega' \cdot \cos \mathrm{T}_{5}:$$

page 235, line 8, for "these values" read "these values multiplied into e^2, ee', e'^2, γ^2 respectively." In the "Theorie Analytique du Systeme du Monde" of Pontécoulant, vol. 3, p. 30, for the terms of R of the third order depending on the inclinations, read

$$\mathrm{N}^{0} \cdot e\lambda^{2} \cdot \cos\left[i\,(n't - nt + \varepsilon' - \varepsilon) + 3nt + 3\varepsilon - \omega - 2\Pi\right]$$
$$\mathrm{N}' \cdot e'\lambda^{2} \cdot \cos\left[i\,(n't - nt + \varepsilon' - \varepsilon) + 3nt + 3\varepsilon - \omega' - 2\Pi\right].$$

It is also deserving of particular attention, that in these treatises the fundamental quantities A, B, etc., have different signs.

The following are the fundamental quantities added by Neptune to the theory of Uranus.

$$\text{Log. } \alpha = \log. \frac{a}{a'} = 9{\cdot}80527$$

Then

$$\text{Log. } b_{\frac{1}{2}}^{(0)} = 0{\cdot}35604, \qquad \log. b_{\frac{1}{2}}^{(1)} = 9{\cdot}88774$$

$$b_{\frac{1}{2}}^{(2)} = 9{\cdot}57763, \qquad b_{\frac{1}{2}}^{(3)} = 9{\cdot}30852$$

$$b_{\frac{1}{2}}^{(4)} = 9{\cdot}05839, \qquad b_{\frac{1}{2}}^{(5)} = 8{\cdot}81878$$

$$b_{\frac{1}{2}}^{(6)} = 8{\cdot}58479,$$

$$\log. \frac{db_{\frac{1}{2}}^{(0)}}{d\alpha} = 0{\cdot}05863, \qquad \log. \frac{db_{\frac{1}{2}}^{(1)}}{d\alpha} = 0{\cdot}25335$$

$$\frac{db_{\frac{1}{2}}^{(2)}}{d\alpha} = 0{\cdot}17756, \qquad \frac{db_{\frac{1}{2}}^{(3)}}{d\alpha} = 0{\cdot}05686$$

$$\frac{db_{\frac{1}{2}}^{(4)}}{d\alpha} = 9{\cdot}91670, \qquad \frac{db_{\frac{1}{2}}^{(5)}}{d\alpha} = 9{\cdot}76596$$

$$\frac{db_{\frac{1}{2}}^{(6)}}{d\alpha} = 9{\cdot}60935,$$

$$\log. \frac{d^2 b_{\frac{1}{2}}^{(0)}}{d\alpha^2} = 0{\cdot}65429, \qquad \log. \frac{d^2 b_{\frac{1}{2}}^{(1)}}{d\alpha^2} = 0{\cdot}62914$$

$$\frac{d^2 b_{\frac{1}{2}}^{(2)}}{d\alpha^2} = 0{\cdot}71899, \qquad \frac{d^2 b_{\frac{1}{2}}^{(3)}}{d\alpha^2} = 0{\cdot}74087$$

$$\frac{d^2 b_{\frac{1}{2}}^{(4)}}{d\alpha^2} = 0{\cdot}71334, \qquad \frac{d^2 b_{\frac{1}{2}}^{(5)}}{d\alpha^2} = 0{\cdot}65251$$

$$\frac{d^2 b_{\frac{1}{2}}^{(6)}}{d\alpha^2} = 0{\cdot}56795,$$

$$\log. \frac{d^3 b_{\frac{1}{2}}^{(1)}}{d\alpha^3} = 1{\cdot}50060, \qquad \log. \frac{d^3 b_{\frac{1}{2}}^{(2)}}{d\alpha^3} = 1{\cdot}47439$$

$$\frac{d^3 b_{\frac{1}{2}}^{(3)}}{d\alpha^3} = 1{\cdot}54483, \qquad \frac{d^3 b_{\frac{1}{2}}^{(4)}}{d\alpha^3} = 1{\cdot}55285$$

$$\log. \frac{d^3 b_{\frac{1}{2}}^{(5)}}{d\alpha^3} = 1{\cdot}59356, \qquad \log. \frac{d^3 b_{\frac{1}{2}}^{(6)}}{d\alpha^3} = 1{\cdot}56119$$

$$\log. \; b_{\frac{3}{2}}^{(1)} = 0{\cdot}71354, \qquad \log. \; b_{\frac{3}{2}}^{(3)} = 0{\cdot}44757$$

$$b_{\frac{3}{2}}^{(4)} = 0{\cdot}29534, \qquad b_{\frac{3}{2}}^{(5)} = 0{\cdot}13666$$

$$\log. \frac{d b_{\frac{3}{2}}^{(4)}}{d\alpha} = 1{\cdot}29207, \qquad \log. \frac{d b_{\frac{3}{2}}^{(5)}}{d\alpha} = 1{\cdot}19331$$

With these values, and supposing the terms depending on the mean anomalies included in the elliptic movement, the following principal inequalities of true longitude are derived. They are expressed in terms of the space-unit of the system.

$$m'. \begin{cases} +\ 3{\cdot}251 \sin (n't - nt + \varepsilon' - \varepsilon) \\ +79{\cdot}230 \sin 2(n't - nt + \varepsilon' - \varepsilon) \\ -\ 1{\cdot}351 \sin 3(n't - nt + \varepsilon' - \varepsilon) \\ -\ 0{\cdot}305 \sin 4(n't - nt + \varepsilon' - \varepsilon) \\ -0{\cdot}102 \sin 5(n't - nt + \varepsilon' - \varepsilon) \end{cases}$$

$$m'. \begin{cases} +0{\cdot}321 \sin (n't + \varepsilon' - \omega) \\ -248{\cdot}890 \sin (2n't - nt + 2\varepsilon' - \varepsilon - \omega) \\ -1{\cdot}594 \sin (3n't - 2nt + 3\varepsilon' - 2\varepsilon - \omega) \\ -5{\cdot}639 \sin (4n't - 3nt + 4\varepsilon' - 3\varepsilon - \omega) \\ +0{\cdot}234 \sin (5n't - 4nt + 5\varepsilon - 4\varepsilon - \omega) \\ -0{\cdot}205 \sin (-n't + 2nt - \varepsilon' + 2\varepsilon - \omega) \\ -4{\cdot}594 \sin (-2n't + 3nt - 2\varepsilon' + 3\varepsilon - \omega) \\ +0{\cdot}090 \sin (-3n't + 4nt - 3\varepsilon' + 4\varepsilon - \omega) \\ +0{\cdot}024 \sin (-4n't + 3nt - 4\varepsilon' + 3\varepsilon - \omega) \\ -0{\cdot}048 \sin (n't + \varepsilon' - \omega') \\ +16{\cdot}431 \sin (2n't - nt + 2\varepsilon' - \varepsilon - \omega') \\ +\ 0{\cdot}411 \sin (3n't - 2nt + 3\varepsilon' - 2\varepsilon - \omega') \\ +\ 1{\cdot}500 \sin (4n't - 3nt + 4\varepsilon' - 3\varepsilon - \omega') \\ -\ 0{\cdot}063 \sin (5n't - 4nt + 5\varepsilon' - 4\varepsilon - \omega') \end{cases}$$

$$m'. \begin{cases} -12{\cdot}188 \sin (2n't + 2\varepsilon' + 21^\circ \cdot 33' \cdot 43'') \\ -12{\cdot}061 \sin (2n't - 2nt + 2\varepsilon' - 2\varepsilon - 2^\circ \cdot 55' \cdot 54'') \\ +11{\cdot}898 \sin (4n't - 2nt + 4\varepsilon' - 2\varepsilon + 2^\circ \cdot 54' \cdot 6'') \\ +\ 0{\cdot}396 \sin (6n't - 4nt + 6\varepsilon' - 4\varepsilon + 2^\circ \cdot 00 \cdot 27'') \end{cases}$$

$$+m'\ 0{\cdot}805 \sin (6n't - 3nt + 6\varepsilon' - 3\varepsilon + 5^\circ \cdot 2' \cdot 14'')$$

It will readily be seen, that the approximation has been carried as far as terms of the fourth order in eccentricities and inclinations. The secular variations of the eccentricity and longitude of the perihelion corresponding to two different values of Neptune's mass, and for three synodic revolutions of Uranus, are the following:

Mass of Neptune,	$\frac{1}{14494}$	$\frac{1}{19840}$
$\frac{de}{dt}$	$-0''\cdot009525$	$-0''\cdot006958$
$\frac{d\omega}{dt}$	$-1''\cdot586088$	$-1''\cdot158696$

Let us now assume that the theory of Uranus may be completed on the basis of certain small corrections of its elements and the action of Neptune. In forming the equations of condition between these corrections, the inequalities just given, and the residual perturbations, it is necessary to take account of the second term of the equation of the centre. This has been done. Let $\delta\varepsilon$, δn, δe, $\delta'\omega$, denote respectively the corrections of the epoch, the mean motion, the eccentricity and the mean anomaly of the epoch,

p = Mean Anomaly of Uranus

$A = 2e.\cos p + \frac{5}{2}.e^2.\cos 2p$

$B = 2\sin p + \frac{5}{2}.e.\sin 2p$

P = disturbing effect of Neptune:

then the general residual perturbation of true heliocentric longitude

$$= \delta\varepsilon + (1+A).\delta n.t + B.\delta e + A.\delta'\omega + P.$$

From this general formula have been derived the following equations of condition, in which the dates represent their corresponding residual perturbations.

$$m'' = \frac{m'}{10000}.$$

$$(1715\cdot17) = \delta\varepsilon - 34\cdot427\,\delta n + 0\cdot0998\,\delta e + \cdot09854\,\delta'\omega - 4030''.8m''$$
$$(1753\cdot92) = \delta\varepsilon - 16\cdot976\,\delta n + 0\cdot3515\,\delta e - \cdot08636\,\delta'\omega - 6145''.1m''$$
$$(1764\cdot03) = \delta\varepsilon - 14\cdot080\,\delta n - 0\cdot9516\,\delta e - \cdot07676\,\delta'\omega - 6200''.0m''$$
$$(1771\cdot95) = \delta\varepsilon - 12\cdot112\,\delta n - 1\cdot7375\,\delta e - \cdot04178\,\delta'\omega - 5918''.9m''$$
$$(1783\cdot00) = \delta\varepsilon - 9\cdot296\,\delta n - 1\cdot9228\,\delta e + \cdot03294\,\delta'\omega - 5063''.5m''$$
$$(1789\cdot07) = \delta\varepsilon - 7\cdot499\,\delta n - 1\cdot4222\,\delta e + \cdot07135\,\delta'\omega - 4506''.6m''$$
$$(1795\cdot15) = \delta\varepsilon - 5\cdot475\,\delta n - 0\cdot5679\,\delta e + \cdot09485\,\delta'\omega - 4064''.0m''$$
$$(1801\cdot22) = \delta\varepsilon - 3\cdot289\,\delta n + 0\cdot4341\,\delta e + \cdot09645\,\delta'\omega - 3863''.9m''$$
$$(1807\cdot29) = \delta\varepsilon - 1\cdot075\,\delta n + 1\cdot3229\,\delta e + \cdot07565\,\delta'\omega - 3957''.5m''$$
$$(1813\cdot36) = \delta\varepsilon + 1\cdot039\,\delta n + 1\cdot8798\,\delta e + \cdot03870\,\delta'\omega - 4278''.7m''$$
$$(1816\cdot40) = \delta\varepsilon + 2\cdot034\,\delta n + 1\cdot9966\,\delta e + \cdot01729\,\delta'\omega - 4529''.5m''$$
$$(1819\cdot44) = \delta\varepsilon + 2\cdot987\,\delta n + 2\cdot0028\,\delta e - \cdot00427\,\delta'\omega - 4777''.1m''$$
$$(1822\cdot47) = \delta\varepsilon + 3\cdot902\,\delta n + 1\cdot9056\,\delta e - \cdot02479\,\delta'\omega - 5028''.2m''$$
$$(1825\cdot51) = \delta\varepsilon + 4\cdot784\,\delta n + 1\cdot7181\,\delta e - \cdot04329\,\delta'\omega - 5270''.4m''$$
$$(1828\cdot55) = \delta\varepsilon + 5\cdot646\,\delta n + 1\cdot4559\,\delta e - \cdot05905\,\delta'\omega - 5495''.5m''$$
$$(1831\cdot58) = \delta\varepsilon + 6\cdot499\,\delta n + 1\cdot1362\,\delta e - \cdot07158\,\delta'\omega - 5697''.3m''$$
$$(1834\cdot61) = \delta\varepsilon + 7\cdot355\,\delta n + 0\cdot7753\,\delta e - \cdot08063\,\delta'\omega - 5873''.7m''$$
$$(1837\cdot65) = \delta\varepsilon + 8\cdot225\,\delta n + 0\cdot3886\,\delta e - \cdot08604\,\delta'\omega - 6022''.0m''$$
$$(1840\cdot69) = \delta\varepsilon + 9\cdot122\,\delta n - 0\cdot0108\,\delta e - \cdot08779\,\delta'\omega - 6140''.6m''$$

It has not been judged necessary to determine the residual perturbations of these equations by a critical revision of the old theory of Uranus. This has already been done by Messrs. Le Verrier and Adams. The values which they have obtained differ widely from each other, and involve, as will be seen, essentially different final-results.

Let G = Geocentric longitude of Uranus.

H = Heliocentric longitude reduced to the ecliptic.

r = Radius vector reduced to the ecliptic.

dG = Residual perturbation of true geocentric longitude.

R = Radius vector of the earth.

♁ = Its longitude.

N = Nutation.

Then the residual perturbation of true heliocentric longitude is

$$\left\{ 1 - \frac{\mathrm{R}\,.\cos(\mathrm{G}-\text{♁})}{r\,.\cos(\mathrm{G}-\mathrm{H}-\mathrm{N})} \right\} .\, d\mathrm{G}\,;$$

which, near the time of mean opposition, practically reduces to

$$\cdot 948\, d\mathrm{G}.$$

Hence we have

	Le Verrier's.	Adams'.		Le Verrier's.	Adams'.
(1715·17)=	+62″·9	+73″·8	(1816·40)=	+32″·7	+22·9
(1753·92)	—33 ·3	—39 ·5	(1819·44)	+29 ·2	+20·7
(1764·03)	—21 ·4	—34 ·9	(1822·47)	+28 ·1	+21·0
(1771·95)	—11 ·4	— 2 ·3	(1825·51)	+27 ·1	+18·2
(1783·00)	+17 ·7	+ 8 ·4	(1828·55)	+16 ·6	+10·8
(1789·07)	+28 ·7	+19 ·0	(1831·58)	" "	— 4·0
(1795·15)	+27 ·4	+21 ·4	(1834·61)	" "	—20·1
(1801·22)	+31 ·6	+22 ·2	(1837·65)	—42 ·4	—42·7
(1807·29)	+35 ·0	+22 ·1	(1840·69)	—65 ·4	—66·6
(1813·36)	+35 ·7	+22 ·0			

From these two systems of values and an application of the method of least squares, are derived the following values of the arbitrary constants of our equations of condition. It is to be observed that these are not strictly the numerical corrections of the elements of Uranus for the epoch, but these corrections together with certain other small quantities to which allusion was made at the commencement of the article.

Mass of Neptune,	$\frac{1}{19840}$	$\frac{1}{14494}$	$\frac{1}{19840}$	$\frac{1}{14494}$
	Due to Residual Perturbations of Adams.		Due to Residual Perturbations of Le Verrier.	
$\delta'\omega$ . .	—5703″·4	—7927″·9	—6085″·0	—8274″·2
$\delta\varepsilon$ . .	+2560 ·1	+3505 ·2	+2569 ·3	+3514 ·9
δe . .	— 76 ·8	— 109 ·2	— 66 ·4	— 100 ·8
δn . .	— 1 ·0	— 1 ·2	— 2 ·7	— 2 ·7

The numbers based on the residual perturbations of Le Verrier, were derived from the modern equations of condition alone: the others were furnished by the modern and ancient equations united.

The final results are comprised in the following table. It exhibits the amount of perturbation of true heliocentric longitude, which, according to our theory, remains unexplained after the application of the effect of Neptune and the best possible modifications of the orbit of Uranus.

OBSERVATION — THEORY.

Mass of Neptune,	$\frac{1}{19840}$	$\frac{1}{14494}$	$\frac{1}{19840}$	$\frac{1}{14494}$
	Due to Residual Perturbations of Le Verrier.		Due to Residual Perturbations of Adams.	
1840, . .	+ 1″·7	+ 4″·7	— 6″·6	+ 1″·4
1837, . .	— 5 ·4	— 6 ·7	— 4 ·5	— 2 ·7
1834, . .	" "	" "	+ 0 ·7	— 1 ·1
1831, . .	" "	" "	+ 5 ·6	+ 2 ·0
1828, . .	+ 1 ·9	— 1 ·5	+12 ·1	+ 8 ·7
1825, . .	+ 5 ·1	+ 3 ·3	+13 ·6	+10 ·2
1822, . .	+ 1 ·6	+ 1 ·9	+11 ·7	+11 ·2
1819, . .	— 0 ·3	+ 2 ·1	+ 6 ·7	+ 7 ·3
1816, . .	+ 1 ·3	+ 4 ·2	+ 3 ·8	+ 5 ·4
1813, . .	— 7 ·9	— 8 ·7	—13 ·4	—15 ·2
1807, . .	— 0 ·4	+ 1 ·2	—13 ·3	—12 ·5
1801, . .	— 2 ·0	— 3 ·0	—16 ·6	—17 ·2
1795, . .	+ 0 ·2	— 1 ·7	— 9 ·0	—10 ·0
1789, . .	+ 7 ·9	+ 7 ·7	+ 6 ·2	— 1 ·2
1783, . .	— 4 ·4	— 2 ·5	+13 ·7	+13 ·8
1771, . .	— 68 ·2	— 64 ·3	+13 ·9	+10 ·9
1764, . .	—113 ·2	—106 ·6	—21 ·9	—26 ·5
1753, . .	—148 ·8	—128 ·6	—17 ·1	—13 ·2
1715, . .	—156 ·1	—132 ·2	+14 ·9	+15 ·7

Art. XXIII.—*Caricography;* by Prof. Dewey.

(Appendix, continued from vol. v, ii ser., p. 176.)

No. 234. *Carex fusiformis*, Chapman *in literis.*

Spicis distinctis; spica staminifera unica pedunculata erecta gracili, squamis oblongo-lanceolatis; pistilliferis binis vel ternis ovatis oblòngis brevibus laxifloris, superioribus subapproximatis sessilibus, inferiore subremota pedunculata, *tristigmaticis* erectis; fructibus subinflatis inferne teretibus triquetris conoideo-rostratis longis brevi-bidentatis, squamam ovatam acutam duplo superantibus.

Culm 6–10 inches high, triquetrous, smooth, slender, erect; leaves linear lanceolate, smooth, long as the culm; staminate spike single, erect, slender, pedunculate, near the upper pistillate; pistillate spikes 2–3, ovate-oblong, few and loose-flowered, two upper nearly sessile and approximate, lowest subremote and pedunculate, with leafy bracts scarcely sheathing; stigmas three; fruit elliptic-triquetrous, tapering below, conic-rostrate above and slightly bidentate, smooth and a little inflated; pistillate scale ovate and acute, half as long as the fruit; plant pale green.

Floridas, *Dr. Chapman;* named in his letters as above, and is a distinct species.

235. *C. Illinoensis*, Dew.

Spica staminifera solitaria erecta cylindracea longo-pedunculata ebracteata; spicis pistilliferis ternis remotis folio-bracteatis, suprema ovata subsessili, inferioribus oblongis laxifloris exserte-pedunculatis erectis; fructibus *tristigmaticis* ovato-conicis ore integris nervosis subobtusis, in spicam supremam multo majoribus et longioribus aggregatis, squamam ovatam cuspidatam superne multo superantibus.

Culm 12–16 inches high, erect, slender, glabrous, scabrous on the edges, leafy towards the base, with long and leafy bracts; staminate spike single, erect, short, oblong, pedunculate, having oblong and obtusish scales brown on the edges; pistillate spikes three, remote, leafy-bracteate, the highest nearly sessile and ovate close-fruited, the two lower oblong, distant, loose-flowered and exsertly pedunculate; stigmas three; fruit ovate, conic, rather obtuse, entire at orifice, on the upper spike closer, larger, and much longer than the ovate and cuspidate scale, on the lower spikes loose and a little longer than the scale.

Augusta, Ill., *Dr. S. B. Mead.* Though related to *C. conoidea*, Schk., it is very different, and appears to be a new species. It is singular in the different size of the fruit on the same plant, being much larger and longer on the upper spike.

236. *C. Georgiana*, Dew.

Spica staminifera unica (plures?) pedunculata longo-cylindracea bracteata, squamis denis lanceolatis longo-setaceis; spicis pistilliferis ternis vel quaternis oblongis cylindraceis densi-floris foliaceo-bracteatis erectis, inferioribus longo-pedunculatis exsertis, superioribus subsessilibus; fructibus *tristigmaticis* ovatis conico-rostratis nervosis bidentatis, squama lanceolata scabro-aristata brevioribus.

Culm 20 inches or more high, triquetrous, with long leafy bracts surpassing the culm; staminate spike slender, long, with long and slender bristly scales; pistillate spikes 3–4, erect, cylindric, 1½–2 inches long, the two lower long pedunculate and exsert, the upper sessile, all long leafy bracteate; stigmas three; fruit ovate, conic-lanceolate, scabro-rostrate, round-triquetrous, short two toothed, sometimes teeth a little elongated; scale lanceolate, awnlike, scabrous, longer than the fruit.

Georgia, *Dr. Cooley.* I referred to this locality under *C. mirata*, but, as my friend John Carey, Esq. suggests, the plant differs too much from that species. The fruit of *C. mirata* is long and wide bifurcate, while this is short two-toothed; the scale of the former equals the fruit, while this surpasses the fruit. On *C. mirata* too the fruit is longer and more slender than on this. The fertile spikes on both are large, but are far less than on *C. gigantea*, Rudge and Muh.

Art. XXIV.—*On Gutta Percha;* by Edward N. Kent.

Gutta Percha is soluble in *pure* chloroform, bi-sulphuret of carbon, rectified oils of turpentine, resin, gutta percha and tar, and also in terebene, hydrochlorate of terebene, and slightly in pure ether. Of these solvents the first two are the best, and dissolve the gutta percha at low temperatures. The other solvents act only at a temperature above 70° F., and when the solutions are cooled much below 60°, the gutta percha is deposited in a voluminous granular mass. The length of time required for the production of this precipitate, depends upon the degree of cold; sometimes it requires several days, and at other times the exposure of an hour suffices to produce it. By warming this mixture, the precipitate is readily redissolved, and by exposure to cold is again precipitated at will.

Solutions of gutta percha are naturally of a reddish brown color, and do not become colorless by standing at rest for several months in a warm situation. If the solution is made sufficiently dilute, which is the case when one part of the gum is used to sixteen parts of the solvent, it can be filtered slowly through paper or muslin, and is then colorless.

Solutions of gutta percha are precipitated by alcohol, and when chloroform or bi-sulphuret of carbon are used as the solvent, the gum is recovered in its natural state either by evaporation or precipitation; but when any of the hydro-carbons are used for a solvent, a portion is retained with such tenacity that it cannot be removed without decomposition of the gum.

A solution in chloroform, filtered, and precipitated with alcohol, leaves the gutta percha when dry, of its natural strength, translucent, colorless, and pure.

When two or three parts of washed ether are mixed with a filtered solution of gutta percha in chloroform, and the mixture left for a short time at a temperature below 60° F., it precipitates in a perfectly white powder, which when washed with alcohol, filtered and dried, leaves the gutta percha in a pure white, opaque, voluminous mass, very soft and delicate to the touch, not unlike the pith of a young tree.

If a small quantity of the above mixture (before precipitation) is poured upon a glass plate and allowed to evaporate spontaneously, a thin opaque film of pure white gutta percha remains, which has the appearance and delicate feeling of the finest white glove leather. By a gentle warmth it loses its opacity and beautiful appearance, and becomes transparent or translucent, according to the thickness of the film. The state of aggregation which causes the opacity and delicate feeling of gutta percha prepared in the above manner, is owing to the precipitation of the gum, caused by the cold produced in the rapid evaporation of the ether.

The small portion of gutta percha, insoluble in any of the above solvents, consists of a red coloring matter, woody fibre, and earthy bases. The coloring matter is soluble in water, and precipitates on the addition of alcohol.

Crude gutta percha contains a small portion of a soft yellow resin, soluble in alcohol, ether and turpentine. This resin is separated by precipitating a solution of gutta percha with alcohol and evaporating the solution.

By destructive distillation, gutta percha yields an oil similar to that obtained from caoutchouc. The crude oil is dark brown by reflected, and red by transmitted light. It is limpid, grows darker by exposure to light, has a very disagreeable smell, is not spontaneously volatile, is but slowly soluble in 90 per cent. alcohol, and has a specific gravity of ·856. By two rectifications a light yellow oil is obtained, volatile below 320° F., which constitutes about one-half the measure of the crude oil. This product is spontaneously volatile, dissolves readily in alcohol, and grows darker by exposure to the light.

The most remarkable property of gutta percha, that of its becoming soft and plastic by heat, and returning to its natural state when cold, has already been taken advantage of in the arts, and several patents have been granted to Mr. Hancock in Europe for valuable processes of working the material into a great variety of articles, for which it appears to be admirably adapted. In this country but little has been done with it, except for the manufacture of bands for machinery, and soles for boots; but it will doubtless be soon brought into extensive use, in a great number of our domestic manufactures.

The interesting electrical property of gutta percha, first noticed by Faraday, is truly wonderful. A piece of the manufactured thin sheet gum, cannot be taken from a paper in which it has been wrapped, without exhibiting this remarkable property, and by gentle friction with a silk handkerchief, a spark is readily obtained from it of an inch in length.

From the excellent non-conducting power of gutta percha, it is likely to come into extensive use in the manufacture of electrical apparatus, and it has already been employed to some extent for insulating the wires of Morse's electro-magnetic telegraph.

New York, Aug. 1st, 1848.

ART. XXV.—*On Emerald Nickel from Texas, Lancaster County, Pa.;* by Prof. B. SILLIMAN, Jr.

THIS is the same mineral which I have before described under the name of "hydrate of nickel."* The name now proposed is in accordance with the custom of giving a trivial name to mineralogical species, and has been suggested by my friend, Prof. C. U. Shepard, as peculiarly appropriate from the brilliant color and transparency of the mineral, resembling the emerald. The existence of carbonic acid in this mineral as an essential constituent, was overlooked by me from the fact that it is all expelled at redness, and was therefore in my analysis put down as water. The water given off in the close tube does not change litmus paper, and the mineral does not effervesce in dilute cold hydrochloric acid. My attention was first directed to the probable existence of carbonic acid in this mineral, by a notice from Dr. D. R. Thomson,† describing as a new mineral a carbonate of nickel from the United States, coating specimens of chromic iron. Prof. Shepard also mentioned to me that he had found carbonic acid in the Texas nickel mineral first described by me. I have therefore made a new analysis of the mineral in question, selecting the finest and most transparent colored specimens in my power.

The following mineralogical description is mainly the same which I have before given, save that having much better specimens on which to determine the specific gravity, that now given may be regarded as more correct than the former determination.

Emerald Nickel.

Massive, stalactitic, occurring in thin crusts on chromic iron.
Hardness = 3—3·25, being but little above calc spar.
Gravity = 2·570—2·693, two trials on different portions.
Lustre vitreous, brilliant. *Color* emerald-green. Transparent. *Streak* delicate pea-green. Very brittle. Its pyrognostic characters have already been so fully described in the article first quoted, that it is useless to repeat them here; they differ in no respect from those of pure artificial hydrate of nickel.

The water of this mineral is partially expelled at the ordinary temperature of a water bath (212° F.); this fact led to estimating the total volatile product of the mineral too low, in the former description of this species. Carefully dried over sulphuric acid, the mineral lost on two trials 41·370 and 41·008; mean = 41·189 per cent.

The carbonic acid was estimated in the apparatus described by Fresenius and Will for analyzing carbonates.

---

* This Journal, ii ser., vol. iii, p. 407. † Phil. Mag., Dec., 1847, p. 541.

The mean of three trials gave 11·691 of CO^2. A trace of magnesia in the specimen examined was disregarded, as being accidental. The mineral rests on a basis of carbonate of magnesia, which is difficult to separate entirely.

The constitution resulting from the analysis is—

		Atoms.
Oxyd of nickel, . .	58·811	$26{\cdot}22 = 3$
Carbonic acid, . .	11·691	$4{\cdot}23 = 1$
Water, ...	29·498	$12{\cdot}52 = 6$

This gives the empirical formula, $3\dot{N}i + \ddot{C} + 6\dot{H} = \dot{N}i\,\ddot{C} + 2\dot{N}i\,6\dot{H}$, or $\dot{N}i\,\ddot{C} + 2(\dot{N}i\,\dot{H}_3)$.

When we remember the isomorphism of magnesia and oxyd of nickel, it will be agreed by all who attach any value to this agency in modifying minerals, that we may have many cases in which these two oxyds are mutually interchanged. Hence we find at the Texas locality, dolomitic carbonates with a faint tint of green derived from a small trace of oxyd of nickel present in them—others of green color several shades deeper, and others which closely approach the high color and other properties of the pure hydrous carbonate of nickel described in this paper. In some specimens, unquestionable emerald nickel is found mechanically mingled with and coating whitish dolomite. I cannot agree with the opinion expressed by Prof. Shepard, at page 250 of this volume, that these varieties are distinct species. Certainly we must demand analyses to show that the Mg O and Ni O are in fixed atomic proportions with water, before the "hydrated carbonate of magnesia and nickel" can be regarded as a true species.

Analytical Laboratory, August, 1848.

Art. XXVI.—*On new Minerals from Texas, Lancaster Co., Penn.*; by Charles Upham Shepard, M.D.

Williamsite.

Massive: composition lamellar, individuals of considerable size. Lamellæ straight, rather difficultly separable. Faces of composition not very even. Fracture even. Surface nearly dull.

Lustre feebly shining, pearly to resinous. Color apple-green. Streak white. Translucent.

Hardness = 4·5. Sp. gr. = 2·59 . . . 2·64.

Before the blowpipe, it phosphoresces, turns white, and hardens so as to scratch glass, but does not fuse. It dissolves with much difficulty in borax, without imparting any color or opacity to the bead. In powder, it dissolves slowly in hot hydrochloric acid.

It consists of—

		Atoms.	Ratio.
Silica,	45·40	22·7	6
Magnesia,	33·60	13·4	3
Alumina,	8·50	3·7	1
Water,	12·50	11·0	3
	100·		

with traces of oxyd of nickel.

It approaches therefore the following: three atoms sesquisilicate of magnesia, + one of silicate of alumina, + three atoms of water.

$$3\overline{MgO, SiO^{3}}1\tfrac{1}{2} + Al^{2}O^{3}, SiO^{3} + 3HO.$$

This mineral was sent to me by L. White Williams, Esq., (for whom it is named,) of West Chester, Chester Co., Penn. It had been designated as nephrite. It occurs in irregularly shaped seams, sometimes above an inch in thickness, between chrome iron ore and serpentine. It belongs to the order Mica, and has affinities with schiller spar (metalloidal diallage).*

New Haven, July 12, 1848.

---

* *Hydrated carbonate of magnesia and iron, and hydrated carbonate of magnesia and nickel* (*hydro-nickel magnesite*).—These two new compounds occur at the same locality with the foregoing species, but in quantities so minute as to render the most of their natural properties indeterminable. I refrain therefore for the present, from attempting any formal description of them. They are very closely associated together, and mingled up also with minute granular crystals of white dolomite,—the three substances forming together, thin, drusy incrustations upon the joints of serpentine rock, and presenting an apple green color. Examined under a microscope however, the mixture resolves itself into three distinct substances,—the first consisting of pearly white, thin laminæ which form the basis of the coating, next to the serpentine, and which are arranged perpendicularly to its surface. This is the hydrated carbonate of magnesia and iron. Upon the top of these laminæ, are scattered little particles of a lively colored apple-green mineral, mixed with minute granules of a grayish white substance,—the former is the hydrated carbonate of magnesia and nickel, the latter is dolomite. These three minerals become much more readily distinguishable if heated for a few minutes in a glass tube over a spirit-lamp. Abundance of moisture, attended with a peculiar odor, is evolved, while the foliated mineral first mentioned exfoliates and turns reddish-brown, the green mineral turns bluish black, and the little crystals of dolomite are left of a characteristic white color.

Hitherto I have been unable to separate these minerals from each other so as to enable me to make a quantitative analysis of the two which are new; but my examinations have been carried far enough to satisfy me that the foliated, pearly mineral is a hydrated carbonate of magnesia and iron, and the green one, a hydrated carbonate of magnesia and nickel, which for the present may be called *hydro-nickel magnesite*.

ART. XXVII.—*An Account of the Meteorite of Castine, Maine, May* 20, 1848; by CHARLES UPHAM SHEPARD, M.D.

THE following abstracts of letters, and description of the lately fallen meteoric stone in Maine, in the absence of fuller accounts, will no doubt prove interesting to meteorologists.

The only stone thus far found, together with the principal facts in the case, fell into the hands of Prof. P. Cleaveland of Bowdoin College, from whose letter (of August 5th) it seems proper to make the following quotation as my apology for not leaving this communication to be made by himself. "I have written to Castine, proposing certain queries, with a view of obtaining more facts. When I receive them, I will prepare a notice, if in season for the next number of the Journal. The notice ought to appear in the next number, and as you have all the facts which I now possess, if you hear nothing from me before the printing of the last pages, you had better put the facts in due form, and insert the notice yourself."

On observing a paragraph in a newspaper respecting the fall of a meteoric stone in Maine, I addressed a letter to my friend, Rev. Ray Palmer, of Bath, (Me.,) requesting his aid in procuring a reliable account of the occurrence. This drew forth the following excellent description from Rev. Daniel Sewall, of Castine, in a letter dated June 12th, to Mr. Palmer. "I received your note on Friday evening, and on the day following, I rode out to the place (which is one mile distant) where the stone fell. I made what inquiries and search I could, but without being able to procure a specimen. The only stone that has been found as yet, is now in the possession of Prof. Cleaveland of Brunswick. Mr. Lemuel Atherton, a member of College from Bowdoin, took it with him thither a few days since. I saw the stone, the morning it was picked up. It was not larger than a hen's egg.

"The appearance of the meteor and the attendant circumstances, so far as I have been able to gather them, may be described as follows: On Saturday morning, May 20th, about half past four in the morning, Mr. Charles Blaisdell, a mechanic, who lives about a mile from the village, being out of the house at the time, noticed dark clouds, apparently gathering from different quarters of the heavens. Soon, he saw what he supposed to be a flash of lightning. Presently, however, upon looking at that portion of the cloud which came from the northwest, he saw what appeared like the moon in a cloud, not as at the horizon, but when high in the heavens. A sudden, sharp report like a cannon was heard, followed by a quick succession of reports not so loud as the first, but which resembled a running fire of musketry; and after these a whistling sound in the air, as of a body passing through it with great rapidity. Something was seen and heard to strike the ground in the road, but a little distance from the place where he was standing, which proved to be the stone in question. Mr. Giles Gardiner also saw the stone strike the ground, but he did not notice the meteor. I could not learn from Mr. Blaisdell that the meteor had any apparent motion, except with the cloud, before the explosion. He stated that he was looking at it from eight to ten minutes. The report was heard by great numbers in the village and elsewhere. Some saw a streak of light."

Prof. Cleaveland's account of the stone and the attending phenomena is the following. "It fell at Castine, Maine, May 20, (*4h. 15m.* A.M.,) 1848. The fall was accompanied by a noise similar to thunder, but quicker and more like that of a gun. The report was distinctly heard at a distance of thirty or forty miles from Castine. A second report, resembling the discharge of muskets, was also heard.

"The stone came from the southeast, and by its fall penetrated to the depth of two inches into a dry, hard road. No flash of light was observed by the person who witnessed the fall, although the stone struck the earth within a few feet of him. Others assert that they saw a flash.

"Its whole weight when entire was 1½ oz. avoir. The finder broke off a piece to examine the inside, and threw the fragment away. It was farther diminished by the portion sent to you. Its present weight is 1oz. 3pwts. 5grs. The whole was invested by a black crust. Its shape was somewhat wedge-shaped, one surface being nearly plane, and the other irregular or slightly waved. This stone is now in the mineralogical cabinet of Bowdoin College, to which it was presented by Mr. Lemuel W. Atherton, of Castine, who received it from the person who observed its fall."

To the foregoing, I have the following observations to make, derived from an examination of the fragment so obligingly presented to me for the purpose by Prof. Cleaveland.

Sp. Gr. = 3·456.

In general appearance, it resembles the Poltawa stone (of March 12, 1811); but is distinguishable from that, by possessing a much lighter color, a more pearly lustre, and in being destitute of specks of iron-rust. The nickeliferous iron is in smaller points, and possessed of an unusually brilliant silver-white lustre. The magnetic iron pyrites is easily distinguishable in little points, though less abundant than the malleable iron. A few, very fine black points are also discernible, which give before the blowpipe the reaction of chromium: they are probably chrome-iron.

The malleable iron was separated by means of the magnet, and equalled in weight 11·22 p. c. of the entire stone. It proved uncommonly rich in nickel, being identical in composition with the Green Co., Tenn., meteoric iron; i. e., having

Iron, ...	85·3
Nickel, ...	14·7
	100·

The earthy constituent of this stone, like that of the Iowa meteorite, is decomposed by concentrated hydrochloric acid, and like it, appears to be a tersilicate of the protoxyd of iron and magnesia, a mineral which though frequent in meteoric stones, has never yet been distinctly recognized, and which in a future paper on American Meteorites, I shall more particularly describe under the name of *Howardite*, after the Hon. Mr. Howard, that celebrated chemist, who was the first British writer whose labors contributed to elucidate the history of these extra-terrestrial bodies.

New Haven, Aug. 16, 1848.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *Ice, a Conductor of Galvanism.*—In experimenting with a Grove's battery of eighteen cups, I left the whole standing over night the poles not being connected, or the circuit not being closed. There was no action going on, or at least, no hydrogen was evolved in the cups. Owing to a sudden change of weather, the liquid in the cups was found frozen in the cups next morning. In each of the cups the local action was evolving hydrogen, which continued till, by a knife, I had separated the ice from the platinum, when, in each instance, it immediately ceased. C. Dewey.

2. *Grove's Battery with only Water used with the Zinc cup.*—Having seen in some of the papers that the telegraph was made to operate by means of water alone with the zinc, I charged a new Grove's battery of eighteen cups in the usual way, only using water instead of diluted sulphuric acid. The whole was quickly put in operation and the poles connected.

(1.) In the first minute there was the indication of only the feeblest action, either in evolving hydrogen, or making iron filings magnetic.

(2.) In two or three minutes the action had sensibly increased, as shown in both these results, and in thirty to sixty minutes the action was quite powerful. With a large helix the large dancing iron was made to play finely. The action had now attained its maximum power.

(3.) In two or three hours the power was manifestly less, and ere long it was exhausted. The strength of the nitric acid was nearly gone.

It is evident, that the action of the battery was dependent upon the passing of the nitric acid through the porous cup into the water so as to operate on the zinc; that the power increased with the exosmosis of the acid, and decreased as this diminished; that the acid was rapidly used up. As amalgamated zinc was used, nitrate of mercury was formed, for the crystals yielded red oxyd of mercury. C. D.

Vermont Medical College, March, 1848.

3. *Oxyd of Zinc in the Porous Cup.*—I connected four cups of Grove's battery, charged in the common method by strong nitric acid in the porous cup and sulphuric acid diluted with twelve of water, so that the zinc of the fourth cup was connected by its platinum with the acid of the first porous cup, so that there was a complete circle among the cups themselves. The action was strong and rapid; nitrous acid gas was thrown off abundantly, while no hydrogen appeared in the zinc cups. The process was suffered to go on till nearly all of both acids was consumed. After a while the porous cups began to fill with a white powder till each cup was nearly one third full. This was oxyd of zinc, and must have been derived from either sulphate or nitrate of zinc, which had been decomposed in the zinc cup or in the porous cup or both. It is more probable that the salt passed through and into the porous cup, and was there decomposed. A little nitrate of mercury was in the liquid. This appears to show the advantage of using Glauber's salt in the zinc cup in preventing the action of the nitric acid on the mercury. C. D.

Rochester, May, 1848.

4. *Selenium*, (Acad. Berlin, Nov., 1847.)—The specific gravity of selenium has been determined by Fr. de Schaffgotsch as follows:

For vitreous selenium,—obtained by a rapid cooling from fusion,—4·276 to 4·286 at 20° C.; the mean is 4·282.

For fine-grained selenium,—obtained from slow cooling after heating to 250° C.,—4·796 to 4·805 at 20° C.; mean 4·801. This selenium had the aspect of hematite, and left traces on porcelain less red than the vitreous selenium.

The red selenium precipitated cold, such as is obtained by the reduction of selenic acid by sulphhydric acid, and which becomes black when moderately heated, has the specific gravity 4·259 for the red, and 4·264 for the black colored, which corresponds with that of the vitreous selenium.

5. *Cause of Irised Colors on Minerals*, (Soc. Sci. Göttingen; L'Institut, No. 750.)—From M. Hausmann's valuable memoir on this branch of optical mineralogy, we gather that the irised colors on minerals, like that on steel, is due to a thin film covering the surface; and that the colors are varied by a variation in the thickness of this film. It is often produced by a chemical change in the surface of the mineral, and sometimes by deposition of a foreign substance. Hydrated oxyd of iron is one of the most common of the substances that communicate irised hues. This compound results from the decomposition of pyrites, either forming first a carbonate which is common in many waters, and then by the evaporation of the water yielding the hydrate, or forming the hydrate direct. The colors on anthracite and specular iron often proceed from this source: and an exposure of the latter species to waters containing the carbonate, afforded Hausmann after a while, irised specimens.

Arsenic becomes irised through the action of hydrogen from the atmosphere; *bismuth*, by a superficial oxydation; *arsenical cobalt*, *nickel* and *iron*, by oxydation; *galena*, probably from the formation of a thin coating of sulphate of lead; magnetic iron and some ferruginous silicates, (as olivine, yenite, &c.,) from a change in the oxyd of iron to a hydrate; *pyrites*, from the formation of a hydrate of iron; *copper pyrites* and *variegated pyrites*, probably from the same, the latter being very remarkable for the rapidity with which the change takes place in a moist atmosphere; *antimony glance*, and other antimony ores, from the formation of antimony ochre; *fahlerz*, and other arsenical ores, probably from the oxydation of the arsenic.

These irised colors sometimes proceed from the absorption of oxygen and the elimination of water, or from a disengagement of carbonic acid with a loss of water, as in spathic iron and carbonate of manganese.

Irisation is often favored by heating, as in the case of steel.

6. *On the Radiating Power of Substances;* by A. Masson and L. Courtépée, (Comptes Rendus, Dec. 20, 1847.)—In the experiments of Masson and Courtépée, the substances, pulverized with some water holding a little glue in solution, were applied in coats to the faces of a small cube of copper. This cube filled with boiling water was placed before a thermo-electric pile, with the radiating surfaces perpendicular to its axis. They concluded that

1. The metals have a much greater radiating power when in grains, than when melted or in mass.

2. That the radiating power of a substance depends on the cohesion of its parts, and not upon their nature.

3. That if all bodies were reduced to the same degree of chemical subdivision, they would have at 100° C., the same radiating power.

7. *On Auriferous Glass;* by H. Rose, (Pogg. Annal., lxxii, 556.)—Gold is well known to be used in making a beautiful red glass. After fusion this glass is colorless; but when heated not above a red heat, it becomes of a bright red color. Rose suggests that the gold is contained in the glass in the state of a protoxyd, which forms a colorless silicate by fusion, but sets free some portion of the protoxyd when reheated to a temperature a little below that which forms it. This protoxyd disseminated in a small quantity, in an extreme state of subdivision, is believed to give the red color. When too much heated the red changes to a brown, and Rose attributes this to the oxyd of gold becoming partly reduced and metallic gold set free. A fact, according to Rose, confirming this view, is presented by copper. For a glass containing the protoxyd of copper is colorless after fusion, a silicate being formed; but it becomes green after heating, owing to the oxyd set free. The ingredients used for the auriferous glass, are 46 pounds of quartz, 12 of borax, 12 of nitre, 1 of minium, and 1 of arsenous acid; these are moistened with a solution of 8 ducats of gold in aqua regia, and then fused.

8. *Dimorphism of Zinc*, (Jour. Pharm. et Chem., xiii, 18.)—Nœggarath has described (Annales de Pogg., xxxix, 324) crystals of pure zinc of the form of hexagonal prisms. J. Nicklès reports that a specimen of zinc prepared by M. Favre, after Jacquelain's process, was crystallized in pentagonal dodecahedrons, like those of pyrites and gray cobalt. Zinc is therefore dimorphous. This is not the only example of dimorphism among metals. Miller has shown that tin crystallizes in square prisms (dimetric system), and Frankenheim has observed it in cubes. G. Rosè (Annales de Pogg., xlv, 319) has announced that palladium and iridium are isodimorphous, crystalling both in the rhombohedral and tesseral systems.

9. *On the Estimation of Urea—Presence of Urea in the Vitreous Humor of the Eye;* by M. E. MILLON, (Comptes Rendus, Jan., 1848.)—Nitrite of mercury dissolved in nitric acid gives off no nitrous vapors, but yet readily transforms urea into nitrogen and carbonic acid. The carbonic acid is collected and weighed in the usual manner in potash tubes; its weight multiplied by 1·371, gives the quantity of urea.

This method is easy of execution, consumes but little time, and is reliable to the ·001 of the weight of the urine. Substances usually present in this liquid are said not to affect the accuracy of the process.

M. Millon points out a curious relation between the specific gravity of urine and the quantity of urea present. The second and third figures after the decimal place in the specific gravity, very nearly represent the quantity of urea in 1000 parts of urine. This empirical law holds good only for the secretion from man in a state of health. From animals and from men laboring under various diseases no such correspondence is found.

M. Millon has also shown that the residue left on evaporating the liquid of the vitreous humor of the eye of the ox, man, or dog, contains 20 to 35 per cent. of *urea*—the remainder being chlorid of sodium without any albumen, as stated by Berzelius.

The aqueous humor also contains urea and chlorid of sodium.

G. C. SCHAEFFER.

10. *On the Employment of Gun-cotton in Mining;* by M. COMBES, (Comptes Rendus, Jan., 1848.)—It is known that this substance does not contain oxygen enough for the complete combustion of all its carbon. M. Combes proved the presence of a large quantity of carbonic oxyd, after a blast with gun-cotton, and even exploded the mixture formed with atmospheric air.

To avoid this difficulty, chlorate of potassa was added in quantity sufficient to complete the combustion—80 parts to 100 pyroxyline. The salt finely powdered was mixed with the cotton by hand. In this case the effect was excellent—no combustible vapors, no odor of any kind could be noticed; moreover, 5 parts of gun-cotton and 4 of chlorate were equal in effect to 30 parts of mining powder.

Mixtures with 80 parts nitrate potassa, or 70 nitrate of soda, were equally free from fumes and almost as powerful as that with chlorate.

In the plaster rock in which the trials were made, M. Combes asserts that these mixtures are nearly as effective as their own weight of gun-cotton, three times their weight of gunpowder, or four times that of blasting powder.

The volume of gas is the same with or without the mixture; the increased effect must be due to the greater heat produced by the carbonic oxyd burning to carbonic acid. G. C. S.

11. *On a new Process for preparing Chloroform;* by MM. HURATET and LABOCQUE, (Comptes Rendus, Jan., 1848.)—A still with a water bath is used; into this are to be put 37 quarts of water, which are to be heated to about 100° Fahr. Then stir in 11 pounds of quick lime previously slacked, and 22 lbs. commercial chlorid of lime. Upon this pour 3½ pints of alcohol of 85, and when the whole is mixed, the head is to be put on, and the water of the bath caused to boil as quickly as possible.

As soon as the heat reaches the neck of the still, the fire is to be slackened, when the distillation proceeds rapidly and continues without further heat.

The chloroform is to be separated as usual, but the liquid which floats over it is immediately employed in the following manner. Without removing any thing from the still, 10 quarts of water are to be added; when the whole has cooled to about 100° Fahr., add 6 or 8 pounds of quick lime and 22 pounds of chlorid of lime. Mix well, and pour in the liquid resulting from the preceding distillation, together with another quart of alcohol. The operation is to be conducted as before, and if the still is large enough, a third or even fourth operation may be made with advantage.

Thus, 3825 grms. alcohol gave the	1st distill'n,	550	grms. chloroform.
	2d "	640	"
	3d "	700	"
	4th "	730	"
		2620	

The authors from an estimate conclude that this substance can be made for 14 francs the kilogramme, or $1·25 per pound. As advantages of their process, they point out the previous heating of the water, and the absence of all swelling up, owing to the use of lime and the water bath.

G. C. S.

12. *On the Crystallized Hydrated Oxyd of Zinc;* by M. J. NICKLÈS, (Ann. de Chim. et de Phys., Jan., 1848.)—The mineral known as *cupriferous hydrate of zinc*, contains hydrate of zinc and copper, and crystallizes in the right prismatic (trimetric) system. Anxious to ascertain whether the pure artificial hydrate of zinc belonged to the same system, it was prepared by the process of Runge. Iron and zinc are put into a vessel containing a solution of potash or ammonia; at the end of a few days the crystals are found on the sides of the vessel. These proved to belong to the same system with the mineral above named.

In the course of preparation several curious particulars were noted. The sheet zinc of commerce was readily attacked, while cast zinc refused to dissolve. The difference is attributed to the crystalline texture existing in the cast zinc, but entirely destroyed by the process of rolling—the amorphous condition being always more favorable to solution than the crystalline. On the other hand, iron in the shape of turnings was found more favorable to the action than any form of wrought iron—the crystalline structure here rendering the metal more negative. In all cases the intensity of the reaction is measured by the disengagement of hydrogen. Ammonia affords the best crystals.

Lead was substituted for iron with success; also copper, when it was noticed that though there was free exposure to the air, no coloration took place, provided both metals were completely immersed. Solution of oxyd of zinc in ammonia is however decomposed by copper—the liquid becoming blue, while crystals of the hydrated oxyd are formed. The blue solution in its turn is decomposed by metallic zinc with a precipitation of copper. These reactions are cited by the author as deserving attention.

G. C. S.

13. *Electro-magnetic Balance for measuring the Intensity of Currents;* by M. Ch. Mène, (Comptes Rendus, Jan., 1848.)—A horse-shoe of soft iron is wound a certain number of times with an insulated wire; the armature is attached to a counterbalanced scale pan. The intensity of the current is directly measured by the magnetic force developed. If the same sort of wire is used, the apparatus may be made more delicate by using a greater number of turns.

The peculiarity of this method is, that the weight supported, divided by the number of turns, represents the influence of one turn of the wire, that is, the intensity of the current. The recorded experiments shew a tolerable degree of accuracy in the results. G. C. S.

14. *On certain properties of Iodine, Phosphorus, Nitric acid, &c.;* by M. Niépce de Saint Victor, (Ann. de Chim. et de Phys., Jan., 1848.)—The author has discovered that iodine has the property of attaching itself to the black lines of engraving, printing, writing, &c., and not at all to the white part. On this is founded a process for copying engravings, &c. The design is exposed for a few minutes to the vapor of iodine, and after moistening it in water slightly acidulated with sulphuric acid, it is applied to paper coated with starch paste, on which the copy is most accurately traced. These impressions are of course rather fugitive, and may be preserved for some time by securing them beneath a glass plate.

Several copies may be made without a second preparation of the original, and the latter proofs thus taken are the clearest.

It appears that all kinds of marks and drawing may be copied, provided gum does not enter into the writing or drawing material. For India ink and lead pencil marks, it is advised to plunge the design into a very slight solution of ammonia and then another of acid, before exposing to the vapor of iodine.

Porcelain, opal, glass, ivory, &c., when covered with starch size, gave copies of far greater beauty and permanence: they should when dry be varnished.

An iodized engraving when pressed upon a silver plate, without being moistened, leaves a very clean copy, which exposed to mercurial vapor in all respects resembles the daguerrian proofs. Copper plates require ammoniacal vapor to bring out the image, which may be cleaned by a little water and tripoli without being removed.

The black parts of a feather exposed to iodine vapor were faithfully copied while the white of the same feather was unmarked. Pieces of whitewood and ebony fastened together and the face dressed so as to be perfectly uniform, in like manner gave a copy of the black alone.

The vapor of phosphorus undergoing slow combustion, produced the same effect, the copies on metal being fixed by mercury or ammonia.

Nitric acid vapor gave renewed effects, the whites on metal being white, the blacks being represented by the pure metal surface. After using this vapor a few times the engraving will no longer give copies and must be exposed for twenty-four hours before it can again be used: with the other substances named there need be no delay.

Solutions of iodine were found to answer as well as iodine vapor. Sulphuret of arsenic (orpiment) in vapor afforded copies on metal which needed no further preparation. We need not follow the detail of the experiments with chlorine, &c., as the effects were similar to those given above. G. C. S.

Photography upon Glass.—The author has produced photographs (Calotype) upon glass plates covered with starch, &c., by a process, which, with some modification, has probably been tried by every one who has experimented upon this interesting subject. The use of albumine (white of egg) afforded far better proofs. This substance, or rather the most liquid portion, in which is dissolved the iodid of potassium, is spread over the plate and dried at a moderate temperature.

The usual application of the aceto-nitrate of silver renders the albumen insoluble, and not liable, therefore, to be disturbed throughout the process. The proofs upon paper are far finer if one or two coats of starch paste or white of egg have been previously applied.

[A French paper of very fine surface is sometimes found which contains a large quantity of starch. A solution of iodine in iodid of potassium gives a blue color immediately on its application to this paper, which is again rendered white (or rather yellowish) on the contact of the silver solution. Hence the silver may be applied by the light of the faintest taper with great certainty, no spot being left untouched—we can even measure very nicely the amount of silver solution by the manner in which the blue iodid is decolored. Such paper we have found to give the clearest proofs and most free from spots.]

G. C. S.

15. *Note to a paper on the Chemical Nature of Gelatine, published in the American Journal of Jan.*, 1848, p. 74; by T. S. Hunt, (extract from a letter to one of the editors.)—In the January number of this Journal, I published a communication, the object of which was to prove that gelatine is to be regarded as the amidized species of a body identical, in composition, with dextrine. This was supported by a comparison of its analysis with a calculated formula and its metamorphosis by the action of dilute sulphuric acid which converts it into sulphate of ammonia and glucose or grape sugar. At the same time it was suggested that when taken into the stomach, its assimilation was effected by combining with it the elements of water, thus forming ammonia and dextrine of glucose. A medical friend has recently communicated to me a curious case, which seems directly to confirm this suggestion and deserves to be recorded.

A person who had for a long time been the subject of *diabetes mellitus*, consulted him a few months since in regard to his case. He is a young gentleman of scientific and observant habits, and has made his disease a subject of special study, marking carefully all its various phases and the changes produced in the urine by differences in diet. While confined to an exclusively animal diet, he was recommended by his physician, as an agreeable variety, to eat calves-foot jelly. This he found, to his surprise, at once increased the specific gravity of his urine, and the secretion of sugar became abundant. The patient was at this time using no sugar or farinaceous food whatever, and he observed that the formation of sugar was invariably consequent on the use of the calves-foot jelly and ceased when this was discontinued.

In this disease it is well known that the digestive function is impaired in such a manner that all farinaceous substances ingested are converted into glucose, (a change which there is reason to believe, takes place also in the normal digestion of these substances,) after which no farther assimilation goes on, but the sugar formed is created by the urinary passage. In the present case it is evident that the gelatine had been decomposed in the manner suggested and that the sugar incapable of assimilation had passed off in the urine. In no other manner can we account for this otherwise singular fact; but upon the present view of the constitution of gelatine, it is just what we should expect. It is indeed a direct proof, and furnished as it is, by a cautious and intelligent observer, who had no theory to sustain, is of peculiar value.

A comparison of the quantity of ammonia in the urine when the patient was subsisting upon a flesh diet, and one of gelatine, would be of much interest and would, doubtless, show in the latter case, a greatly increased excretion of ammoniacal salts.

Montreal, April 22, 1848.

16. *Purifying Liquids by Galvanism*, (Patent Office Rep. issued in 1848, p. 41.)—A patent has been granted for an interesting process, by which a feeble galvanic power is employed to separate salts, acids or alkalies from water or other liquids. Two porous vessels containing water are partly immersed in the liquid to be purified, and a zinc plate placed in one vessel and an iron plate in the other vessel. Other metals would answer, but the inventor prefers the above. The zinc and copper plate being connected by a wire, galvanic action is established, and the salts or other soluble matters are carried through into the porous cups, and these accumulate in one or the other according to the electrical relations of the impurities.

17. *Decomposition of Substances by Steam, and Manufacture of Sulphate and Muriate of Potash*, (Patent Office Report for 1847, Washington, 1848, p. 27.)—The most interesting and probably the most valuable of the patents granted during the last year, under the subject of chemistry, are two which have been granted to an American citizen, now residing in England. One is for the manufacture of sulphate and muriate of potash from feldspar, and the other for decomposing alkaline salts by the action of steam at a high temperature. The latter appears highly interesting as a purely scientific discovery, apart from its practical value. In this exhibition of the solvent power of steam, we see at once a new, powerful and most economical chemical reagent.

In the process of decomposing feldspar, the inventor heats together a potash feldspar, lime or its carbonate, and the sulphate of either lime, baryta or strontia, and afterwards lixiviates the mixture with water. The heat is to be kept at or above redness. In obtaining the muriate of potash, the muriate of either soda, lime or iron is added to the potash feldspar, in place of the sulphate above mentioned, the modus operandi being substantially the same as in obtaining the sulphate.

The process of decomposing salts by steam is so replete with interest and novelty, as to warrant the citation in full of its description by the inventor.

My invention consists in a method of decomposing the sulphates and muriates of the alkalies and alkaline earths, by exposing them at a high temperature to a current of steam or vapor of water, by which the acid is carried off, and the alkaline base either remains free, or enters into combination with some third substance provided for that purpose.

To decompose sulphate of lime, and obtain from it sulphuric and sulphurous acids, and free lime, I proceed in the following manner: I have a fire-clay cylinder of close texture, and of any convenient size, placed vertically in a furnace, and provided with openings at the top and bottom, for charging and discharging, which openings are capable of being closed air-tight. To the top of this cylinder I adapt an escape tube of fire-clay, for conveying off the acid vapors; and to the bottom, for the admission of the steam, I adapt another clay pipe, connected with a steam-boiler, by a series of fire-clay tubes, which are to be kept at a red heat. In order to diminish the corrosion of the cylinder by the sulphate of lime or the lime itself, I line it with a coating of native carbonate of magnesia, applied in a manner similar to the usual clay linings of chemical furnaces. I fill the cylinder with pieces of sulphate of lime, about a quarter of an inch in diameter, and having luted the openings air-tight, I heat the cylinder and its contents to a high red heat. I then pass steam from the boiler, through the red hot clay tubes, into the bottom of the cylinder, and up through the charge. The heated steam, in its passage through the pieces of sulphate of lime, carries off the acid in the state of sulphurous acid and oxygen, with sometimes a little sulphuric acid mixed with it. The acid vapors pass off by the escape tube at the top of the cylinder, and I convey them by stone-ware tubes into a leaden chamber, in order to combine them into sulphuric acid by the usual means. I take care that the heat is not raised so high at first as to melt the sulphate of lime in the cylinder, but I increase it towards the end of the operation, the charge becoming more infusible when partly decomposed. I have an opening in the tube conveying off the acid vapors from the top of the cylinder, by means of which I examine the vapors from time to time, and from the relative acidity of these, ascertained by the usual tests, I judge of the progress of the operation. I regulate by a stop-cock the quantity of steam passed through the charge in the cylinder, maintaining the supply at that point which produces the greatest quantity of acid in the vapors. When the vapors cease to contain any notable proportion of acid, the cylinder and its contents being at a high red or low white heat, I shut off the steam, withdraw the charge from the cylinder by the lower opening, and put in a fresh one to be treated like the first. The charge thus operated upon will be found to consist chiefly of caustic lime. When I wish to obtain the acid and alkaline base from the sulphate of magnesia, I first drive off by heat all its water. I then introduce it, in small pieces, into a cylinder such as I have before described, and operate upon it in the manner directed for the sulphate of lime. But I take care to keep the heat at low redness at first, to prevent the fusion of the charge, which would choke up the cylinder and prevent the passage of the steam. The decomposition of the sulphate of magnesia takes place at a much lower temperature than that of sulphate of lime, (a low red heat is sufficient,) and a considerable part of the acid is given off in the state of sulphuric acid. When the charge has been treated as directed, the residue will be found to consist chiefly of caustic magnesia.

When I wish to decompose the sulphates of baryta and strontia, I operate upon them in a reverberating furnace. This mode is less advantageous for the manufacture of sulphuric acid than the use of the close cylinder formerly described, but I prefer it for the two last mentioned salts, because I consider their bases the more important product of their decomposition, and the hydrates of these alkalies, and particularly that of baryta, being fusible, would have much tendency to corrode the interior of the cylinder, at the heat necessary to decompose the salts. I use a common reverberatory furnace, with its hearth covered with a compact bed of native carbonate of magnesia, three or four inches thick. Several clay steam pipes are introduced through the roof of the furnace, so as to throw a current of heated steam over the whole width of the hearth; these pipes are connected with a steam-boiler by a series of fire-clay tubes kept red hot. The sulphate, broken into pieces of about half an inch in diameter, is spread over the lining of carbonate of magnesia on the hearth of the furnace, and brought to a high red or low white heat. A current of steam is then admitted from the boiler, through the red hot tubes, upon the charge.

The acid of the sulphate is carried off by the steam, and when I wish to condense it, the acid vapors are conveyed along with the gases of the fire, into a leaden chamber, to be combined into sulphuric acid by the usual means. The quantity of steam thrown upon the charge is kept at the point which produces the most rapid evolution of acid, and the charge is stirred occasionally, so as to expose fresh surfaces to the action of the steam. As the contact of deoxydizing gases with the sulphate is injurious, I admit, if necessary, by suitable openings above the fuel, such an excess of air as will render the atmosphere in the furnace oxydizing. The sulphate of strontia requires a higher heat than the sulphate of lime for its decomposition, and the sulphate of baryta still higher than the sulphate of strontia.

When the sulphate of baryta is partly decomposed, the mass melts and becomes more fusible as the decomposition proceeds. I judge of the progress of the operation by testing a portion of the charge from time to time; when it dissolves altogether or nearly so in dilute nitric acid, I withdraw the charge which now consists chiefly of the hydrate of baryta or strontia. To obtain muriatic acid, and the hydrates of baryta or strontia, or caustic lime from the muriates of these bases, I employ the same process as that above described for the decomposition of the sulphate of baryta.

The sulphates of potash and soda may to some extent be decomposed by being subjected at a high temperature to the action of a current of steam, in the manner directed for the decomposition of the sulphate of baryta. But owing probably to the volatile nature of the bases of these salts at a high temperature, no large proportion of them can thus be obtained in a free state. To aid therefore the decomposing action of the steam, I employ some substance capable when mixed with these sulphates, highly heated and exposed to steam, of forming a combination with their alkaline bases which shall yet when cold give up the alkali to the action either of water or of water and carbonic acid.

Of the large class of substances possessing these properties, which for convenience I will call combining substances, I prefer to use either alumina or the subphosphate of alumina. The alumina is prepared by strongly igniting the sulphate of alumina, or by any other well known process. The subphosphate of alumina is prepared (as directed in chemical works) by mixing solutions of the phosphate of soda, and the sulphate of alumina, and adding to the solution a slight excess of ammonia. I mix the alumina in the state of powder with an equal weight of the sulphate of potash or of soda also powdered, and spread the mixture upon the hearth of a reverberatory furnace, such as I have before described for the decomposition of the sulphate of baryta. The mixture is then heated, exposed to steam, stirred, and the operation conducted in all respects in the manner described for the treatment of the sulphate of baryta. When it is desired to collect the sulphuric and sulphurous acids produced by the decomposition of the sulphates of potash and soda, I prefer to moisten the mixture of alumina and the sulphate with water, and form it into balls about half an inch in diameter, which I heat and expose to steam in a close cylinder in the manner formerly described for the sulphate of lime. When a specimen of the charge shows by the usual tests that it contains no notable proportion of sulphate undecomposed, the operation is completed. I then withdraw the charge, lixiviate it with hot water, and when the clear solution of aluminate of potash or soda thus obtained has become cold, I pass through it an excess of carbonic acid until no more precipitate of alumina is formed. The clear solution of carbonate of potash or soda is then drawn off and evaporated. The alumina thus recovered is again used as the combining substance. When I wish to obtain the aluminate of potash or of soda, I merely evaporate the solution above described without introducing the carbonic acid.

The muriate of potash or of soda I merely evaporate the solution above described, without introducing the carbonic acid.

The muriate of potash or of soda may also be decomposed when in a fused state by the action of steam; alumina or the subphosphate of alumina being present, the operation is to be conducted in all respects in the same manner as that just described for the sulphates of potash and soda. But owing to the great volatility of the muriates of potash and soda when exposed at a high temperature to a current of air or steam, a large quantity of the muriate will escape with the steam and gases of the fire in the state of vapor undecomposed, and will be lost or will be difficult to condense. I prefer therefore to effect the decomposition of the muriates of potash and soda by causing their vapors, intimately mixed with highly heated steam, to pass slowly through a mass of small pieces of alumina kept at a high red heat. I use for this purpose a vertical fire-clay cylinder lined with a coating of native carbonate of magnesia to diminish the corrosion of its sides by the alkali, and made with convenient openings at top and bottom for charging and discharging, which openings should be capable of being closed air-tight. I arrange a cast iron retort so that its tube enters directly the cylinder near its bottom. The retort should have a charging door at the top capable of being made air-tight, through which is introduced the muriate of potash or soda to be decomposed.

The muriates of potash and soda will not vaporize freely when fused and highly heated, unless the atmosphere above them is continually changed. This may be effected by a current of steam, and I find that I can sufficiently regulate the quantity of the salt volatilized from the retort, by the amount of steam which I blow over its melted surface. I therefore insert a small steam pipe into the top of the retort, so as to throw a jet of heated steam upon the surface of the melted salt, and thus force its vapor to enter the cylinder. The quantity of steam thus introduced to aid the volatilization, is not sufficient to decompose all the salt volatilized. The rest of the steam necessary for this purpose is passed directly into the cylinder by a fire-clay pipe entering it near the bottom, and connected through a series of fire-clay tubes kept red hot with a steam-boiler. Both steam pipes are provided with cocks, an escape tube is inserted into the top of the cylinder to convey the acid vapor and the vapor of any undecomposed muriate into suitable condensers. I have an opening in this tube, by which I can withdraw at times a portion of the vapors in it, to examine their saline and acid characters.

The cylinder and retort are to be so constructed and arranged, as to allow their contents to be heated to high redness and upwards by any of the well known means. The mode of operating is as follows: The discharging door being closed air-tight, I fill the cylinder with alumina in pieces of about one quarter of an inch in diameter, and fill the retort with the muriate of potash or soda, and then close both the charging door of the cylinder and that of the retort air-tight. I now bring the cylinder to a high red or white heat, and the retort to a cherry red heat, so that the salt in it is melted and ready to volatilize freely at the admission of steam upon its surface: steam is now passed from the boiler through the red hot tubes into the cylinder by the pipe entering near its bottom, so that it is filled with highly heated steam passing upwards in a slow current through the interstices of the pieces of alumina. I now admit by degrees a jet of heated steam into the salt retort, by the pipe entering its top, and thus drive a quantity of salt vapor into the cylinder, where it mixes thoroughly with the current of steam which has entered by the other pipe, and ascends with it through the column of highly heated alumina. In its passage the alkaline base of the muriate combines with the alumina, forming an aluminate of potash or soda, and the muriatic acid together with any salt vapor which may have escaped decomposition, passes off with the steam through the escape tube at the top of the cylinder into the condensers provided. The progress of the operation can be ascertained by examining the nature of the vapors which are passing through the escape tube.

When these vapors contain a large quantity of salt and are strongly acid at the time, I admit more steam through the pipe leading directly into the cylinder, and if this does not have the effect of diminishing the quantity of salt in the vapors, I lessen the quantity of steam thrown into the salt retort, and by that means decrease the supply of salt vapor driven into the cylinder. Where the escaping vapors contain but little salt and a large quantity of acid, I consider the operation as proceeding favorably, and I always endeavor to regulate the quantities of steam passed through the two pipes, and by that means, the proportions of salt vapor and steam thrown into the cylinder so as to produce this effect.

When the escaping vapors contain a large quantity of salt and steam and but little acid, the cylinder and its contents being at a high red heat, I consider that the decomposition of the salt is no longer effected in the cylinder, and I then shut off both currents of steam, withdraw the charge by the lower door, and replace it by fresh alumina. The withdrawn charge is then lixiviated with hot water, and the solution of aluminate of potash or soda thus obtained is treated with carbonic acid, as before described.

The lining of the cylinder should be examined occasionally, and kept in repair so that the fire-clay may not be corroded by the alkali. Provided the charge of alumina in the cylinder is readily and equally permeable to the current of steam and salt vapor, the smaller the pieces of which it consists and the greater the surface they expose to the current, the more rapidly will the decomposition of the muriate proceed. The steam used need not be of a higher boiler pressure than will suffice to secure its passage through the charge in the cylinder. The subphosphate of alumina may be substituted for the alumina, in the processes for the decomposition of the sulphate and muriates of potash and soda, and its action is even more powerful, but its first cost is greater. Although to aid the decomposition of the sulphates and muriates of potash and soda by steam at a high temperature, the use of either alumina or its subphosphate is preferred as the combining substance, yet there are a great number of substances which also possess the requisite properties, but act with various degrees of energy. Thus many salts which contain already a certain proportion of base, will yet, when exposed in contact with the sulphates and muriates of potash and soda, at a high heat, to the action of steam, form a combination with the potash or soda, decomposable when cold by water, or water and carbonic acid. The subphosphates of lime, baryta and strontia, and the subsilicates of lime, baryta and strontia, will under these circumstances combine with the alkali and yield it to the action of water alone when cold. The sulphates of baryta and strontia although themselves decomposable by the action of steam at high temperatures, are still capable of thus aiding in the decomposition of the sulphates and muriates of potash and soda, and yield the alkali by the action of water. The neutral phosphates, and neutral silicates of potash and soda, when thus treated, form basic salts which are soluble in water and decomposable by carbonic acid.

The alkalies, lime and magnesia, will also thus combine with a portion of free potash or soda which may be extracted by water. Other materials are capable of being used as combining substances; but I have named these which I consider preferable.

The decomposition of the muriate of soda by the action of steam at a high temperature may be applied to the production of sulphate of soda, by exposing the muriate mixed with sulphate of lime to a high heat and to the current of steam. For this process I use a horizontal cylinder of close fire-ware, protected on the inside from the action of the lime or the sulphate by a lining of carbonate of magnesia, and provided with an opening for charging capable of being made air-tight. Into the top of the cylinder, at one end, a steam pipe is introduced, and from the other end at the top an escape pipe connects with suitable condensers for collecting the vaporized salt and acid. The cylinder is half filled with a mixture of equal parts by weight of sulphate of lime and muriate of soda, the opening made air-tight, and the cylinder and its contents brought to a red heat. A current of heated steam is then admitted, which passes over the surface of the melted mixture and carries off muriatic acid with more or less volatilized salt into the condensers. When the steam escaping from the cylinder ceases to contain any notable quantity of muriatic acid, the operation is discontinued and the charge is withdrawn. Its soluble salts are extracted by water, and the sulphate of soda separated from any undecomposed muriate by evaporation and crystallization.

In this operation the heat should not be raised so high as to cause the decomposition by the steam of the sulphate of soda produced, or the sulphate of lime itself.

Though I prefer in all the above described processes heating the steam highly before passing it upon the salt to be decomposed, yet the same effect will be produced whenever the steam and salt are in contact at the proper temperature for the respective decompositions, whether they have both been previously heated, or one alone heated so highly as to be able to raise the other to the required temperature. As has been before stated, some of the salts are decomposable by steam at a much lower temperature than others, but with all the decomposition proceeds more rapidly in proportion as the heat is increased.

I claim as my invention the decomposing the sulphates of baryta, strontia, lime and magnesia, and the muriates of baryta, strontia and lime, by exposing them at a high temperature to the action of a current of steam, for the purpose of obtaining the acids and the alkalies of these salts respectively.

I also claim the decomposing the sulphates and muriates of potash and soda, for the purpose of obtaining the acids and the alkalies of these salts respectively, by exposing them at a high temperature to the action of a current of steam, alumina or the other combining substances being present.

I also claim making aluminates of potash and soda by the action of a current of steam upon a mixture of alumina and the sulphate or muriate of potash or soda at a high red heat.

I also claim the making sulphate of soda by the action of a current of steam upon the muriate of soda at a red heat, sulphate of lime being present as described.

II. Mineralogy and Geology.

1. *Samarskite.*—M. H. Rose has shown that while minerals that present luminous phenomena when heated, have generally greater specific gravity after heating than before, (as gadolinite, orthite and allanite,) samarskite, on the contrary, has the reverse relation to heat. Specimens having a specific gravity 5·617 before heating, afforded 5·37 and 5·485 after they had been heated and pulverized. This change of gravity takes place without any variation in the amount of actual weight. This fact accounts for the different specific gravity obtained by Hermann for the mineral he designated yttro-ilmenite, since proved to be samarskite.

Rose has found, after several trials, that the luminous phenomena of gadolinite and oxyd of chrome precipitated by ammonia, were always accompanied by a sudden disengagement of heat. This was shown by the dilatation of air enclosed with the mineral by means of the heat given out. With samarskite, scarcely any dilatation was observed, the amount of air expelled being ten times greater for gadolinite and oxyd of chrome.

Rose has received from Hermann, specimens of the ilmenic acid this chemist found in his yttro-ilmenite and also in the pyrochlore of Miask; and he has ascertained that it was mostly niobic acid, mixed with a little tantalic and pelopic acid and an appreciable quantity of titanic acid.

2. *Bagrationite, a new mineral from the Urals;* by M. de Koscharov, (Pogg. Ann., lxxiii; Bib. Univ. de Genève, March, 1848, p. 232.)—Bagrationite occurs with diopside and chlorite in the mines of Achmatovsk, in opaque black crystals, affording a deep brown powder. It has a vitreous luster on the lateral faces and is submetallic on those of the summit. The fracture is uneven or small conchoidal, without cleavage. H=6·5. G=4·115. It is not attacked by acids, and when heated in a tube yields no water and no odor. Before the blowpipe it effervesces and then melts to a black magnetic globule. With borax and salt of phosphorus it dissolves, affording the reactions of iron and silica. The crystals are oblique rhombic, much modified; M : M= 70° 50′, P : M=104° 8′.—The author places it near gadolinite. In the Bibliotheque Universelle where the description is cited, its close relation to *Epidote* and its probable identity with that species are pointed out.

3. *Pseudomorphism.*—Dr. J. Reinhard Blum has just issued a supplement* to his valuable work on Pseudomorphs, noticed at some length in vol. xlviii. of this Journal, p. 66. Dr. Blum in his introductory chapter, alludes to the observations connected with the former notice, and very properly observes that it is quite impossible always to distinguish pseudomorphs by incrustation from pseudomorphs by replacement; for where there is seemingly only an incrustation, there may actually have been a removal of the exterior of the incrusted mineral corresponding to this apparent incrustation. The following examples of pseudomorphs are described in this new volume.

Division I.

Pseudomorph.	Form imitated.
Quartz.	Heulandite, Stilbite.
Steatite (Rensselaerite).	Hornblende.
Mica.	Pinite.
Brown iron ore.	Specular iron.
Fluor spar.	Calc spar.
Gypsum.	Calc spar.
Dolomite.	Calc spar.
Mica.	Andalusite, feldspar, wernerite, tourmaline.
Mica, aspasiolite, fahlunite, esmarkite, bonsdorffite, chlorophyllite, weissite, praseolite, pyrargillite, gigantolite, pinite.	Iolite.
Prehnite.	Natrolite.

* Nachtrag zu den Pseudomorphosen des Mineraleichs, von Dr. J. Reinhard Blum, pp. 213, 8vo. Stuttgart, 1847.

Pseudomorph.	Form imitated.
Wernerite.	Epidote.
Talc.	Chiastolite, kyanite, couzeranite, pyrope.
Steatite.	Dolomite, quartz, andalusite, chiastolite, feldspar, mica, wernerite, augite.
Serpentine.	Spinel, mica, garnet, augite, chondrodite.
Chlorite.	Feldspar, garnet.
Stiblite.	Gray antimony.
Minium.	White lead ore.
Pyromorphite.	Galena, white lead ore.
White lead ore.	Lead vitriol.
Magnetic iron ore.	Spathic iron.
Peroxyd of iron.	Brown iron ore, pyrites, spathic iron.
Brown iron ore.	White iron pyrites, spathic iron.
Stilpnosiderite.	Vivianite.
Kupferpecherz.	Copper pyrites.
Kupferindig.	Copper pyrites.
Malachite.	Copper pyrites, gray copper ore.
Azurite.	Gray copper ore.

DIVISION II.

Graphite.	Pyrites.
Stone salt.	Dolomite.
Gypsum.	Stone salt.
Quartz.	Heavy spar, fluor spar, calc spar, dolomite, galena.
Steinmark.	Fluor spar.
Pyrolusite.	Dolomite.
Stilpnosiderite.	Dolomite, calamine.
Brown iron ore.	Calc spar.

The volume continues with valuable details and views respecting the fossilization of shells and wood.

4. *On Dolomisation;* by A. VON MORLOT, (Naturwiss. Abhandl. von W. HAIDINGER, Band I, Vienna, 1847.)—A. von Morlot states that the metamorphic nature of dolomite was first suggested by Arduino.* As early as 1827, W. Haidinger in an article on pseudomorphism described certain dolomitic pseudomorphs, and states that in their formation, "part of the carbonate of lime was replaced by carbonate of magnesia so as to form in the new species a compound of one atom of each."† From this fact and other observations he inferred that dolomite originated in a similar change. Elie de Beaumont in 1837 suggested the same view, and thus accounted for the occurrence of open spaces in the dolomite, often amounting to twelve per cent. of the mass.

The association of gypsum with dolomite had been noticed by various observers. Haidinger in view of this well known fact, concluded

* Osservazioni chimiche sopra alcuni Fossili. Venezia, 1779.

† Trans. Roy. Soc. Edinb., March 19, 1827.

that it must arise from sulphate of magnesia being the agent by which the change into dolomite was produced. The magnesia of the sulphate of magnesia going to a portion of the lime to form *dolomite* (or carbonate of lime and magnesia), the sulphuric acid thus set free would form with water and another portion of the carbonate of lime, *gypsum* (sulphate of lime).

But chemistry had shown that when a solution of gypsum was filtered through pulverized dolomite, sulphate of magnesia was formed and carbonate of lime set free. Haidinger had also observed the efflorescence of sulphate of magnesia in gypsum quarries, and traced it to a decomposition of this character. As these last are results of ordinary exposure, Haidinger naturally inferred that this *dedolomisation* required no unusual heat or pressure, while for the inverse decomposition (or dolomisation), both heat and pressure might be necessary. Experiments on this point were projected in 1843, by Haidinger and Wöhler, but were not carried out. Von Morlot has at last applied this test, and confirmed the view so far as to show that when carbonate of lime and sulphate of magnesia in the requisite proportions are heated together under pressure, dolomite is actually formed, together with sulphate of lime. The temperature to which they were subjected was 200° C., and the pressure 15 atmospheres. An interesting problem was thus solved.

[It is still a question, what is the least quantity of heat requisite for this dolomisation. Many compact limestones of our western states contain 30 to 40 per cent. of carbonate of magnesia, as first shown by Mr. D. D. Owen; and these rocks present no evidence of the action of heat.

In the analysis of recent corals by Prof. B. Silliman, Jr., published in the volume on Zoophytes by the writer, there is less than one per cent. of magnesia. But in a compact coral rock made up of material of coral origin, he found 38·07 per cent. of carbonate of magnesia. The coral rock was a result of consolidation without heat, as we may judge from the absence of all evidence of its effects. Another specimen of a fragmentary character afforded 5·29 per cent. of magnesia. Both resemble the common reef rocks. They appear to show that there are circumstances in which the magnesian salt of the ocean, and the carbonate of lime of the corals, may react and produce a magnesian rock at the ordinary tropical temperature of the water. This action may favor the consolidation into rock which is in progress beneath the seawater. It is evident that the finer the coral or calcareous material, the more magnesian the product; this principle accounts for the small proportion of magnesia in the second case alluded to above.—J. D. Dana.]

5. *Three Minerals from the Lake Superior Copper Region;* by J. D. Whitney, (Jour. Bost. Soc. Nat. Hist., v, 486.)—These minerals occur at Kewenaw Point, and on Isle Royal, where many zeolites have been found. The first of the three analyzed and described by Mr. Whitney, is *Tabular spar*. The other two are new species.

(1.) *Jacksonite*, (named in honor of Dr. C. T. Jackson.) It is near prehnite in composition, but contains no water. It occurs in finely radiated or lamellar radiated masses, of a white color tinged with green. H. = 6. G. = 2·881. Translucent; lustre vitreous. Dissolves slowly but perfectly in muriatic acid, the silica separating as a flocky powder.

Fuses very readily before the blowpipe in the platinum forceps, with a brilliant yellow light and a strong intumescence. Affords a colorless transparent glass with borax. Dissolves readily in a large quantity of soda; but with more soda, swells to an infusible slag. The analysis gave silica 46·12, alumina and a little peroxyd of iron 25·91, lime 27·03, soda 0·85 = 99·91, from which comes the formula $\dot{C}a^2 \dddot{S}i + \dddot{\mathbf{A}}l \dddot{S}i$.

(2.) *Chlorastrolite.* This mineral occurs in finely radiated stellated masses, having a pearly lustre, and slightly chatoyant on the rounded sides. H. = 5·5—6. G. = 3·180. Color light bluish green. Fuses easily before the blowpipe to a grayish blebby glass, intumescing and swelling up like a zeolite. In an open tube it gives off water and whitens. Soda dissolves it in small quantity, and gives a bead colored by a trace of manganese; with more of the assay it swells to an infusible slag. Dissolves readily with borax, affording a transparent glass colored by iron. Gives a beautiful blue with nitrate of cobalt. Dissolves readily and affords a flocky precipitate with muriatic acid. The analysis gave silica 36·99, alumina 25·49, peroxyd of iron and a little protoxyd 6·48, lime 19·90, soda 3·70, potash 0·40, water 7·22 = 100·18. The following formula is deduced:—$(\dot{C}a^3, \dot{N}a^3)\dddot{S}i + 2(\dddot{\mathbf{A}}l, \dddot{\mathbf{F}}e)\dddot{S}i + 3\dot{\mathbf{H}}$: it is that of meionite, excepting the water.

6. *Mines of Cinnabar in Upper California*, (communicated for this Journal by Rev. C. S. LYMAN, in a letter dated Pueblo de San José, March 24, 1848.)—The mine of New Almaden is situated a few miles from the coast, about midway between San Francisco and Monterey, and in one of the ridges of Sierra Azul mountain. The mouth of the mine is a few yards down from the summit of the highest hill that has yet been found to contain quicksilver, and is about 1200 feet above the neighboring plain, and not much more above the ocean. This hill extends longitudinally in a northwesterly direction, decreasing in height; and in various parts of it, for several miles, traces of the ore have been found, and some openings have been made which promise to be valuable. This range of hills consists of a variety of rocks, which I have not yet had an opportunity properly to study. The prevailing one is a greenish talcose rock, which seems to embrace the bed of ore at the New Almaden mine both above and below. A specimen from the rock immediately contiguous to the ore, is contained in the box. The ore is interspersed through a yellow ochreous matrix, which forms a bed 42 feet in thickness, dipping northwesterly at an angle of about 45°. The richest ore, is at present found in the upper part of the bed, the poorer ores being taken from the lower portion.

This mine, known to the aborigines from time immemorial as a "cave of red earth," from which they obtained paint for their bodies, was first discovered to contain quicksilver about four years since, during experiments made by some Mexicans to smelt the ore for the purpose of obtaining *gold*, which they supposed it to contain. About two years ago it fell into the hands of Barron, Forbes & Co., who sent on hands, tools and funds to commence working it. Unfortunately the vessel fell into the hands of the United States forces, and was confiscated; the operations of the mine were of course delayed till the arrival of Mr. Forbes himself a few months since, with miners, tools, and whatever things he was able to procure in Mexico, to enable him to make a fair experiment on the capabilities of the mine. The great trouble was to obtain suitable apparatus for extracting the ore. At length four potash kettles were found, which were set in a furnace of adobies, with condensers of mason-work immediately adjacent—a wretched apparatus indeed for managing so subtle a thing as mercurial vapor. While I was at the mine, the daily mode of working was to fill these pots in the morning with 1600 lbs. (400 to each pot) of the ores of average quality, broken in lumps of the size of apples, put on the covers and *lute* them with a layer of *sand*. The fires were then kept up till near night, when the furnaces were allowed to cool gradually. The next morning the condensers were opened, and the metal dipped up; which usually amounted to from 200 to 300 pounds for the four pots. This was a much less per-centage than the assay indicated, and it was obvious that a large portion of metal was lost. The upper parts of the pots and condensers were found to be generally coated with a crust of sulphuret of mercury, of which No. 15 is a small specimen. Mr. Forbes wished to devise some way of extracting the metal without mixing lime with the ore in the roasting, but was unsuccessful. At length a kiln of lime, which occurs in the immediate vicinity, was burned, and I am informed that, mingled with this, the ores yield a vastly larger per-centage of metal. In the last three weeks, about 10,000 pounds of metal have been extracted with the same apparatus, being a yield of over 50 per cent. Whether the ores were picked or not, I cannot say, but presume they were. Between 15,000 and 20,000 pounds have been extracted in about two months, only six miners having been employed in digging the ore, and the hands of the establishment, all told, miners, furnace men, wood-choppers, &c. &c., numbering only a score. The mine is probably yielding a nett profit of $100,000 a year, with its present crude apparatus. With suitable furnaces and iron cylinders or retorts, the mine would easily yield $1,000,000 and upwards. Mr. F. sails to Europe shortly for the apparatus necessary. The bed has as yet been followed but a few hundred feet, but the ores grow more and more rich and abundant.

The other mines opened in the vicinity, have not yet been sufficiently developed to decide upon their character. Ore has been found in fifteen or twenty other places within a few miles around, and within a few days in hills that do not seem to belong to the same range with that which contains the mine already described.

Some ores of silver have also been recently discovered in this region. But I have had no opportunity of procuring any genuine specimens as yet, and whether silver mines worth the working will be found, is at least problematical.

There are traces of coal in the country, but nothing of value has yet been discovered.

Gold has been found recently on the Sacramento, near Sutter's Fort. It occurs in small masses in the sands of a new mill race, and is said to promise well.

7. *Argentiferous Galena and Iron Ore in Algeria*, (L'Institut, No. 748.)—From a work on the mineral riches of Algeria, by M. Henry Fournel, we learn that there is a valuable mine of argentiferous galena

at Kefoum-Thaboul, near the frontiers of Tunis, occurring in argillaceous schists connected with sandstones and conglomerates.

Magnetic iron ore abounds in the mountains Bou Hamra, the small chain Belelieta, and to the north of lake F'zara. To the north of the place last mentioned there is an entire mountain, the Mokta-el-Hadid, which rises out of the gneiss to a height exceeding three hundred meters, and presents, from top to bottom, pure ore without a particle of rock. Remains of ancient Roman works and scoria were found, indicating that they were formerly mined.

8. *Emery in Asia Minor.*—M. Tchihatcheff, in his recent explorations in Asia Minor, has brought to light extensive beds of emery in the western portions of this country, particularly between the ruins of Stratonicea in Caria and Smyrna.

9. *Fossil Footprints;* by DEXTER MARSH, (in a letter to the Senior Editor, dated Greenfield, Mass., May 20, 1848.)—I have for a long time thought of sending you some account of my explorations in the rocks of this valley, and my success in obtaining fossils, but have hesitated from reasons unnecessary for me to state, knowing as you do, that I am an unlearned, laboring man.

You will recollect that the first specimen of fossil footprints of birds ever brought into public notice in this country, was the slab I discovered among the flagging stone, while laying the sidewalk near my house, which Dr. Deane first described to President Hitchcock, as the *footprints of birds.* Since that time I have felt an increasing interest in the subject, and have spent much time each year, in searching for these interesting fossils, and you will be able to judge of my success, when I tell you that I have in my collection more than eight hundred footprints of birds and quadrupeds, besides having furnished specimens to many individuals and institutions in this and other countries. I have some very perfect tracks of a quadruped so small that a five cent piece will more than cover the entire impression of the foot, and the tracks of a bird that measures more than half a yard from the heel to the point of the longest toe, with the foot very thick and heavy in proportion to the length. The most perfect specimens I have been able to obtain, are from Turner's Falls, or its immediate neighborhood; they not only show the joints of the toes, but in some specimens perfectly exhibit the impression of the skin.

I have obtained also valuable specimens at other places; for instance, a very interesting slab at South Hadley, found in the highway leading to Amherst, a mile and half north of the Seminary. It is in a coarse gray sandstone, cut and used for building purposes; the quarry was opened for that purpose, and a few tracks discovered before my attention was called to it; the beds containing the tracks lie some three feet deep, and are nearly horizontal. I quarried a small section, and turned up a slab seven or eight feet in length by one and a half in breadth, having on its under surface fifteen or twenty beautiful footprints of a number of different birds in relief. I then thought by taking up a large section, I should obtain all the tracks I desired; but to my great disappointment, after several days labor in getting down to the same layer, not the slightest appearance of a footprint was to be seen. I then examined the location more particularly, and to my mind it was easily explained; the material of which this rock is composed, was deposited by running water, which accounts for its being so coarse, all the finer particles being carried away: but after the water had subsided, there seemed to be a depression, or small basin, but a few feet in diameter, where the water was left to evaporate, depositing a thin layer of fine light colored clay, over which the birds walked. The impressions in this layer were very beautiful, but they could not be preserved, as the matter did not harden into rock, but was easily removed with the shovel. This is precisely like what we often see by the roadside after a heavy rain, where the water is left in small ponds to settle and evaporate, leaving a fine deposit, on which we often find the footprints of birds.

I have obtained at the south part of Montague some hundreds of footprints of birds, and some species that I have not seen at any other location, but have met with no quadrupeds. This location is more than half a mile from the river, and nearly two hundred feet above it; the tracks at this place are not as perfect as those I have obtained at the Falls, in consequence of the surfaces over which the birds walked being destitute of that smooth polished appearance that is necessary to receive fine impressions, though I have some specimens that are good.

But some of the largest (and most perfect for large ones) I have ever seen, I obtained on the eastern declivity of Mount Tom, near South Hadley Falls. If the height of these birds was in proportion to the length of their feet, when compared to some existing birds, they must have stood some twenty feet high. But the rocks of this place are too coarse to have retained fine impressions of small birds or quadrupeds, for when the matter was deposited, the water was in continual motion, so as not to leave smooth surfaces to the strata. I have one slab containing two footprints of a large bird, the surface being very rough and uneven; but the great weight of the bird (probably a thousand pounds or more,) pressed the sand so hard that it is perfectly smooth, showing distinctly the structure of the bottom of the foot.

I have many specimens from Wethersfield, Conn., which show very plainly that they are the tracks of birds; still I consider them imperfect because they do not show where the bottom of the foot rested. The deposit seems to have been a fine reddish clay, so soft that the bird settled down a number of inches, the mud closing up again when the foot was withdrawn, leaving no depression on the surface; the tracks are seen only by splitting the strata, through which the foot passed.

I have at some localities traced the tracks of a single bird thirty or forty feet, when the bird went into the water; this I know from the fact, that the first tracks would be very slight indeed, being pressed on hard sand or clay, and each successive step would be deeper and deeper, until the mud closed over the impression; and when he got into the water, though he settled deep in the mud, the motion of the water entirely obliterated all appearance of the track on the strata over which the bird had walked. But by removing a thin layer we find the impression. This has oftentimes enabled me to ascertain how high the water was at the time, or how much of the layer was out of the water when the impressions were made.

I have one slab four or five inches thick, containing two footprints of a bird, which I split into five layers, the impression being distinct in each layer, although on the upper surface, it only shows a straight mark three or four inches long over each impression, the mud having been so soft as to close up, leaving no depression, while the lower slab shows where the foot rested.

I have spent many days the past season searching for these interesting relics of olden time. I have traversed the valley from the north line of this state (Massachusetts) to Wethersfield in Connecticut, and had almost despaired of finding anything *new*, but in January I spent a few days more in my favorite amusement of quarrying the rocks. I opened a new quarry on the bank of Connecticut River, near the mouth of Fall River, and after seven or eight days labor, I succeeded in obtaining two or three hundred foot prints of various birds and quadrupeds, many of them are entirely new. I only forward you a sketch of the footprints of one of the quadrupeds, (reduced one-half,) you will see that this is a *walking*, and not a *leaping*, animal, the fore feet are very small in proportion to the hind ones, the toes are very slim and tapering, terminating in a point, with a sharp claw which is very distinct, the toes are wide spread and curve outward very much, which is not the case with any of those I have heretofore obtained; the fore foot shows only the impression of the toes, while the hind foot shows the impression of a very long heel, (or it may be a part of the leg;) though it is not as deep as the toes, it is the deepest at the part near them, and extends back an inch or inch and a half, showing no joint back of the connection of the toes with the heel.

10. *Gold in Canada.*—I have had an opportunity lately of seeing the masses of gold found in the valley of the Chaudière. Mr. Charles De Lèry, the proprietor of the seigniory on which the precious metal is

found, showed me the original mass, first found in 1833, of which mention is made by Lt. Baddeley of the Royal Engineers.* Its weight is about 1052 grains troy (exactly 68·203 grammes). Other masses of equal weight have also been found in the bed of the same stream. The weight and density of these were taken which were respectively,

	Grains.	Grammes.	Density.
Weight,	73·24	7·022	16·00
"	742·16	48·095	15·54
"	1058·56	68·598	12·86

Numerous smaller masses have also been found. The density indicates the presence of silver in the gold—which the faint color also confirms. The analysis of a fragment by Mr. Hunt gave 13·67 pr. ct. silver. The less density of the larger mass was owing, doubtless, to foreign matter mechanically entangled as well as to interstices filled with air. The lumps are worn smooth as is usual in alluvial gold, but fragments of quartzose gangue could still be detected in some of them. Mr. De Lèry informs me that they were firmly imbedded in what appeared to him to be slate, but which is probably a concrete of detritus, cemented by oxyd of iron. Chromic iron, titaniferous iron, serpentine, spinel, rutile, and talcose rocks remind us very strongly of the mineralogical characters of the Russian gold regions, and their occurrence with the gold in Canada certainly affords favorable grounds for the hope that this may become a rich auriferous region.

As yet no excavations have been made on any scale of magnitude sufficient to warrant an opinion of the actual wealth of the deposit. A few tons of gravel have, however, been washed in a rude way with the Berks rocker, which have yielded about $4 of gold to the ton of gravel. B. S., Jr.

11. *Liebenerite—a New Mineral*, (Journ. de Ph. et de Ch., March, 1848; Phil. Mag., xxxii, 544.)—This name has been given to a mineral of a greenish-gray color, crystallized in hexahedral prisms, and found disseminated in a red felspar porphyry at Monte Viesena, near Forno, in the valley of Flems (Vallé de Fassa).

M. Marignac has submitted this mineral to analysis, and has determined its mineralogical characters. Its density is 2·814; its hardness between that of carbonate of lime and fluor-spar. Its composition, taking the mean of three experiments, was found to be—

Silica,	44·66
Alumina,	36·51
Protoxyd of iron,	1·75
Magnesia,	1·40
Potash,	9·90
Soda,	0·92
Water and carbonic acid,	4·49
	99·63

12. *Produce of Gold in the Ural and Siberia in the year* 1846, (Erman's Russ. Archiv. 1847, Bd. vi, p. 318; Quart. Jour. Geol. Soc., No. 13, Feb., 1848.)—According to a notice in the 'Kommertscheskaja

* This Journal, 1835, vol. xxviii, p. 112.

Gaseta,' or Russian Commercial Journal, published by the Ministry of Finance, in February, 1847, there had been remitted to the mint at St. Petersburg 1397·378 poods of gold, the produce of the imperial and private mines in the Ural and Siberia during the year 1846. There was still expected 325·368 poods of gold, the produce of these mines in that year.

The total produce therefore of Russian gold in 1846 was 1722·746 poods, or about 62,792 lbs. avoirdupois, whilst in the previous year (1845) it was only 1371·800 poods, or 49,522 lbs. avoirdupois. The annual increase, which had fallen in the last two years to 47 and 30 poods, has consequently risen to 351 poods, or 12,670 lbs. avoirdupois, which much surpasses any previous increase; the largest formerly, or that between 1842 and 1843, being only 323·80 poods.

III. Zoology.

1. *Pancreatic secretion*, (L'Institut, No. 748, May 3, 1848.)—M. Cl. Bernard in his recent investigations, arrives at the conclusion that the secretion of the pancreas is the agent indispensable to the digestion of fatty substances. It is a limpid fluid, viscous and alkaline, having the physical properties nearly of the saliva. The following are the principal experiments bearing on this subject which he has made.

1. On mixing the pancreatic juice with oil in a glass tube, the oil is immediately and completely emulsionated; and the same takes place with hog's lard, butter or suet, at a temperature of 35° or 40° C.

2. No other fluid of the animal economy possesses this property of emulsionating simultaneously neutral fatty substances. The bile, saliva, serum of the blood, gastric juice, have afforded me no such results.

3. The action of the pancreatic juice on fats is not a saponification or chemical combination. It is at first an emulsion and a subdivision of the fatty matter operating under the influence of an organic substance peculiar to the pancreatic juice. Sometimes this substance which is destroyed and precipitated by heat, produces other modifications much more complex on fatty bodies.

4. In the neutral fatty substances emulsionated by the pancreatic juice, an energetic acid reaction is rapidly developed and the odor of butyric and sebacic acids, which becomes very decided if butter or suet are used. With MM. Barreswill and Marguerite we have examined the products of this nature, and have found that the fatty bodies are changed to a fatty acid and glycerine.

5. Bile removes spots of grease long exposed, while the pancreatic juice does not; because the former dissolves the fatty acids, though not, as the latter, the fat itself.

6. A mixture of the bile and pancreatic juice, as in the duodenum, will dissolve both the fat and the fatty acids.

7. In saying that the pancreatic juice decomposes fatty bodies into fatty acids and glycerine, I would not imply that the fatty bodies are absorbed in these two conditions. In ordinary cases, they are absorbed in the state of a simple emulsion. It is to the fat thus taken up, that the chyle owes its milky appearance. But, without the pancreatic juice there is no emulsion formed, and consequently no absorption of fatty substances.

8. I have tried the two pancreatic ducts of dogs, and in the rabbit, the single pancreatic duct which opens very low into the intestine. After this operation, the chyliferous system of the dogs and rabbits which were fed intentionally with fatty matters, contained no fat, whilst the intestine was filled with fatty matters not emulsionated.

9. This function of the pancreas, now for the first time ascertained, proves that they have no relation to the salivary glands, and that the expression *abdominal salivary gland* is altogether inappropriate.

2. *Sponge*, (L'Institut, No. 751, May 24, 1848.)—According to recent observations of M. Laurent, the reproductive bodies of two species of marine sponge, the *Spongia usitatissima* and *S. bacinulosa* are contained in the cellules of the fleshy parenchyma. These are regarded by him as oviform bodies and not ciliated gemmules, as described by Mr. Grant in his researches on several species of marine sponges. These oviform bodies or simple ovules, consist of a single germinative substance enclosed in a more or less dense envelop. The individuals dying, M. Laurent was not able to present with exactness the data for determining so important a point in zoology; and the observation is mentioned to excite attention to the subject among such as are favorably situated for such investigations. The sponges examined are those with a horny texture throughout, and called *Ceratopongiæ*, to distinguish them from those containing calcareous spicula (*Calcipongiæ*) and those with siliceous spicula (*Silicipongiæ*.) M. Lallemand suggested that the term *spore* applies best to such ovules as M. Laurent describes. The latter then cited in support of his opinion the results of his researches on the eggs or simple ovules of the Hydræ and fresh water sponge, which without regular fecundation (since these animals are completely agamous) are still transformed into embryonnary bodies, which become distinct isolated individuals, whose development from birth to their death he had described and figured.

IV. Astronomy.

1. *Neptune;* by Sears C. Walker, (in a letter to the editors dated Cambridge, Mass., Aug. 17, 1848.)—In the Ephemeris of Neptune computed for early distribution in the Smithsonian Contributions, I omitted to mention that the date there given is for the *true* place of the planet, and that for comparison with direct observations, the *aberration time* must be added to that date. I subjoin a table of Neptune's aberration time, for the term of the Ephemeris, in parts of a day. A small term used in computing the planet's place as a fixed star referred to the mean equinox, was retained in the Ephemeris. This should have been omitted—its value is here appended. It is to be applied according to its sign to the Ephemeris places. These omissions are of no importance in finding the planet by the Ephemeris; they amount on the average to only seven seconds of space. They should be applied however in comparisons of theory with observations. I subjoin three recent meridian observations of Neptune, made by Mr. Rumker, the Director of the Hamburg Observatory. They were communicated to me by Prof. Peirce through his correspondent, Dr. Benjamin Apthorp Gould.

Mean Time, Hamburg Observatory.	Neptune's Obs. R.A.	Dec.	Obs.—Eph. in R.A.	Obs.—Eph. in Dec.
1848, July 10*d.* 15*h.* 1*m.* 27*s.*·3	334° 29′ 12″·2	−11° 16′ 59″·3	−0″·06	−0″·83
11 14 57 27 ·5	334 28 13 ·7	−11 17 23 ·9	+2 ·51	−0 ·68
12 14 53 27 ·4	334 27 9 ·1	−11 17 46 ·6	+0 ·78	+1 ·86
By the mean of the three results, (Observation—Ephemeris)			+1 ·08	−0 ·12

Should no greater discrepancies appear in the entire series for this opposition, the theory of Neptune furnished by my elements and Prof. Peirce's Tables of the Perturbations, may be considered as completed till the Opposition of 1849. I subjoin the tables above referred to.

Date.	Correction of Ephemeris in R.A.	" in Dec.	Aberration time in parts of a day.
1848, July 1	+3″·58	+1″·33	+0d·16916
9	3 ·58	1 ·32	·16857
17	3 ·57	1 ·32	·16807
25	3 ·56	1 ·28	·16763
Aug. 2	3 ·56	1 ·27	·16731
10	3 ·56	1 ·27	·16708
18	3 ·57	1 ·26	.16697
26	3 ·58	1 ·26	·16694
Sept. 3	3 ·59	1 ·26	·16704
11	3 ·60	1 ·25	·16724
19	3 ·60	1 ·24	·16755
27	3 ·60	1 ·23	·16795
Oct. 5	3 ·60	1 ·22	·16845
13	3 ·60	1 ·22	·16902
21	3 ·59	1 ·22	·16967
29	3 ·58	1 ·21	·17038
Nov. 6	3 ·56	1 ·21	·17113
14	3 ·54	1 ·21	·17191
22	3 ·52	1 ·21	·17270
30	3 ·50	1 ·21	·17350
Dec. 8	3 ·49	1 ·20	·17427
16	3 ·47	1 ·20	·17504
24	3 ·44	1 ·19	·17572
1849, Jan. 1	3 ·43	1 ·19	·17632

2. *The tenth Asteroid, Diana.*—A new planet has recently been discovered by Prof. Kaiser, at Leyden. It belongs to the group between Mars and Jupiter, performing its revolution in about three years and eight months.

The asteroid discovered by Mr. Graham, has been designated by the name of *Metis.*

3. *Shooting Stars of August* 10, 1847, (communicated by E. C. Herrick.)—The night of August 8th, 1847, was here overcast and rainy. The two nights following were also overcast. The evening of the 11th was less unfavorable, the sky being partly clear. Messrs. Wm. E. Moore, Andrew T. Pratt, J. Donnell Smith, and myself, took a station in the open air, and began the watch for the expected meteors, at 9h 15m. The sky soon grew cloudy, and from 10 to 11 remained wholly overcast. We therefore left the field, and have good reason to suppose that no opportunity for observation occurred during the night.

Within three quarters of an hour we saw *thirty-seven* different meteors, as follows,

in N. E.	6
S. E.	13
S. W.	10
N. W.	8

Throughout the period the sky was so much obstructed by clouds that we probably lost as many meteors as we observed.

At *Manlius*, N. Y., my friend Mr. Wm. Manlius Smith was more successful. On the night of Tuesday, August 10th, Mr. S. with three assistants, began the watch at midnight, up to which time, the sky was nearly overcast. During the two hours ending at 2 A. M. of the 11th, they observed *four hundred and fifteen* different meteors as follows:

	N. E.	S. E.	S. W.	N. W.
12 to 1,	54	33	54	63 = 204
1 " 2,	28	53	63	67 = 211.

Throughout the first hour the sky was nearly clear. The second hour was less favorable, the N. E. quarter being two-thirds cloudy, and and the S. W. and N. W. quarters considerably obstructed by clouds. A few minutes after 2 A. M. the sky became wholly overcast, and thus continued.

4. *Shooting Stars of August* 10, 1848, (communicated by E. C. HERRICK.)—On Wednesday, August 9th, 1848, from sunset to 10 P. M. the sky here was about three-fourths overcast; and the moon, ten days past the new, was shining through the broken clouds. In such circumstances, watch would have been useless. A few minutes before 1 A. M. of the 10th, Messrs. Samuel Emerson, Andrew T. Pratt, Wm. Manlius Smith, and myself, took a station in the open air. We began the count at 1 A. M., each observer having charge of a quarter of the heavens, and the meteors being reckoned in the quarter where they commenced. Between 1 and 2 A. M. we observed *one hundred and sixty-four* different meteors, as follows:

in N. E. 40 S. E. 48 S. W. 35 N. W. 41.

During this hour the sky was at times obstructed by clouds, and we probably lost about a fourth part of the meteors which would have been seen in a clear sky.

Between 2 and 3 A. M. we observed *one hundred and seventy* different meteors as follows:

in N. E. 38 S. E. 45 S. W. 48 N. W. 39.

During the first part of this hour the sky was partly obscured by haze and fog so that we lost about as many as in the preceding hour.

About 3 A. M. the sky became beautifully clear, and thus remained while we observed. By $3\frac{1}{2}$ A. M. the dawn was so bright that we retired. During this half hour we saw *one hundred and forty-one* different meteors as follows:

in N. E. 30 S. E. 36 S. W. 41 N. W. 34.

Of the meteors seen this morning full three-fourths were estimated to conform to the usual radiant in *Perseus.* Many were very brilliant, exceeding in brightness stars of the first magnitude.

The evening of Thursday the 10th was clear; but we chose to defer observation until moonset. We took our posts at 1^h 50^m A. M. of the 11th, at which time the sky was nearly clear, but within fifteen minutes clouds came up and soon obscured every star. We waited in vain till about 2½ A. M., and then left the field.

During the same night, Messrs. Gurdon Evans, John H. Pumpelly, and Mason C. Weld, being on the top of Mount Carmel, (a peak six hundred feet high in an adjoining town,) kept a look out for meteors, from about 1½ A. M. until about 3½ A. M. During this time they observed *two hundred and sixteen* different meteors, after which fog prevented further observation. During the last half hour many must have been lost.

V. Miscellaneous Intelligence.

1. *California.*—A valuable Report on California has recently been addressed to the U. S. Senate, and published by government, prepared by Mr. J. C. Frémont.* It is stated to be only a brief sketch preliminary to a general work on Oregon and California; it contains, however, a well digested account, physical and geographical, of the regions of which it treats. We gather from it the following facts.

The great chain of mountains which stretches north and south through Oregon and California within one hundred and one hundred and fifty miles of the coast, is called in Upper California, the Sierra Nevada. Its summits are crowded with perpetual snows. It divides the country into a coast and an interior section, the two widely differing in climate. The former receives the warm winds that blow from the Pacific, which through a portion of the year are charged with vapor and yield fertilizing rains. The latter experiences the cold airs that roll down from the heights around. This region, east of the Sierra, is called the *Great Basin.* It is some five hundred miles in length and breadth, and between four and five thousand feet above the level of the sea; it is shut in all around by mountains, and contains numerous lakes and rivers without outlets. By far the greater part of the region is nearly a desert, yet there are some arable spots. The country is mountainous with intervening plains—the mountains wooded and watered, with grass about their bases or lower slopes, the planes arid and sterile. These interior mountains run north and south, conforming to the general trend of the Rocky Mountains and Sierra Nevada; they are from two to five thousand feet in height, and snow continues on many through the year.

The Great Salt Lake, about seventy miles long, and the Utah, just south, about thirty-five miles long, are in this basin. The latter is fresh water and is situated one hundred feet above the former, or four thousand three hundred feet above the level of the sea. These lakes drain an area of ten or twelve thousand square miles. The spot of land between is fertile and here the Mormons have established themselves. This position lies on the route across the mountains to Cali-

* Geographical Memoir upon Upper California in illustration of his map of Oregon and California, by John Charles Frémont, addressed to the Senate of the United States, 67 pp., 8vo, Washington, 1848.

fornia. South of Utah is another lake, of which little more is known than when Humboldt published his map of Mexico. The western side of the Great Basin contains many lakes, among which Pyramid lake is thirty-five miles long and between four and five thousand feet above the sea. The rivers, among which *Humboldt* river is the longest, are discharged, either into some of the lakes, or lose themselves in the soil. Humboldt river, sometimes called Mary's or Ogden's, rises west of the Great Salt lake and flows to within fifty miles of the Sierra Nevada. It is a fine stream with some narrow strips of fertile alluvium, and is especially important on account of its lying on the line of travel to California, being the best route through the Great Basin. It terminates opposite the Salmon Trout pass in the Sierra, a pass only seven thousand two hundred feet above the sea, leading into the valley of the Sacramento.

The settlement of the Mormons near the Great Salt lake is making good progress. On the first of April they had "three thousand acres in wheat, seven saw, and grist mills, seven hundred houses in a fortified enclosure of sixty acres, besides stock and other accompaniments of a flourishing settlement." The Great Basin, although arid in most parts, has many exceptions to this character and deserves a full and thorough exploration.

West of the Sierra Nevada, between the range and the sea, there is an area one hundred and fifty to two hundred miles wide, extending from lat. 32°, where it touches the peninsula of California, to 42°, and having an area of above one hundred thousand square miles. It contains the extensive plains or valleys of the Sacramento and Joaquim, two rivers emptying together into the Bay of San Francisco, besides others of less importance. The soil is fertile and the climate mild. In the winter season for three to five months there are usually abundant rains, and the crops grow luxuriantly. For the rest of the year there is no rain, and the whole country except some narrow strips along the edge of the larger streams and the higher slopes and valleys of the ridges, and a small breadth of coast within the influence of the sea fogs, is throughout parched, with hardly a green blade of grass. The soil however requires only irrigation; and, excepting about the lower flats, this may be easily effected. Vegetation comes with the rains and decays as they fail; the winter revives the vegetation which through the long summer drought is in appearance dried up.

2. *Verbal Communication from Dr. Hare, on the Rationale of the Explosion causing the Great Fire of* 1845, *at New York*, (Proceedings of the Franklin Institute, for 20th April last, p. 392.)—Dr. Hare communicated to the meeting some inferences and facts, tending to account for the contradictory impressions which have existed respecting the competency of fused nitre to explode with water, or with aqueous, hydrogenous, and carbonaceous combustibles. This subject was treated of in reference to a series of detonations terminating in an explosion of tremendous force, by which, in July, 1845, the intensely ignited contents of a store, in Broad street, New York, were thrown over an extensive district, involving the destruction of about two hundred houses and property estimated at two millions of dollars. As far as the oaths of highly competent witnesses could avail, no gunpowder was present;

so that the result could only be attributed to the reaction between an enormous quantity of nitre and combustible merchandise with which the store was promiscuously occupied. In all there were three hundred thousand pounds of nitre in parcels of 180 lbs. (each secured by two bags, an additional bag having been put over that originally employed.) About 180,000 lbs. was situated upon the second floor, 30,000 on the first floor, and 80,000 on the third floor.

Of the merchandise, the aggregate was more than double the weight of the nitre.

It was, however, the general opinion of those best acquainted with the subject, that when ignited with combustibles, nitre produces only that species of combustion which is called deflagration by chemists without being capable of the more violent and instantaneous reaction designated by the word explosion. This impression was strengthened by the failure of every effort (made by several eminent chemists employed by the Corporation of New York) to explode nitre by ignition with combustibles.

Nevertheless, agreeably to Hayes, of Massachusetts, an explosion was effected in his laboratory, by bringing water into contact with about 100 lbs. of incandescent nitre; also the accidental falling of a jet of melted nitre on some water, in the laboratory of the University of Pennsylvania, had been productive of a similar result.

The explosion of a vessel laden with nitre, which, while lying in Boston harbor, was burnt to the water's edge, and of others similarly ladened and burnt, could only be explained by supposing that nitre, when sufficiently heated, will explode with water on due contact. Consistently, it might be inferred that this salt (well known to be a compound of nitric acid and oxyd of potassium or potash) would explode with any substance capable of yielding either or both of the elements of water or hydrogen. The presence of the latter would be equivalent to water, since it would, with the oxygen of the acid, form water.

In a letter, addressed to the distinguished chemist above mentioned, in July, 1845, Dr. Hare had adverted to the explosion which succeeds the combustion of potassium upon water, as arising from the combination of one portion of the water with the resulting incandescent globule of oxyd, while the heat of this globule uniting with another portion of the liquid, converts it into high steam. Moreover, it was suggested that, in this instance, chemical affinity between the water and the oxyd, in causing the water and heated globule to coalesce, is equivalent in efficacy to the momentum of the hammer when a bar of iron, at a welding heat, is forced into contact with some moisture situated upon an anvil.

Dr. Hare presumes that no explosion can take place unless the reagents for producing it are held or brought together, at the moment of reaction, by a certain force, either chemical or mechanical.

Some chemical compounds, such as are formed with fulminic acid, or with ammonia, by metallic oxyds, also the chlorid of nitrogen and perchloric ether, explode violently without confinement, so as to fracture a plate or saucer, upon which a small quantity may be detonated; but pulverulent mixtures, such as gunpowder, however powerfully explosive when employed in gunnery or rock-blasting, in open vessels flash without fracturing them, or producing any report. In an exhausted receiver, gunpowder is far less explosive than when subjected to atmospheric pressure in an open vessel. Nevertheless, when gunpowder is restrained until the temperature requisite for the appropriate reaction of its ingredients is attained, it exerts a force far exceeding that of the chamber confining it. In this respect it differs from steam, of which, when the temperature of the fire applied is sufficiently high, the explosive force is directly as the pressure before bursting, and this, of course, is commensurate with the strength of the confining boiler.

The ingredients of gunpowder, sulphur, charcoal, and nitre, to produce the greatest effect, require extreme comminution and intimate intermixture by trituration, and to be so granulated, that the flame of the portion first ignited may convey inflammation to the rest through the interstices between the grains. Its superiority over any other mixture of nitre with combustible matter destitute of sulphur, is conceived to be due not only to the pre-eminent susceptibility of this substance, of vaporization and inflammation, but likewise to its well known ability to decompose metallic oxyds by attracting both the metal and oxygen. Such an opinion was expressed in 1845, in the letter above mentioned to Hayes, that the formation of sulphid of potassium is the first step in the process of the explosive reaction of gunpowder, Faraday has alleged the flame of the compound to be, in the case in point, an important instrument in the propagation of fire throughout the mass.

The hepatic odor of the fumes consequent to the firing of cannon, and likewise of the washings of a gun after the customary service, demonstrate the production of a sulphid. It has been found that a filtered solution of the residue displays, when tested by iron, the red hue which indicates the presence of a sulphocyanid.

Agreeably, however, to a qualitative examination, the solid residue of exploded gunpowder consists mainly of nearly equal parts of carbonate and sulphate of potash, while the gaseous residue is constituted nearly of equal volumes of carbonic acid and nitrogen. Of course the sulphate may arise from the oxydation of sulphide, formed at the outset. Notwithstanding that the ingredients of gunpowder are prepared as above stated, confinement is necessary to prevent the grains from being thrown apart and chilled, so as to prevent the propagation of the ignition, through the congeries forming a charge, by means of the flame of the first portions fired. This was fully demonstrated by the exposure of a pile of gunpowder comprising enough for the charge of a musket, within an exhausted receiver, to a wire intensely ignited by a galvanic discharge. The grains did not take fire instantly, probably because the vapor evolved prevented actual contact; and when ignition did ensue it extended only to the production of a feeble flash. On examination, it was found that a portion of the powder had escaped inflammation.

In the next place, a like weight of gunpowder was consolidated into a cylinder by intense pressure. Thus prepared and ignited, by contact with an incandescent wire in the exhausted receiver, more than half of the cylinder remained unconsumed.

A much larger cylinder of the same mixture, similarly consolidated, placed at the bottom of an iron pot, four inches in diameter and twelve inches in depth, on being touched by the end of an iron rod reddened in the fire, burnt at first like a squib, but towards the last was dissipated with an activity in some degree explosive, probably in consequence of the pressure created by the reaction of the gaseous current generated by its own deflagration.

The want of confinement, which is thus capable of lessening the explosiveness of gunpowder, of which the constituents are intimately intermingled, is still more enfeebling, where analogous reagents are ignited together without admixture or comminution. Under these circumstances, the reagents are made to recede from each other by the generation of that vapor or gas, to the evolution of which, under confinement, the capability of exploding is due. Thus sundered, they are chilled by radiation, so that the temperature requisite to sustain and communicate ignition is not supported. Moreover, the rapidity of reaction being as the multiplication of the points of contact, and these being fewer as the substances are less divided and intermingled, the deflagration takes place in detail, instead of having that simultaneousness which is indispensable to render it explosive.

In addition to the ideas above mentioned as having been conveyed in Dr Hare's letter to Hayes, it was urged, also, that his inference as to the explosion of water with incandescent nitre being attributable to a reaction analogous to that represented as taking place when potassium is burnt with the oxyd of potassium, was supported by the fact, that at a white heat, the base of nitre spontaneously abandons its acid, while from water it cannot be separated by any temperature. Consequently, the presentation of substances, consisting of carbon, hydrogen, and oxygen, by yielding water to the base, could not but be productive of a result analogous to that which results from the presentation of sulphur and carbon.

The only obstacle is as follows:—Substances containing hydrogen and oxygen, whether in the proportion for forming water, like sugar, starch, gum, and wood; or having an excess of hydrogen, like oils and resins; moreover, all the constituents of nitre, even the base, are susceptible of the aëriform state at the temperature producible by the reaction of nitre with them. But when kept together until that point is attained, the explosive power must be fully equivalent to that of gunpowder. The reagents are in a state analogous to that of two gases extremely condensed.

The explosibility of incandescent nitre with water was illustrated in the small way, by heating a portion in a platinum capsule by the flame of a hydro-oxygen blowpipe, and sudden immersion in the liquid. So active was the explosion, that a portion of the resulting hydrate flew out upon the operator. Yet when thrown in the same state upon molasses or sugar, no explosion ensued: nevertheless, when a capsule containing nitre heated to the point of volatilization, was struck with the face of a hammer, coated with sugar melted upon it and made to adhere by moisture, a detonation took place. A still more powerful detonation was produced as follows:—

Upon an anvil, a disk of paper, three inches in diameter, was laid, covered with pulverized sugar. Over the sugar was placed another similar disk covered with pulverized nitre. A bar of iron, rather wider than the disks at a welding heat, was then held over them, and subjected to a blow from a sledge. An explosion, with a report like that of a cannon, ensued.

Instructed by the facts and considerations above stated, it is inferred that the explosions which contributed to extend the conflagration in New York, as above mentioned, arose from the reaction of the nitre with the combustible merchandise with which it was surrounded. It is presumed that as soon as the fire reached any of the gunny bags, it must have run rapidly through the whole pile, by means of the interstices necessarily existing between them, the nitre with which they were embued causing them to deflagrate. Much of the salt being thus brought to the temperature of fusion, it must have run about the floor, reached the combustibles, and soon found its way to the next story through the scuttles which were open. All the floors must have been rapidly destroyed by the consequent deflagration, far exceeding in activity any ordinary combustion. Meanwhile, the nitre being all liquified and collected in the cellar in a state of incandescence, and the merchandise conglomerated by the fusion of sugar and shell lac, aided by the molasses, the weight, the liquidity, and temperature, must have produced all the conditions requisite to intense detonations. The floors having been consumed, the store must have been equivalent to an enormous crucible of twenty feet by ninety, at the bottom of which were nearly three hundred thousand pounds of nitre, superficially heated far above the temperature producible by any furnace, so as to convert the reagents into nascent aëriform matter under a pressure of half a million of pounds. The intense reaction, however, would not permit of durable contact. At each impact, the whole mass must have been thrown up explosively, and hence the successive detonations. But the chemical reaction, the heat, and the height of the fall, growing with their growth, and strengthening with their strength, the last elevation was succeeded by the thundering report and stupendous explosion of which it has been an object to afford a satisfactory explanation.*

3. *Building Material.*—The following are the results of examinations by the building committee of the Smithsonian Institution, of different kinds of building material in Maryland, as mentioned in the recent Report of the Regents.

"1st. That the marble quarries of Maryland, chiefly in the vicinity of the village of Clarksville, about thirteen miles from Baltimore, on the line of the Susquehanna railroad, contain two qualities of marble: one fine-grained and of beautiful uniform color, approaching the character of statuary marble; the other, of inferior quality, similar to the Sing Sing marble employed in New York, in Grace church and other public structures, of a somewhat coarse and highly crystalline structure, and known to the quarrymen here under the name of 'alum limestone.'

* In a short time a more circumstantial account of Dr. Hare's experiments and inferences respecting the subjects of the above communication will be published.

The former was confidently recommended as a building material equal in durability to any in the world; the latter was pronounced inferior, both in beauty and durability, yet capable of furnishing a very lasting material if the selection was made with care. Being less tough than the finer-grained variety, it was thought less suitable for ornaments having bold projections, and somewhat liable to chip off where there was much undercutting.

"2d. That the granite quarries of Maryland, in the vicinity of Woodstock, on the line of the Baltimore and Ohio railroad, and about sixteen miles beyond the Relay House, furnish a granite equal to that of Quincy, and not excelled for beauty of appearance, compactness of structure, and uniformity of color, texture and composition, by any granite in the United States; splitting, also, with remarkable facility, so that on a block twelve or fourteen feet in length, the face of cleavage may not vary more than a single inch from a true level; in short, a building material of unsurpassed durability and uniformity, and to which, as to the finer-grained marble in the Clarksville quarries, no possible objection, except on the score of expense, could be found, unless, indeed, it be considered one, that in this material the effect of light and shade from projecting surfaces is in a measure lost, while in marble and good tinted freestone every shadow is sharply marked.

"3d. That the Aquia creek freestone, heretofore used in public buildings in Washington, is a material not to be trusted, being pervaded by dark specks of the protoxyd and peroxyd of iron, which in peroxydating acquire a yellowish or reddish color, and having occasional clay holes, such as disfigure the Treasury and the Patent Office. A portion of this freestone was, indeed, considered durable and free from material blemish; but the chance of actually procuring it free from disfiguring spots and stains was considered so uncertain, that it was recommended to refrain from using it in the institution building.

"4th. That the freestone of the upper Potomac, in the vicinity of Seneca creek, and found in quarries close to the line of the Chesapeake and Ohio canal, is the best and most durable of all the Potomac freestones.

"The lilac-gray variety found in the Bull Run quarry, twenty-three miles from Washington, was especially recommended, and pronounced to be equal, if not superior, to that supplied for Trinity church, New York, from the quarries of New Jersey.

"In regard to this latter material, it was stated that it possessed a quality that should especially recommend it to the attention of builders. When first quarried it is comparatively soft, working freely before the chisel and hammer; but by exposure it gradually indurates, and ultimately acquires a toughness and consistency that not only enables it to resist atmospheric vicissitudes, but even the most severe mechanical wear and tear. Thus, on the tow-path of the aqueduct, near Seneca creek, over which horses and mules have been traveling almost daily for upwards of twenty years, this freestone was found still unimpaired. Even the corners around which the heavy lock-gates swing, showed no signs of chipping or decay; and on the perpendicular wall of the aqueduct, where the water is continually oozing through the joints and trickling down its face, forming an incrustation of carbonate of lime, this freestone was observed, where the calcareous crust had scaled off, with the grooves and ridges of the surface still nearly as distinct as when the blocks first came from the hands of the stone-mason, more than twenty years ago."

The same report by the Regents of the Smithsonian Institution, contains the following table giving the results of experiments by C. G. Page, to ascertain the relative disintegrating effects of frost upon stones used for building. The process of Brard was adopted, which substitutes the crystallization of sulphate of soda for the freezing of water. Inch cubes of the several kinds of stone were dipped into a solution of this salt once a day for four weeks, and allowed to remain each time for a few minutes; and after taking them out daily, they were washed off. After the first week a moderate heat was employed. The following are the results.

Specimens marked.		Specific gravity.	Loss by frost, in grs.
No. 1	Not tested; the specimen being too small.		
No. 2	Symington's close-grained marble (similar to Worthington's)	2·834	0·19
No. 3	Connecticut sandstone, coarsest-grained quality	not ascertained.	14·36
No. 4	Dark red Seneca sandstone (similar to Peter's)	2·672	0·70
No. 5	Symington's large crystal marble	2·857	0·50
No. 6	Symington's blue limestone	2·613	0·34
No. 7	Coarse, large crystal marble, Mt. Pleasant, N. York	2·860	0·91
No. 8	Port Deposite granite	2·609	5·05
No. 9	Too small to examine.		
No. 10	Trinity sandstone, fine-grained and light-colored	not ascertained.	1·58
No. 11	Connecticut sandstone, finer-grained quality	2·583	24·93
No. 12	Nova Scotia sandstone, coarse-grained	2·518	2·16
No. 13	Light Seneca sandstone, dove-colored	2·486	1·78
No. 14	Pennsylvania marble, close-grained	2·727	0·35
No. 15	Pennsylvania blue limestone	2·699	0·28
4 T C	Trinity church light colored, close-grained sandstone, New Jersey	2·482	0·62
P O	Patent Office light sandstone	2·230	18·60
S B	Soft brick	2·211	16·46
H B	Hard brick	2·294	1·07
1 D	Granite from Potomac Great Falls	Not ascertained.	0·35
2 D	Dark coarse sandstone, of Seneca aqueduct, Peter's quarry	Not ascertained.	5·60
3 D	Sandstone four miles above No. 2 D, Peter's, next west of Beaver dam quarry	Not ascertained.	1·58
4 D	Dark sandstone, from quarry near Wood's residence	Not ascertained.	3·94
5 D	Not tested, specimen being too small.		
6 D	Lower stratum, Beaver dam quarry	Not ascertained.	1·72

4. *Types*, (Patent Office Rep. for 1847, issued in 1848, p. 59.)—Letters patent have been granted within the year for a type machine for the manufacture of type from malleable metal. This machine in its general characteristics is like a nail or spike machine. It rolls the wire into a flat rod which is received into proper dies, where it is held, cut off, and punched into the general form of type, and a die of proper form resembling a header die is brought up against the end of it, forming the required letter—when it is discharged and another blank received. Those acquainted with spike machinery will easily understand

the modifications necessary for forming type, and that there would be but little novelty in such a machine.

5. *Bullets*, (Patent Office Report for 1847, issued in 1848, p. 81.) —Letters patent have been granted for improvements in casting bullets. The moulds are connected together in sections, forming an endless chain or belt. This belt passes under the reservoir of molten lead, and the moulds are filled, and the belt passes along in a horizontal position until the balls become cool. The belt is then bent around a pulley which at once drives it and opens the sections of the moulds from which the balls fall. The belt afterwards passes around one or more additional pulleys, and up again to the reservoir. Thus while one portion of the moulds is receiving the molten lead, the bullets are cooling in another, and are discharged at a third without any interruption.

6. *Quantity of the different Grains produced in the United States in* 1847, (Patent Office Report for 1847, issued in 1848, p. 545.)—The following is the amount of the different kinds of grain produced in the United States in 1847, according to the estimate contained in the table preceding the agricultural report of this office for the present year, viz.

Breadstuffs.	Bushels.	Total bushels.
Indian corn or maize,	539,350,000	
Wheat,	114,245,500	
Rye,	29,222,700	
Buckwheat,	11,673,500	
		694,491,700
Grain not used for breadstuffs.		
Oats,	167,867,000	
Barley,	5,649,950	
		173,516,950
Total,		868,008,650

Other articles of food.	
Potatoes,	100,950,000 bushels.
Beans and Peas,	50,000,000 "
Rice,	103,640,590 pounds.

Estimated population, 20,746,400.

7. *Smithsonian Institution.*—The Report of the Board of Regents of the Smithsonian Institution, recently presented to Congress, (dated January 6, 1848,) shows that good progress has been made during the year past in carrying forward both the erection of the projected building and the publication of Memoirs. It contains the following as the Plan of organization, based on the Will of Smithson, who bequeathed the property to the United States of America, "to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men."

Section I. *Plan of Organization.*

To Increase Knowledge. It is proposed—

1. To stimulate men of talent to make original researches, by offering suitable rewards for memoirs containing new truths; and,

2. To appropriate annually a portion of the income for particular researches, under the direction of suitable persons.

To Diffuse Knowledge. It is proposed—

1. To publish a series of periodical reports on the progress of the different branches of knowledge; and,

2. To publish occasionally separate treatises on subjects of general interest.

DETAILS OF THE PLAN TO INCREASE KNOWLEDGE.

I. *By stimulating researches.*

1. Rewards, consisting of money, medals, &c., offered for original memoirs on all branches of knowledge.

2. The memoirs thus obtained to be published in a series of volumes, in a quarto form, and entitled Smithsonian Contributions to Knowledge.

3. No memoir, on subjects of physical science, to be accepted for publication, which does not furnish a positive addition to human knowledge, resting on original research; and all unverified speculations to be rejected.

4. Each memoir presented to the institution to be submitted for examination to a commission of persons of reputation for learning in the branch to which the memoir pertains; and to be accepted for publication only in case the report of this commission is favorable.

5. The commission to be chosen by the officers of the institution, and the name of the author, as far as practicable, concealed unless a favorable decision be made.

6. The volumes of the memoirs to be exchanged for the Transactions of literary and scientific societies, and copies to be given to all the colleges, and principal libraries, in this country. One part of the remaining copies may be offered for sale; and the other carefully preserved, to form complete sets of the work, to supply the demand from new institutions.

7. An abstract, or popular account, of the contents of these memoirs to be given to the public through the annual report of the Regents to Congress.

II. *By appropriating a portion of the income, annually, to special objects of research, under the direction of suitable persons.*

1. The objects and the amount appropriated, to be recommended by counsellors of the institution.

2. Appropriations in different years to different objects; so that in course of time, each branch of knowledge may receive a share.

3. The results obtained from these appropriations to be published, with the memoirs before mentioned, in the volumes of the Smithsonian Contributions to Knowledge.

4. Examples of objects for which appropriations may be made:

(1.) Systems of extended meteorological observations for solving the problem of American storms.

(2.) Explorations in descriptive natural history, and geological, magnetical, and topographical surveys, to collect materials for the formation of a Physical Atlas of the United States.

(3.) Solution of experimental problems, such as a new determination of the weight of the earth, of the velocity of electricity, and of light; chemical analyses of soils and plants; collection and publication of articles of science, accumulated in the offices of Government.

(4.) Institution of statistical inquiries with reference to physical, moral, and political subjects.

(5.) Historical researches, and accurate surveys of places celebrated in American history.

(6.) Ethnological researches, particularly with reference to the different races of men in North America; also explorations, and accurate surveys, of the mounds and other remains of the ancient people of our country.

DETAILS OF THE PLAN FOR DIFFUSING KNOWLEDGE.

I. *By the publication of a series of reports, giving an account of the new discoveries in science, and of the changes made from year to year in all branches of knowledge not strictly professional.*

1. These reports will diffuse a kind of knowledge generally interesting, but which, at present, is inaccessible to the public. Some of the reports may be published annually, others at longer intervals, as the income of the institution or the changes in the branches of knowledge may indicate.

2. The reports are to be prepared by collaborators, eminent in the different branches of knowledge.

3. Each collaborator to be furnished with the journals and publications, domestic and foreign, necessary to the compilation of his report; to be paid a certain sum for his labors, and to be named on the title page of the report.

4. The reports to be published in separate parts, so that persons interested in a particular branch, can procure the parts relating to it without purchasing the whole.

5. These reports may be presented to Congress, for partial distribution, the remaining copies to be given to literary and scientific institutions, and sold to individuals for a moderate price.

The following are some of the subjects which may be embraced in the reports:

I. Physical Class.

1. Physics, including astronomy, natural philosophy, chemistry, and meteorology.

2. Natural history, including botany, zoology, geology, &c.

3. Agriculture.

4. Application of science to arts.

II. Moral and Political Class.

5. Ethnology, including particular history, comparative philology, antiquities, &c.

6. Statistics and political economy.

7. Mental and moral philosophy.

8. A survey of the political events of the world, penal reform, &c.

III. Literature and the Fine Arts.

9. Modern literature.

10. The fine arts, and their application to the useful arts.

11. Bibliography.
12. Obituary notices of distinguished individuals.

II. *By the publication of separate treatises on subjects of general interest.*

1. These treatises may occasionally consist of valuable memoirs translated from foreign languages, or of articles prepared under the direction of the institution, or procured by offering premiums for the best exposition of a given subject.

2. The treatises should, in all cases, be submitted to a commission of competent judges, previous to their publication.

3. As examples of these treatises, expositions may be obtained of the present state of the several branches of knowledge mentioned in the table of reports. Also of the following subjects suggested by the Committee on Organization, viz: The statistics of labor, the productive arts of life, public instruction, &c.

SECTION II. *Plan of organization, in accordance with the terms of the resolutions of the Board of Regents providing for the two modes of increasing and diffusing knowledge.*

1. The act of Congress establishing the institution contemplated the formation of a library and a museum; and the Board of Regents, including these objects in the plan of organization, resolved to divide the income into two equal parts.

2. One part to be appropriated to increase and diffuse knowledge by means of publications and researches, agreeably to the scheme before given. The other part to be appropriated to the formation of a library and a collection of objects of nature and of art.

3. These two plans are not incompatible with one another.

4. To carry out the plan before described, a library will be required, consisting, 1st, of a complete collection of the transactions and proceedings of all the learned societies in the world; 2d, of the more important current periodical publications, and other works necessary in preparing the periodical reports.

5. The institution should make special collections, particularly of objects to verify its own publications.

6. Also a collection of instruments of research in all branches of experimental science.

7. With reference to a collection of books, other than those mentioned above, catalogues of all the different libraries in the United States should be procured, in order that the valuable books first purchased may be such as are not to be found in the United States.

8. Also catalogues of memoirs, and of books in foreign libraries, and other materials, should be collected for rendering the institution a centre of bibliographical knowledge, whence the student may be directed to any work which he may require.

9. It is believed that the collections in natural history will increase by donation as rapidly as the income of the institution can make provision for their reception, and, therefore, it will seldom be necessary to purchase any articles of this kind.

10. Attempts should be made to procure for the gallery of arts casts of the most celebrated articles of ancient and modern sculpture.

11. The arts may be encouraged by providing a room, free of expense, for the exhibition of the objects of the Art-Union and other similar societies.

12. A small appropriation should annually be made for models of antiquities, such as those of the remains of ancient temples, &c.

13. For the present, or until the building is fully completed, besides the Secretary, no permanent assistant will be required, except one, to act as librarian.

14. The duty of the Secretary will be the general superintendence, with the advice of the Chancellor and other members of the establishment, of the literary and scientific operations of the institution; to give to the Regents annually an account of all the transactions; of the memoirs which have been received for publication; of the researches which have been made; and to edit, with the assistance of the librarian, the publications of the institution.

15. The duty of the Assistant Secretary, acting as librarian, will be, for the present, to assist in taking charge of the collections, to select and purchase, under the direction of the Secretary and a committee of the board, books and catalogues, and to procure the information before mentioned; to give information on plans of libraries, and to assist the Secretary in editing the publications of the institution, and in the other duties of his office.

16. The Secretary and his assistants, during the session of Congress, will be required to illustrate new discoveries in science, and to exhibit new objects of art; distinguished individuals should also be invited to give lectures on subjects of general interest.

17. When the building is completed, and when, in accordance with the act of Congress, the charge of the National Museum is given to the Smithsonian Institution, other assistants will be required.

This programme of organization is followed by remarks by Professor Henry, the distinguished Secretary of the Institution.

8. *Tenacity of Life in Black Ants;* by DEXTER MARSH, (in a letter to Prof. Silliman.)—I was led to the following experiments, by hearing the discussion on the subject of the hybernation of animals, at the meeting of the Association of American Geologists and Naturalists, at Boston, last September.

While cutting wood in February last, I discovered a number of large black ants, in a partially decayed block, frozen perfectly solid, so they would not bend without breaking. I cut off the heads of a number of them, and after keeping them in a cold place half an hour, without their showing any appearance of life, I placed them, with some whose heads I did not sever, in a warm sunny exposure, and in about ten minutes they came to life, so as to kick about smartly, and throw themselves over and over, like a hen with her neck wrung, and in about five minutes died, while the others ran off.

A few days after this, I tried the same experiment on some more, by keeping them an hour and a half after cutting off their heads, and they too began to show signs of life by moving their legs considerably; but just at this time, the sun became clouded, and the wind blowing cold, I could not restore them further to life, but it was enough to satisfy me that they may be kept hours, and perhaps days, or weeks, after their heads are taken off, and still be restored to life.

9. *Cabinet and Observatory at Amherst College, Mass.*—A handsome building has recently been erected at Amherst, for the purposes of natural history and astronomy, and on the 28th of June last, there was a gathering of the friends of the institution to celebrate its completion. Amherst is indebted for this structure to the donations of over forty individuals, among whom Hon. Abbot Lawrence stands at the head with a subscription of $1,000, and Samuel Stone, Esq., of Townsend, Mass., follows next with nearly the same amount. The cabinet is an octagonal building, lighted from above. On one side there is a projection or wing, ending in a tower eighteen feet in diameter and forty-four in height to the dome, which is well adapted for astronomical purposes. The cabinet consists of two stories; the lower is occupied by geological specimens, among which the fossil footprints, the collections of Pres. Hitchcock, are of surpassing interest. There are in all 250 specimens, and they belong to forty-nine different species of animals, including "twenty-three of birds, ten of bipeds and perhaps of the Batrachian or frog family; twelve certainly quadrupeds; two creeping animals and three of doubtful character." Besides these, there are large collections of geological specimens from Europe and England, others from Asia; an extensive suite of Massachusetts specimens obtained in the course of the geological surveys of Pres. Hitchcock; rocks and minerals from Connecticut, collected by Prof. C. U. Shepard; from Vermont, collected by Prof. C. B. Adams, while in the survey of that state; besides collections from other parts of the Union, and the West Indies.

In the second story, a single beautiful room with a gallery, is mainly occupied by the mineralogical cabinet, deposited by Prof. C. U. Shepard. The collection is one of remarkable completeness and elegance. Besides minerals, it embraces a very large number of meteorites, and numerous geological specimens and fossils. The first suggestion that led to the erection of the new building, was the offer of Prof. Shepard to deposit his cabinet with the College, provided a fire-proof building could be built for its reception; this cabinet alone is well worthy of the fine structure now containing it.

The zoological museum of Amherst College has been of late enriched by the zoological collections of Prof. C. B. Adams. The conchological cabinet of Prof. Adams is one of great value. It includes a general series of 4,400 species, embracing about 500,000 individuals, and a series of shells of Jamaica, containing 400 species and about 10,000 individuals. These collections require still another building for their reception. They are displayed in the old cabinet room and library.

The observatory remains yet unsupplied with a telescope, waiting the generosity of some of the liberal minds of Massachusetts—a state where considering its wealth, more is done for literary and scientific progress by private beneficence than in any other part of the civilized world.

10. *Bromine from the Bittern of Salt Works;* by Messrs. Allis & Gillespie, (from a letter to the editors, dated Freeport, Penn., Dec. 30, 1847.)—The bittern is generally concentrated so as to float bituminous coal, and will yield about a pound of bromine to thirty gallons. Each of the wells produce on an average about 150 gallons of bittern

to every 15 barrels of salt, which is about the average amount manufactured per twenty-four hours. We have been able with our present establishment, to manufacture 10 to 15 pounds of bromine per day.

It also contains iodine but not in sufficient quantity to justify its manufacture, there being only about one ounce in ninety gallons. We attempted the manufacture of iodine, made a few pounds, but were obliged to give it up, the cost overrunning the profit.

11. *Bosphorus.*—From the late extensive observations of M. Hommaire de Hell it appears that there is no appreciable difference of level between the Black Sea and the Sea of Marmora; and consequently, there is no real current flowing out of the Black Sea through the Bosphorus. He attributes all apparent currents to the winds, which being mostly from the north, produce generally a flow towards the south. This is compensated for by the strong currents flowing to the north during the southerly winds.

12. *American Association for the Promotion of Science.*—On the 20th of September, 1848, the first meeting of this Association will be held, being the ninth annual session from the origin of the Association of American Geologists. The organic change in the name and purposes of the Society made at the last meeting, held at Boston, had been in contemplation for some years previous. A committee appointed at the Boston meeting have issued a circular with an enlarged constitution and plan of organization, together with a full statement of the reasons which have led to the change. This committee consists of Professors H. D. Rogers, Benjamin Peirce, and Louis Agassiz. As this circular has been sent out very generally to all followers and friends of science in the country, it is needless to repeat its contents here. We cannot doubt that with the new plans and enlarged sphere of action, now before it, the next meeting of the *American Association*, on the 20th inst. at Philadelphia, will be one of great interest, and numerously attended. The officers are—

Chairman, W. C. Redfield.
Secretary, Prof. W. R. Johnson.
Treasurer, Dr. J. Wyman.*

Standing Committee.

W. C. Redfield, Prof. W. R. Johnson, Dr. J. Wyman,* } *Ex-officio.*

Dr. J. E. Holbrook.	Dr. S. G. Morton.
Prof. H. D. Rogers.	Dr. C. T. Jackson.
Prof. B. Silliman, Jr.	J. D. Dana.
Prest. E. Hitchcock.	John L. Hayes, Esq.

Local Committee.

Dr. S. G. Morton.	Prof. James B. Rogers.
Dr. Robert Hall.	Prof. John J. Mitchell.
Prof. S. S. Haldeman.	John Price Wetherill.
James Dundas, Esq.	Peter A. Browne, Esq.
R. C. Taylor, Esq.	

* Erroneously stated in the circular to be Prof. B. Silliman, Jr.

13. TABLE *of the periods when the Hudson River opened and closed at Albany, so far as the same can now be ascertained.*

Winters.	River closed or obstructed by ice.	River open or free of ice.	No. days closed.
1785–86	. . . .	*March 23, 1786	
1789–90	February 3, 1790	*March 27, 1790	52 days.
1790–91	December 8, 1790	*March 17, 1791	99 days.
1791–92	December 8, 1791		
1792–93	December 12, 1792	*March 6, 1793	84 days.
1793–94	December 26, 1793	*March 17, 1794	81 days.
1794–95	January 12, 1795		
1795–96	January 23, 1796		
1796–97	November 28, 1796		
1797–98	November 26, 1797		
1798–99	November 23, 1798		
1799–1800	January 6, 1800		
1800–01	January 3, 1801		
1801–02	February 3, 1802		
1802–03	December 16, 1802		
1803–04	January 12, 1804	*April 6, 1804	84 days.
1804–05	December 13, 1804		
1805–06	January 9, 1806	*February 20, 1806	42 days.
1806–07	December 11, 1806	*April 8, 1807	121 days.
1807–08	January 4, 1808	*March 10, 1808	65 days.
1808–09	December 9, 1808		
1809–10	January 19, 1810		
1810–11	December 14, 1810		
1811–12	December 20, 1811		
1812–13	December 21, 1812	*March 12, 1813	83 days.
1813–14	December 22, 1813		
1814–15	December 10, 1814		
1815–16	December 2, 1815		
1816–17	December 16, 1816		
1817–18	December 7, 1817	March 25, 1818	108 days.
1818–19	December 14, 1818	April 3, 1819	110 days.
1819–20	December 13, 1819	March 25, 1820	102 days.
1820–21	November 13, 1820	March 15, 1821	123 days.
1821–22	December 13, 1821	March 15, 1822	92 days.
1822–23	December 24, 1822	March 24, 1823	90 days.
1823–24	December 16, 1823	March 3, 1824	78 days.
1824–25	January 5, 1825	March 6, 1825	60 days.
1825–26	December 13, 1825	*February 26, 1826	75 days.
1826–27	December 24, 1826	*March 20, 1827	86 days.
1827–28	November 25, 1827	*February 8, 1828	About 50 days.
1828–29	*December 23, 1828	*April 1, 1829	100 days.
1829–30	*January 11, 1830	*March 15, 1830	63 days.
1830–31	*December 23, 1830	*March 15, 1831	82 days.
1831–32	*December 5, 1831	*March 25, 1832	111 days.
1832–33	*December 21, 1832	*March 21, 1833	83 days.
1833–34	*December 13, 1833	*February 24, 1834	73 days.
1834–35	*December 15, 1834	*March 25, 1835	100 days.
1835–36	*November 30, 1835	*April 4, 1836	125 days.
1836–37	*December 7, 1836	*March 28, 1837	111 days.
1837–38	*December 13, 1837	*March 19, 1838	94 days.
1838–39	*November 25, 1838	*March 21, 1839	116 days.
1839–40	*December 18, 1839	*February 21, 1840	65 days.
1840–41	*December 5, 1840	*March 24, 1841	109 days.
1841–42	*December 19, 1841	*February 4, 1842	47 days.
1842–43	*November 29, 1842	*April 13, 1843	136 days.
1843–44	*December 9, 1843	*March 14, 1844	95 days.
1844–45	*December 11, 1844	*February 24, 1845	74 days.
1845–46	*December 4, 1845	*March 15, 1846	100 days.
1846–47	*December 15, 1846	*April 6, 1847	112 days.
1847–48	*December 24, 1847	*March 22, 1848	89 days.

14. Heat and cold of Utica.

A table showing the mean or average temperature of each month of the year for eight years, from 1840, *to* 1847 *inclusive, from observations taken daily at sunrise*, 1 *P. M., and* 9 *P. M., by S. Aylsworth.*

Months.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.
January, ...	16·26	27·31	26·25	28·86	15·56	26·82	24·67	23·10
February, ...	30·62	23·46	30·78	18·32	25·07	26·03	21·88	24·04
March, ...	34·58	29·82	39·41	23·63	34·75	37·35	35·13	28·27
April, ...	50·00	41·63	47·31	43·92	52·71	46·37	50·44	41·00
May, ...	60·04	56·28	51·10	55·24	59·48	54·09	60.37	58·00
June, ...	65·41	68·39	60·95	63·23	66 22	66·00	66·84	62·78
July, ...	71·78	67·13	68·58	69·13	70·90	70·39	70·80	72·00
August, ...	70·33	67·50	67·79	70·77	67·82	71·92	71·44	67·62
September, . . .	57·30	62·00	57·76	62·40	62·09	60·47	65·66	59·03
October, ...	47·33	41·82	47·13	45·24	49·43	50·94	48·08	45·25
November, . . .	37·44	34·42	33·93	34·23	36 78	40·23	43·03	41·03
December, . . .	22·41	28·28	25·46	30·08	28·94	22·24	26·45	31·43
Annual means, . .	46·95	45·67	46·37	45·42	47·48	47·73	48·72	46·13

Extreme cold during the above years in the following months:

Month.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.
January, ...	—28	—10	—10	— 1	—14	— 6	—18	2
February, ...	—10	— 6	4	— 5	—10	—16	—12	—10
March, ...	4	0	12	— 4	10	16	— 2	4
December, ...	— 6	—14	6	4	6	— 5	4	4

The preceding Tables are from the Annual Report of the Regents of the University of the State of New York, made March 22, 1848. The asterisks in the first table indicates those numbers which are derived from authentic records or personal observations.

Utica, N. Y., is situated in latitude 43° 7′, longitude 75° 13′, where the extremes of heat and cold are as great as in any part of this country in the same latitude.

15. *Atmidoscope*, (L'Institut, No. 751, May 24, 1848.)—M. Babinet presented to the French Academy in May last an Atmidoscope constructed by M. Lerebours to indicate, from the dryness of the atmosphere, its temperature and its movements, the quantity of evaporation which takes place in a given time. As in Leslie's instrument, it is a reservoir made of porous plastic earth and filled with water, the consumption of which is measured by a fall in the level of the water in a recurved tube communicating with the reservoir. M. Babinet mentioned various uses of the instrument in hygiene, meteorology, agriculture, &c.

16. *Magnetic Perturbations*, (L'Institut, No. 751.)—M. Quetelet gives the following list of magnetic perturbations at Brussels during the year 1847.

January, 20, 21, 30.
February, 6, 16, 22, 23, 24, 25.
March, 1, 2, 4, 5, 8, 9, 10, 11, 16, 19, 20.
April, 3, 5, 8, 12, 15, 20, 29, 30.
May, 8, 15.
June, 11.
July, 10.
August, 5, 25.
September, 13, 17, 24, 25, 28, 29, 30.
October, 8, 12, 23, 25.
November, 2, 23, 25, 26, 27.
December, 3, 11, 17, 18, 20, 21.

17. *Gold Medal of the Royal Geographical Society of London.*—The gold medal of this Society has been awarded to CAPTAIN CHARLES WILKES, U.S.N., Commander of the late U. S. Exploring Expedition. The President of the Society, Mr. W. J. Hamilton, after remarking upon the various explorations of the Expedition under Captain Wilkes, thus addressed Mr. Bancroft on putting the medal in his charge. "In addressing you for the purpose of placing in your hands the medal which has been awarded by the Council of the Royal Geographical Society of London to your distinguished countryman Captain Wilkes, for the valuable work which he has published under the title of the 'United States Exploring Expedition,' I rejoice in being the organ of expressing to you the sentiments entertained on this side of the Atlantic of the merits of Captain Wilkes. This is the second occasion on which our medal has been awarded to one of our transatlantic brothers, and I feel no small gratification in being thus enabled to give to the whole civilized world this additional proof, that the pursuit of science operates as a powerful inducement in knitting the bonds of friendship still more closely together between the two great nations of the Anglo-Saxon race. May this union long exist, and may they in their continued harmony and good fellowship continue to point out by their enlightened institutions the value of that sound practical common sense for which they are both so preëminently distinguished. May I request you to convey this medal to Captain Wilkes, with the expression of the best wishes of the Royal Geographical Society of London for his future prosperity and success."

18. *Beavers;* by D. D. PHARES, (from a letter dated Whitesville, Miss., May 8, 1848.)—Some months ago, I noticed in the Journal of Science and Arts, an article in relation to the southern limits of the habitation of the beaver. I am in latitude 31° 2′, being just two miles north of the boundary line between Mississippi and Louisiana. I have seen for the last twenty years a number of Beaver dams in this vicinity; and there is one family of them now within one mile of me, and two other families in two or three miles of my residence. Members of these families have been caught from time to time. I saw one alive a few days ago, and have now before me the skull and jaws of one of them caught within a mile of this place. I know of other colonies in other vicinities. They dwell as far south as latitude 31,° perhaps farther.

19. *F. Markoe's Mineralogical Cabinet.*—The mineralogical cabinet of F. Markoe, Esq. has been purchased for the U. S. Military Academy at West Point, for $2,000. It has been esteemed one of the most valuable private collections in the United States, and is a great acquisition to the means of instruction at West Point, where they had before almost no mineralogical collection.

20. *Meteorite of Arkansas.*—The account of the meteorite of Arkansas, cited in this Journal, vol. v, p. 293, ii series, from a Philadelphia paper, proves to be false. There has since been an account of a recent Pennsylvania meteorite going the rounds of the newspapers, which is found to be a fabrication.

21. OBITUARY.—*Death of J. Richardson.*—This gentleman, who was the author of a popular work on geology, and one of the Curators of the British Museum, died by his own hand in London in July last.

VI. Bibliography.

1. De Bow's *Commercial Review of the South and West;* a Monthly Journal of Trade, Commerce, Commercial Polity, Agriculture, Manufactures, Internal Improvements and General Literature, conducted by J. D. B. de Bow, Prof. Polit. Econ. and Statist. in the Univ. of Louisiana, New Orleans.

This monthly journal is in its fifth volume. It embraces practical science and literature to some extent, and is especially full in information relating to mining and commerce in the west, and whatever from a foreign source bears upon these interests. It is conducted with ability, and each number abounds in articles, both readable, practical, and economically important. The number for April contains the following articles :—I, Northern Arkansas and its Natural Advantages ;—II, Essay Writing and the Press ;—III, Texas Sugar Lands ;—IV, Silk and the Silk Culture ;—V, The Science of History ;—VI, Description of Soleil's Saccharometer ;—following these, are various shorter articles on the Products of Florida—the Cotton Region of the United States —the Commerce and Prosperity of several Western Cities—the Lakes and Western Rivers—Natchez Manufactures—Southern Railroads—American Copper and Iron Ore—Sugar Culture in Singapore—U. S. Imports, Exports, Trade, &c.—Agriculture of France, &c.—with Bibliographical Notices.

2. *Annual Report of the Regents of the University of the State of New York, made to the Legislature, March* 22, 1848. 310 pp. 8vo. *Albany*, 1848.—This valuable report—the sixty-first annual—contains the usual statistics respecting the schools and colleges of the state of New York, together with various tables and observations in Meteorology in its different departments. This latter subject receives so much attention, that the report has become a Journal of Meteorology for the State, of high importance, as well as a register of educational statistics.

The number of students in general literature and science in the colleges for the year ending, from July to October, 1847, was 957, which is 156 more than those of the preceding year. The number of students in the academies stands as follows for the last four years.

	Whole number attending during the year.	Number attending at the dates of the Reports.
1845, ...	22,782	11,802
1846, ...	25,173	12,608
1847, ...	22,077	12,776
1848, ...	25,838	13,058

The whole number of academies, subject to the visitation of the Regents, is 184. Of these, 153 academies reported the possession of 63,365 volumes in their libraries, making an average of 414 volumes to each.

3. *Letters on Geology;* by David Christy. 84 pp. 8vo. Oxford, Ohio, 1848.—The letters here collected into a pamphlet and enlarged, were originally published in the Cincinnati Gazette. The author in his preface modestly claims for them "no very great merit either as literary or scientific productions;" adding that "The reader will be able

easily to discern where my descriptions are accurate, and where they are only designed as approximations to the true geology of any point named." They are devoted principally to the geological structure of parts of Ohio, Tennessee, Kentucky and Missouri. They contain much of general and economical interest, and may prove a valuable source of information to geologists who shall undertake thorough surveys in this part of the country. The author also touches upon the age of Niagara and other rivers, and the phenomena of erratic blocks. The pamphlet is accompanied by five lithographic plates of fossils, and a large chart of sections.

4. *Boston Journal of Natural History*, vol. v, No. 4.—This number, the last of vol. v, contains the following papers:—

Art. xxxiv. JEFFRIES WYMAN and T. S. SAVAGE:—Notice of the external characters, habits and osteology of Troglodytes gorilla, a new species of Orang from the Gaboon River; the osteology by Dr. Wyman; p. 417, with 4 plates.

xxxv. N. M. HENTZ:—Descriptions and figures of the Araneides of the United States; p. 443, (continued from p. 370,) with 4 plates.

xxxvi. S. KNEELAND, Jr.:—Dissection of Scymnus brevipenna, *Leseueur;* p. 479.

xxxvii. J. D. WHITNEY:—Description and analysis of three minerals from Lake Superior; p. 486.*

xxxviii. SAMUEL CABOT:—The Dodo, a rasorial and not a rapacious bird; p. 490.

5. *Elements of Meteorology;* by Prof. BROCKLESBY.†—This work is designed by its author to introduce the study of Meteorology as a branch of common education in schools and academies. To this end the style is plain and direct, as devoid of technicalities as possible, and the theoretical views presented in a simple manner. He divides the subject into six parts.—I. The Atmosphere, embracing a description of the barometer, thermometer and hygrometer. II. Aerial phenomena—of Winds in general, of hurricanes, of tornadoes or whirlwinds, of water-spouts. III. Aqueous phenomena—of rain, of fogs, of clouds, of dew, of hoar frost and snow, of hail. IV. Electrical phenomena—of atmospheric electricity, of thunder-storms. V. Optical phenomena—of the color of the atmosphere and of clouds, of the rainbow, of mirage, of coronas and halos. VI. Luminous phenomena—of meteorites, of shooting stars and meteoric showers, of the aurora borealis. These several heads are treated of in a lucid and interesting style, well calculated to arrest the interest and attention of the minds of pupils.

6. *Lead Diseases;* by Dr. S. L. DANA.‡—If people are poisoned by lead-pipe, the fault will not lie at the door of Dr. Dana. Several years since he made a report to the City Council of Lowell, on the chemical

---

* See this volume, page 269.

† Elements of Meteorology, with Questions for Examination, designed for the use of Schools and Academies. By John Brocklesby, A.M., Prof. of Mathematics and Natural Philosophy in Trinity College, Hartford. (Illustrated.) 12mo, pp. 240. New York: Pratt, Woodford & Co., 1848.

‡ Lead Diseases; a Treatise from the French of L. Tanquerel des Planches, with notes and additions on the use of Lead-pipe and its substitutes. By Sam'l L. Dana, M.D., LL.D., &c. &c. Lowell, 1848. Bixby & Co. 8vo, pp. 441

action of lead-transmitted water on health. The result of this report was the abandonment of lead-pipes for conveying water, by city ordinance. Since that time he has on various occasions called public attention to this important hygienic subject in the daily journals. The late enquiries set on foot by the City Council of Boston, have called out a large amount of experiments and speculation upon this subject; and the aid of both chemical and medical science has been invoked, to enable the New England metropolis to make a wise decision, as to the material in which they shall distribute the beautiful water of Lake Cochituate, now to be introduced in a few months by their new and costly aqueduct. The experiments on this subject are understood to be still in progress, and their full results are not yet made public. Enough however has transpired to convince the public that in all probability the Boston authorities will authorize the use of lead-pipes. Opposed to this decision, are the opinions and facts of Dr. Dana and others, who cannot be convinced that the experience of years of observation has deceived them in the results to which he and they have arrived, hostile to the use of lead as the means of conveying water for human consumption. In support of his views, and with a view to the diffusion of a correct knowledge upon this subject, he has translated and condensed the great work of Tanquerel on lead diseases—a work the very title and existence of which is doubtless unknown to most intelligent readers in this country. That this work is one of unquestionable reputation, is abundantly shown by the fact that its author was rewarded by the Royal Academy of Medicine at Paris in 1841, by the Montyon prize of 6000 francs. The committee consisted of Roux, Magendie, Serres, Larry, de Blainville, Savart, Breschet, Dumeril and Double. It is comprehensive and complete in its design and execution, extending to all the arts and employments of man in which lead is employed or manufactured, and describing in full all known forms of lead disease, as well as cognate diseases produced by the poisonous influences of other metals. Dr. Dana has certainly performed a most acceptable service in presenting to the public this able work. We cannot now pause to analyze and review it as we could wish; this task must be referred to another occasion. An appendix contains numerous results obtained by Dr. Dana and others in this country, and proofs of the injurions effects of lead-conveyed water in numerous instances.

7. *Genera Illustrata:—Illustrated Genera of American Plants;* by Asa Gray, M.D., illustrated by figures and analyses from nature, by Isaac Sprague, &c.*—The study of natural science is encumbered with many difficulties arising from the wide extent of the subject, the great number of objects embraced, and the unavoidable minuteness and technicality of description. Illustrated works are often therefore an indispensable resource. The beginner may find the desired aid in part supplied by the well-stored mind of his teacher, to whom all doubtful points can be referred. Yet finished illustrations make a more definite and permanent impression, and in many points are better than an instructor. Those who have become versed in science are so fully satisfied of the necessity of such aids that they usually have

* The full title is given on page 450, vol. v, ii ser. of this Journal.

their libraries abundantly furnished with illustrated works. Prof. Gray, in view of this necessity, projected, in connection with Mr. Sprague, the work above referred to, of which the first volume has just been issued.

The object of the work is to illustrate each genus of plants growing in the United States, by giving along with descriptions, figures of a species representing in detail the foliage, inflorescence and fructification. Concerning the plates, the preface remarks as follows:—

"The figures in all cases are drawn directly from nature, by Mr. Sprague, and from the living plant whenever that is practicable. In almost every instance, the whole plant, or a branch or smaller portion, in flower, and often also in fruit, is delineated of the natural size; and the microscopical analyses, as numerous as the compass of an octavo page will allow, are so chosen as to display the principal floral characters of the genus, from the æstivation of the flower-bud to the fruit, the seed, and the embryo. When needful, on account of size or of subgeneric diversity, two plates are devoted to the illustration of a single genus. On the other hand, characters which are uniform or nearly so throughout a whole order are not repeated upon every plate."

The arrangement adopted, is that generally received at the present time among botanists. The volume issued, the first of the ten in preparation, commences with the Ranunculaceæ or Ranunculus family, and continues through the Portulacaceæ. Each genus is taken up in succession, its description given with fullness, accompanied by synonyms, references, etymological remarks, a brief statement of medicinal properties, observations on geographical distribution, &c.

The author's name is a sufficient guaranty for the science of the text. The illustrations by Mr. Sprague occupying 100 octavo plates, are correct and chaste in style, and of high scientific excellence, satisfying the desires both of the eye of taste and of scrutinizing science. Prof. Gray observes in his preface—

"The higher character of the later as compared with the earlier executed analyses, as well as the further improvement which will be manifest to the experienced botanist in the second volume,—now in an advanced state of preparation,—is attributable to the increasing botanical knowledge of the self-taught artist who is associated with me in the work. And, although I am alone responsible for the text, I must in justice add, that whatever of original value these illustrations may be found to possess is largely owing to the scientific insight and the careful investigations of Mr. Sprague, as well as to his skill and accuracy in delineation."

As the plants selected for illustration belong to typical species, they serve to convey to the mind a general idea of each group, and thus they accomplish more than the most detailed description.

The "Genera Illustrata," is American in subject; and the name of Prof. Gray has long been associated with American botany. The publication of such a work with so numerous plates, must have been attended with much labor and expense; and it remains for the American public to sustain the authors in their great undertaking. Public libraries, and all teachers of the science should possess the work; and the student will find his studies greatly promoted by connecting it with the Botanical Manual.

8. *Manual of Mineralogy, including Observations on Mines, Rocks, Reduction of Ores, and the application of the Science to the Arts, with* 260 *illustrations; designed for the use of Schools and Colleges;* by JAMES D. DANA, A.M., &c., 430 pp. 12mo. New Haven: Durrie & Peck. 1848.—This Manual is intended for instruction in scientific and practical Mineralogy, and especially for the American student. The usual introduction on structure and physical and chemical characters, much simplified, occupies the first seventy-five pages, after which commence the descriptions of species. The work embraces all American minerals and such others as are of importance; while the rarer species are only briefly noticed in smaller type. The arrangement adopted, places the ores of the same metal together. This order is required by the practical mineralogist, and considering the convenience of it for conveying economical information, it has many advantages for the ordinary purposes of instruction. The descriptions of the ores of a metal are preceded by a paragraph giving briefly their general characteristics; after the descriptions, there are remarks on the distribution of the more important ores and mines,—the modes of assay and reduction,—the uses of the metal—besides other facts of a historical and statistical nature. In describing other minerals also, and the various rocks, their applications in the arts are mentioned, and as far as practicable in a small manual, the modes of use are explained.

The descriptions of the species of minerals are followed by a chapter on rocks—a catalogue of American localities of minerals brought down to the present time, convenient for the mineralogical tourist—a brief notice of foreign mining regions—description of mineralogical implements—values of American and foreign weights, measures and coins—and tables for the determination of minerals.

The Manual contains also a glossary, and a full Index.

9. *The British Desmidieæ;* by JOHN RALFS, M.R.C.S., &c., with drawings by EDWARD JENNER, A.L.S. 1 vol. 8vo. pp. 226, with 35 colored plates. London: 1848.—This beautiful volume should be in the hands of all lovers of the microscope. Every page of it bears evidence to the zeal and accurate research of its author, who is already most favorably known by his able papers on the Diatomaceæ and Desmidieæ, published in the Annals and Magazine of Natural History. It is not a work of merely local interest, but owing to the cosmopolite character of the Desmidieæ, it will be as serviceable to the American as the British student. It includes figures and descriptions not only of all the British species, with their localities as far as known in Europe and America, but in order to make the work as complete as possible, de Brebisson and Kützing have contributed their recent discoveries with regard to the European forms, while figures and descriptions of many curious American species never before published, have been supplied by Prof. Bailey. The plates which adorn this volume are far superior in their execution to any thing of the kind which has yet appeared; and in addition to representations of the different species in various positions, they contain highly interesting figures of the sporangia recently detected by the author. In the introduction to the work will be found

a full account of the conjugation of the Desmidieæ; an able argument in favor of their vegetable nature, together with directions for collecting and preserving specimens. We cordially recommend the volume as one of rare merit. J. W. B.

10. *The Patent Office Report for the year* 1847. Referred to the Committee of Patents, March 3, 1848. 662 pp. 8vo. *Washington.*—The Patent Office Report has become a voluminous document, stored with valuable information of recent date bearing upon science and the arts. The volume issued during the present year under the auspices of Hon. Edmund Burke, Commissioner of Patents, contains, besides records of various patents, information relative to the crops of the past year in this country and Europe, various articles on practical agriculture, the growth and treatment of the sugar cane, flax, rice, silk, &c.; herds of cattle, sheep, making of butter; indeed, a thousand things important to the agriculturalist. There is besides an excellent account of the German Agricultural schools, their modes of farming, wool culture, best merino sheep, &c., illustrated with figures, besides plans of buildings, sheep stables, &c., prepared by C. L. Fleischman, Esq., as the result of observations during a visit to Germany in 1844, '45. The volume closes with statistics relating to the agriculture and commerce of different parts of the United States. In the preceding pages we have made some citations from this volume.

T. L. Mitchell: Journal of an Expedition into the interior of Tropical Australia. 8vo, pp. 454, with illustrations. *London.* Cloth. 12*s.*

Report of the Seventeenth Meeting of the British Association for the Advancement of Science, held at Oxford in June, 1847. *London*, 1848.

R. Chambers: Ancient Sea Margins, as memorials of Changes in the relative level of Sea and Land; by Robert Chambers, Esq., F.R.S.E. 338 pp. 8vo, with maps and illustrations. *Edinburgh*, 1848.

H. B. Leeson: On Crystallography, with a description of a new double refracting Goniometer and Crystallonome. 75 pp. 8vo. *London*, 1848.

Mary Somerville: Physical Geography; two vols. *London*, 1848.

Transactions of the Geological Society, vol. vii.—*Mr. Hopkins* on the Geological Structure of the Wealden District—*Mr. Bain* on Fossil Remains in South Africa—*Professor Owen* on the Dicynodon—*Mr. Kaye* and *Prof. E. Forbes* on the Cretaceous Fossils of Southeastern India.

Erman, A.: Archiv für wissenschaftliche Kunde von Russland. vol. iv, 8vo.

Scheerer, Th.: Lehrbuch der Metallurgie. 8vo.

Combes, M.: Traité de l'Exploitation des Mines. 3 vols. 8vo, with a folio atlas.

Saint-Claire Deville: Voyage Geologique aux Antilles. 4to.

L. Agassiz et E. Desor: Catalogue Raisonné des Familles, des Genres, et des Espèces de la Classe des Echinodermes. 168 pp. 8vo, with a large plate. (Extrait des Annales des Sciences Naturelles, 3e. ser., Tomes vi, vii, et viii.)

De Koninck: Recherches sur les Animaux Fossiles. 1re partie, Monographie des genres Productus et Chonetes, prepared for publication.

M. Spring: Monographie de la famille des Lycopodiacées.

Zantedeschi: *Raccolta Fisico-chimica Italiana*, Venise, 1846, 1847. This is a volume of memoirs on various subjects connected with physical and natural science; on Astronomical, by Plana, Santini, Colla; on Electricity and Magnetism, by Marianini, Botto, Fusinieri, Zamboni, Zantedeschi,—and other distinguished savants on other topics. A second volume is announced as in the press.

Fr. von Kobell: Die Mineralogie leicht fasslich dargestelt mit Rücksicht auf das Vorkommen der Mineralien, ihre technische Benutzung, ausbringen der Metalle, etc.: 8vo, 211, Taf. 1. *Nürnberg*, bey Schrag. 1847.

F. Berge: Taschenbuch für Käser- und Schmetterlings-Sammler. 8vo, pp. 360, pl. 2. *Stuttgart*, bey Hoffman. 1847.

C. Reclam: De plumarum pennarumque evolutione disquisitio microscopica. 8vo. 36 pp. tab. 3. 1846.

David Low: An Inquiry into the Nature of the simple bodies of Chemistry. 1 vol. 8vo, pp. 344. *London*, 1848.

C. Woodward: A familiar Introduction to the study of Polarized light, illustrated by numerous wood engravings. 40 pp. *London*, 1848.

Proc. Amer. Acad. Arts and Sci. Boston.—*Jan.* 26, 1848. p. 301. Conditions for awarding the medal offered by the King of Denmark.—*Feb.* 1. p. 302. On the relations of the chemical formulas of sweet substances, also of acid substances; *Prof. Horsford.*—*March* 7. p. 307. On ventilating apparatus; *M. Wyman.*—p. 325. Results on some recent observations on Jupiter, and on the nebulæ of Herschel, Nos. 1357 and 1376, and the great nebula of Orion; *Mr. Bond.*—*Ap.* 4. p. 327. On Jupiter, continued; *Mr. Bond.*—p. 329. A meteor seen at Nantucket; *Mr. Mitchell.*—p. 331. Corrections of the elliptic elements of Neptune; *S. C. Walker.*—p. 338. Observations on Neptune; *Prof. Peirce.* [This number closes vol. i. of the Proceedings, embracing from May, 1847, to May, 1848.]

Proc. Acad. Nat. Sci. Philadelphia, vol. iv.—*May* 2, 1848. p. 57. On the Dorudon; *R. W. Gibbes.*—*May* 30. p. 59. On two new species of Onychocephalus from the west coast of Africa, with a plate; *E. Hallowell.*—p. 62. Notes of the post mortem appearances of a Cynocephalus papion; *E. Hallowell.*—p. 63. Notes on some Mexican birds; *G. A. McCall.*—*June* 27. p. 65. New birds of the genera Vidua, Euplectus, Pyrenestes and Pitylus; *J. Cassin.*

Annales des Sciences Naturelles, Paris.—DEC., 1847. On the organization of Vermes; *E. Blanchard.*—Description and anatomy of a larve of Hydropsichus having external branchiæ; *L. Dufour.*—Echinodermata; *Agassiz* and *Desor.*—Note on the Oribasia stagnalis, a new Bryozoa; *Duchassaing.*—Observations on the pith of ligneous plants; *A. Guillard* (continued).—New plants from Colombia; *L. R. Tulasne.*—Second memoir on the organogeny of irregular corolla; *M. Barnéoud.*—On the buds and inflorescence of the linden (Tilia); *Brunner* and *A. de Candolle.*—Methodical distribution of the Uredineæ; *J. H. Léveillé.*—Conspectus of the genus Reaumuria; *Jaubert* and *Spach.*—JANVIER, 1848. Structure and functions of the vitelline appendages and umbilical vesicle of the Hen; *A. Courty.*—On the development of the egg and embryon of the "Taret"; *A. de Quatrefages.*—Researches on Zoophytes ("Les Polypiers"); *Milne Edwards* and *Jules Haime.*—On the causes limiting species of plants of the coast on the north of Europe and analogous regions; *A. de Candolle.*—On the adventitious buds of the Cardamine latifolia; *A. de St. Hilaire.*—On the impregnation of the Dischidia; *Griffith.*—Development of the embryo of the Orchis morio; *H. Mohl.*—On the development of the vegetable embryo; *C. Muller.*—On the Diatomaceæ; *G. H. K. Thwaites.*—A new species of the genus Sarothamnus; *P. B. Webb.*

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XXVIII.—*Explanations and Illustrations of the plan of the Smithsonian Institution;* by Prof. HENRY, LL.D., Sec. Smithsonian Institution.*

ALTHOUGH the leading propositions of the programme of the Smithsonian Institution have been fully discussed by the Board, yet it will be important to offer some remarks in explanation and illustration of them.

That the institution is not a national establishment, in the sense in which institutions dependent on the government for support are so, must be evident when it is recollected that the money was not absolutely given to the United States, but intrusted to it for a special object, namely: the establishment of an institution for the benefit of men, to bear the name of the donor, and, consequently, to reflect upon his memory the honor of all the good which may be accomplished by means of the bequest. The operations of the Smithsonian Institution ought, therefore, to be mingled as little as possible with those of the government, and its funds should be applied exclusively and faithfully to the increase and diffusion of knowledge among men.

That the bequest is intended for the benefit of men in general, and that its influence ought not to be restricted to a single district, or even nation, may be inferred not only from the words of the will, but also from the character of Smithson himself; and I beg leave to quote, from a scrap of paper in his own hand,

* The programme of the Smithsonian Institution, from the recent Report, is published on page 289. The article here presented our readers, follows that programme in the Report.

the following sentiment bearing on this point: "The man of science has no country; the world is his country—all men, his countrymen." The origin of the funds, the bequest of a foreigner, should also preclude the adoption of a plan which does not, in the words of Mr. Adams, "spread the benefits to be derived from the institution not only over the whole surface of this Union, but throughout the civilized world." "Mr. Smithson's reason for fixing the seat of his institution at Washington obviously was, that *there* is the seat of government of the United States, and *there* the Congress by whose legislation, and the Executive through whose agency, the trust committed to the honor, intelligence and good faith of the nation, is to be fulfilled." The centre of operations being permanently fixed at Washington, the character of this city for literature and science will be the more highly exalted in proportion as the influence of the institution is more widely diffused.

That the terms *increase* and *diffusion* of knowledge are logically distinct, and should be literally interpreted with reference to the will, must be evident when we reflect that they are used in a definite sense, and not as mere synonymes, by all who are engaged in the pursuits to which Smithson devoted his life. In England there are two classes of institutions, founded on the two ideas conveyed by these terms. The Royal Society, the Astronomical, the Geological, the Statistical, the Antiquarian Societies, all have for their object the increase of knowledge; while the London Institution, the Mechanics' Institution, the Surry Institution, the Society for the Diffusion of Religious Knowledge, the Society for the Diffusion of Useful Knowledge, are all intended to diffuse or disseminate knowledge among men. In our own country, also, the same distinction in the use of the terms is observed by men of science. Our colleges, academies, and common schools, are recognized as institutions partially intended for the diffusion of knowledge, while the express object of some of our scientific societies is the promotion of the discovery of new truths.

The will makes no restriction in favor of any particular kind of knowledge; though propositions have been frequently made for devoting the funds exclusively to the promotion of certain branches of science having more immediate application to the practical arts of life, and the adoption of these propositions has been urged on the ground of the conformity of such objects to the pursuits of Smithson; but an examination of his writings will show that he excluded from his own studies no branch of general knowledge, and that he was fully impressed with the important philosophical fact, that all subjects of human thought relate to one great system of truth. To restrict, therefore, the operations of the institution to a single science or art, would do injustice to the character of the donor, as well as to the cause of general knowledge. If preference is to be given to any branches of research, it should be to the higher, and apparently more abstract; to the discovery of new principles, rather than of isolated facts. And this is true even in a practical point of view. Agriculture would have for ever remained an empirical art, had it not been for the light shed upon it by the atomic theory of chemistry; and incomparably more is to be expected as to its future advancement from the perfection of the microscope, than from improvements in the ordinary instruments of husbandry.

The plan of increasing and diffusing knowledge, presented in the first section of the programme, will be found in strict accordance with the several propositions deduced from the will of Smithson, and given in the introduction. It embraces, as a leading feature, the design of interesting the greatest number of individuals in the operations of the institution, and of spreading its influence as widely as possible. It forms an active organization, exciting all to make original researches who are gifted with the necessary power, and diffusing a kind of knowledge, now only accessible to the few, among all those who are willing to receive it. In this country, though many excel in the application of science to the practical arts of life, few devote themselves to the continued labor and patient thought necessary to the discovery and development of new truths. The principal cause of this want of attention to original research, is the want, not of proper means, but of proper encouragement. The publication of original memoirs and periodical reports, as contemplated by the programme, will act as a powerful stimulus on the latent talent of our country, by placing in bold relief the real laborers in the field of original research, while it will afford the best materials for the use of those engaged in the diffusion of knowledge.

The advantages which will accrue from the plan of publishing the volumes of the Smithsonian Contributions to Knowledge, are various. In the first place, it will serve to render the name of the founder favorably known wherever literature and science are cultivated, and to keep it in continual remembrance with each succeeding volume, as long as knowledge is valued. A single new truth, first given to the world through these volumes, will forever stamp their character as a work of reference. The contributions will thus form the most befitting monument to perpetuate the name of one whose life was devoted to the increase of knowledge, and whose ruling passion, strong in death, prompted the noble bequest intended to facilitate the labors of others in the same pursuit.

Again, the publication of a series of volumes of original memoirs will afford to the institution the most ready means of entering into friendly relations and correspondence with all the learned societies in the world, and of enriching its library with their current transactions and proceedings. But perhaps the most important effect of the plan will be that of giving to the world many valuable memoirs, which, on account of the expense of the illustrations, could not be otherwise published. Every one who adds new and important truths to the existing stock of knowledge, must be of necessity, to a certain degree, in advance of his age. Hence the number of readers and purchasers of a work is generally in the inverse ratio of its intrinsic value; and consequently, authors of the highest rank of merit are frequently deterred from giving their productions to the world on account of the pecuniary loss to which the publication would subject them. When our lamented countryman, Bowditch, contemplating publishing his commentary on La Place, he assembled his family and informed them that the execution of this design would sacrifice one-third of his fortune, and that it was proper his heirs should be consulted on the subject which so nearly concerned them. The answer was worthy of the children of such a father: "We value," said they, "your reputation more than your money." Fortunately, in this instance, the means of making such a sacrifice existed; otherwise one of the proudest monuments of American science could not have been given to the world. In the majority of cases, however, those who are most capable of extending human knowledge are least able to incur the expense of the publication. Wilson, the American Ornithologist, states, in a letter to Michaux, that he has sacrificed everything to publish his work: "I have issued," he says, "six volumes, and am engaged on the seventh, but as yet I have not received a single cent of the proceeds." In an address on the subject of natural history, by one of our most active cultivators of this branch of knowledge, we find the following remarks, which are directly in point: "Few are acquainted with the fact that from the small number of scientific works sold, and the great expense of plates, our naturalists not only are not paid for their labors, but suffer pecuniary loss from their publications. Several works on different branches of zoology, now in the course of publication, will leave their authors losers by an aggregate of $15,000. I do not conclude in this estimate works already finished—one, for instance, the best contribution to the natural history of man extant, the publication of which will occasion its accomplished author a loss of several thousand dollars. A naturalist is extremely fortunate if he can dispose of two hundred copies of an illustrated work, and the number of copies printed rarely exceeds two hundred and fifty." It may be said that these authors have their reward in the reputation which they thus purchase; but reputation should be the result of the talents and labor expended in the production of a work, and should not in the least depend upon the fact that the author is able to make a pecuniary sacrifice in giving the account of his discoveries to the public.

Besides the advantage to the author of having his memoir published in the Smithsonian Contributions free of expense, his labors will be given to the world with the stamp of approval of a commission of learned men; and his merits will be generally made known through the reports of the institution. Though the premiums offered may be small, yet they will have considerable effect in producing original articles. Fifty or a hundred dollars awarded to the author of an original paper, will, in many instances, suffice to supply the books, or to pay for the materials, or the manual labor required, in prosecuting the research.

There is one proposition of the programme which has given rise to much discussion, and which, therefore, requires particular explanation: I allude to that which excludes from the contributions all papers consisting merely of unverified speculations on subjects of physical science. The object of this proposition is to obviate the endless difficulties which would occur in rejecting papers of an unphilosophical character; and though it may in some cases exclude an interesting communication, yet the strict observance of it will be found of so much practical importance that it cannot be dispensed with. It has been supposed, from the adoption of this proposition, that we are disposed to undervalue abstract speculations: on the contrary, we know that all the advances in true science—namely, a knowledge of the laws of phenomena—are made by provisionally adopting well-conditioned hypotheses, the product of the imagination, and subsequently verifying them by an appeal to experiment and observation. Every new hypothesis of scientific value must not only furnish an exact explanation of known facts, but must also enable us to predict, in kind and quantity, the phenomena which will be exhibited under any given combination of circumstances. Thus, in the case of the undulatory hypothesis of light, it was inferred, as a logical consequence, that if the supposition were true that light consisted of waves of an ethereal medium, then two rays of light, like two waves of water under certain conditions, should annihilate each other, and darkness be produced. The experiment was tried, and the anticipated result was obtained. It is this exact agreement of the deduction with the actual result of experience that constitutes the verification of an hypothesis, and which alone entitles it to the name of a theory, and to a place in the Transactions of a scientific institution. It must be recollected that it is much easier to speculate than to investigate, and that very few of all the hypotheses imagined are capable of standing the test of scientific verification.

For the practical working of the plan for obtaining the character of a memoir, and the precaution taken before it is accepted for publication, I would refer to the correspondence, given in a subsequent part of this report, relative to the memoir now in process of publication by the institution. As it is not our intention to interfere with the proceedings of other institutions, but to coöperate with them, so far as our respective operations are compatible, communications may be referred to learned societies for inspection, as in the case of the above mentioned memoir, and abstracts of them given to the world through the bulletins of these societies, while the details of the memoirs and their expensive illustrations are published in the volumes of the Smithsonian Contributions. The officers of several learned societies in this country have expressed a willingness to coöperate in this way.

Since original research is the most direct way of increasing knowledge, it can scarcely be doubted that a part of the income of the bequest should be appropriated to this purpose, provided suitable persons can be found, and their labors be directed to proper objects. The number, however, of those who are capable of discovering scientific principles is comparatively small; like the poet, they are "born, not made," and, like him, must be left to choose their own subject, and wait the fitting time of inspiration. In case a person of this class has fallen on a vein of discovery, and is pursuing it with success, the better plan will be to grant him a small sum of money to carry on his investigations, provided they are considered worthy of assistance by competent judges. This will have the double effect of encouraging him in the pursuit, and of facilitating his progress. The institution, however, need not depend upon cases of this kind, even if they were more numerous than they are, for the application of its funds in the line of original research. There are large fields of observation and experiment, the cultivation of which, though it may afford no prospect of the discovery of a principle, can hardly fail to produce results of importance both in a practical and a theoretical point of view. As an illustration of this remark, I may mention the case of the investigations made a few years ago by committees of the Franklin Institute, of Philadelphia. The Secretary of the Treasury of the United States placed at the disposal of this society a sum of money, for the purpose of making experiments with reference to the cause of the explosion of steam boilers. A committee of the society was chosen for this purpose, which adopted the ingenious plan of writing to all persons in the United States engaged in the application of steam, and particularly to those who had observed the explosion of a steam boiler. In this way opinions and suggestions in great variety, as to the cause of explosions, were obtained. The most plausible of these were submitted to the test of experiment: the results obtained were highly important, and are to be found favorably mentioned in every systematic work on the subject of steam which has appeared, in any language, within the last few years. New and important facts were established; and, what was almost of as much consequence, errors which had usurped the place of truth were dethroned.

In the programme, examples were given of a few subjects of original research to which the attention of the institution may be turned. I will mention one in this place, which in connexion with the contents of our first memoir, may deserve immediate attention. I allude to a small appropriation made annually for researches with reference to the remains of the ancient inhabitants of our country. This is a highly interesting field, and what is done in regard to it should be done quickly. Every year the progress of civilization is obliterating the ancient mounds, cities and villages are rising on the spots they have so long occupied undisturbed, and the distinctive marks of these remains are every year becoming less and less legible.

In carrying out the spirit of the plan adopted, namely, that of affecting men in general by the operations of the institution, it is evident that the principal means of diffusing knowledge must be the *press*. Though lectures should be given in the city in which Smithson has seen fit to direct the establishment of his institution, yet, as a plan of general diffusion of knowledge, the system of lectures would be entirely inadequate; every village in our extended country would have a right to demand a share of the benefit, and the income of the institution would be insufficient to supply a thousandth part of the demand. It is also evident that the knowledge diffused should, if possible, not only embrace all branches of general interest, so that each reader might find a subject suited to his taste, but also that it should differ in kind and quality from that which can be readily obtained through the cheap publications of the day. These requisites will be fully complied with in the publications of the series of reports proposed in the programme. A series of periodicals of this kind, posting up all the discoveries in science from time to time, and giving a well digested account of all the important changes in the different branches of knowledge, is a desideratum in the English language. The idea is borrowed from a partial plan of this kind in operation in Sweden and Germany; and for an example of what the work should be, I would refer to the annual report to the Swedish Academy of its perpetual Secretary, Berzelius, on physical science. The reports can be so prepared as to be highly interesting to the general reader, and at the same time of great importance to the exclusive cultivator of a particular branch of knowledge. Full references should be given, in foot-notes, to the page, number, or volume of the work from which the information was obtained, and where a more detailed account can be found. It is scarcely necessary to remark, that the preparation of these reports should be intrusted only to persons profoundly acquainted with the subjects to which they relate—namely, to those who are devoted to particular branches, while they possess a knowledge of general principles. Sufficient explanations should be introduced to render the report intelligible to the general reader, without destroying its scientific character. Occasionally reports may be obtained from abroad—as, for example, accounts of the progress of certain branches of knowledge in foreign countries—and these may be translated if necessary, and incorporated into other reports, by some competent person in this country.

Besides the reports on the progress of knowledge, the programme proposes to publish occasionally brief treatises on particular subjects. There are always subjects of general interest, of which brief expositions would be of much value. The preparation of these, however, should be intrusted to none but persons of character and reputation, and should be subjected to a revision by competent and responsible judges before they are given to the public. They may be presented in the form of reports on the existing state of knowledge relative to a given subject, and may sometimes consist of memoirs and expositions of particular branches of literature and science, translated from foreign languages. The reports and treatises of the institution, sold at a price barely sufficient to pay the expense of printing, will find their way into every school in our country, and will be used not as first lessons for the pupil, but as sources of reliable information for the teacher.

The second section of the programme gives, so far as they have been made out, the details of the part of the plan of organization directed by the act of Congress establishing the institution. The two plans, namely, that of publication and original research, and that of collections of objects of nature and art, are not incompatible, and may be carried on harmoniously with each other. The only effect which they will have on one another is that of limiting the operation of each, on account of the funds given to the other. Still with a judicious application, and an economical expenditure of the income, and particularly by rigidly observing the plan of finance, suggested by Dr. Bache, in the construction of the building, much good may be effected in each of the two branches of the institution. To carry on the operations of the first, a working library will be required, consisting of the past volumes of the transactions and proceedings of all the learned societies in every language. These are the original sources from which the most important principles of the positive knowledge of our day have been drawn. We shall also require a collection of the most important current literature and science for the use of the collaborators of the reports; most of these, however, will be procured in exchange for the publications of the institution, and therefore will draw but little from the library fund. For other suggestions relative to the details of the library, I would refer to the communication from Professor Jewett, Assistant Secretary, acting as Librarian.

The collections of the institution, as far as possible, should consist of such articles as are not elsewhere to be found in this country, so that the visitors at Washington may see new objects, and the spirit of the plan be kept up, of interesting the greatest possible number of individuals. A perfect collection of all objects of nature and of art, if such could be obtained and deposited in one place, would form a museum of the highest interest; but the portion of the income of the bequest which can be devoted to the increase and maintenance of the museum, will be too small to warrant any attempt towards an indiscriminate collection. It is hoped that in due time other means may be found of establishing and supporting a general collection of objects of nature and art at the seat of the general government, with funds not derived from the Smithsonian bequest. For the present, it should be the object of the institution to confine the application of the funds, first, to such collections as will tend to facilitate the study of the memoirs which may be published in the Contributions, and to establish their correctness; secondly, to the purchase of such objects as are not generally known in this country, in the way of art, and the illustration of antiquities, such as models of buildings, &c.; and, thirdly, to the formation of a collection of instruments of physical research, which will be required both in the illustration of new physical truths, and in the scientific investigations undertaken by the institution.

Much popular interest may be awakened in favor of the institution at Washington, by throwing the rooms of the building open, on stated evenings during the session of Congress, for literary and scientific assemblies, after the manner of the weekly meetings of the Royal Institution in London. At these meetings, without the formality of a regular lecture, new truths in science may be illustrated, and new objects of art exhibited. Besides these, courses of lectures may be given on particular subjects by the officers of the institution, or by distinguished individuals invited for the purpose.

Commencement of the operations of the Institution.—I was authorized, in connexion with the Committee on Organization, to commence the publication of the Smithsonian Contributions to Knowledge, and to receive any memoir which might be presented on any subject, provided it was found, on examination, to furnish an interesting addition to the sum of human knowledge, resting on original research. The first memoir presented, and found to be of the character prescribed by the resolution of the Board, was one on the remains of the ancient inhabitants of the North American continent. It contains the result of several years' labor in the survey and exploration of the mounds and earthworks of the Mississippi valley, and will furnish a highly interesting addition to the antiquities of our country, which could not have been given to the world, but for the timely aid extended to it by this institution. The memoir was referred to the American Ethnological Society, with a request that a committee of its members might be appointed to examine and report on its character, as to fitness for publication in the Smithsonian Contributions to Knowledge. On the favorable report of this committee, and on the responsibility of the Society, the memoir has been accepted for publication. * * * *

The memoirs of Messrs. Squier and Davis will occupy the greater portion, if not the whole, of the first volume of the Contributions. The illustrations will consist of fifty-five quarto plates of the mounds, earthworks, and maps of the adjacent country; also, of about two hundred wood-cuts, principally delineations of the various articles found in the mounds. Those who consider no branch of knowledge of any value but such as relates to the immediate gratification of our physical wants, have objected to the acceptance of this memoir as one of the first publications of the institution; but it must be recollected that the will of Smithson makes no restriction in favor of any particular kind of knowledge, and that each branch is, therefore, entitled to a share of his bequest. The Ethnological memoir of Messrs. Squier and Davis was the first, of the proper character, presented for publication, and hence it was entitled to the first place in the series of Smithsonian Contributions. Besides this, it furnishes an addition to a branch of knowledge which is at this time occupying the attention of a large class of minds, and which cannot fail to be interesting to every intelligent person who would learn something of the changes to which man has been subjected.

One of the volumes of the Contributions will contain a sketch of the life of Smithson, by the Chancellor. The materials for this have been collected from the several volumes of the Transactions of the Royal Society, and the scientific journals of the beginning of the present, and the latter part of the last century. The first volume will be published as soon as the wood-cuts and plates, now in the course of preparation, are finished.

Besides the memoirs before mentioned, a number of others have been presented, some of which though apparently of interest, and the product of thought and labor, were not of the character required by the resolution of the Board, and these have either been returned to the authors, or are in the possession of the Secretary. A number of others have also been provisionally adopted, or are in the course of preparation. Some of these are on the most abstruse parts of physical science, and all will do honor to the intellectual character of our country. Though the number of original memoirs which will be found worthy of a place in the Contributions will probably not be large, yet it will, perhaps, be best to set apart a definite portion of the income of the bequest—as, for example, at present three or four thousand dollars annually—to defray the expense of this part of the plan of increasing knowledge. A considerable portion, however, of the sum thus expended will be returned to the institution in the form of additions to its library. I may also suggest, in this place, the propriety of the adoption, by the board, of the resolution inviting all engaged in original research, to send the results of their labors for publication in the Smithsonian Contributions.

The Board also directed me to commence the collection of apparatus, and I accordingly sent orders to Europe, to the amount of twelve hundred dollars, for the purchase of such articles as could not be procured in the United States. Most of the instruments have been received, and will be found of importance, not only in the way of original research, but also in illustrating some of the most interesting and recent phenomena of physical science, as well as serving as samples for imitation to the artists of this country. It was thought that these articles would be admitted free of duty, and a petition to this effect was presented to the Secretary of the Treasury; but, though this officer is well known to be much interested in the prosperity of the institution, such is the nature of the law that the duty could not be remitted.

There is an article of apparatus which, within a few years past, has opened almost a new world of research in the phenomena of life and organization, the use of which is now indispensable in advancing our knowledge of physiology and its kindred branches of science. I allude to the achromatic microscope, to increase the power of which, the artists of Germany, France, and England have vied with each other. On account of the small number of persons who are capable of constructing the proper lenses, the best specimens of this instrument are very scarce in this country, and can be procured only at a great expense. Under these circumstances, it was a matter of much interest to learn, from a source which could be relied upon, that an individual in the interior of the state of New York had successfully devoted himself to the study of the microscope, and that he was able to produce instruments of this kind which would compete with the best of those constructed in Europe. In order to do justice to the talents and labors of this person, as well as to furnish the institution with a valuable instrument of research, I requested him to construct a microscope, to be paid for out of the funds for the purchase of apparatus, provided that a commission, appointed by myself, should find it capable of producing certain effects. This proposition was accepted, and the result will probably be given to the Board at the next meeting.

Preparations have also been made for instituting various lines of physical research. Among the subjects mentioned in the programme as an example for the application of the funds of the institution, is terrestrial magnetism. I need scarcely say that this is a subject not only of high interest in a theoretical point of view, but also in its direct reference to navigation and the various geodetical operations of civil and military life. A resolution of Congress, authorizing the exploration of the mineral lands adjacent to the great lakes, has given to us the means of advancing this branch of knowledge with but little expenditure of the funds of the institution. The Secretary of the Treasury readily agreed to the proposition that there should be added to the mineralogical and geological surveys of these regions, determinations of the dip, the variation, and the intensity of the magnetic forces, provided that the Smithsonian Institution would furnish one set of the instruments, and take charge of the direction of the observations, and of reducing and publishing them. In the survey of the mineral lands in the vicinity of lake Michigan under Dr. Jackson, Dr. Locke, of Cincinnati, has been employed with his own apparatus; and to supply the necessary instruments for the survey in Wisconsin, preliminary steps have been taken to procure other instruments from London.

Another subject of research mentioned in the programme, and which has been urged upon the immediate attention of the institution, is that of an extensive system of meteorological observations, particularly with reference to the phenomena of American storms. Of late years, in our country, more additions have been made to meteorology than to any other branch of physical science. Several important generalizations have been arrived at, and definite theories proposed, which now enable us to direct our attention, with scientific precision, to such points of observation as cannot fail to reward us with new and interesting results. It is proposed to organize a system of observations which shall extend as far as possible over the North American continent; and in order to this, it will be necessary to engage the coöperation of the British government. I have accordingly addressed a letter on this subject to Lieutenant Colonel Sabine, Corresponding Secretary of the Royal Society, who assures me that, as soon as the plan is fully matured for this country, there will be no difficulty in establishing a system of corresponding observations in the British provinces. I have also addressed letters to several gentlemen distinguished for their attainments in meteorology, asking for suggestions as to the plan of observation; and I beg leave to refer the Board to the report of Prof. Loomis, of New York University, and also to the communication of Prof. Espy, received in answer. The former contains an exposition of the advantages which may be derived from the study of meteorology, and what has been done in this branch of science in this country, and what encouragement there is for the further prosecution of the same subject, together with a general plan of operations. The present time appears to be peculiarly auspicious for commencing an enterprise of the proposed kind. The citizens of the United States are now scattered over every part of the southern and western portion of North America, and the extended lines of telegraph will furnish a ready means of warning the more northern and eastern observers to be on the watch for the first appearance of an advancing storm.

Art. XXIX.—*On a New empirical Formula for ascertaining the Tension of Vapor of Water at any Temperature;* by J. H. Alexander, Esq.

(Concluded from page 223.)

In the last number of this Journal, I gave the formula itself, the principles from which it was deduced, and a comparison of results by it, with those by experiment at numerous identical temperatures. Want of room excluded then what remained to complete this Memoir, in shewing the probable errors of the formula as compared with the principal experiments, and with the probable errors affecting too those different series of experiments themselves. Such a discussion is the object of the present paper.

It was already said, in the preceding part, that the most proper mode of expressing these errors is by the linear scale of temperature; which both in theory is the most important, and in practice is the most accessible and usual. In this last aspect, it is on this scale too where errors of observation are the most easy to be made, and likely to occur. With this view, the formula need be repeated here only in its converse form, (i. e., for ascertaining temperatures from given pressures,) as under:

$$t^{\circ}\text{ Fahr.} = 180\sqrt[6]{p} - 105^{\circ}{\cdot}13\,;$$

p being in inches of mercury: and

$$t^{\circ}\text{ Fahr.} = 317{\cdot}13\sqrt[6]{p'} - 105^{\circ}{\cdot}13\,;$$

p' being in atmospheres at 32°.

As this will have to be frequently applied for interpolation throughout the following discussion, it may be as well to remark here, once for all, in justification of such application, that there need be no apprehension of its affecting the results; for it is easy to see, by inspecting a few instances taken at random from the table, that the rational deviation of the formula (i. e., the difference between calculated and observed pressures) is, for small differences of temperature, either null, or so remote a fraction as to be inappreciable in the calculation.

In applying this formula, I shall take up the principal series of experiments separately, beginning with the most recent; and shall then make assemblage of the mean results.

1. *Experiments of Mr. Regnault.*—To deduce the absolute mean error of the numerous quantities of this observer, it would be obviously requisite to take up each experiment;—a labor of which I am by no means ambitious, and which would be disproportionate at once to what is admissible in the other series presently to be noticed, and to the present aim. I shall, therefore, in all, only make use of short general methods which, without laying claim to the accuracy of geometrical refinements, will yet be recognized as having foundation in the theory of mathematical probabilities; and will, by their popular form, recommend themselves the more readily to the convictions of those who are chiefly conversant with steam in practice, and for whose benefit the whole of the present discussion is mainly intended.

It is obvious, then, in the first place, that the idea of freedom from error is associated with symmetry in the results. Such symmetry will always be observable in quantities that progress (as natural quantities may be assumed to do) according to some constant law; and as, in our ignorance of what the true law is in this case, all that we can deal with is *relative* symmetry, it is of no importance what law or formula we take as the other term of comparison, provided there be no material difference between the origin and termination of the two. I shall therefore compare a few of Mr. Regnault's observations at the lower temperatures with the results of the present formula; as under:

Temp. (Fahr.)	Pressure in inches of Mercury.		Differences.
	Observed means.	Calculated.	
−27°·112	0*in*·01063	0*in*·00664	+0·00399
−13 · –	0 ·02047	0 ·01799	+0·00248
− 4 ·504	0 .02835	0 ·03055	−0·00220
+ 1 ·706	0 ·04567	0 ·04375	+0·00192
+ 9 ·41	0 ·06378	0 ·06643	−0·00265
17 ·402	0 ·09410	0 ·09111	+0·00299
23 ·702	0 ·12559	0 ·13451	−0·00892
27 ·626	0 ·15000	0 ·16106	−0·01106
32 · –	0 ·18111	0 ·19561	−0·01450

It is apparent then, that so far, these observations do not follow any uniform or symmetrical progression; and without pretending to criticize the experiments themselves, which doubtless have as much accuracy as the nature of the research admitted, it follows that, in spite of all the extraordinary tact and skill of the observer, there is yet *primâ facie* evidence against the absolute accuracy of the results. It is to be remarked upon the column of temperatures, both here and hereafter, that the remote decimals result from the reduction of Centigrade degrees to those of Fahrenheit, and are preserved because they added to the accuracy, while they did not increase the labor of the calculation. Nevertheless, the thermometer of Mr. Regnault could be read directly to the $\frac{1}{50}$ of a degree Centigrade, corresponding very nearly to $\frac{1}{25}$ of a degree Fahrenheit; and by estimation, to the next decimal place.

The temperatures of this table under 32° F., are lower than pressures have ever been observed at before, and rest upon single observations. They do not admit, therefore, of a comparison other than has been instituted. But the observations at 32° F., a temperature especially disengaged from instrumental errors, are, as has been already said, very numerous, and allow of being compared among themselves. Of the forty-seven observations, whose arithmetical mean pressure is given in the table, the

maximum was	0*in*·18485;	corresponding to a temp. by formula of	30°·72 Fahr.
and *minimum* "	0 ·17717	" " "	29 ·77 Fahr.
and the difference	0 ·00768	corresponding diff. of temp.	0 ·95

This difference shews a mean error in temperature, unaccounted for, of 0°·425 Fahr.; and a limiting error in pressure rather more than half the difference between the formula and the mean of all the observations.

In the various series of Mr. Regnault, the temperature is given sometimes by one thermometer only, and sometimes by two, and even four. Of these latter classes, I have taken out of each series the observation where the difference of reading of the several thermometers is the greatest, to serve for another comparison, as follows:

Series.	THERMOMETER. Maximum.	Minimum.	Differences.
A.	33°·61 Cent.	33°·49 Centigr.	0°·12 Cent.
B.	42 ·63	42 ·56	0 ·07
N.	43 ·64	42 ·84	0 ·81
O.	47 ·84	47 ·14	0 ·70
P.	47 ·87	47	0 ·87
Q.	91 ·25	91 ·06	0 ·19
R.	122 ·72	122 ·50	0 ·22
S.	110 ·72	110 ·64	0 ·08
T.	137 ·75	137 ·52	0 ·23
Mean temperat.	75°·154 Cent.;	mean difference	0°·366; corresponding with
" "	167°·277 Fahr.	" "	0°·659 Fahr.

This difference is that of the extremes; and as the mean error of any number of observations is as likely to be *plus* as *minus*, it is equivalent in this example to an absolute error of 0°·33 Fahr.

This error manifests itself in a series where the thermometric variations are the greatest. I shall now present another where these same differences, although not perhaps the lowest of all, are yet very much less than in the last. At least, this series (which in fact forms part of the Comparative Table in the preceding Memoir) was selected without any reference to the present investigation, and with a view to the introduction of the greatest number of accordant observations; and may be considered, therefore, as offering an impartial, if not favorable, term of comparison.

The mean temperatures are given here, as in our former Table, in degrees of Fahrenheit; the individual differences between the thermometer readings are, to save calculation, retained in centigrade degrees.

Mean temperatures. Fahrenheit.	Differences of thermomet. readings. Centigrade.
151°·124	0°·52
176 ·416	0 ·30
198 ·05	0 ·13
211 ·27	0 ·06
222 ·44	0 ·08
233 ·132	0 ·16
252 ·662	0 ·22
263 ·3	0 ·14
276 ·224	0 ·20
297 ·464	0 ·19

Mean difference 0°·20 Cent.; corresponding with mean temp. 228°·2 F.; " " 0°·36 Fah., which is equivalent to an absolute mean error of 0°·18 Fahr.

We have, then, for the mean error at	32° F. .	0°·42
" " "	at 167 .	0 ·33
" " "	at 228 .	0 ·18
the average of which, or		0°·31

is the probable amount of error, *plus* or *minus*, with which the various series of Mr. Regnault are still to be considered as affected.

Such being the error of the experiments, I shall now show, by the following table, the comparative error of the formula. The quantities in the column of differences, are considered as on the same side of the equation with the results from the formula; those marked + indicate, therefore, the *default*, while the sign — indicates the *excess* of the calculated temperatures.

Pressures in Inches.	Temperatures. Observed.	Temperatures. Calculated.	Differences.
0 *in* ·01063	−27°·112 F.	−20°·73 F.	+7°·38 Fah.
0 ·02047	−13	−10 ·98	+2 ·02
0 ·02835	− 4 ·504	− 5 ·74	−1 ·24
0 ·04567	+ 1 ·706	+ 2 ·49	−0 ·78
0 ·06738	+ 9 ·410	+ 8 ·65	+0 ·76
0 ·09410	+17 ·402	+16 ·27	+1 ·13
0 ·12559	+23 ·702	+22 ·25	+1 ·45
0 ·15000	+27 ·626	+26 ·08	+1 ·55 . . . +1°·53
0 ·18111	32°	30°·26	+1°·74
7 ·6977	151 ·124	147 ·80	+3 ·32
14 ·081	176 ·416	174 ·58	+1 ·84
22 ·538	198 ·050	197 ·38	+0 ·67
29 ·620	211 ·27	211 ·49	−0 ·22 . . . +1°·47
35 ·779	224°·44	221°·62	+2°·82
44 ·752	233 ·132	234 ·03	−0 ·90
63 ·333	252 ·662	254 ·24	−1 ·58
76 ·152	263 ·3	265 ·45	−2 ·15
93 ·859	276 ·224	278 ·59	−2 ·37
130 ·790	297 ·464	300 ·42	2 ·96 . . . −1°·19
	Mean difference,	. . . .	+0°·605

This mean difference (say 0°·61 Fahr.) is the error of the formula as compared with the observations above; which are themselves the mean of more than twice as many experiments, and which may be taken as representing impartially the whole range of Mr. Regnault's results. In arriving at this mean difference, I have arranged the several instances into groups whose individual means furnish the definitive general one. This is proper, in view of the different methods of experiment which the different relations of temperature in the respective groups rendered necessary. The indiscriminate mean of all, however, (0°·657 Fahr.) is not materially variant. It will be seen that up to the point of boiling water, the formula-temperatures are generally *lower* than experiment; above that point, they are in general *higher*. I believe that such a change of sign accords with what might be anticipated, and in so far does not diminish the reliability of the formula.

The difference (+0°·61 F.) would be the absolute error of the formula, were we to assume the experiments as perfectly accurate. But they have been already shown to be themselves affected by an error of ±0°·31 F.; and the absolute error of the formula, then, may be either 0°·30 or 0°·92 F., according as the equation is made of the sum or the difference. Either of these quantities may, in the theory, represent the true error; and we have, therefore, in fine the case of an even chance for accuracy with the formula or with the observation.

Such are the conclusions that arise from the comparison with Mr. Regnault's experiments.

2. *Experiments of the Franklin Institute.*—The temperatures were read by these observers to only the nearest quarter of a de-

gree of Fahrenheit; they are, therefore, not comparable in precision, whatever they may be in accuracy, to those that have just been considered. And as but one reading either of temperature or pressure is given in each instance, they do not allow of being treated in the method that has just now been applied. I can only then compare them as in the following table:

Pressures in Atmosph'rs.	Temperatures.				Differences of Frank. Inst. in formula and experiment.
	Calculated by my formula.	Observed by F. Academy.	Observed by Frank. Inst.	Calculated by formula of Frank. Inst.	
1.	212°· F.	212°· F.	212°· F.	212°· F.	—
2.	250 ·84	250 ·52	250	248 ·8	+1°·2
3.	275 ·73	275 ·18	275	272 ·3	+2 ·7
4.	294 ·43	293 ·72	291 ·5	290 ·1	+1 ·4
5.	309 ·57	307 ·54	304 ·5	304 ·4	+0 ·1
6.	322 ·36	320 ·36	315 ·5	316 ·5	−1 ·0
7.	333 ·49	331 ·70	326	327 ·3	−1 ·3
8.	343 ·36	341 ·78	336	336 ·4	−0 ·4
9.	352 ·25	350 78	345	344 ·8	+0 ·2
10.	360 ·36	358 ·88	352 ·5	352 ·5	—
Mean differences,	−1°·20		−3°·45	+0°·36	

The temperatures of the Academy in this table, were not, as has been said already, from experiments at the precise epochs of pressure; but were interpolated from experimental terms not remote. Under a general principle, I excluded them from the Comparative Table in the preceding Memoir, but they satisfied even the fastidiousness of Mr. Dulong, as representing accurately the results of observation; and are therefore fit to be compared as they are here. The last line of *mean differences* shows the excess of the formula-temperatures above those of the Academy, to be not much more than *one-third* of the excess of the latter above those of the Franklin Institute; the probability of accuracy of these last then, at most, cannot be more than in the same ratio. It also shows a mean error between the formula adopted by these observers and their observations, of 0°·36; by which deviation the former, with the advantage of having the two extremes arbitrarily to coincide, yet fails to adjust itself to the latter.

3. *Experiments of the French Academy of Sciences.*—Out of the whole of this series Mr. Dulong has himself selected *eleven*, as the most unexceptionable, and has used them for a standard whereby to compare the merits of divers proposed formulæ as well as his own. It is true this group contains, among others, one of the very experiments which I have, in the preceding Memoir, noted as faulty, and as being differently recorded in the two tables; but I have not allowed myself to exclude it here any more than before. Also for his comparison, Mr. Dulong has taken the reading of only the maximum thermometer, which represented the actual temperature of the *water* in the boiler. For the present purpose, however, as in the case of Mr. Regnault's experiments, it is necessary to take the other thermometer-reading also

and register the variation of the extremes, as under. I have entered the pressures here in English inches, since they have already been reduced for the Comparative Table; but to save unnecessary calculations, I retain the temperatures in Centigrade degrees.

No. of Experiment.	Pressures in inches.	Temperatures.		Diff. in deg. Centi.
		Maximum.	Minimum.	
1.	64*in*·14	123°·7 C.	122°·97 C.	0°·73
3.	85 ·70	133 ·3	132 ·64	0 ·66
5.	136 ·85	149 ·7	149 ·54	0 ·16
8.	194 ·42	163 ·4	163 ·00	0 ·40
9.	220 ·69	168 ·5	168 ·40	0 ·10
15.	348 ·04	188 ·5	188 ·30	0 ·20
21.	514 ·22	206 ·8	206 ·40	0 ·40
22.	516 ·84	207 ·4	207 ·09	0 ·31
25.	553 ·69	210 ·5	210 ·47	0 ·03
28.	644 ·96	218 ·4	218 ·30	0 ·10
30.	716 ·13	224 ·15	223 ·88	0 ·27

Mean difference, . 0°·3055 C. = 0°·55 Fah.,

equivalent to a mean error of ± 0°·28 Fah., arising from the uncertainties of temperature.

To contrast this with the formula we have from the same experiments as under:

No. of experim't.	Temperatures.		Differences.
	Observed.	By the formula.	
1.	123°·7 C.	123°·9 C.	−0°·2 Centig.
3.	133 ·3	133 ·8	−0 ·5
5.	149 ·7	150 ·8	−1 ·1
8.	163 ·4	164 ·5	−1 ·1
9.	168 ·5	169 ·5	−1
15.	188 ·5	189	−0 ·5
21.	206 ·8	206 ·8	0
22.	207 ·4	207 ·2	+0 ·2
25.	210 ·5	210 ·4	+0 ·1
28.	218 ·4	217 ·7	+0 ·7
30.	224 ·15	222 ·9	+1 ·2

Mean difference, . . −0°·2 C. = −0°·36 F.,

a deviation between the formula and the experiment but little more than the admitted error of the thermometric readings. The mean error of observation from this last source, was found just now to be ±0°·28 Fahr., and the mean error of the formula then may be either 0°·08 or 0°·64 of Fahrenheit. These quantities equally satisfy the equation; and the probabilities in favor of each are even.

It is observable that errors in this series come out with a different sign from those of Mr. Regnault; though the errors of observation in the two experimental series are nearly identical, as might be expected in advance from the great skill and probably equal tact of the two observers. Such a difference of sign is favorable to the character of the formula; which will be seen by combining the two results, as under:

	Error of formula.	
	Maximum.	Minimum.
From experiments of Academy of Science, .	$-0^{\circ}\cdot64$ F.	$-0^{\circ}\cdot08$ F.
" " Mr. Regnault, . . .	$+0\ \cdot92$	$+0\ \cdot30$
Mean error by both, ...	$+0^{\circ}\cdot14$	$+0^{\circ}\cdot11$

The nearness of these limits and the smallness of the number enclosed by them warrant, I think, a sole and entire reliance upon the formula, in the present state of experimental knowledge on the subject. I do not introduce into combination any of the other and earlier series of observations; because, from the way in which they have been reported by their respective authors, they do not admit the application of the same methods of comparison; and because it may justly be supposed that the apparatus, intellectual and mechanical, resorted to in 1829 and since, is paramount in accuracy to what had been at disposal in preceding researches.

I shall only, therefore, in farther illustration of the present formula, compare its results with those of expressions that have been proposed by other mathematicians; only extending, in point of fact, for this purpose, a similar comparison which MM. Dulong and Arago have already instituted; and using, except for the last column, quantities from the calculation of these philosophers. Their table is founded upon the same eleven observations of their own, just now quoted; and they have given for each instance the individual deviations of the several formulæ from the result of experiment. Not to employ so much room, I have thought it equally satisfactory to give the general results and inferences, as under. The deviations are given in Centigrade degrees, and belong to the same side of the equation with the temperatures given by the respective formulæ.

	Formulæ proposed by				
	Tredgold.	Roche.	Coriolis.	Dulong.	J. H. A.
Maximum deviation in excess, . .	$0^{\circ}\cdot69$	$0^{\circ}\cdot53$	$0^{\circ}\cdot80$	$0^{\circ}\cdot40$	$1^{\circ}\cdot10$
Maximum do. in defect, . .	$2\ \cdot11$	$0\ \cdot75$	$0\ \cdot25$	$0\ \cdot73$	$1\ \cdot20$
Mean devi. without regard to signs,	$0\ \cdot79$	$0\ \cdot37$	$0\ \cdot44$	$0\ \cdot24$	$0\ \cdot60$
do. with regard to do.	$+0\ \cdot338$	$-0\ \cdot001$	$-0\ \cdot363$	$-0\ \cdot007$	$-0\ \cdot20$

The last formula, as is seen, although the sum of its deviations is greater than two or three of the others, lies yet more symmetrically with the curve of the experiments than any.

The three first are given by Mr. Dulong, after a copious enumeration of different formulæ, as agreeing the best with observation. Of these, in that of Tredgold and of Coriolis, the elasticity is a function of the temperature; but Mr. Coriolis uses, instead of an integral, a mixed fractional index. His exponent, instead of 7 as Dr. Young took, or 6 as Creighton and Tredgold preferred, or 5·13 as Southern chose, or 5 as Dulong adopted, is 5·335; whose coincidence with the natural law is only empirical and can be but accidental. In the formula of Mr. Roche, (which he offers, not as a means of interpolation, but as the expression of a general physical law,) the temperature is itself an element of the index by which certain constant quantities are to be involved. The principles, however, upon which he has founded the expression, are disapproved both by Mr. Dulong and Mr. Regnault. The formula of Mr. Dulong presents a smaller aggregate deviation than any of the others; and it would be singular if it did not, seeing that it was derived from a constant furnished by his own experiments. But as might also be anticipated, this constant, taken (to four places of decimals) from the result of the highest experimental temperature, fails to apply in the lower ones. The maximum deviation under his formula, given in the last table, occurs at the lowest experimental temperature; and in fact in his final table of atmospheric pressures and corresponding temperatures, he has preferred, below the limit of four atmospheres, (145°·4 Cent. or 293°·72 Fahr.,) to abandon his own formula and use that of Tredgold. Below the ordinary atmospheric pressure, his quantities are utterly inapplicable; as will be seen by the following statement:

Pressures in Atmospheres.	Temperatures (Centigrade).			
	Observed by Regnault.	Calculated by formulæ of		
		Dulong.	Franklin Institute.	Alexander.
0·047368	32°·38	36°·16	33°·52	29°·80
0·006	0 ·00	10 ·45	4 ·28	− 1 ·08
0·000684	−25 ·00	− 7 ·25	−17 ·31	−23 ·89

The last two columns are added here for illustration; and show, among other things, that the formula of the Franklin Institute is, like that of the French Academy, inapplicable to low temperatures and pressures.

Later than these, Mr. Biot, in 1839, proposed another formula, and, in 1841, published a table calculated by it; in which the pressures are given in metres and for every degree Centigrade from −20° to 220° Cent., corresponding to the limits of −4° and 428° Fahrenheit. The patient labor requisite for this task, has not been overrated by its distinguished performer; as can be readily appreciated, when it is known that part of the calculations actually were, and it was apprehended that even the whole might require to be, executed with logarithms of eleven decimals, and that the constants reach even the twelfth decimal place. These constants were derived, for the higher temperatures, from the already quoted experiments of Dulong and Arago and of Taylor; and, for the lower, from unpublished experiments of Mr. Gay Lussac. The temperatures are throughout given in terms of an *air*-thermometer instead of a mercurial one; a modification which undoubtedly impresses a more systematic accuracy upon the method; but yet, in spite of the aid afforded by tabular corrections for reduction, appears to diminish materially the chances of practical resort to the table itself. These temperatures, Mr. Biot, in the form first proposed by Prony, (the same which Dr. Young, with more emphasis than reflection, has called "ridiculously complicated,") employs as the exponents of a series; the peculiarity of the method, however, is in that the direct numerical result of the equation gives, instead of the pressure itself, the tabular logarithm of the pressure. It is, therefore, essentially a logarithmic formula.

I present the following comparison between it and the present formula; applied to the same instances of experiment, which have been already signalized by Mr. Dulong himself, and already quoted here. To save both the tedium and hazard of a reduction to English measures, I leave the quantities under their original denominations; and, in so far varying from the preceding instances, I give the deviation of the formulæ in terms of the pressure instead of the temperature. This method enables me, by an easy and safe interpolation, to extract the proper quantities from Mr. Biot's table; and thus to avoid the portentous labor of working out the numerical transformation of his theorem.

No. of Experiment.	Temperatures, (Centigrade.)		Pressures in Metres.		
	Mercurial thermometer.	Air thermometer.	By Biot's formula.	Observed by Dulong & Arago.	By present form.
1.	123°·7	123°·13	1·65020	1·62916	1·62022
3.	133 ·3	132 ·47	2·26396	2·1816	2·14687
5.	149 ·7	148 ·41	3·47146	3·4759	3·37449
8.	163 ·4	161 ·69	4·94220	4·9383	4·80439
9.	168 ·5	166 ·63	5·60263	5·6054	5·45121
15.	188 ·5	185 ·96	8·89046	8·840	8·73476
21.	206 ·8	203 ·60	13·05578	13·061	13·04525
22.	207 ·4	204 ·18	13·21410	13·137	13·21202
25.	210 ·5	207 ·16	14·05179	14·0634	14·10266
28.	218 ·4	214 ·75	16·36717	16·3816	16·60100
30.	224 ·15	220 ·28	18·18048	18·1894	18·64254

Not to embarrass this table with so many columns, I omit the individual deviations of the two formulæ; and present the general result as under.

	Biot.	Alexander.
Mean deviation from experiment without regard to signs,	0·02566	0·12191
Mean deviation from experiment with signs,	−0·01704	−0·02114

It is hardly necessary to repeat that the first of these formulæ is founded in part upon the very experiments with which it accords so well; and that the other was not.

The table of Mr. Biot goes up as far as 220° Cent.; but he supposes that his formula is applicable much father; and in fact he has given results, in a small supplementary table, as high as 300° C. or 572° F.; at which temperature it makes the pressure equal to almost exactly 85 atmospheres. The present formula would make, corresponding to this pressure, a temperature of 559°·92 F. or 293°·3 Cent.; differing from the other within the correction between a mercurial and an air-thermometer.

It is at the other extremity, where we still have opportunity of referring to experiment, that the difference between the two formulæ becomes more marked; and where that of Mr. Biot, neither in its terms nor its progression, can be considered applicable. This may be seen as under:

Pressures in inches of Mercury.	Temperatures, (Centigrade).		
	Observed by Regnault.	B.	A.
0*in*·024	−23°·83	−20°·	−22°·46
0 ·033	−20°·	−17°·	−19 ·52

About the same time with Mr. Biot, other formulæ claiming (like that of Mr. Roche) a foundation on abstract theoretical principles, were proposed by Mr. Russell; who has also applied their somewhat extensive logarithmic apparatus to the calculation of a table of pressures for each degree from 32° to 250° Fahr., and then for intervals of one or more atmospheres up to fifty. This does not properly come into this discussion; because the author has found it necessary to employ different terms above and below the point of boiling water, and in point of fact to have *two* formulæ; an inconvenience, the same in kind, though not in degree, with what the object of the very research is to avoid. Nor do they counterbalance this, by a proportionate accuracy which would warrant their results to be substituted for those of experiment. On the contrary, starting from their common zero, 212°, they both deviate in their respective directions from the curve given by observation; the pressures calculated by them, are, at the two extremities, very much above any experimental ones. Not to trouble ourselves with the part of the scale below the boiling temperature, where the errors are not of so much practical importance, I give a few instances in the higher degrees, contrasted with the results of the French Academy.

Pressures in Atmospheres.	Temperatures, (Fahrenheit.)		Differences.
	French Academy.	Russell's Table.	
1·	212°·	212°·	—
5·	307 ·5*	306 ·8	0°·7
10·	358 ·9	355 ·6	3 ·3
20·	418 ·5	410	8 ·5
30·	457 ·2	444 ·6	12 ·6
50·	510 ·6	491 ·4	19 ·2

The formulæ of Mr. Regnault, to whose experimental researches such resort has been had, are in one respect in the same category as those of Mr. Russell: they are *three*, one adapted to pres-

* Mr. Russell in his comparison, as well as the Franklin Inst. in theirs, give this temperature at 308°·8; an error which has arisen from hastily reducing the actual Centigrade temp. of 153°·08, as if it were 153°·80.

sures below the melting of ice, the second reaching from that point to the ordinary atmospheric pressure, and the last, proper for high temperatures only. He promises, when his experiments in this upper part of the thermometric scale shall have been sufficiently extended and accumulated, to apply himself to the grouping of all three divisions in one comprehensive expression; and, from his well known character, much may be expected, original and appropriate. In the mean time, it would be premature to enter here upon any discussion of what is only provisional.

To resume, then, in conclusion of this rather protracted Memoir; it seems to me that in the various combinations and comparisons that have been given, the claim of the formula I propose is reasonably well established—not to be an expression of a law of nature, for to this much it makes no pretension, but to represent the phenomena of reciprocal pressures and temperatures more exactly and with a more extensive scope, than any that has yet been offered; and that, in so far, it is worthy of being taken as paramount to all that have preceded it. How far, in view of the discord yet existing between experimental results of the most recent and reliable observers, it is fit to come in as a substitute for any and all of those results themselves, is not of course for me to determine. I shall only allow myself to notice, then, its remarkable simplicity, and the consequent facility with which it adapts itself to calculation, either with or without logarithms; as well as the readiness with which, from its elements and form, it suggests itself at all times to the memory. One important use of a formula, it is to be observed, is in enabling an enquirer in any emergent case, away from books and tables, to extemporize an accurate result; in proportion to its complexity and arbitrariness, then, it becomes a question of individual strength of memory, and its resort more and more limited. In the present instance, all its terms are either given in the very case to be solved, or are physical constants at the foundation of the theory of Heat; which, I may even say, it is impossible for one, ordinarily well informed, to forget. And the composition of these terms, thus susceptible of instant recall to the mind, is so plain and necessary even, that it is equally impossible, with a moment's reflection, for one to go wrong. I believe I am only stating the simple fact when I say that, in these respects, the present formula stands alone.

Finally, then, I offer for general practical use and reference, the following table of temperatures corresponding to pressures in atmospheres and parts, through the whole range of experiment hitherto. If my labor in so far shall be fortunate enough to meet with the approval of the learned, it will be but an inconsiderable task hereafter to complete its scope, by furnishing a table of pressures at all useful temperatures for each degree of Fahrenheit's thermometer: to whose arbitrary and otherwise inconvenient scale the present investigation has served not a little to reconcile me.

Table of Temperatures corresponding to the Pressures of Steam in Atmospheres.

Pressures in Atmospheres and parts.	Temperatures in deg. of Fahrenheit.	Pressures in inches of Mercury at 32° F.	Pressures in lbs. Avdp. per sq. inch: mercury sp. gr. 13·6.
0·00025	−25°·53	0in·0075	0lb·0037
0·0005	−15 ·78	0 ·015	0 ·0074
0·001	− 4 ·84	0 ·030	0 ·0147
0·005	+26 ·01	0 ·15	0 ·0735
0·01	42 ·41	0 ·30	0 ·1470
0·05	87 ·36	1 ·50	0 ·7352
0·10	110 ·93	2 ·99	1 ·4704
0·20	137 ·39	5 ·98	2 ·9407
0·25	146 ·58	7 ·48	3 ·6759
0·50	177 ·40	14 ·96	7 ·3518
1·	212 ·00	29 ·92	14 ·7036
2·	250 ·84	59 ·84	29 ·41
3·	275 ·73	89 ·76	44 ·11
4·	294 ·43	119 ·68	58 ·81
5·	309 ·57	149 ·60	73 ·52
6·	322 ·36	179 ·52	88 ·22
7·	333 ·49	209 ·44	102 ·93
8·	343 ·36	239 ·36	117 ·63
9·	352 ·25	269 ·28	132 ·33
10·	360 ·36	299 ·20	147 ·04
11·	367 ·81	329 ·12	161 ·74
12·	374 ·72	359 ·04	176 ·44
13·	381 ·16	388 ·96	191 ·15
14·	387 ·20	418 ·88	205 ·85
15·	392 ·90	448 ·80	220 ·55
16·	398 ·28	478 ·72	235 ·26
17·	403 ·40	508 ·64	249 ·96
18·	408 ·27	538 ·56	264 ·66
19·	412 ·91	568 ·48	279 ·37
20·	417 ·36	598 ·40	294 ·07
21·	421 ·62	628 ·32	308 ·78
22·	425 ·73	658 ·24	323 ·48
23·	429 ·67	688 ·16	338 ·18
24·	433 ·48	718 ·08	352 ·89

Art. XXX.—*Considerations on the Divisibility of Magnitude;* by Alexander MacWhorter, New Haven.

Geometry is the science of magnitude; and magnitude, has been defined to be, that which has one or more of the three dimensions, length, breadth, and thickness. The conception denoted by the term magnitude, to which this science has reference, is an abstract general conception, notion, or idea, and like all other abstract notions is formed, first, by making a concrete thing or a real existence, an object of thought; next, by distinguishing in mental analysis between different characteristics of this real existence; and finally, by giving to the several characteristics thus separated and set apart in thought, names, so far as the case in hand may require. In the present instance, the concrete or real existence made the object of thought is a body, as that which occupies space. The characteristics distinguished by mental analysis and set apart under distinct names, are the three dimensions of body, length, breadth, and thickness; while to these characteristics, taken either separately or in combination, the name of magnitude has been assigned.

Thus the conception denoted by the term magnitude has for its object, like every other abstract general conception, *some only* of the characteristics of a concrete or existing reality, which object though a mere object of thought, corresponds with what is real, but not with all that is real in the concrete reality. That which is real in every existing body and to which the object of the abstract general conception corresponds, is the *dimensions of that body*, to which of course belongs an existence distinct and separate both *from the conception itself* and from the mind which forms the conception.

Space as fitted to be occupied by body, may be considered as extension in three directions, and thus as having three dimensions, and if the term magnitude be used to denote these three characteristics of space, taken either separately or in combination, the conception denoted by the term magnitude has also, in this instance, for its object only some of the characteristics of a concrete or existing reality, and the reality to which this object corresponds, is *the dimensions of space*, to which of course belongs an existence which is *necessary*, and which at the same time is *distinct and separate* both *from the conception itself* and from the mind which forms the conception. The distinction here made between the objects of mental conception and real existences, or existences which are such independent of our thinking, though quite obvious, is of the first importance, and may be made more apparent by considering the wide difference between those objects of *thought*, which are constituted what they are *by the nature and action of the mind*, and *things*, which are what they are *in virtue of a constitution of their own;* known by our minds, to a certain extent, but still, *existing independent of our thinking*.

It is also obvious that when a general term, such as magnitude, is used to denote an abstract general conception, the object denoted by this term, in these circumstances, is subject *solely to the laws which control and determine the nature and relations of mere thoughts*, that is, *to the laws of thinking;* while if the same general term be used to denote either an object, or some property of an object, which has a *real existence independent of our thinking*, then the object denoted by this term, under these circumstances is subject to the laws which control and determine the *nature and relations of real existences,* that is, to *the laws of nature.* It is because philosophers have failed to carry out this distinction consistently, and thus have overlooked and denied their own knowledge, that so much imposing logic has been at war with common sense. Failure on this very point constitutes the grand and vital error of Hegel, with whom "thoughts are the only concrete realities, and logic, as being a true description of their processes, is at the same time a true description of the Laws of the Universe." In the confusion between thoughts and things is found the central fallacy of his Idealistic Pantheism, in which "the process of the evolution of ideas in the human mind is, at the same time, the process of all existence," in a word, in which "the dialectic process is the Method, the dialectic process the Deity, the dialectic process everything;" a system no less remarkable for the unsoundness of its premises, than for the logical rigor and scientific beauty with which it marches forward to its fatal results.

With the preceding distinction in view, the way is opened for a decision of the much vexed question respecting the divisibility of magnitude. In every age, from that of the earliest skeptic to the present moment, the contradictions on this subject, which the reasoning of geometry seems fairly to involve, have furnished weapons by which the certainty of human knowledge has been assailed; leaving room for a doubt, which the defenders of truth have appeared more willing to avoid than directly to meet; very many of them seeming to think, that the solution of the problem included something beyond the limits of the human understanding.

The difficulty referred to is this. It is well known to the geometrician that according to the principles of mathematical reasoning, every line representing magnitude is divisible beyond any assignable limit; that is, let any magnitude or line representing magnitude, be given, a magnitude can always be found, less than the given magnitude. For, let any magnitude whatever, be supposed, and, for the sake of argument, let it be considered as the least conceivable. This magnitude is some assignable distance. It can therefore become the radius of a circle. But* "if a point be taken in the diameter of a circle which is not the centre, of all the straight lines which can be drawn from it to the circumference, the greatest is that in which the centre is, and *the other part of the diameter is the least.*"

That is, a point being taken in the radius which is neither at the centre nor at the circumference of the circle, a magnitude can be cut off between this point and the circumference, (or this point and the centre,) less than radius. But, by supposition, radius was the least conceivable magnitude, a magnitude therefore has been found *less* than the least conceivable. Now this process can be repeated as often as a new radius is taken, so that, on the principles of geometry, magnitude is divisible beyond any assignable limit, in other words, magnitude is indefinitely, or as it is commonly called, infinitely divisible.

On the other hand, it is urged by the natural philosopher as well as by common sense, that there is a world which exists independent of our conceptions, governed by its own laws, which

* Euclid, Lib. iii, Prop. vii.

are not the laws of logic but the laws of nature; and that in this world are found a series of facts as certain, and which involve consequences as sure, as are the conclusions deduced by the geometrician from his definitions, postulates and axioms. The natural philosopher considers the existence of body and space, of distance and motion, to be among such facts; he knows by observation and experiment, that bodies moving in opposite directions through space sometimes pass by each other, that a body moving in the same direction with another body will sometimes overtake it, and he believes, that the opposite faces of approaching solids sometimes come in contact.

He also reasons, that if a body is in motion through space toward another body at any given distance from it, and if these two *finally come in contact*, then *antecedent to such contact* there must be a least intervening distance not occupied, or filled up, by the approaching body. In other words, that when the bodies are in contact *no distance* intervenes, and when not in contact *some distance* intervenes; distance, in the case supposed, being the interval between the opposite faces of each solid *unoccupied by the presence of either body;* while, of all the distances which can be supposed to intervene, *the least* is that *next antecedent to contact.* The same consequence follows in respect to bodies moving in opposite directions, and also in respect to bodies which overtake each other. If Achilles overtake the tortoise, the greyhound the hare, or the minute-hand the hour-hand of a clock, then there must, in the nature of things, be a least intervening distance next antecedent to each event. Should the distance thus limited be denoted by the term magnitude, then this will be the least magnitude which, in the nature of things, can be conceived to be, that is, can be conceived as having a *real* as opposed to an *ideal* existence. And if there be a least distance or length, then for the same reason, there must be a least breadth and depth, in other words, a least space; and if there be a least space, then for anything we know to the contrary respecting the nature of matter, a body may be conceived as occupying this least space, and this will be the least body, the least impenetrable solid which, in the nature of things, can be conceived to be, that is, be conceived as having a *real* as opposed to an *ideal* existence.

It follows from this, first, that every body which has a real existence, if it be a definite body such as a tree, the globe or a star, must be made up of indivisible units, or impenetrable and extended particles having a form; and next, that the magnitude of these particles can in no case be less than the least space; in other words, that the ultimate particles of a body can in no case be actually reduced so as to become less than the magnitude, which, by reasoning from the nature of actual extension, has been shown to be the least conceivable, that is, the least which can be conceived to have a *real* as opposed to an *ideal* existence.

There is an apparent objection to the existence of a least distance, or least magnitude, turning upon an ingenious fallacy respecting motion, which may as well be resolved at this point.

It appears from experiment that bodies move with unequal velocity, that is, traverse *equal spaces in unequal times;* time being measured by *some common standard.* Now, let two bodies traverse a given distance, greater than the least, with unequal velocity, that is, in unequal times; on the hypothesis of continuous motion, other things being equal, since their velocities differ, they must traverse some one least space or least distance, of which the whole distance is the sum, in *unequal times;* time being measured by some standard common to both. But to traverse the least distance is to make the least motion, or the least change of place, which, in the nature of things, can be; consequently, the bodies supposed make a least motion or a least change of place, which in the nature of things, can be, in unequal times. And if the bodies supposed make a least motion in unequal times, then bodies of unequal velocity in making some one least motion or least change of place, *while their velocity remains unequal,* require *unequal times* as *necessary to the existence* of this least motion or least change of place, in each particular case. And if bodies of unequal velocity require *unequal times* as NECESSARY TO THE EXISTENCE of some one least motion or least change of place, then this least motion *cannot be supposed to occur* in any time *less* than the one *necessary to its existence* in the particular case, *without supposing a contradiction;* that is, without supposing that a body moving with a given velocity requires a *certain time* to make some one least motion; *this time being necessary in the nature of things to the existence of the motion;* and then to suppose, that *the same body,* moving with *the same velocity,* can make the same least motion in a time *less* than the one necessary in the nature of things *to the existence* of that motion, which is absurd. Yet this is the fallacy at the basis of the various and celebrated sophisms used by the ancients against the possibility of motion. It generally comes in the shape of an interrogation, thus:

On the hypothesis of continuous motion, other things being equal, suppose two bodies moving with unequal velocity, and suppose the one moving with the greater velocity to have traversed a least distance by making the least motion or the least change of place. What has the body moving with the less velocity, and consequently requiring more time as necessay to the existence of its least motion, *done;—how far has it moved, during the time* the first body moved? Now to ask this question, is simply to ask, what has a body *done, how far* has it moved, when *one of the conditions necessary to the very existence* of its least motion, viz. the requisite time is, by supposition, NON-EXISTENT. In other words, it is to ask, if a contradiction be true, what consequences will follow, it being the purpose of the inquirer to use the conclusions drawn from such a premise, in order to overthrow some other conclusion resting on independent evidence. So far then as this reasoning is concerned, the circumstance that existing bodies have different velocities, furnishes nothing to disprove the existence of a least distance or a least magnitude.

In fact, the proposition that every finite body is definitely divisible, in other words, is so limited by its finite nature as to be reducible only to a certain extent, is a proposition which would never have been questioned had philosophers paid more attention to the nature of the objects of thought which the premises of geometry involve; since an attentive consideration of these premises will show, that the conclusions of the geometrician respecting the infinite divisibility of magnitude do in no way conflict with the decisions of natural philosophy and common sense, but, on the contrary, are simply the enunciation of what is true in respect to the relations in which the objects of *certain abstract general notions* stand to each other, as deduced solely from what belongs of necessity *to their nature* as *mere objects of thought.*

The distance just described has been shown to be the least magnitude which, in the nature of things, can be conceived to be. Now *things* have been very beautifully classified into things existing as mere *thinks*, that is, as *mere objects of thought;* and things which are *real existences*, whether we think of them or not. Thus, in the phrase "the least magnitude which in the nature of things can be conceived to be," the term magnitude may denote either the object of an abstract conception, or a characteristic of a real existence, viz. a dimension of space; that is, it may denote either a mere object of thought or a real existence; and the phrase "nature of things" is equally ambiguous, and may denote either the *nature of mere objects of thought or the nature of real existences.* Now if the term magnitude be taken as denoting a *real* as opposed to an ideal magnitude, that is, as denoting *a dimension of space*, to which belongs an existence distinct and apart from the mind's conception of it, and the phrase "nature of things" as denoting the nature of real existences, then manifestly there is a least magnitude which in the nature of things can be conceived to be, or can be conceived to have a *real* as opposed to an *ideal* existence, viz. that distance next antecedent to the contact of bodies.

If, on the other hand, the term magnitude be taken as denoting the object of an abstract conception, that is, be taken as denoting *a mere object of thought;* and the phrase "nature of things" as denoting the nature of *thinks*, that is, *the nature of mere objects of thought*, then it is equally true that magnitude must be conceived as infinitely divisible, or more properly, as divisible beyond any assignable limit.

In this case three questions arise; first, what is the meaning of the term divisible when applied to mere objects of thought? secondly, what is the nature of the conceptions denoted by the terms mathematical line and mathematical point? and thirdly, what is it to divide a mathematical line at a mathematical point?

Respecting the first inquiry, it is evident, that while to divide means primarily to dispart, or disjoin, when material existences are spoken of, to divide when used in reference to things which are *mere objects of thought*, must mean simply *to distinguish* between them *as mere objects of thought;* so that, in this case, infinitely *divisible* means merely *infinitely distinguishable*, or distinguishable beyond any assignable limit.

In the next place a line, by definition, denotes the object of the abstract conception of length or distance, considered as a mere object of thought, apart from the abstract conceptions of breadth and depth; while a point is defined by Legendre to be, "a *limit* terminating a line."

In this definition of a point the abstract notion of length, represented by a line, is considered as ceasing or ending, and this notion of *limit to length* being a notion of the *cessation* and consequent *negation* of length, it is a conception which, in its own nature, excludes from itself the conception thus denied. It is in this view that Euclid defines a point to be "that which hath no parts or which hath no magnitude;" a definition imperfect because not convertible, everything "having no parts or no magnitude" not being a point.

But as in *things* a given distance is *in* actual space, that is, sustains the relation to actual space denoted by the terms place, situation, or position, so *in mere objects of thought* the coëxisting conceptions of abstract length, breadth, and thickness, are viewed as holding such relations to each other, as to authorize the application of the term place, or position, borrowed from real existences and applied to these conceptions in order to denote a particular relation between them. Now as mere objects of thoughts are not *in* space, the only relation which they can sustain to each other at all resembling the relations subsisting between actual existences in respect to place, is THE RELATION OF LIMITATION, the term limitation when applied to mere objects of thought denoting that the given conception is *just what it is*, AND NOT ANOTHER conception.

Thus, in answer to the second inquiry, it appears that a mathematical line is merely the object of the abstract conception of length or distance; and in respect to a mathematical point it also appears, first, that it is *not* a thing "in re" and in this sense a real existence, but on the contrary, is a mere object of thought formed by the mind, analytically, in accordance with the laws of thinking; and next, that this object of thought is *limit* as applied to the dimensions of body or of space when these are viewed as objects of abstract conception.

Now since to *divide* means *to distinguish*, when *mere objects of thought* are spoken of; in answer to the third inquiry it appears, that to divide a magnitude represented by a line, at a mathematical point, means,—*to distinguish* one magnitude *viewed as a mere object of thought* from another magnitude *viewed as a mere object of thought, by the notion of limitation*, as *the differentia* ;—and then, to *represent this distinction* by the *division of an actual and visible line*. Thus, let any two magnitudes be conceived, and let them be made distinct objects of thought; each object is distinguished from the other by being conceived to be *just what it is*, as an object of thought, and, at the same time, being conceived to be NOT THE OTHER object. Now this mode of distinguishing between mere objects of thought can be repeated *just as often* as any two conceptions of magnitude can be formed, *each of which is not the other*, that is, can be repeated indefinitely; and this *distinction between* objects of *thought* can be *represented* by the division of actual lines;—this difference between these objects being simply *numerical* as mere objects of thought, having no real or substantial existence. So that in this sense, magnitudes, as mere objects of thought, are *distinguishable*, and in this sense only is magnitude *divisible* beyond any assignable limit.

The fallacy involved in the mathematical argument against the possibility of a least conceivable magnitude consists in assuming, without a shadow of warrant, that the least conceivable magnitude may be divided at a mathematical point. For the phrase, "least conceivable distance" denotes an actual distance, a *concrete* or *existing reality*. The term mathematical point, on the contrary, denotes merely the object of an abstract general conception, notion, or idea. This object is also a *mere object of thought*, having *no counterpart* or *corresponding object*, among *real existences*. Now to suppose that a *mere object of thought*, which has no corresponding object "in re," can divide a concrete or existing reality, and thus *diminish it by partition*, is to suppose, what is impossible in the known nature of things; it is to suppose, a real existence divided by a mere object of thought, the properties of a body or of space divided by an abstract idea; which is absurd. Moreover, even as a *mere object of thought*, a point, by definition, has *no extension* or no magnitude, being simply the notion of a *limit*, by which one extension is conceived of as not another. Can then extension be divided by that which has *no* extension, and magnitude be diminished by that which has no magnitude? Plainly, to divide means to *distinguish*, when mere *objects of thought* are spoken of; and it is in this sense, and in this sense only, that magnitude, which, when the subject of geometrical reasoning, is considered merely as an object of thought, is indefinitely or as it is usually, but improperly termed, infinitely divisible.

Thus by reasoning in one mode it appears that there must be a least conceivable magnitude; that is, a least magnitude which, in the nature of things, can be conceived to have a *real* as opposed to an *ideal* existence. Here the term magnitude denotes *existing dimensions* of body or of space, and the reasoning is conducted wholly in reference to what is true respecting *real existences*. By reasoning in another mode it appears, that there cannot be a least conceivable magnitude, but that magnitude must be conceived as divisible beyond any assignable limit. Here the term magnitude denotes an abstract conception, whose object is a *mere object of thought*, and the reasoning is conducted wholly in reference to what the mind can do *in forming mere objects of thought, analytically*, and, when they are thus formed, *in distinguishing* between them.

The solution of this apparent contradiction, which has hitherto perplexed every inquiry respecting the divisibility of magnitude, turns upon the difference between things existing as mere *thinks*, that is, as *mere objects of thought*, and things which are *real existences*, whether we think of them or not. It is a distinction, which a German would immediately recognize as made between *thought in itself*—(Der Gedanke an sich), and *thing in itself*—(Das Ding an sich); and claims our assent not merely as true, but as the starting point of all truth, in respect to anything which can with propriety be called mental science. In the preceding discussion this principle has been applied to the solution of a single difficulty; what light a similar analysis may cast upon kindred problems may be left, at least for the present, to the reflections of the geometrician.

ART. XXXI.—*Researches on Salts;* by C. GERHARDT.

Translated from the Journal de Pharmacie et de Chimie, t. xii: third series.

THE following experiments, form the outlines of a more extended research into the laws which govern the formation and the composition of salts. They are intended particularly to determine with precision the phenomena of the double decomposition of salts. I hope, through them, to arrive at a rigorous appreciation of what is to be understood by a neutral salt, an acid and a basic salt.

The part most neglected in the history of the salts, is undoubtedly that which relates to the *basic* or *subsalts*. Since the introduction of polybasic acids, it is no longer possible to give a precise definition of them; for we do not so readily perceive the difference which can exist between a salt said to be neutral, containing two or three equivalents of oxyd, and a salt called basic containing the same number. In most cases, the reactions do not indicate, in this respect, any difference.

It is generally thought that the number of subsalts formed by the same acid and the same base, is much greater than that of the corresponding persalts or acid salts. So that five or six subnitrates of lead are admitted, five or six subsulphates of copper, three or four subacetates of copper, etc., and the most irregular relations are considered as occurring in the composition of these bodies.

My experiments do not give the same results. Whenever I have been able to obtain a crystallized subsalt, or it has been possible for me so to control circumstances as to avoid a mixture, the composition of the product was exceedingly simple. I have thus been able to satisfy myself that there does not exist but a single subsalt, or at most but two, for the same acid and the same base.

There is one fact whose importance is not perceived at first sight, but which must nevertheless be borne in mind to prevent errors; it is the influence of masses in the double decomposition of salts. It is not a matter of indifference, when one solution is to be precipitated by another, whether we pour the first liquid into the second or the second into the first. It is stated, for example, in all the books, that potash if added to a solution of sulphate of copper precipitates the hydrate from it. The truth of the matter is this; if potash is added drop by drop to the salt of copper in such a way as to keep this latter in excess, we obtain a green sub-sulphate of constant composition; by operating in an inverse manner, we produce the blue hydrate perfectly pure. Without the precaution of *always maintaining in excess the liquid into which we pour the other*, we obtain nothing but mixtures. The observance of this simple rule cannot be too strongly insisted upon: very often the products of a reaction seem to have a complicated composition, when in reality they are only mixtures.

Another not less striking example of this influence of masses, is one I have noticed in the case of phosphate of soda and nitrate of lead. If we pour neutral nitrate of lead into ordinary phosphate of soda kept in excess, we shall have a flocculent precipitate of tribasic phosphate of lead anhydrous at 212° F. [$P^2O^5, 3Pb^2O$ or $PO^4(Pb^3)$]; if, on the contrary, we pour the phosphate into the nitrate in excess, we shall obtain a crystalline precipitate of a new salt to which I give the name of *nitro-phosphate of lead*. This salt crystallizes without alteration from nitric acid, in the form of small hexagonal tables, derived from a symmetrical oblique prism, and resembling the crystals of cane sugar; it does not lose weight at 212° F.

This salt constitutes a phosphate in which half the phosphorus is replaced by nitrogen, or a subnitrate in which half the nitrogen is replaced by phosphorus:

Bibasic phosphate of soda,	$PO^4(Na^2H) = P^2O^5, 2Na^2O, H^2O$
Bibasic subnitrate of lead,	$N^2O^4(Pb^2H) = N^2O^5, 2Pb^2O, H^2O$
Bibasic nitrophosphate of lead,	$\left\{\begin{matrix} N_{\frac{1}{2}} \\ P_{\frac{1}{2}} \end{matrix}\right\} O^4(Pb^2H) = \left\{\begin{matrix} N^2O^5, 2Pb^2O, H^2O \\ P^2O^5\ 2Pb^2O, H^2O \end{matrix}\right.$

By calcination, the crystals give off water and nitrous vapors, and are converted, without changing their form, into quadribasic subphosphate of lead, $PO^{9}_{2}(Pb^{4}) = P^{2}O^{5}, 4Pb^{2}O$. Cold water does not change them, but boiling water converts them into tribasic phosphate of lead and neutral nitrate of lead.

Besides the influence of masses, there is another element to be considered in the double decomposition of salts, viz., temperature.

On mixing a solution of nitrate of copper with neutral sulphate of potash, we do not observe any phenomenon at ordinary temperatures. But let the mixture be heated to boiling, and a green powder will be precipitated, which when washed with boiling water, will give the composition of the quadribasic subsulphate of copper, i. e. of the same salt which is precipitated by potash in the neutral sulphate of copper, used in excess.

This fact is by no means isolated. It is even still more remarkable that sulphate of potash and sulphate of copper, being both neutral, should also be decomposed at the temperature of boiling water, into bisulphate of potash and insoluble subsulphate of copper; sulphate of potash can therefore act on sulphate of copper, as caustic potash itself would.

This reaction confirms the opinion M. Laurent and myself hold respecting the nature of acids and bases. The acids and bases are not bodies distinct from the salts. To give a good definition of salts we must say that, they are molecular systems which contain hydrogen or a metal, capable of being exchanged by double decomposition for another metal or for hydrogen. Hence potash and sulphate of potash are two salts of the same species, but belonging to different genera.

Potash, . . $O(K^{2})$, potash species of the genus oxyd.
Sulphate of potash, $SO^{4}(K^{2})$, potash species of the genus sulphate.

Moreover, although the subsulphate of copper is formed only at the temperature of boiling water, the *quadribasic subchromate of copper*, of which the composition is precisely similar, even to the proportion of water, is produced at the ordinary temperature, by mixing neutral chromate of potash with neutral sulphate or nitrate of copper. The fact which I point out then, causes an anomaly to disappear which seemed to exist between the reactions of the chromates and those of the sulphates. The analogy holds good even in the following case: if we collect the clear green precipitate, formed by boiling a mixture of sulphate of potash and sulphate of copper, or nitrate of copper, and examine it under a microscope, we shall see that it is composed of an infinite number of hexagonal tables, of a green so pale that singly they appear colorless. I find in these crystals*

* By calcination this salt gives off water and a little acid. It then takes a fine green color which stands fire. This stability might make it a suitable article to employ in painting instead of Scheele's green, of which both the preparation and the use are attended with such serious inconveniences.

$$SO^5\,(Cu^2\,K_{\frac{1}{2}}\,H_{\frac{3}{2}}) = \begin{cases} SO^3, Cu^2O, H^2\,O \\ SO^3, Cu^2O, (KH)O. \end{cases}$$

Derived from a subsulphate $SO^5\,(M^4) = SO^3, 2M^2\,O$.

It is only when we treat this salt with water, that we obtain bisulphate of potash and insoluble subsulphate of copper. Now the brown precipitate formed immediately by neutral chromate of potash in neutral salts of copper, is also a subchromate containing both potassium and copper, and boiling water extracts from it bichromate of potash, leaving an insoluble subchromate of copper.

To the action of masses and temperature, then, in double decomposition, is united also the influence of a third element, water; an influence which is permanent and not so easy to control as the others.

The water which is present, often enters into the composition of salts. Chemists have long since established a difference between water of crystallization and that of constitution so called; I shall attempt to demonstrate that basic salts obey in this respect the same laws as acid salts. I shall use dualistic formulas to show the analogy better.

Neutral oxalate of potash.	Binoxalate of potash.	Quadroxalate of potash.
$C^2\,O^3, K^2\,O$	$\begin{cases} C^2\,O^3, K^2\,O \\ C^2\,O^3, H^2\,O \end{cases}$	$\begin{cases} C^2\,O^3, K^2\,O \\ C^2\,O^3, H^2\,O \\ C^2\,O^3, H^2\,O \\ C^2\,O^3, H^2\,O. \end{cases}$

I find the same water of constitution in the salts called basic, only the relations of acid, base and water are interchanged. My experiments show that there are only two subnitrates of lead which may be obtained, both of them, in a crystalline state. The formation of the *bibasic subnitrate of lead* is known; I have obtained the *quadribasic subnitrate of lead*, in the form of very small rectangular tables, by a process I have elsewhere pointed out.* The other subnitrates of lead admitted by M. Berzelius are mixtures. The following is the composition of these two subnitrates at 392° F.:

Neutral nitrate of lead.	Bibasic subnitrate of lead.	Quadribasic subnitrate of lead.
$N^2\,O^5\,Pb^2\,O$	$\begin{cases} N^2\,O^5, Pb^2\,O \\ H^2\,O,\ Pb^2\,O \end{cases}$	$\begin{cases} N^2\,O^5, Pb^2\,O \\ H^2\,O,\ Pb^2\,O \\ H^2\,O,\ Pb^2\,O \\ H^2\,O,\ Pb^2\,O. \end{cases}$

Here the same relations will be noticed as between the neutral oxalate, the binoxalate and the quadroxalate of potash.

I have also corrected by new experiments the composition of the *quadribasic subnitrate of copper*, to which the experiments of Mr. Graham had led him to apply another formula. This subnitrate consists of [$N^2\,O^5, 4Cu^2\,O, 3H^2\,O$]; it cannot even be deprived of its water without destroying it altogether.

---

* Ann. de Chimie et de Phys., t. xviii, p. 178.

I have since obtained the *subnitrate of zinc* in the form of prismatic needles, containing, as in the preceding example, $[N^2O^5, 4Zn^2O, 3H^2O]$. The formulas of Schindler and of Grouvelle are not exact. These chemists analyzed mixtures; and consequently failed to notice that the precipitate produced by ammonia in nitrate of zinc contains ammonia in combination $[N^2O^5, 4Zn^2O, H^2O, N^2H^6]$, which is not the case in nitrate of copper.* There are then three subnitrates, having a precisely similar composition, and the same water of constitution.

Subnitrate of lead Pb: $NO^6(Pb^4H^3) = N^2O^5, 4Pb^2O, 3H^2O$
" " of Cu: $NO^6(Cu^4H^3) = N^2O^5, 4Cu^2O, 3H^2O$
" " of Zn: $NO^6(Zn^4H^3) = N^2O^5, 4Zn^2O, 3H^2O$.

I think I can safely affirm that the *subnitrates of cobalt* and of *nickel* present a similar composition; however, as I have not operated upon salts of nickel entirely free from cobalt, and vice versa, I do not advance this opinion unreservedly.

Lest the analogy I have pointed out between the water of constitution of acid salts and that of basic salts, should still seem doubtful, I will add another proof. When acid salts contain a quantity of water (water of crystallization) greater than that which corresponds with the composition previously indicated, we know they are deprived of this excess by desiccation at a temperature lower than that at which the water of constitution is driven off. Thus, for example, the crystallized quadroxalate of potash contains at 212° F.,

$$\left\{\begin{matrix} C^2O^3, K^2O \\ C^2O^3, H^2O \\ C^2O^3, H^2O \\ C^2O^3, H^2O \end{matrix}\right\} + 4aq.$$

The 4 aq. are driven off at 262°·4 F. The quadribasic subsulphate of copper contains at 212° F.:

$$\left\{\begin{matrix} SO^3, Cu^2O \\ H^2O, Cu^2O \\ H^2O, Cu^2O \\ H^2O, Cu^2O \end{matrix}\right\} + 2aq.$$

The 2 aq. are also driven off between 248° F. and 266° F., while the $3H^2O$ resist a temperature of 392° F. The *quadribasic subchromate of copper* has exactly the composition of this subsulphate.

I could cite still further examples of other subsalts, my analyses of which confirm the principles I have just put forth.

Their composition is quite as simple as that of acid salts; for as there are rarely more than two acid salts for the same acid and

* Before knowing the composition of the ammoniacal subnitrate of zinc, I myself thought it identical with the other salt, for I had constantly found in the two products the same quantity of oxyd of zinc (67·1 per cent.). They do contain in fact the same centesimal proportions.

the same base, so I have been unable to obtain more than two subsalts; and if it is a case of sesqui-salts, of bi-salts, of tri-salts, of quadri-salts with water of constitution, my experiments also show that the same relations, only reversed, exist in the basic salts, so that we have subsalts, sesqui-metallic, bi-metallic, tri-metallic and quadri-metallic, with the same water of constitution as in the corresponding acid salts.

In my view, the subsalts are neutral salts of a particular type, as truly as the metaphosphates and the pyrophosphates. The phosphates which are called tribasic are nothing but subsalts, and there is the same relation between an ordinary phosphate and a metaphosphate as between a subnitrate and a nitrate. The difference is at most in their relative stability. We give the following as proofs.

On adding neutral chromate of potash to neutral nitrate of lead, we obtain a *canary-yellow* precipitate of chromate of lead; if on the contrary, we pour the same neutral chromate into the bibasic subnitrate of lead, there is formed an orange red precipitate of a chromate of lead, in which the quantity of lead is double that which it contained in the yellow precipitate.* Is not the case the same as with the phosphates and the pyrophosphates?

Mr. Graham admits that the phosphates are tribasic salts, and the pyrophosphates bibasic salts; to be consistent, must he not admit also a type of monobasic nitrates, and another of bibasic? I shall not at present discuss the theory of polybasic acids; but will confine myself to stating the following facts, which are in direct contradiction to the theory of the learned English chemist.

Ordinary phosphate of soda contains [$P^2O^5, 2Na^2O, 25H^2O$] in its crystallized state, and [$P^2O^5, 2Na^2O, H^2O$] after desiccation at 212° F. From this Mr. Graham concludes that this salt contains one equivalent of water of constitution which is replaced in the other salts by one equivalent of metallic oxyd.

But I find that the *tribasic phosphate of soda also contains at* 212° F., *one equivalent of water*, i. e. 5·2 per cent., so as to consist of: $PO\frac{o}{2}(Na^3H) = P^2O^5, 3Na^2O, H^2O$.

And this water is not even entirely driven off at 392° F.; it has to be expelled by calcination, as is the case with ordinary phosphate of soda. The calcined salt regains this equivalent with the same avidity as the last mentioned salt; when slightly moistened, it becomes so strongly heated that the vessel containing it cannot be held in the hand. Besides, the fact I cite is not isolated; the *tribasic phosphate of barytes* and the *tribasic phosphate of lime* retain also the elements of water as high as 392° F. And indeed, except the phosphate of lead and that of silver, I have

* Hot solutions should be used, for the subnitrate of lead is almost insoluble in the cold.

not found a phosphate which does not retain some water at a pretty high temperature.

The pyrophosphates have afforded me similar facts. Thus the *pyrophosphate of barytes* was found to consist of:

$$PO_{\frac{9}{2}}(Ba^2 H^2) = P^2 O^5, 2Ba^2 O, 2H^2 O.$$

I am well aware that it may be objected that the temperature at which the water of constitution is expelled, is higher or lower according to the salts; this objection is based on the reactions. But have I not shown above that the composition of the precipitated salts can vary according to certain conditions of mass and temperature? It is not then exact to say that any salt, for example a tribasic, will always give, by double decomposition, precipitates of an analogous composition, i. e. tribasic. The principle based by Mr. Graham on two or three facts, is in contradiction to fifty others. Water, in which all these reactions take place, modifies them continually, and determines metamorphoses in mineral salts as well as in organic substances; at one time the elements of water combine with the salts, at another they separate from them, at another they themselves effect changes. Since the phosphates have been divided into monobasic metaphosphates, bibasic pyrophosphates and tribasic phosphates, why not establish the same differences in the nitrates, the sulphates, the chlorids? Do not the nitrates of the magnesian series exhibit different phenomena, when subjected to heat, from the nitrates of K, Na, Pb, Ba? The first always retain the elements of water, and give on heating, nitric acid, as well as a subnitrate retaining in its turn the elements of water, and the same is true of the whole magnesian series $[NO_4(MH_2)]$; while the nitrates of K, Na, Pb, Ba, are anhydrous, and produce under the same circumstances, nitrites and oxygen gas.

I will mention another fact not less conclusive. Alum, which chemists consider as a combination of two neutral salts, has an acid reaction. At 248° F. it loses five-sixths of its water, and then becomes

$$SO^5(K_{\frac{1}{2}} Al\beta_{\frac{1}{2}} H^2) = \begin{cases} SO^3, K^2 O, H^2 O. \\ 3SO^3, Al^4 O^3, 3H^2 O. \end{cases}$$

This product is easily redissolved in water. But let it be dried at 392° F. and it loses all its water and becomes *insoluble.* I have produced this same insoluble alum in the wet way: all that is necessary is to sprinkle the crystals of alum with concentrated sulphuric acid, and apply heat; in a very few minutes the crystals will be changed into a crystalline powder insoluble even in boiling water, and settling in it rapidly. However, if this insoluble alum be left in the water eight or ten days, it may be seen changing by degrees into small octahedrons of soluble alum.

From this it seems to me that alum contains, as truly as the phosphates, water of constitution, which when expelled from the salts, leaves it a body altogether different.*

I would also call to mind that the anhydrous *chlorid of aluminium* is a body volatile without decomposition, while the crystallized *hydrochlorate of alumina* is decomposed by heat into *hydrochloric acid* and pure alumina.

The conclusions which follow from the facts I have instanced, may be summed up in the following manner:

The expressions neutral salt, basic salt, acid salt, are arbitrary terms, used to designate particular types of salts which differ from each other by the elements of H^2O, or of the metallic oxyd M^2O.

These types are interchangeable, with greater or less facility, according to certain conditions of mass, of temperature, etc., which it is impossible to determine with precision in the present state of the science; and there are absolutely the same chemical relations between the metaphosphates, the pyrophosphates and the ordinary phosphates, as between the nitrates and the basic nitrates, the sulphates, the bisulphates and the subsulphates, the chlorids, the hydrochlorates and the oxychlorids, etc.

It cannot be said exclusively in the ordinary acceptation of the terms, that any particular salt is monobasic, bibasic or tribasic. When the reactions take place in water, as is almost always the case, the types of the salts are modified or remain unchanged according to the degree of their stability; sometimes they remain unaltered, at others they combine with the elements of the water or of a metallic oxyd, and then give rise to a new type. But there is no rule for predicting these modifications.

To make my idea more intelligible, I will write out a few formulas.

Genus Phosphate, $PO_{\frac{7}{2}}(M^2) \pm M^2O$.

A. Sub-genus *perphosphate*,

$$PO_{\frac{7}{2}}(M^2) - \tfrac{1}{2}M^2O = PO^3(M) = [P^2O^5, M^2O].$$

All the so-called metaphosphates will belong to this type.

B. Sub-genus *equiphosphate*, $PO_{\frac{7}{2}}(M^2) = [P^2O^5, 2M^2O]$.

It includes a few pyrophosphates, and especially the salt of soda dried at 212° F., $PO_{\frac{7}{2}}(Na^2)$.

---

* I will take this occasion to remark that, the *cubical alum* has exactly the same composition as the alum in octahedrons. The formation of cubical alum or Roman alum belongs to the class of phenomena of crystallization so well investigated by M. Beudant. I shall give in my work all the proofs respecting it.

M. Jacquelain (*Comptes Rendus de l'Acad.*, t. xxiv, p. 44) affirms that alum contains 22 atoms of water instead of 24 in the usual formula. This assertion is not accurate, for the new formula would require 43·38 per cent. of water, and we obtain, *by direct determination*, 45·5 per cent. Now this is exactly the same number cubical alum also gave me.

C. Sub-genus *α subphosphate*,

$$PO_{\frac{7}{2}}(M^2)+\tfrac{1}{2}M^2O=PO^4(M^3)=[P^2O^5,3M^2O].$$

Phosphate of soda called neutral, at 212° F.,	$PO^4(Na^2H)$.
" of silver, ...	$PO^4(Ag^3)$.
" of lead, ...	$PO^4(Pb^3)$.

D. Sub-genus *β subphosphate*,

$$PO_{\frac{9}{2}}(M^2)+M^2O=PO_{\frac{9}{2}}(M^4)=[P^2O^5,4M^2O].$$

Phosphate of soda called basic, at 212° F.,	$PO_{\frac{9}{2}}(Na^3H)$.
" of baryta at 212° F., . .	$PO_{\frac{9}{2}}(Ba^3H)$.
Pyrophosphate of baryta at 212° F., .	$PO_{\frac{9}{2}}(Ba^2H^2)$.
Basic phosphate of lead, . . .	$PO_{\frac{9}{2}}(Pb^4)$.

Genus Sulphate, $SO^4(M^2)\pm M^2O$.

A. Sub-genus *persulphate*,

$$SO^4(M^2)-\tfrac{1}{2}M^2O=SO_{\frac{7}{2}}(M)=[2SO^3M^2O].$$

Fuming sulphuric acid, ...	$SO_{\frac{7}{2}}(H)$.
Crystallized anhydrous bisulphate of potash, .	$SO_{\frac{7}{2}}(K)$.

B. Sub-genus *equisulphate*, $SO^4(M^2)=[SO^3,M^2O]$.

Concentrated sulphuric acid, . . .	$SO^4(H^2)$.
Neutral sulphate of potash, . . .	$SO^4(K^2)$.
Bisulphate of potash at 212° F., . .	$SO^4(KH)$.
Insoluble alum, ...	$SO^4(K_{\frac{1}{2}}Al_{\frac{3}{2}})$.
White sulphate of copper, . . .	$SO^4(Cu^2)$.

C. Sub-genus *β subsulphate*,

$$SO^4(M^2)+M^2O=SO^5(M^4)=[SO^3,2M^2O].$$

Crystallized sulphuric acid, density 1·780,	$SO^5(H^4)$.
Alum desiccated at 262°·4 F., . .	$SO^5(K_{\frac{1}{2}}Al_{\frac{3}{2}}H^2)$.
A salt obtained by boiling a mixture of sulphate of copper and neutral sulphate of potash, at 212° F.,	$SO^5(K_{\frac{1}{2}}H_{\frac{3}{2}}Cu^2)$.

D. Sub-genus *δ subsulphate*,

$$SO^4(M^2)+2M^2O=SO^6(M^6)=[SO^3,3M^2O].$$

Turpeth mineral, ...	$SO^6(Hg^6)$.

Genus Chlorid, $Cl^2(M^2)\pm M^2O$.

There cannot be any *perchlorids*.

A. Sub-genus *equichlorid*, . . .	$Cl^2(M^2)$ or $Cl(M)$.
Hydrochloric gas, ...	$Cl^2(M^2)$.
Chlorid of potassium, . . .	$Cl^2(K^2)$.
Double chlorid of zinc and potassium,	$Cl^2(KZn)$.
Anhydrous chlorid of aluminium, .	$Cl^2(Al^2)$.

B. Sub-genus *α subchlorid*,

$$Cl^2(M^2)+M^2O=Cl^2O(M^4)=[Cl^2M^2,M^2O].$$

Chlorate of alumina, ...	$Cl^2O(Al^2H^2)$.
Oxychlorid of lead, ...	$Cl^2O(Pb^4)$.

I give the name of *equisalts* to those which correspond to the acids produced by the combination of equal volumes of hydrogen and a non-metallic body (for example, hydrochloric gas), or by the direct combination of equal volumes of water and an anhydrid* (for example, concentrated sulphuric acid). The *subsalts* contain the elements of an equisalt, *plus* nOM^2, the persalts are composed of the same elements *minus* nOM^2.

These definitions appear to me much more precise than the names applied to the same combinations in the dualistic system.

The researches of which I have just given the first results, will soon be followed by a volume on mineral chemistry, in which I shall discuss more at length the principles of the *unitary system* (système unitaire), which along with M. Laurent, I am endeavoring to establish.

ART. XXXII.—*Observations on Rammelsberg's Analysis of the Juvenas Meteoric Stone, and on the Conclusion of Fischer's Examination of the Braunau Meteoric Iron;* by CHARLES UPHAM SHEPARD, M.D.

THE two memoirs here referred to, are contained in the Annalen der Physik und Chemie, von J. C. Poggendorff, Band lxxiii, Stuck 4, (1848).

1. *Rammelsberg's Analysis.*

This chemist commences his paper by a reference to my report on meteorites published in former numbers of this Journal,† and especially to the circumstance of my assigning the feldspathic mineral in the Juvenas stone to the species anorthite; it having been previously referred by Haüy and Laugier to feldspar, and by Rose to labradorite. This led him to undertake a fresh analysis of the meteorite, Alexander von Humboldt having supplied him with a specimen for the purpose. The investigation confirms my opinion respecting the mineral in question, while Rammelsberg affirms that it has led to new results. "Das Resultat ist nun allerdings zu Gunsten der Ansicht von Shepard ausgefallen, und liefert noch einige vielleicht nicht ganz uninteressante Details."

My report on meteorites having been mainly devoted to such productions as had been observed in the United States, it was not thought proper to allude to foreign localities, except in a very concise and general manner. This brevity led Rammelsberg to doubt whether my inference respecting the feldspathic ingre-

* I have elsewhere shown (*Journ. de Pharm. et de Chimie*, t. xi, p. 379) how we can estimate, by analogy, the volume of a non-volatile anhydrid in the state of vapor, by taking as a basis the known volume of the corresponding anhydrous chlorid.

† Vol. ii, ii ser., p. 377, and iv, p. 74.

dient of the Juvenas stone was made from the descriptions of others, or had resulted from a new examination of the mineral itself. I may therefore be allowed to state, that it was formed from an examination of a large specimen of the Juvenas stone, that had been supplied to me by H. Heuland, Esq., out of the fine meteoric cabinet of the late Sir F. Chantrey. Besides, I am ignorant of the fact, if any writer has noticed the particular crystal I have figured of the anorthite, or made the observations respecting the sphenomite of the Juvenas stone which were included in the same paper.

Rammelsberg finds the Juvenas stone to consist of the following minerals:

Anorthite, about, ...	36·00 p. c.
Augite, "	60·00 "
Chrome iron, "	1·50 "
Magnetic pyrites, ...	·25 "

With perhaps minute traces of apatite and rutile.

The anorthite is soluble in moderately strong hydrochloric acid; and consists of:

			Oxygen.
Silicic acid, . .	44·38	. . .	23·06
Alumina, . . .	33·73	15·75	16·73
Oxyd of iron, .	3·29	0·98	
Lime, . . .	18·07	5·14	5·59
Magnesia, . .	0·36	0·14	
Soda, . . .	1·03	0·26	
Potassa, . .	0·33	0·05	
Phosphoric acid, .	0·54		
Proto-sulphuret of iron,	0·71		
	102·44		

The augite was insoluble in hydrochloric acid; and was decomposed by carbonate of soda (and by hydrofluoric acid for determining the soda content). It contained:

			Oxygen.
Silicic acid, . .	52·07	27·16	27·27
Alumina, . . .	0·24	0·11	
Protoxyd of iron, .	30·81	6·91	12·57
Lime, . . .	5·68	1·61	
Magnesia, . .	9·98	3·95	
Soda, . . .	0·41	0·10	
Chrome iron, .	2·13		
Titanic acid, . .	0·16		
	101·48		

In supposing that the phosphoric and titanic acids were for the first time discovered in meteorites by the present research, Rammelsberg has overlooked my announcement of the existence of the first of these in 1829, in the Virginia stone,* the reaffirmation in 1843,† of its presence in the same stone (in answer to the doubt expressed by Rumler in relation to the subject in Pogg. Band liv, Stuck 2, 1841), and repeated allusions to the same point in my recent meteoric reports: while, concerning titanic acid, it has also escaped him, that I gave in my report the following reasons for supposing that it existed in the Juvenas stone under my description of sphenomite. "Thus named from its resemblance to sphene. It occurs in brownish-grey (with a tinge of yellow) thin, tabular crystals, H. =5·5. Implanted on crystals of black pyroxene, and associated with anorthite in the Juvenas stone. Before the blowpipe, it fuses readily to a black glass, which is magnetic. It dissolves in borax with effervescence, presenting the reaction of sphene. It is soluble in nitric acid, with the exception of a heavy white powder, insoluble in ammonia. This solution contained silicic acid and lime."

I was therefore led to regard the presence of titanic acid as nearly certain in the meteorite; and accordingly twice referred to titanium in the course of the report, as a probable ingredient of meteors.

I am not, however, certain that the phosphoric acid exists combined with lime, in the form of apatite. It is possible that magnesia enters into the compound, and that the mineral constitutes a new species. Nor can I yield to the suggestion, that the supposed titanic acid exists as rutile. On the other hand, I believe it to be present in the sphenomite, in which I also detected silicic acid, lime and protoxyd of iron.

2. *Fischer's Analysis.*

The first part of Fischer's research respecting the Braunau iron appeared in the Annalen, Band lxxii, S. 475, and was translated by Mr. Lettsom for this Journal (vol. v, ii ser., p. 338).

The principal portion of the present article relates to the composition of the insoluble ingredient of the iron, concerning which Fischer observes, that it has very properly been called *Schreibersite* by the Vienna naturalists.

Now this is the name by which, in 1846, I designated the sulphuret of chromium, found in the Bishopsville (S. C.) meteoric stone, one year before the fall of the Braunau iron occurred. And I had moreover described in my report on meteorites, the very ingredient of meteoric irons with which Fischer occupies himself in the present inquiry, under the name of dyslytite. Whether there has been an accidental interchange of my names, or whether some writer has named the insoluble substance in ques-

* See this Journal, vol. xvi, p. 199. † Ibid, vol. xlv, p. 102.

tion after Dr. Schreibers, (whom, I am happy to learn from Prof. Agassiz still survives, contrary to my impressions when I named the mineral,) I am unable to conjecture.

Fischer finds the insoluble matter to consist of:

Iron,	56·430
Nickel,	25·015
Phosphorus,	11·722
Chromium,	2·850
Carbon,	1·156
Silica,	0·985
	98·158.

He concludes that the Braunau iron consists of 95 to 98 p. c. of nickeliferous iron, with traces of cobalt, calcium, magnesium, chlorine, &c., (the sulphur and chromium, found by him and Duflos, appearing to belong to the pyrites and the insoluble, scaly mineral. He thinks that the constitution of the nickel-iron will not be found constant throughout the mass; and that no two analyses will give constant results.

The little balls of diffused pyrites are found to be a peculiar chemical compound of a simple sulphuret of iron and nickel, since it dissolves in hydrochloric acid at common temperatures with the evolution of hydrosulphuric acid, unattended by the separation of sulphur,—there remaining only a little residuum (about 1 p. c.) which contains chromium, carbon and silica.

The dyslytite constitutes the remaining ingredient of the iron; and is everywhere diffused through its mass. To its presence, Fischer, (after the suggestion of Berzelius,) attributes the Widmannstättian figures of meteoric irons.

All these ingredients are more or less crystallized. They are also magnetic; the nickel-iron and the dyslytite with polarity, the latter more so than the former; while the magnetic pyrites is simply attracted by the magnet.

New Haven, August 29, 1848.

Art. XXXIII.—*Contributions to the Mycology of North America;* by M. A. Curtis.

The history of Mycology in this country is soon told. Passing by the few species noticed by Plukenet, Clayton, Walter, and the almost always doubtful matter of Rafinesque, we find M. Bosc first giving any definite and intelligent attention to our Fungi.

In 1811, he published in the Berlin Magazine several new species found near Charleston, S. C., where, like Delile at Wilmington, N. C., he held the office of French Consul. His new species, which are all interesting, do not exceed half a dozen; and only one—the curious Hyperhiza—retains the place he gave them. Agaricus dorsalis, *Bosc*,—a very handsome species—belongs to Panus, *Fries*. This is very common in both Carolinas upon pine logs and stumps. Lycoperdon heterogeneum, *Bosc*, —a beautiful Fungus—belongs to Mitremyces, *Nees*. L. transversarium, *Bosc*, is Cauloglossum transversarium, *Fries*. And L. cyathiforme, *Bosc*, I suspect is a state of L. Bovista, *Linn*.

Dr. Muhlenberg established the fine genus, Glonium. Beyond this I am not aware that he added anything new.

The largest additions to the knowledge of Fungi in this country were made by the learned Schweinitz. He had already acquired a European reputation by a valuable local work on Fungi, prepared by himself and Albertini It is in this department of botany that he was especially skilled and successful, though he is generally better known among us for his investigations in other orders. In 1820, he published in the Leipsic Transactions, under the editorship of Schwægrichen, his FUNGI CAROLINÆ SUPERIORIS, being an enumeration of species already published which he had detected in North Carolina, with descriptions of new ones. The number of species in that paper is 1373.

In 1831, Mr. Schweinitz published in the Transactions of the American Philosophical Society of Philadelphia, a "Synopsis Fungorum in America Boreali media degentium." This includes all the species of the former paper, and like that, is composed of enumeration and description. It includes 3098 species, of which over twelve hundred are given as first discovered by himself. From these some deduction must be made for bad species, Mycelia, pseudo-Fungi, and a few already described by others. Still his additions, confined as his examinations were to small districts, must be considered very large and interesting. Some half dozen new genera were founded by this author.

The late Mr. Lea of Ohio, had given some attention to this class of plants. His small collection was sent to the Rev. M. J. Berkeley of England. It comprised thirty or forty undescribed species, part of which have been published by Mr. B. in Hooker's London Journal of Botany. This accomplished mycologist has also published a few other species from different parts of North America, which have been easily gathered by various collectors. Among them is a species of Cyclomyces—C. Greenei, *Berk.*—a very interesting addition to our Fungi, discovered by B. T. Greene, Esq., at Tewksbury, Mass.

At present I do not know that any American botanist is giving this obscure but interesting order any special attention, except H. W. Ravenel, Esq., of South Carolina, and myself.

In the present paper are enumerated two decades of Fungi not before included in any American publication, and one of new species. They are taken at random from lists of several hundred, which will be published from time to time hereafter. To acknowledge a heavy debt of obligation, and to insure to the following list an authority which I could not myself give it, I must here state that nearly all the species have passed under the eye of my very attentive and generous correspondent, Mr. Berkeley.

The species requiring illustration will be figured with others in a future number of the Journal.

1. AGARICUS RACHODES, Vettadini.—Ad radicem arboris mortuæ. Hillsborough, N. C.

2. MARASMIUS HÆMATOCEPHALUS, Fries.—Ad terram, fimum, ramulosque dejectos in graminosis, Hillsborough; item, Santee Canal, S. C.! ex Ravenel.

3. POLYPORUS MENANDIANUS, Mont.—In ramis emortuis. Hillsborough, N. C.

4. P. NEELGERRHENSIS, Mont.—Ad truncos prostratos præsertim Liriodendri. Hillsborough.

5. P. SULLIVANTII, Mont.—In ramis dejectis. Hillsborough.

6. HEXAGONA SERICEO-HIRSUTA, Fries.—Ad truncos cariosos. Santee Canal, S. C.! Mr. Ravenel.

7. BOLETUS SATANAS, Lenz.—Ad terram in sylvis. Hillsborough.

8. BOLETUS ANANAS, n. sp.—Pileus pulvinatus, crasse et rigide verrucoso-floccosus, luteus, ad basin floccorum venis carneis variegatus; margine tenui; hymenio plano, ad stipitem depresso, sulphureo fulvescente, vulneribus viridescentibus; tubulis mediis, obtuse angulatis; stipite lævi, solido, albo; sporidiis ferrugineis.

Species pulcherrima, subter truncos Pineos prostratos. Aug., Sept. Society Hill, S. C.; item, Santee Canal! Ravenel.

Pileus 3–4 inches broad, 1 thick. Tubes ½ line in diameter. Stipe about 3 inches long, ½–¾ inches thick, the base somewhat enlarged. In habit approaches B. strobilaceus, *Scop.*, otherwise very different.

9. GEOFLOSSUM DIFFORME, Fries.—Ad terram in sylvis humidis. Society Hill.

10. TYPHULA TENUISSIMA, n. sp.—Simplex, gregaria, lævis, setaceo-filiformis, acutissime attenuata, pallida; stipite fusco-nigro; tuberculo nullo. In foliis putrescentibus Phaseoli. Aug., Sept. Society Hill. ½–1 inch long, about ⅛ line thick.

11. Stictis Sesleriæ, Lib.—In vaginis imis emortuis Andropogonis. Santee Canal. Mr. Ravenel.

12. Spermœdia Tripsaci, n. sp.—Lineari-lanceolata, lenta, squamosa, pallida, apice fuliginea. E seminibus Tripsaci. Hillsborough, N. C.
About ½ inch long, 1 line thick. In texture this is very unlike S. Clavus.

13. Sphæria Notarisii, Mont.—In ramulis emortuis Gleditschiæ et Robiniæ. Hillsborough, N. C.

14. Dothidea Pteridis, Reb.—In frondibus Pteridis aquilinæ. Rhode Island. Misit J. Olney.

15. Geaster saccatus, Fries.—Ad terram juxta truncos cariosos prostratos. Santee Canal, S. C. Ravenel.—This is a Brazilian species, and an interesting addition to our Flora.

16. Physarum decipiens, n. sp.—Adnatum, globosum et ovale (vel confluens, inde lineare et reniforme,) olivaceo-virente flavescens, rugulosum, indefinite diffractum. Floccis aureis. Sporidiis nigris. Ad truncum vivum Quercus. Aug.—Dec. Society Hill, S. C.
Less than ½ a line broad, mostly simple. Morphosis not seen. Continues five to seven days.

17. Stemonitis tenerrima, n. sp.—Sparsa, absque hypothallo; peridio ovato, acuto; capillitio sporidiisque pallide ferrugineis; stipes 2–3plo longior, subulatus, attenuatus, niger, nitens, toto penetrans. Ad caules herbarum putrescentium. Society Hill. About a line high.

18. Lachnobolus cribrosus, Fries.—Ad runcum Quercus prostratum. Hillsborough.

19. Helminthosporium macrocarpon, Grev.—In ramis variis emortuis. N. and S. Carolina.

20. Helminthosporium Ravenelii, n. sp.—Longe effusum, velutinum, fusco-olivaceum; fibris dense aggregatis, obtusis, nodosis, pellucidis; sporidiis elliptico-oblongis, 3–4 septatis.—Totam paniculam Sporoboli Indici investiens. July—Oct. N. and S. Carolina.
This is so common upon Sporobolus Indicus, that it is difficult to obtain specimens not wholly blackened by this Fungus. It is perhaps from this that it has gotten the name of "black seed grass." The seeds are far from black.

21. Helicoma Berkeleyi, n. sp.—Fibris aggregatis, atris, ramosis, opacis, septatis, flexuosis, fragilibus; sporis helicoideis, reniformibus, opacis, multiseptatis; sporidiis biseriatis non sece-

dentibus.—Ad corticem et lignum Corni floridæ et Liquidambaris, Society Hill; item, Salicis Babylonicæ, Santee Canal; Ravenel.

Appearing as black spots of two lines to several inches extent; the flocci invisible to the naked eye.

22. Triposporium elegans, Corda.—Ad caules herbarum in quisquiliis. Society Hill.

23. Aspergillus maximus, Lk.—Ad Polyporos mucidos. Society Hill.

24. Oidium pulvinatum, n. sp.—Cæspitulis pulvinatis, compactis, primo ochroleucis dein aureis; floccis fertilibus in articulos globosos ovalesque secedentibus.—Ad ligna putrida, Society Hill; item, Santee Canal; Ravenel.

Tufts roundish, 1–2 lines broad and high, sometimes confluent. An elegant species.

25. Pestalozzia pezizoides, De Notaris.—In ramis mortuis Vitis ripariæ. Hillsborough.

26. Aregma mucronatum, D. C.—In foliis Rosarum. Hillsborough.

27. Puccinia Amorphæ, n. sp.—Amphigena. Soris sparsis et approximatis in macula flavescente, subrotundis, nigris; sporidiis compactis, ovalibus, raro globosis, in medio constrictis, opacis; pedicello brevi aut nullo. Ad folia Amorphæ herbaceæ, Society Hill; item, A. fruticosæ, Santee Canal, Ravenel.—Sporidia remarkable for a loose transparent vesicular (?) epidermis often enclosing and bordering the opake nucleus.

28. Cronartium asclepiadeum, Kunze.—In foliis Comptoniæ. Hillsborough.

29. Uredo Prunastri, D. C.—In foliis Amygdali Persicæ. Society Hill.

30. Uredo Hyptidis, n. sp.—Sparsa et fasciculata, maculis emarcescentibus; pseudo-peridia parva, convexa, rotunda vel oblonga, lutescentia. Sporidia ochroleuca, ovalia obovata et subglobosa, minima, subpellucida, (sporidiolis farcta?) raro subpedicellata.—In utraque pagina foliorum, in caulibus, bracteis, floribusque, Hyptidis radiatæ.

The nearest affinity of this species seems to be with U. Labiatarum, D. C.—Santee Canal, Ravenel.

Art. XXXIV.—*Geology of South Alabama;* by C. S. Hale, Mobile.

Of the three divisions included in the tertiary system, the upper, middle and lower,—or agreeably to the nomenclature of Mr. Lyell, the pliocene, miocene, and eocene—only the last has been found with certainty to exist in Alabama; and even this appears to be limited to the older portion of the series. For certain deposits of this formation, which occur in the Carolinas and Florida, contain fossils specifically distinct from those of the Alabama beds, and which evince that the former localities embrace a newer part of the series.

The geographical limits of the formation, on the north, may be defined by an imaginary line passing between the Upper and Lower Peach-tree landings, on the Alabama river; through Moscow on the Tombecbee, thence by the Suearnochee creek, through Kemper and Carrol counties, Miss., to Arkansas state, and to Natchitoches on the Red river. On the south, the last knobs of the coralline white limestone beds disappear beneath the overlying sands and clays near the junction of the Alabama and Tombecbee rivers. And on the Mississippi the equivalents of these beds terminate near its junction with the Red river, forming a zone about sixty miles in width.

The surface of this region is generally very uneven, consisting principally of the white limestone beds, which have been furrowed out into detached precipitous masses, laying bare, in many instances, the subsequent strata, and the whole is often covered by more recent deposits of sand and clay.

The following is the order of the eocene series of Alabama.

1. (or lowest) Clay bed.
2. Lignite.
3. Sand and shells.
4. Clay bed with oysters.
5. Marly arenaceous limestone.
6. Clay bed with oysters.
7. Sand and shells.
8 and 9. White limestone.

(Nos. 3–9:) Section of the Claiborne bluff.

The best natural section of these beds occurs at Claiborne, and may be regarded as normal deposits. This cliff which is nearly two hundred feet in height, includes the entire series of the formation with the exception of a few strata at the two extremes.

The basal bed of the cliff which may be seen here at extreme low water, is a sandy deposit, partially developed at this locality, but in other places it exhibits very decided characteristics, as an important part of the group. We have identified its existence through a wide geographical range. Its northern outcrop may be seen near Black's and Wood's bluffs, on the two main water courses. Its thickness varies from fifteen to twenty feet. It consists of fine quartzose sand, mixed with silicate of iron, and is sometimes marly by testaceous remains, with which it greatly abounds. The best development of this deposit occurs in Clark county on Bashui creek and its branches. It is here densely charged with fossils, including nearly all the different species of testacea common in the other parts of the series, together with many new ones, some of which are unique. Of the latter may be noticed a species of Rostellaria, differing from Lea's R. Lamarckii in having a more attenuated rostrum, and a very prominent tubercle situated on the back of the body whorl. Also a new species of Voluta, having a general resemblance to V. luctator of the London clay, but differing in a remarkable deposit of enamel behind the aperture, forming a large bourelet covering half the spire to the summit, enveloping also the folds of the columella, and otherwise flattening and deforming the symmetry of the aperture. Also a new species of Tornatella: shell robust, spirally fluted with flattened ribs, spire attenuated, two stout folds on the columella, outer lip denticulated. A new species of Ranella transversely ribbed, cancellated, with small intermediate varices between the two principal ones, and coarse indentations on the inner margin of the outer lip. Another species answering to Cassidaria carinata, *Lam.*, figured in Lyell's Principles of Geology, as a characteristic of the European equivalents; the only difference exhibited in our shell is that of possessing three instead of four rows of tubercles. The bed under consideration which we designate No. 3, is the source of several mineral springs, as the Tallahatta, Bladon, Monroeville, Lauderdale, and some others of less notoriety. These all appear to be identical in their mineral properties, which are evidently derived by infiltration from the ingredients of the subjacent bed of lignite through which they percolate. But this bed of lignite, (No. 2,) for other reasons may be considered a very important part of the series. It lies upon the lowest bed of the group, which last, No. 1, consists of bituminous clay, more or less sandy and sometimes containing large masses of sandy concretions. This clay bed is about twenty-five feet in thickness and rests conformably upon the subjacent cretaceous beds. It may be traced along the Alabama river from Tate's ferry to near the Upper Peach-tree landing, where it terminates; also on the Tombecbee river from Wood's bluff to its termination, at Black bluff. It appears to be destitute of fossils; but with its associated bed of lignite, it forms a very distinct line of demarkation between the tertiary and cretaceous systems. At Grayson's landing on Coal bluff, as it is sometimes called, the deposit of lignite is well developed in connexion with the overlying sand and subjacent clay bed. Its thickess here amounts to four feet. The color is dull black, texture compact with occasional thin fibrous laminations, structure massive, sometimes fragmentary; it burns without swelling or caking, and abounds with sulphate of iron both crystallized and amorphous.

Want of leisure has prevented a suitable examination of its organic remains. The vegetable part however furnishes decided evidence of its intertropical character. Between our two principal water courses this deposit of lignite lines the bottom and sides of the streams through a zone ten or fifteen miles in width. It occurs in a western direction in Pigeon creek on the border of the state of Mississippi, near the northern limits of Washington county. It is found also at Natchitoches on Red river, where the underlying bed consists of a grayish plastic clay, very adhesive; on Bedia's creek near the Trinity river, Texas; at Robin's ferry on the Brazos; and at Bastrop on the Colorado. At all these places the lignite occupies the same relative position in the series, and is probably continuous through the whole of this extent, marking the former coast line.

The greensand deposit, No. 3, already noticed as partially developed at the base of Claiborne bluff, passes insensibly into No. 4, an argillaceous muddy deposit above, with a thickness varying from fifteen to twenty feet. The fossils of this bed are limited almost exclusively to the Ostrea genus; the only exceptions appear to be the Cardita planicosta, two or three species of Turritella and an Arca. The stratum No. 4, also makes its appearance at Coffeeville landing on the Tombecbee, where it exhibits the same identical fossiliferous character.

There occur here however a new species of Turbinolia, resembling very much the Turbinolopsis ochracea of Lamouroux—two or three new species of Lonsdale's new genus Endopachys, also a new species of Lunulite. This stratum may also be seen at Bell's landing on the Alabama, where its thickness amounts to fifty feet. At the bottom of this cliff with the Ostrea common in the stratum, I found the Cardita planicosta of very large dimensions.

The next in the ascending series is a limestone deposit with sandy and argillaceous ingredients variously intermixed. The few species it contains are common also in the other beds, and probably were introduced here in some adventitious way. I have not been able to discover this deposit anywhere else except in the Claiborne section.

To this limestone deposit, another clay bed, No. 6, succeeds, being about twenty feet in thickness. It is remarkable for nothing else but a band of oysters of the selliform species, all of which are of a mature size, and probably lived on the spot. This clay bed with oysters, occurs again five miles below on the river, in the same relative situation in the series; in both of which instances the oysters are full grown; whereas in the lower bed both at Claiborne and Coffeeville, they are principally of immature size, a peculiarity which may possibly be owing to the circumstance of their exposure in the latter case to the influence of a current, when small and easily drifted.

The next bed, No. 7, is a deposit of fine yellow quartzose sand with a small mixture of silicate of iron; in some instances it is highly ferruginous. It contains nearly all the different species of fossils found in the series. Its medium height is about fifteen feet. I obtained, at different times, from this stratum, various species of radiata, mollusca, reptiles, fish, and mammifers, amounting in all to about three hundred. Those which embrace the greatest number of individuals, belong to the genera, Cytherea, Cardita, Crassatella, Pectunculus, Crepidula, Oliva, Turritella, Dentalium, and Corbula. Several of these species are grouped in distinct layers or bands; but the greater portion of them seem to have been promiscuously thrown together, as if they had been exposed to the violent agitation of the waves. The testacea of this bed are all marine and nearly all of them of the littoral kind. Not a single species of land or freshwater shells has yet been found in any of these beds.

A small seam of earthy lignite, disseminated in small fragmentary masses, forms a somewhat striking feature about midway in the yellow sand; and associated with it were found the only remains yet discovered of terrestrial mammalia. The greater portion of the fossils peculiar to this bed have already been described. We shall therefore omit the notice of such, and at present merely allude to those in our cabinet which are unique. One of the most remarkable of these is that of a Nautilus, which appears to be restricted to this deposit. Our specimen is too imperfect to admit of a very particular description. In its entire state it could not have been less than one foot in diameter. We have also obtained from this deposit several new species of Echinoderms, and Madrepores, and many new species of Molluscs, of the genera Fusus, Terebra, Ancillaria, Phasianella, Murex, Turretilla, Solarium, Scalaria, Pyrula, Venus, Arca, Tellina.

Of fish, there are remains of the Pristis, spines of the Ray, various species of palatal teeth, vertebræ of many unknown species, and teeth and vertebræ of the shark. Of terrestrial mammalia there are several maxillary fragments of small quadrupeds. The most interesting relic of this class is the cranium of a quadruped, whose type is now exclusively confined to the southern part of this continent. It belongs to an extinct genus of the Edentate order of animals, and is allied to the existing armadillos. Our fossil answers to a skeleton lately found in the tertiary beds near Buenos Ayres, called the glyptodon. The occipital surface of the skull slopes forward, from the plane of the occipital foramen, at an angle of 45°. In the small existing armadillos it is vertical. In the glyptodon this surface is divided by a medium vertical ridge, and separated from the upper surface of the skull by a transverse ridge. The interorbital part of the upper surface of the cranium is somewhat broad, and nearly flat, and concave at its posterior half. The anterior part of the base of the cranium, shows the large cavities of the olfactory bulbs, and the remains of an extensive cribriform process, evincing that the organ of smell was well developed. The existing species of this order of animals inhabit the warm and temperate parts of South America. It is characterized by the sloth, the ant-eater, and the armadillo. In their habits they are nocturnal and gregarious, burrow in the ground, and feed on dead bodies, reptiles, the root of the manioc, and other succulent plants. Were this the only relic of the family that has been found in this part of the continent, it might seem presumptuous to deduce any special conclusion from its occurrence in our tertiary beds. A single individual might, for once, have wandered beyond the limits of its habitat, or by some accidental means have been transported into a foreign situation. But since other kindred remains of this family, the megatherium, for instance, have been found in this part of the continent, we may reasonably conclude that it was once their proper abode, and zoologically connected with the southern division. What might have been its condition then, and what are the changes that have since occurred to have caused the present diversity of the two faunas, are inquiries that force themselves upon our consideration. That this diversity has been produced by external physical causes, such as change of climate, and modifications of the earth's surface, can scarcely be doubted; for no other reason can be assigned why a living typical representation of these extinct species, should not still be found north as well as south of the Mexican gulf.

That the geographical distribution of faunas has changed since the opossum lived in the British isles, and the mastodon was indigenous to both North and South America, are interesting facts to be accounted for in the adaptation of the nature and habits of animals to the external circumstances in which they are placed. Such an adaptation furnishes the reason of the limitation of the present congeners of our species to their South American locality. And we have only to suppose an assimilation of conditions between the two parts of the continent, and perhaps the substitution of an unbroken connection by means of the continuation of the table lands of Mexico, or the Carribean Islands, in order to produce a similar correspondence between our present and extinct faunas.

But to pursue the details of our researches, we remark, that the bed, No. 7, which forms so interesting a feature in the Claiborne section, is exhibited in many other places, and often becomes an important criterion to determine other parts of the series. Two miles below, near Forward's landing, it makes its appearance in a similarly elevated cliff, and becomes quite as interesting for the abundance of its fossils, with no apparent diversity of species. And again, still farther down the river, at Barefield's plantation, it is developed about ten feet above the water, in connection with the subjacent oyster bed.

Four miles farther south, at the bend of the river, near limestone creek, the bed, No. 7, appears at low water in connection with the overlying Claiborne beds. It also occurs in the interior of Clark county, where it is exposed in a ravine at the base of the white limestone hill; on Limestone creek, near the salt works, and at the base of St. Stephen's bluff one mile above the landing: thence in a northeasterly direction, its outcroppings may be traced to the borders of Mississippi.

In all these situations, the stratum under consideration exhibits a remarkable identity both in its mineral and zoological characters; it also retains its parallelism with the exception of the two first localities, where its uncommon elevation may be attributed to the unevenness of the older cretaceous beds which it overlaps in a tortuous and irregular manner.

The remaining part of the eocene series, exclusive of the superficial sand and clay, may be included under the appellation of white limestone. The peculiarities of this part of the series, seem to require such a distinction. It consists of limestone, both compact and loose, somewhat arenaceous and marly below, but passing upwards into a very pure carbonate of lime, having often a white chalky appearance without signs of stratification. But the distinction regards more especially its fossils. Though the general type of its fauna identifies it as a part of the eocene group, yet there is a manifest peculiarity; the upper portion especially consists almost entirely of comminuted remains of marine organisms, such as Orbitolites and other coralline forms. Indeed the aspect of the species in the subordinate part of the formation presents obvious differences, such as occurrences of Echinoderms of various genera, pectens and oysters of a peculiar type, and above, a very unique species of cetacean mammal. These peculiarities were, until lately, considered a sufficient reason to class these deposits as a newer part of the cretaceous system. But it is now ascertained both by stratigraphical and paleontological evidence, that they form an upper section of the eocene strata. We have fixed the commencement of this subdivision immediately after the bed last considered, No. 7, for here we find an evident transition from the prevailing forms of the preceding beds to a peculiar zoological type that marks a very evident change of geological condition.

With a few of the smaller less characteristic species that have passed into these upper beds, we meet with a large proportion of Radiata, such as Scutella, Spatangus, &c., and as we ascend in the series, various new species of pecten and oysters, to the almost entire exclusion of the species that prevailed in the preceding deposits.

The ferruginous sand which we regard as the transition bed, is not very distinguishable from the bed immediately preceding, except for the large number of Scutellæ which it contains. Six miles below Claiborne at the bend of the Alabama, it may be seen with a large amount of its characteristic fossils, where the superjacent strata are identical with those similarly associated in the Claiborne section. But the series are continued upwards so as evidently to connect with the Orbitolite limestone, and a few miles down the river near Dale's ferry, a similar connexion may be seen with a very full development of the Orbitolite limestone. Many other instances of this kind might be adduced if it were necessary to show that such is the true order of the series.

The white limestone formation is exhibited in detached and uneven masses, constituting a prominent feature of the counties of Munroe, Clark and Washington. In the neighboring counties, and even through the state of Mississippi, the white limestone is replaced by a blueish argillaceous marl, in some instances loose, in others hard and compact. After the white limestone was deposited, new agencies appear to have been brought into operation, which furrowed out its beds, and, in many instances, laid bare even the lowest of the subjacent strata. These effects are more manifest in the northern limits of Clark county, where the denudations have extended to the lowest eocene beds and formed ravines between the limestone hills in some instances to the depth of three or four hundred feet. These are the only marked effects of violent disturbance that occur in any part of the series, and they very probably belong to a much later date, perhaps to that change of geological conditions indicated by the overlying mass of sand and clay. But whether this superficial mass was formed within or after the eocene period, we have not the means of knowing, as it is destitute of fossils. The gravel and rolled shingle however seem to indicate a kind of agency more in accordance with events of some subsequent date, than with that of the tranquil deposition of the preceding eocene strata.

The train of these remarks has caused us to omit noticing the paleontological features of the white limestone formation. The orbitolite and other coralline remains which constitute its principal ingredients have already been alluded to. Their accumulation here furnishes a striking illustration of the remark, "That the most important results are often produced by the simplest means." For what can seem more insignificant than one of these small discoidal organisms more attenuated than the thinnest paper? or the still smaller coralline forms scarcely distinguishable from a microscopic fibre? But insignificant as they appear in a separate point of view, they constitute the entire mass of many of these limestone hills.

In addition to this mass of zoophytes, may also be noticed various species of Echinoderms, some of which are quite unique; they belong to the genera, Spatangus, Scutella, and Echinus. One species of Spatangus is very similar to S. retusa, a cretaceous fossil.

It may be presumed, from this similarity of fauna, that the conditions in which the two formations were produced, could not have been very different. If the Mississippi equivalent of the white limestone, which is a bluish marly limestone, were taken for the type, it must be admitted that a striking similarity also exists even in their mineral character.

The molluscs peculiar to these beds are Spondylus dumosum, Pecten Poulsoni, P. perplanata, Ostrea panda, O. cretacea, and indeterminate casts of Cyprea, Conus, Natica, Mya, and Modiola. The remains of fish are principally of the Placoid order, as the ray, shark, and pristis. But the most wonderful of all these associated tribes, is the noted cetacean called the Zeuglodon.

The metropolis of this strange inhabitant appears to have been the tertiary of Alabama. For here principally the relics abound. They are scattered more sparingly in a westerly direction as far as the state of Arkansas, and eastwardly to South Carolina. Their geological situation is in the tertiary beds immediately below the orbitolite limestone, near the denuded surface of those gentle declivities which form a step to the summit of these hills. They are seldom found in their natural position—but in many instances appear to have been torn, by some disturbing cause, from their ancient resting place and scattered to remote distances. We are informed by some of the early settlers that entire skeletons were formerly exposed upon the surface of the earth, and that these remains were in some instances so abundant as to become an encumbrance upon the plantations. We obtained a vertebra of this animal from the white limestone strata of the Claiborne section; and the fragment of another from a similar section near Forward's landing. We also obtained a large portion of the vertebral column in the western part of Clark county; and the lower maxillæ, teeth and other fragments of the head, near Bucatunnie creek, Mississippi.*

* We omit here some descriptive remarks on the Zeuglodon, as the skeleton has been elsewhere described with more fullness.—Eds.

These eocene strata were all evidently formed in circumstances exempt from the influence of disturbing causes. With the exception of a few local interruptions of level, attributable to the inequalities of the older beds, they appear to retain their parallelism in all their geographical extent. It is very rare that in remote situations, a diversity in the sea-bottom, or some other geological change, does not produce a marked diversity in the character of the deposits; but this series furnishes a remarkable exception in this respect. A striking uniformity in the lithological and zoological characters of the same beds, prevails wherever they have been observed. This uniformity evinces not only the absence of disturbing causes, but a very unusual coincidence of geological conditions. The denudation of the white limestone beds, being considered as a subsequent event, is of course not included in this category.

Another circumstance, worthy of consideration, is the absence of land and fluviatile testacea, and the exclusive limitation of the fossils of these beds to a marine fauna, with the exception of the few remains of terrestrial animals already noticed. Even the estuary group of Cerithia so numerous in the European equivalents, is very sparingly represented in these deposits.

Restricted as these beds are to a marine fauna, it is rather surprising that they contain a very considerable abundance of vegetable remains. Nothing very precise however has been ascertained respecting the situation of the land from whence these remains were derived. It is evident however that this part of the globe, in the period under consideration, was very different from what it is at present.

From the general character of the organic remains, as well as from various other considerations, it is not likely that these deposits were formed in very deep water. We may rather conclude, from the indications exhibited, that they were at one time sedimentary shoals, or a mud-bank, forming a suitable habitation for the Acephala and other organisms that cannot live in the open ocean; and at another time that this body of water was so changed as to become expanded into a widely extended ocean, with a corresponding change of fauna, suited to its varying zones of depth, either such as were adapted to inhabit a shallow deepening sea, or the still greater depths of a more expanded ocean.

Taking into view the regular and quiet operation of the agencies which mark the progress of events in the series, it is rather surprising, at first, to notice the contrast exhibited between this and the preceding cretaceous group; the peculiarity of its organic remains, gives to the tertiary fauna more the appearance of a new creation than a gradual development of the same general system. But as the upper portion of the cretaceous equivalents is probably wanting in our series, and possibly some other intervening deposits not yet made out, a sufficient time may have elapsed between the deposition of the two groups, to furnish a partial explanation of the remarkable change of conditions they manifest. * * * *

ART. XXXV.—*On the Oxydation of Uric Acid by means of Potassa and Ferridcyanid of Potassium;* by ADOLPH SCHLIEPER.

ALTHOUGH a great many products of the decomposition of uric acid have been discovered during the last ten years, yet they were nearly all obtained only by the oxydating influence of acids or acid bodies. The oxydating action of brown oxyd of lead and nitric acid on uric acid has been investigated by Liebig and Wöhler in a masterly manner.* I have already demonstrated the formation of alloxan and urea from uric acid, by the action of chlorate of potassa and hydrochloric acid. With these exceptions, the influence of no other oxydating body on uric acid, has ever been the subject of an original investigation. For these reasons it seemed to me interesting, to study the oxydation of uric acid in an alkaline solution, because its decomposition, effected altogether by a new mode, might throw light on many points, still enigmatical, in the constitution of the products of the decomposition of uric acid.

A notice from Mercer, in regard to the bleaching of cotton cloth dyed indigo-blue, by means of a solution of caustic potash and ferridcyanid of potassium, suggested to me the idea of applying the same mode of oxydation to uric acid; but in doing so, I found it exceedingly difficult, to separate the resulting salts of potash in such a way, that the newly generated and so easily decomposable products of uric acid should remain unchanged.

It is well known that one equivalent of ferridcyanid of potassium with one equivalent of potash are decomposed in presence of oxydizible substances, in such a manner, that the red prussiate of potash takes up one equivalent of potassium, forming with it two equivalents of ferridcyanid of potassium, during which the oxygen of the potassa set free combines with the oxydizible body.

Ferridcyanid of potassium $3KCy+Fe_2Cy_3=3KCy+Fe_2Cy_2+Cy$ with potassa $(K+O)=$ two equivalents of prussiate of potossa $=4KCy+Fe_2Cy_2$, and one equivalent of oxygen.

---

* Annalen der Chemie und Pharmacie, Band 26, p. 241.

I communicate the following results, as they presented themselves in the course of the investigation.

To observe the action of ferridcyanid of potassium and potassa on uric acid, some previous essays were made, in which very small quantities of powdered red prussiate of potassa were put into a nearly cold solution of uric acid in a little more potassa ley than was necessary for the formation of neutral urate of potassa $2KO, C_{10} N_4 H_4 O_6$. The salt dissolves easily in the liquid, and is then directly changed into prussiate of potassa. After the first additions of red prussiate of potash, a separation occurred, of a thick, reddish white precipitate, by which all the liquid was soon thickened to a pulp; which on closer investigation, was found to consist of biurate of potash KO, $C_{10} N_4 H_4 O_6$. So much potash and red prussiate of potassa were alternatively added, that the uric acid remained in permanent solution. As soon as biurate of potassa separated, or as soon as the red prussiate of potash was undecomposed with facility, the addition of a few drops of potash ley were sufficient to renew the operation. The addition of red prussiate of potassa was continued till by a few drops of muriatic acid, no uric acid was precipitated. Towards the end of the operation, the decomposition of the uric acid proceeds slowly, and therefore the addition of red prussiate of potassa must be made at greater intervals.

The alkaline liquor which smells weakly of ammonia, and contains prussiate of potash, an excess of potash and the products of decomposition of uric acid, was then nearly neutralized with sulphuric acid, a considerable quantity of carbonic acid was disengaged, and the solution was evaporated by boiling; a constant smell of ammonia seemed to indicate a further decomposition of the generated organic bodies. The solution must not be perfectly neutralized with sulphuric acid, because then the prussiate of potassa is decomposed during the evaporation, prussic acid goes off and a white pulverulent combination $KFe_2 Cy_3$ precipitates itself, which it is nearly impossible to separate, because it goes through every filter.

The greater part of the prussiate of potash was separated by crystallization, the mother liquor was then evaporated to a small volume and mixed with alcohol, by which sulphate and prussiate of potash were precipitated; this precipitate was then boiled several times with alcohol to remove all substances soluble in the same. The alcoholic solution, during evaporation, gave crystalline crusts of an organic body, which having been separated, the liquor was concentrated to a syrup, and indicated after long standing, traces only, of indistinct crystals containing potassa. This syrupy mass was soluble in a great quantity of *weak*, and may be again precipitated in thick white flocks by *absolute* alcohol. The residuary salt mass extracted with alcohol consisted mostly of prussiate and sulphate of potash to which no attention was paid. Other processes were followed to detect the organic substances insoluble in alcohol, which were possibly present.

A second portion of uric acid was treated as the first, except that the solution, which contained principally free potash, carbonate, and prussiate of potassa, and the organic bodies in research, was now neutralized with acetic acid under the precautions before mentioned. On evaporating, a quantity of acetate of ammonia was evolved. After the greater part of the prussiate of potash had crystallized, the separated mother liquor was likewise precipitated by alcohol, and then boiled out several times with the same. A previous essay to separate the prussiate of potash by means of acetate of copper, and an excess of the latter by sulphuretted hydrogen, did not furnish a favorable result, because complex decompositions took place, and sulphur entered into the composition of the organic bodies. The evaporated alcoholic solution which naturally contained a great quantity of acetate of potash, furnished not a trace of crystals, but only the above mentioned viscid syrup, which was separated from the acetate of potash by treating with absolute alcohol; this seemed to indicate that the first had sustained a further decomposition, by boiling with acetate of potassa, which conducts itself in many cases as a feeble alkali; the unmistakable development of acetate of ammonia furnished the proof of such decomposition.

The residuary salts, insoluble in alcohol, were then solved in water, and the prussiate of potassa precipitated from the hot solution by acetate of copper, only very slightly in excess; the filtrated solution contained, however, neither prussiate of potash nor copper salts, a proof that the small excess of acetate of copper was precipitated by the organic matter present. This filtrate treated with strong alcohol, afforded an abundant crystalline white precipitate, soluble in water, and crystallizing in well shaped crystals, which on farther investigation, proved to be *neutral oxalate of potash.* The presence of oxalic acid was further determined by the preparation and an analysis of oxalate of lead which furnished 75·16 oxyd of lead.

The purification of the previous mentioned crystalline substance was effected very easily by crystallization of the watery solution, for this substance is difficultly soluble in cold, but easily soluble in hot water, and crystallizes on cooling, in small, transparent, shining prisms; they have a neutral reaction, are easily soluble in alkalies and develop ammonia when the alkaline solution is heated. After neutralizing with acetic acid and addition of muriate of lime, an abundant precipitate of oxalate of lime is formed. A solution of the same body mixed with a small quantity of ammonia, gives a white precipitate with nitrate of silver. All these reactions pointed out *allantoin,* whose presence was perfectly confirmed by analysis.

To effect the analysis, air-dried crystals were burnt with chromate of lead:

1. 0·345 grammes substance gave 0·334 grammes carbonic acid and 0·109 grammes water.

2. 0·248 grammes substance gave 0·274 grammes carbonic acid and 0·092 grammes water.

3. 0·2321 grammes substance gave by combustion with soda-lime 1·2998 grammes platino-chlorid of ammonium =0·08163 grammes nitrogen.

Calculated in per cents.:

	I.	II.	III.
Carbon,	29·91	30·13	. .
Nitrogen,	. .	. .	35·17
Hydrogen,	3·97	4·12	. .
Oxygen,	. .	. .	. .

These numbers represent exactly the composition of allantoin $C_4N_2H_3O_3$ as results from the comparison of the calculated and found numbers:

	Calculated.		Found.
4C	24	30·37	30·02
2N	28	35·18	35·17
3H	3	3·79	4·04
3O	24	30·66	30·77
	79	100	100

The formation of ammonia and oxalic acid in heating and evaporating an alkaline allantoic solution, were now explained, for allantoin is decomposed perfectly into these two products, by boiling with alkalies; $C_4N_2H_3O_3+3HO=2$ equivalents $NH_3\times$ 2 equivalents C_2O_2.

I have mentioned before that the alcoholic solution, filtrated from the allantoin, leaves by further evaporation, a sticky syrup containing potash, which, though easily soluble in water, can be separated by an addition of absolute or strong alcohol to the watery solution, as a thick, white flocculent precipitate. This precipitate collected on a filter, absorbs moisture with great avidity and deliquesces; as such it is not fit for analysis: I therefore tried to combine the organic body with oxyd of lead, and to analyze it as a lead salt. The watery solution of this substance, was for this purpose mixed with a solution of neutral acetate of lead, by which a sparse white precipitate was produced, consisting for the greatest part of oxalate of lead, which was filtered off. The liquid was then mixed in two fractions with pure ammonia, free from carbonic acid, by which a white, thick, curdy precipitate was formed; only the first precipitation was used for the entire analysis. Dried, this lead salt appeared as a white shining powder, insoluble in cold water and alcohol, little soluble in hot water, easily soluble in acetic acid, and precipitable again by adding ammonia to this solution.

The amount of oxyd of lead was determined from the first and second precipitation, and it varied from 67–73 per cents., as probably this mode of precipitation occasioned the formation of more basic salts, wherefore, I was obliged to renounce the determination of the atomic weight of this body.

For the analysis, the lead salt was dried at 100° C.

1. 0·3127 grammes substance gave 0·2855 grammes sulphate of lead = 0·2100223 grammes oxyd of lead = 67·16 PbO.

2. 0·3455 grammes substance gave 0·3165 grammes sulphate of lead = 0·2328269 grammes oxyd of lead = 67·38 PbO.

3. 1·0433 grammes substance furnished by the combustion with chromate of lead, 0·3935 grammes carbonic acid and 0·1103 grammes water.

4. 0·949 grammes substance furnished by the combustion with chromate of lead, 0·3568 grammes carbonic acid and 0·10 grammes water.

5. 0·683 grammes substance furnished by the combustion with soda-lime 0·8512 grammes platino-chlorid of ammonia = 0·05345 grammes nitrogen.

In this case the relation of the atoms of oxyd of lead and carbon is 6 : 17, which proves clearly, that the determination of the lead in this salt is not decisive for establishing its atomic weight. If the mean amount of oxyd of lead 67·27 is subtracted, the following figures will express the composition of the combined organic body.

	I.	II.
Carbon, . . .	10·28	10·25
Nitrogen, ...	7·82	7·82
Hydrogen, . . .	1·18	1·15
Oxygen, ...	19·22	19·15

From these values the following formula may be deduced, showing exactly the composition of the organic substance which has been combined with oxyd of lead:

$$C_6 N_2 H_4 O_6.$$

The results of the comparison of the found and calculated values expressed in per cents., is as follows:

	Calculated.		Found. I.	Found. II.
C_6	36	31·03	31·40	31·31
N_2	28	24·13	23·89	23·89
H_4	4	3·44	3·60	3·51
O_6	48	41·40	41·11	41·29
	116	100	100	100

This body is a new acid for which I propose the name of *lantanuric acid;* I shall have an opportunity in the course of this paper to return to this subject.

After the presence of allantoin was proved by analysis, it was clear that in the adopted way it was impossible, to study the process of oxydation of uric acid here occurring, because the action of a hot alkaline solution on the generated products so easily occasions secondary decompositions. Hence I adopted a new mode for the decomposition of uric acid, and carefully avoided everything which could possibly occasion a decomposition of the newly generated allantoin.

The solution of uric acid in potassa ley was obtained as before; and to this, an alkaline solution of 5 oz. uric acid in one gallon of water at 20° C. was added alternately for some time; also ferridcyanid of potassium and potash ley till all uric acid was completely decomposed: to effect this, there were necessary 20½ oz. red prussiate of potash and 10¼ oz. hydrate of potash, which is expressed in equivalents nearly exactly:

1 equivalent of uric acid $C_{10} N_4 H_4 O_6$.
2 " of ferridcyanid of potassium.
6 " of hydrate of potassa.

Thus there are only two equivalents of oxygen combined with one equivalent of uric acid. The alkaline solution was mixed with pure nitric acid nearly to neutralization, a great quantity of carbonic acid developed itself, although the hydrate of potassa originally employed in this essay was freshly made and nearly free from carbonic acid, and as far as possible I had prevented the absorption of carbonic acid from the air. The solution became turbid and colored soon after the neutralization, (the same takes place when instead of *nitric* acid, carbonic acid is used for the neutralization of the free alkali,) and after a short time, a small quantity of a light flocculent dirty brick-colored precipitate separated, and nearly at the same time, allantoin began to form in crystals from the liquid. The perfect separation of this red flocculent precipitate took place after 3 or 4 days, and the liquid then assumed the ordinary yellow color of a concentrated solution of prussiate of potash; the crystallization of the allantoin required 8–10 days.

After the separation of allantoin and the red body by filtration, the filtrated liquor was mixed with nitric acid, till a strong acid reaction occurred, and then, all prussiate of potash was precipitated by a solution of nitrate of lead, the prussiate of lead being insoluble in very diluted nitric acid, while the precipitation of an organic lead salt was thus perfectly prevented. After the separation of the prussiate of lead, and the precipitation of a small excess of lead oxyd by means of sulphate of potassa, the solution was then perfectly neutralized with potassa, after which operation it could only contain nitrate of potassa and the problematic organic substances. Oxalic acid was not present. The nitrate of potassa was separated for the greatest part, including a small portion of allantoin still present, by evaporation and crystallization. The mother liquid concentrated to a small volume, was then mixed with cold absolute alcohol; by means of which was precipitated the greatest part of the still present nitrate of potassa, with a small portion of the before mentioned viscid body (lantanurate of potassa). The filtrated alcoholic solution was then evaporated to dryness in the water-bath. The very small crystalline residue, soluble in water and mixed with concentrated nitric acid, a crystallization of *nitrate of urea*, characteristic in its form, instantly took place; the whole amount of it, did not exceed two to three grammes. The identity of nitrate of urea ($C_2\,N_3\,H_5\,O_8$) was rendered unquestionable by means of a combustion analysis with oxyd of copper.

This substance thus furnished in five tubes, a relation of carbonic acid and nitrogen as 2 : 3 or together as 42, 2C . C CO_2 : 66, 1CC N.

The quantity of the appearing urea is too small to allow the idea, that it proceeded from the direct oxydation of the uric acid. I consider it as a secondary product of the decomposition of a small portion of allantoin; I shall show hereafter, the latter suffers an alteration in an alkaline solution; two equivalents of allantoin take in their composition, two equivalents of water, and form with it an easily decomposable new acid $C_8\,N_4\,H_8\,O_8$; this acid separates most probably into urea and lantanuric acid by a longer contact, or heating with alkalies.

$$C_8\,N_4\,H_8\,O_8 \begin{cases} C_6\,N_2\,H_4\,O_6 = \text{lantanuric acid.} \\ C_2\,N_2\,H_4\,O_2 = \text{urea.} \end{cases}$$

The above mentioned red flocculent body appears likewise in too inconsiderable a quantity, to be deemed other than a secondary product of this new method of decomposing uric acid; the only products, which appear in notable quantity, are allantoin and carbonic acid. I have mentioned before that two equivalents of ferridcyanid of potassa, were necessary to effect the decomposition of one equivalent of uric acid; thus one equivalent of uric acid has taken up two equivalents of oxygen; it needs now only two equivalents of water in addition, to allow of its separation into two equivalents of allantoin and two equivalents of carbonic acid. This simple decomposition of uric acid takes place by this process of oxydation. 1 equiv. uric acid + 2 equiv. ferridcyanid of potassa + 4 equiv. potassa + 2 equiv. water, form 4 equiv. of prussiate of potassa, 2 equiv. of carbonate of potassa and 2 equiv. of allantoin.

$$\left.\begin{array}{lr} \text{1 eq. uric acid} = & C_{10}N_4H_4O_6 \\ \text{2 " oxygen} = & O_2 \\ \text{2 " water} = & H_2O_2 \end{array}\right\} = \begin{array}{lr} \text{2 eq. allantoin} & C_8N_4H_6O_6 \\ \text{2 " carb. acid} & C_2O_4 \end{array}$$

$$C_{10}N_4H_6O_{10} \qquad\qquad C_{10}N_4H_6O_{10}$$

The excess of potassa served on the one part to hold in solution the resulting allantoin, and on the other part, to accelerate the decomposition.

I have not submitted the above mentioned red flocculent substance, to a farther investigation, because the quantity of it was very small, and I did not succeed in separating this body perfectly from prussiate of potash and allantoin; the reactions made with it show, nevertheless, that it is a new and certainly an interesting body. It has nearly the same solubility in cold and hot water and alcohol, as allantoin, and it could be obtained only in small quantity washing the latter, and filtering off. This red substance gives to water and alcohol a rich orange color; is easily soluble in hot water, by which means the color changes however to light yellow, and in cooling, the watery solution deposits a fine sulphur-yellow precipitate; a great part remains however in solution. In potassa ley and ammonia, this red body is soluble with an orange color; but after addition of an acid, only a small portion of it separates with a light yellow color. In boiling the alkaline solution, ammonia is formed, and acids added to the nearly colorless solution cause no further precipitate.

The quantity of the crystallized allantoin is very great, so that, if an easy mode of separating the red body adhering so obstinately to it, should be found out, this process would furnish perhaps the most advantageous mode of preparing it.

I succeeded after many essays by the following way, but with great loss, in obtaining allantoin in perfect purity. Relying on the statement of Liebig and Wöhler, that cold potash ley did not exert any decomposing action on allantoin, the brick-colored allantoin separated as well as possible, by means of water, from the prussiate of potassa, was dissolved in concentrated cold potassa ley, which was very easily effected; after filtration the orange-colored alkaline liquor was directly mixed with acetic acid, till an acid reaction; a slight yellow turbidness resulted, occasioned by the red body, and soon afterwards allantoin began to deposit itself in small nearly white crystals. By often repeated crystallization from hot water, it was obtained perfectly pure in white, shining, transparent, prismatic crystals.

By this mode of purifying allantoin, a great part of it remains behind in the solution of acetate of potassa which cannot be obtained by evaporation; on the contrary, a great quantity of acetate of ammonia goes off, indicating a new decomposition. The solution in acetate of potassa, filtrated from allantoin, was concentrated to a syrup, in the water-bath, and then mixed with a great volume of absolute alcohol; by which a thick flocculent nearly white precipitate of an organic potash combination resulted. The alcoholic solution was filtered off from it, and evaporated to dryness; the residue consisted chiefly of acetate of potassa scarcely mixed with other organic substance; oxalic acid and urea were not found. The flocculent substance precipitated by alcohol was solved in a small quantity of water, and only a few drops were sufficient, to convert it into a syrup; after all reactions, it seemed to be perfectly identical with the above mentioned impure lantanurate of potassa. The solution had an acid reaction, and afforded with acetate of lead an abundant white precipitate, in every respect like the lantanurate of lead, already described. This solution ought to contain neutral, or acid lantanurate of potassa; hence the following way was chosen to obtain one of these potassa combinations fit for analysis. The syrup-like watery solution was very cautiously mixed with alcohol, till a slight turbidness presented itself, indicating the precipitation of the potassa salts. The weak alcoholic solution was then left to itself; by and by, after a long time, crystals and crystalline crusts began to deposit; from time to time a new quantity of alcohol was added by which a new impulse was given to the crystallization. Finally, the crystallization terminated; whereby the liquid became more and more neutral, and lost its acid reaction.

The separated crystals were *bilantanurate of potassa*, as will be seen by the result of the following analysis. They were purified by repeated crystallization out of water; and the attached yellow coloring matter became by and by insoluble, and could be separated by filtration.

The pure bilantanurate of potassa crystallizes out of the watery solution in hard crystalline crusts, which consist of an aggregation of very strong shining white tabular crystals; it is soluble in 8–10 parts of cold, and in much less hot water, but it very slowly crystallizes out of the hot saturated solution when cooled; it is insoluble in strong alcohol. I added a small quantity of alcohol to the watery solution, and it directly became milky; but after a short time it cleared up again, and the bilantanurate of potash deposited itself in small dazzling white voluminous acicular crystals. The solution of this salt gives with acetate of lead no precipitate; but after addition of alcohol, there results a thick perfectly white precipitate, which disappears again after addition of more water; probably it is bilantanurate of lead, which is after this easily soluble in water and insoluble in alcohol; there also results a thick white flocculent precipitate of lantanurate of lead, if ammonia is added to a mixture of bilantanurate of potassa and acetate of lead, or if the former is precipitated with basic acetate of lead. With nitrate of silver on the addition of ammonia, a thick white precipitate of lantanurate of silver results, which is not changed by boiling. If bilantanurate of potash is neutralized with potash and evaporated, the solution dries without any signs of crystallization to a viscid syrup, precipitable by alcohol in flocks; by the addition of stronger acids, the acid potassa salt could not be recrystallized. The thick mother-liquor filtered from the impure bilantanurate of potassa, seemed to consist principally of the neutral potassa salt, mixed with a small portion of another substance which could be separated by acetate of lead, as a white precipitate insoluble in acetic acid.

The salt employed for analysis was perfectly pure, and crystallized in small dazzling rhombic plates.

(1) 0·135 grammes of the air-dried salt, gave 0·355 grms. sulphate of potash = 0·0191937 grms. potassa, or 14·22 per cent. KO. From these numbers the atomic weight is = 331·9.

(2) 0·4815 grms. of the air-dried salt, gave by combustion with chromate of lead, 0·400 carbonic acid and 0·1775 grms. water.

(3) 0·2607 grms. of the air-dried salt, gave 0·816 grms. Plat. chl. ammonium = 0 05189 grms. nitrogen.

From the found numbers, the empirical formula of this salt is $KO, C_{12} N_4 H_{13} O_{17}$, which is equal to:

$$KO, C_6 N_2 H_4 O_6, C_6 N_2 H_4 O_6 HO, + 4aq.$$

Atomic weight:

			Calculated.		Found.
1	Equiv.	KO	47·2	14·55	14·22
12	"	C	72	22·20	22·65
4	"	N	56	17·27	17·47
13	"	H	13	4·01	4·09
17	"	O	136	41·97	41·57
			324·2	100·	100·

This formula was perfectly confirmed by a direct determination of the water of crystallization.

0·2934 grms. of the air-dried salt, lost at 100° C., 0·0327 grms. water, which corresponds exactly to 4 equivalents of water.

			Calculated.	Found.
1	Equiv.	$KO, C_6 N_2 H_4 O_6$	50·33	. .
1	"	$C_6 N_2 H_4 O_6 HO$	38·57	. .
4	"	HO	11·10	11·15
			100·	

The bilantanurate of potash dried at 100° C., has then the following composition:

$$KO, C_6 N_2 H_4 O_6, C_6 N_2 H_4 O_6 HO.$$

The composition of lantanuric acid is equal to $C_6 N_2 H_4 O_6 HO$. The dehydrated acid can be considered as consisting of $2Cy + C_2 HO_3 + 3HO$, or as urea + 4 equiv. of carbonic oxyd; it has one equivalent of oxygen more than murexan and difluan.

Its formation from allantoin is very simple; the latter takes up 2HO in contact with alkalies, as already mentioned, and forms the new acid $C_8\,N_4\,H_8\,O_8$, which divides itself on farther contact with alkalies into urea and lantanuric acid. I mentioned that by the investigation of the solution, which was filtered out from the allantoin, and consisting principally of prussiate of potash, lantanuric acid and urea were detected.

I have tried to separate the lantanuric acid from the lead-salt by means of sulphuretted hydrogen. It forms an acid solution, which dries to a gum-like mass, uncrystallizable in water and alcohol. The quantity was however too small, to allow me to make further researches with it. Farther, I have prepared the silver salt from the potash salt, by means of neutralization with ammonia and separation by nitrate of silver, which caused a thick white precipitate. The lantanurate of silver was dried at 100° C., and was just sufficient for a determination of its atomic weight.

0·2645 grms. salt gave 0·140 grms. silver = 0·15097 grms. oxyd of silver. The atomic weight of this combination hence as calculated = 204. The atomic weight of the organic substance combined with silver consequently = 88. Expressed by a formula, the composition of this silver salt is thus:

$$Ag\,O,\ C_6\,N_2\,HO_3.$$

Calculated in per cents.:

	Calculated.		Found.
1 Equiv. $Ag\,O$	116	56·61	56·84
1 $C_6\,N_2\,HO_3$	89	43·39	. .

Thus by drying the lantanurate of silver at 100° C., three equivalents of water have been removed from lantanuric acid. From the composition of the bilantanurate of potash and of the lantanurate of lead dried at 100°, it is however probable that in the analyzed silver salt, the lantanuric acid was not present as such; nevertheless, the composition of lantanuric acid must be expressed by the formula $C_6\,N_2\,H_4\,O_6$, HO.

I had not enough of the substance to permit an analysis of the lantanurate of silver in an air-dried state, or to ascertain whether bilantanurate of potash or lead will still give off water at a high temperature without change of its other qualities.

If a strong acid is added immediately to pure allantoin dissolved in cold concentrated potassa ley, nearly the whole quantity of this substance precipitates, if the alkaline liquor stands a long time. The quantity of allantoin precipitated is smaller and smaller, and after one or two days (in summer), all the allantoin is changed, and acids no longer precipitate that substance. If the solution is now boiled, only a small quantity of ammonia is evolved, and no oxalic acid is formed; hence no allantoin is present. If the colorless alkaline liquor is neutralized with acetic acid till an acid reaction, and then alcohol be added, the liquid becomes milky and clears again very soon, because the potash combination of the new formed acid separates itself at the bottom of the vessel as a concentrated, clear, oily liquid. All attempts to get the potash salt in a crystalline form failed; mixed with water, it gives an abundant white precipitate with nitrate of silver, becoming black on boiling. To estimate the combination of this new acid, to which may be given the name hydallantoinic acid, I used a lead salt. Allantoin was solved in cold concentrated potash ley; after two days standing neutralized with acetic acid till an acid reaction, there was then added to it a solution of acetate of lead; the liquid remained at first clear; but very soon the walls of the vessel were coated with a light white precipitate of a peculiar form, and the liquid became very soon troubled with a thick flocculent, dazzling white voluminous precipitate of the new lead salt, which quickly deposited itself and was easily washed out. The precipitate presented after drying, a white light powder easily soluble in acetic acid, even on boiling with it.

The lead salt dried at 100° C. was analyzed:

1. 0·3745 grm. substance gave 0·199 grm. sulphate of lead = 0·1464 grm. oxyd of lead; atomic weight = 286.

2. 0·286 grm. substance gave 0·153 grm. PbO, SO_3 = 0·1126 grm. PbO; atomic weight = 284.

3. 0·449 grm. substance gave by combustion with soda-lime 1·3635 grm. Plat. chl. ammon. = 0·08552 grm. nitrogen.

4. 0·5275 grm. substance gave, burnt with oxyd of copper, 0·324 grm. carbonic acid and 0·138 grm. water.

From these numbers, the following formula for the hydallantoinate of lead may be calculated:

$$PbO, C_8 N_4 H_8 O_8$$

as the comparison of found and calculated numbers shows.

	Calculated.		Found.	
1 equiv. PbO	112	38·79	39·09	39·37
8 " C	48	16·69	16·75	. .
4 " N	56	19·47	19·04	. .
8 " H	8	2·77	2·90	. .
8 " O	64	22·28	22·22	. .

This new acid thus results from allantoin by taking up two equivalents of water.

2 equiv. of allantoin	$= C_8 N_4 H_6 O_6$
2 " " water	$= H_2 O_2$
1 equiv. of hydallantoinic acid	$= C_8 N_4 H_8 O_8$.

By treating with sulphuretted hydrogen, this acid could be removed from the lead salt as a colorless solution of a very acid taste; it could also be obtained, by decomposing the lead salt with sulphuric acid.

The acid was evaporated in a water-bath to a thick syrup, which could not be crystallized; the same was precipitated by absolute alcohol, (in which the acid, and as it seems the salts of it, are insoluble,) as a white brittle mass, which however very soon, attracted moisture again, and deliquesced; mixed with cold potash ley, ammonia was given off, and evaporated, insoluble flocks separated; mixed with a drop of ammonia, and adding nitrate of silver, a white precipitate resulted, which dissolved for the greatest part by heating. With baryta water there was no precipitate; but after the addition of alcohol a flocculent white precipitate, again disappearing after addition of water. Neutralized with ammonia and evaporated in the water-bath, ammonia escapes, and the solution retakes again its acid reaction; with chlorid of barium under addition of ammonia there is a white precipitate; with acetate of lead, a thick white precipitate; mixed with carbonate of soda or potash, no carbonic acid was given off; on heating, the alkaline solutions became turbid with separation of white flocks. These reactions, and principally the behavior with alkalies and silver, indicated that this acid had suffered already an alteration during evaporation by the heat; nevertheless the silver salt was prepared from it, dried at 100° C. and analyzed; the amount of oxyd of silver was found to be 45·31, and by combustion with soda-lime were obtained 13·12 nitrogen; these numbers give a relation of equivalents of oxyd of silver to nitrogen nearly as 2 : 5, which proves clearly, that an alteration of the acid had taken place.

I did not follow this subject farther, because it was less my intention to investigate the products of decomposition of allantoin, than to study the process of oxydation of uric acid by means of ferridcyanid of potassium and caustic potash. The similarity of these products, obtained by decomposition of allantoin, with the allanturic acid obtained by Pelouze from the decomposition of allantoin by acids, is not questionable; but a comparison of the analytical results was not possible, because in the paper of Pelouze on this subject, only the formula without the details of analysis were given.

I cannot conclude without expressing my thanks to my friend Professor Horsford, for kindly tendering to me the use of his Laboratory and apparatus for the completion of a few experiments unfinished in Europe.

Lowell, July 13th, 1848.

Art. XXXVI.—*New Mexico and California.*

At the last Session of Congress there were four Reports presented relating to Northern Mexico.

I. Memoir of a Tour to Northern Mexico, connected with Colonel Doniphan's Expedition in 1846 and 1847; by A. Wislizenus, M.D.

II. Notes on a Military Reconnaissance from Fort Leavenworth in Missouri, to San Diego in California; by Brevet Major W. H. Emory.

III. Report and Map of the Examination of New Mexico; by Lieutenant J. W. Abert.

IV. Geographical Memoir upon Upper California; by J. C. Fremont.

The last of these four Reports is briefly noticed on page 280 of this volume. We offer here an abstract of such information from the others as relates to the structure and resources of the country.

Dr. Wislizenus was physician to Colonel Doniphan's column. His object in visiting Mexico and California was scientific; and with this end in view, the rocks, mines, and plants of the region were carefully studied, and many important acquisitions to science were made. It had been his intention to travel in a private expedition; but the war with Mexico commencing, his plans were frustrated. After a detention of six months, Dr. Wislizenus accepted a situation in the medical department of the army, and was thus enabled to accomplish in part the main object of his projected tour.

The route led from Independence, Missouri, near latitude 39° N., and longitude 94° 20′ W., by Council Grove, (long. 96° 40′) to Osage Camp on the Arkansas (long. 98½° W.); thence along the Arkansas to a few miles beyond the Pawnee Fork (98° 55′ W.), Fort Mann (100° 10′ W.); here crossing the Arkansas and passing south of west to the banks of the Cimarron, and thence onward by a track leading to the southeast of the Raton mountains, crossing in succession Cedar Creek, McNees Creek, Cottonwood Creek, Rabbit Ear Creek, (head waters of the Rio Nutria,) then more southeasterly, passing Rock and Whetstone Creeks and the head waters of the Colorado, to St. Miguel, and around to Santa Fe, (35° 41′ N., 106° 2′ W.) From Santa Fe, which is on a small stream near the Rio del Norte, within one hundred and fifty miles of the head of the latter, they followed down to El Paso del Norte, (32° 15′ N.) thence south to Chihuahua (29° 20′ N.), and Cadena (26° 10′ N., 104° 40′ W.), thence south of east to Saltillo, (101° W.) and east to Monterey and Matamoras. The author gives the following account of the rocks observed in the course of his journeyings.

The geological sketch which I have drawn, [alluding to a map accompanying the Report,] does not make any pretensions to a geological map, which even a more able geologist than I am could not give in the short time and haste, in which I travelled through that country: but it may elucidate and concentrate at least what little information I have acquired in relation to that subject. To make it more intelligible, I will add a short summary of the various geological observations spread over the whole extent of the journal.

Independence, near the western frontier of the State of Missouri, is situated in the great Missouri coal basin, which occupies more than one-third of that State.

The first rock in situ which I saw in the prairie, after leaving Independence, was on Rock creek, (about 79 miles from Independence.) It was a yellowish-brown compact limestone, with encrinites and simlar fossils of the carboniferous limestone, to those found in Missouri.

On Pleasant Valley creek (125 miles) the bluffs are formed of two different limestones: one is white and compact; the other grayish, soft, and argillaceous. The first contained some indistinct fossils, but in too imperfect a state to determine what formation they indicate.

In Council grove (143 miles) a horizontal, grayish, argillaceous limestone prevails, without fossils.

Leaving Cottonwood creek, (185 miles,) irregular heaps of bog-ore are seen in the prairie, and a ferruginous sandstone of yellow, brown, and blue colors, extends from here to Pawnee fork, (a distance of about 100 miles.)

The bluffs of the Little Arkansas, consisted of a spotted, yellow, calcareous sandstone, and isolated pieces of ferruginous sandstone.

Between Camp Osage (the first camp near the Arkansas river) and Walnut creek, (263 miles,) I met with a very porous and scoriaceous rock in situ, apparently the product of action of subterranean fires upon the ferruginous sandstone. Most likely a large coal-field lying beneath here, has become ignited, and produced this change of the rock. The so-called Pawnee rock (between Walnut creek and Ash creek) consists of the same ferruginous sandstone, changed by fire. On Pawnee fork (292 miles) I saw the last of it; the ferruginous sandstone there was more compact, and deep red.

On a branch of Big Coon creek, (332 miles,) I found the bluffs to consist of common sandstone below, and a white, fine-grained marl above it. This marl resembles very much some from the cretaceous formation of the Upper Missouri; but finding no fossils, I could not ascertain the fact regarding it.

Two miles beyond that place, (341 from Independence,) I had the first chance to examine the bluffs on the Arkansas; the rock was a grayish, conglomerate limestone, with a few small fossils, that were rather imperfect, but seemed to belong to the cretaceous formation. The neighborhood of the above mentioned marl raises this presumption nearly to certainty. I have, therefore, not hesitated to lay it down as cretaceous formation. About 20 miles higher on the Arkansas, I saw, upon a second examination, only a coarse conglomerate of sand and limestone. At the usual fording place (373 miles) where I left the Arkansas for the Cimarron, no rocks in situ were visible.

Having crossed the Arkansas, I met with the first rocks again, on the "middle springs of Cimarron," (468 miles ;) it was a sandy limestone above common sandstone.

Six miles west of the Crossing of Cimarron, (500 miles from Independence,) light bluffs rise in the prairie, of a yellow, reddish, and spotted sandstone, combined with lime and argile.

A few miles beyond them, a large isolated mountain of boulders stands in the plain, composed of heavy blocks of quartz and quartzose sandstone, and many erratic rocks were afterwards found on our road.

On Cedar creek, McNees' creek, and Cottonwood branch, a yellow sandstone prevailed.

On Rabbit-ear creek I met for the first time with amygdaloidal basalt, a black, heavy, basaltic rock, with a great many irregular, vesicular cavities, that are generally hollow—but sometimes, filled with lime; in rare instances, with olivine. This rock is very common throughout the high mountains of Mexico. It occurs in irregular masses, and in whole mountains, as well as in millions of pieces strewn over the surface of the country. Here it rose in high perpendicular walls, as bluffs of the creek, and a very compact quartzose sandstone was below in horizontal layers.

The round mound, a mountain in the prairie about three miles farther west, which I ascended, is formed of a brown, decomposed basaltic rock.

On Rock creek, and Whetstone creek, amygdaloidal basalt with underlying sandstone was found.

In going from there to "Point of Rocks," (600 miles,) extensive strata of a yellow, compact quartzose sandstone were passed, dipping gently towards the east. Point of Rocks itself, a spur of the western mountains, is a mass of syenite.

Some twelve miles beyond it, rises a hill in the plains, composed of very compact, black basalt, with underlying white sandstone.

The bed and bluffs of the Rio Colorado and Ocaté creek, (627 miles,) are formed by quartzose sandstone.

The Wagon mound, an isolated mountain in the high plain, consists of a compact, black, and spotted basalt, rising in columnar shape.

On Wolf creek, (664 miles,) the amygdaloidal basalt and quartzose sandstone reappeared, both in horizontal layers.

Reaching the Gallinas creek, near Las Vegas, (690 miles,) I met, after a long interval, with limestone again. It was a dark blue, with casts of Inoceramus of the cretaceous series.

From here we penetrated into the very heart of the mountains. At first we met with sandstone alone, common and quartzose, and of various colors.

Near San Miguel, (707 miles,) a coarse conglomerate was found of decomposed granite, sandstone, and lime ; and large blocks of decomposed granite lined the Pecos river, opposite the old Pecos village, (737 miles.)

In the cañon leading from here to Santa Fe, at first sandstone was found, common, quartzose, and calcareous, of various colors and granulations, till about fifteen miles from Santa Fe, granite in situ appears, and continues all the way to Santa Fe. Near where I met for the first time with granite in situ, the sandstone, if I may judge from a very limited examination, was suddenly uplifted and thrown back at an angle of nearly one hundred degrees.

West of Santa Fe, granite seems also to prevail. In my excursion to the Placers, southwest of Santa Fe, I found sandstone below, and on the height of the mountains granite and trap rocks.

In the mountains of that neighborhood common limestone and sulphate of lime are said to exist; but on the road over which I travelled I had no opportunity to see any.

Granitic and trap formations seem to predominate, too, in the valley of the Rio del Norte below Santa Fe; but as the road leads always along the river, and the mountains on either side are generally about ten miles distant, I could not examine them as I wished to do, and had often to depend upon the external form of the mountain chain, which apparently indicated unstratified and igneous rocks. Whenever the mountains approached the river, I gained more information. Thus, for instance, I found between Joyita and Joya, (above 115 miles from Santa Fe,) quartzose sandstone and quartz in a spur of the eastern mountain chain; and in Joyita itself, bluffs near the river, of amygdaloidal basalt.

Some miles west of Socorro, (140 miles,) on the right bank of the river, I examined the western mountains, and found porphyritic and trachytic rocks.

Near the ruins of Valverde, (165 miles,) I met with bluffs of a dark brown, nodular sandstone; and about eight miles beyond, with amygdaloidal basalt again.

In the Jornada del Muerto, granitic and basaltic formations, to judge from their shape, exist in the distant mountain chains; part of them in the eastern chain is called, from the basaltic appearance, Organ mountains.

Below Doñana I perceived some primitive rocks again, near the river, resembling a decomposed porphyry.

The mountains above El Paso belong mainly to the trap formation.

During my short stay in El Paso I made an excursion to the southwestern mountains of the valley, and was rather astonished to find mountains of limestone. The foot of the mountains was formed by a horizontal quartzose sandstone, similar to that underlying the amygdaloidal basalt. The very compact and gray limestone, intersected with many white veins of calc spar, rose upon it to the crest of the mountains; but in several places, granite and greenstone seemed to have burst through it and formed partial eruptions. After a long search I discovered some fossils, and though much injured and imperfect, they are nevertheless sufficient to determine the age of this formation. The fossils are a coral (*Calamopora*), and a bivalve shell of the genus *Pterinea*. This limestone is therefore a Silurian rock. Several mines have formerly been worked in it.

On the road from El Paso to Chihuahua I met in the first day or two with the same limestone. The pieces lying on the road were generally surrounded with a white crust of carbonate of lime; pieces, too, of what appeared to be fresh-water limestone, occurred. It is rather probable that this is the same material with the white crust of the blue limestone, and that both are the result of calcareons springs.

About fifty miles south of El Paso the limestone seemed to cease, and porphyritic rocks of the most varied colors and combinations continued from here as far as Chihuahua, interrupted sometimes only by granitic rocks. The base of the porphyry is generally feldspar.

Around Chihuahua and some distance to the south and west of it, in the Sierra Madre, porphyritic rocks predominate, and valuable mines are found in them.

Near Chihuahua, as I understood, about twelve miles northeast of it, mountains of limestone appear; and through the favor of Mr. Potts, in Chihuahua, I received a piece of limestone from there, containing some casts of the chambers of an Orthoceras, proving that this limestone belongs also to the Silurian system. Mines are also found in it.

Another fossil I received in Chihuahua, said to come from the limestone near Corralitas, a mining place about 250 miles northwest of Chihuahua. It is a Pecten quinquicostatus, (Sowerby,) of the cretaceous series; but not having travelled through that part of the state, I am not able to give any comment upon it.

From Chihuahua to Matamoras, travelling with the army as a surgeon, my time was so occupied that I could not make any distant excursions from the road; generally, the geology of the country seemed to be very uniform and uninteresting.

From Chihuahua some distance south, porphyritic rocks continued. In Saucillo, (70 miles from Chihuahua,) I perceived the first limestone again. From there to Santa Rosalia I passed some hills of amygdaloidal basalt, but the main chain of the mountains was all limestone, and continued to be so throughout the whole eastern ramification of the Sierra Madre, over which we travelled from here down to Saltillo and Monterey, where the low country begins. This limestone forms steep, often rugged mountains, rising on an average 2,000 feet above the plain; it is metalliferous, and has all the appearance of the Silurian limestone, found at El Paso and Chihuahua, but I was never able to discover any fossils on this route. Silver and lead mines are of various occurrence in it; in the limestone surrounding Cadena, coal has been found, as I was informed, but I had no time to verify it.

From Monterey to the seashore I made one interesting discovery near Mier. On the bank of the Alamo river, about four miles above its mouth into the Rio Grande, I found an extensive bed of large fossil shells of Ostrea, belonging to the cretaceous formation. As the same formation has lately been found by Dr. Rœmer, of Berlin, to extend in Texas from the San Antonio to the Brazos, this cretaceous bed near Mier is in all probability a continuation of it. In looking over the recent publication of "Notes of the upper Rio Grande, by Bryan Tilden," I found in a description of the river bank of the Rio Grande below Laredo, that "entire hills are to be seen, composed almost wholly of what appears to be a collection of large sea oyster shells." I presume, therefore, that the same cretaceous formation extends in this direction higher up on the Rio Grande.—pp. 135–138.

In farther illustration of the country we cite some paragraphs from other parts of the Report.

Council Grove forms, as it were, a dividing point in the character of the country east and west of it. The country east of it is formed of prairie, with slight ascents and descents—constant undulations, as I might call them; sometimes shorter and more rapid; sometimes larger and fuller, resembling the waves of the ocean, which no doubt once covered those plains, and partly moulded their present form. Of those slight undulations, the barometrical measurements will give evident proof. Big Blue Camp is elevated 1,020 feet above the sea; Council Grove is 1,190; and the highest intermediate point is 1,420 feet, on the divide between the waters of the Osage and the Neosho or Grand river. This eastern portion is well watered, and along the water-courses sufficiently timbered to sustain settlements. The soil is generally very fertile, and, to judge from the higher elevation, more exempt from fevers, the plague of the bottom-land. Let us take a prospective view now of the country west of Council Grove. A short distance west, the country rises suddenly to the elevation of 1,500 feet, and ascends gradually towards the Arkansas to 2,000 and more feet above the sea. The intermediate country exhibits sometimes the short, wavelike form of the eastern portion, but oftener it already resembles the plateaux or high plains between the Arkansas and Cimarron, those representatives of the calm immense high seas, where the horizon extends farther, the soil becomes dryer and more sandy, the vegetation scantier, timber and water more rare. The country between Council Grove and the Arkansas forms the transition to the sandy plains on the other side of the Arkansas; the soil is generally less fertile than in the eastern portion, but all along its water-courses (as Cottonwood creek, Little Arkansas, Walnut creek, Ash creek, Pawnee fork, and the Arkansas) settlements might succeed, though they would have to depend more upon stock-raising than agriculture.—p. 7.

New Mexico is a very mountainous country, with a large valley in the middle, running from north to south, and formed by the *Rio del Norte*. The valley is generally about twenty miles wide, and bordered on the east and west by mountain chains, continuations of the Rocky mountains, which have received here different names, as Sierra blanca, de los Organos, oscura, on the eastern side, and Sierra de los Grullas, de Acha, de los Mimbres, towards the west. The height of these mountains south of Santa Fe may be, upon an average, between six and eight thousand feet, while near Santa Fe, and in the more northern regions, some snow covered peaks are seen that may rise from 10,000 to 12,000 feet above the sea. The mountains are principally composed of igneous rocks, as granite, syenite, diorite, basalt, &c. On the higher mountains excellent pine timber grows; on the lower, cedars, and sometimes oak; in the valley of the Rio Grande, mezquite.

The main artery of New Mexico is the Rio del Norte, the longest and largest river in Mexico. Its headwaters were explored in 1807 by Captain Pike, between the parallels of 37° and 38°; but its highest sources are supposed to be about two degrees farther north in the Rocky mountains, near the headwaters of the Arkansas and the Rio Grande, (of the Colorado of the west.) Following a generally southern direction, it runs through New Mexico, where its principal affluent is the Rio Chamas from the west, and winds its way then in a southeastern direction through the states of Chihuahua, Coahuila and Tamaulipas, to the Gulf of Mexico, in 25° 56′ north latitude. Its tributaries in the latter states are the Pecos, from the north; the Conchos, Salado, Alamo, and San Juan, from the south. The whole course of the river, in a straight line, would be near 1,200 miles; but by the meandering of its lower half, it runs at least about 2,000 miles from the region of perpetual snow to the almost tropical climate of the gulf. The elevation of the river above the sea near Albuquerque, in New Mexico, is about 4,800 feet; in El Paso del Norte about 3,800; and at Reynosa, between three and four hundred miles from its mouth, about 170 feet. The fall of its water appeared to be, between Albuquerque and El Paso, from two to three feet in a mile, and below Reynosa one foot in two miles. The fall of the river is seldom used as motive power, except for some flour mills, which are oftener worked by mules than by water. The principal advantage which is at present derived from the river is from agriculture, by their well managed system of irrigation. As to its navigation in New Mexico, I doubt very much if even canoes could be used, except perhaps during May or June, when the river is in its highest state, from the melting of the snow in the mountains. The river is entirely too shallow, and interrupted by too many sand bars, to promise anything for navigation. On the southern portion of the river the recent exploration by Captain Sterling, of the United States steamer, Major Brown, has proved that steamboats may ascend from the gulf as far as Laredo, a distance of seven hundred miles. Although this steamboat did not draw over two feet of water, yet the explorers of that region express their opinion, that "by spending some $100,000 in a proper improvement of the river above Mier, boats drawing four feet could readily ply between the mouth of the Rio Grande and Laredo." Whenever a closer connexion between the headpoint of navigation and New Mexico shall be desired, nothing will answer but a railroad, crossing from the valley of the Rio Grande to the high table land in the state of Chihuahua.

The *soil* in the valley of the Rio del Norte, in New Mexico, is generally sandy and looks poor, but by irrigation it produces abundant crops. Though agriculture is carried on in a very primitive way, with the hoe alone, or with a rough plough, made often entirely of wood, without any particle of iron, they raise large quantities of Indian corn and wheat, beans, onions, red peppers, and some fruits. The most fertile part of the valley begins below Santa Fe, along the river, and is called "Rio abajo," or, (the country) down the river. It is not uncommon there to raise two crops in one year. The general dryness of the climate, and the aridity of the soil in New Mexico, will always confine agriculture to the valleys of the water-courses, which are as rare here as over all Mexico—such, at least, as contain running water throughout the year. But this important defect may be remedied by Artesian wells. On several occasions I remarked on the high table-land from Santa Fe south, that in a certain depth layers of clay are found, that may form reservoirs of the sunken water-courses from the eastern and western mountain chain, which, by the improved method of boring, or Artesian wells, might be easily made to yield their water to the surface. If experiments to that effect should prove successful, the progress of agriculture in New Mexico would be more rapid, and even many dreaded "Jornadas" might be changed from waterless deserts into cultivated plains. But at present, irrigation from a water-course is the only available means of carrying on agriculture. The irrigation is effected by damming the streams and throwing the water into larger and smaller ditches (*acéquias*) surrounding and intersecting the whole cultivated land. The inhabitants of towns and villages, therefore, locate their lands together, and allot to each one a part of the water at certain periods. These common fields are generally without fences, which are less needed, as the grazing stock is guarded by herdsmen.—pp. 22, 23.

A third, much neglected branch of industry in New Mexico is the *mines.* Many mining places now deserted prove that mining was pursued with greater zeal in the old Spanish times than at present. This may be accounted for in various ways,—by the present want of capital, want of knowledge in mining, but especially the unsettled state of the country and the avarice of its arbitrary rulers. The mountainous parts of New Mexico are very rich in gold, copper and iron, and afford some silver. Gold seems to be found to a large extent in all the mountains near Santa Fe, south of it to a distance of about one hundred miles, as far as Gran Quivira, and north for about one hundred and twenty miles up to the river Sangre de Cristo. Throughout this whole region gold dust has been abundantly found by the poorer classes of Mexicans, who occupy themselves with the washing of this metal out of the mountain streams. At present the old and the new *Placer*, near Santa Fe, have attracted most attention, and not only gold washings, but some gold mines too, are worked there. As far as my knowledge extends, they are the only gold mines worked now in New Mexico. But as I have made an excursion from Santa Fe for the special purpose of examining these mines, I must refer the reader, in relation to them, to that chapter of my narrative. As to the annual amount of gold produced in New Mexico, I am unable to give even an estimate. Since nearly all the gold of the country is bought up by the traders, and smuggled out of the country to the United States, I believe that a closer calculation of the gold produced in New Mexico could be made in the different mints of the United States than in Mexico itself. In Spanish times, several rich silver mines were worked at Avo, at Cerrillos, and in the Nambe mountains, but none at present. Copper is found in abundance throughout the country, but principally at Las Tijeras, Jemas, Abiquiu, Guadelupita de Mora, etc. I have heard of but one copper mine worked at present south of the Placers. Iron, though also abundantly found, is entirely overlooked. Coal has been discovered in different localities, as in the Raton mountains, near the village of Jemez, southwest of Santa Fe, in a place south of the Placers, etc. Gypsum, both common and selenite, are found in large quantities in Mexico; extensive layers of it, I understood, exist in the mountains near Algodones, on the Rio del Norte, and in the neighborhood of the celebrated "Salinas." It is used as common lime for whitewashing, and the crystalline or selenite instead of window-glass. About four days travelling (probably one hundred miles) south-southeast of Santa Fe, on the high table-land between the Rio del Norte and Pecos, are some extensive *salt lakes*, or "*salinas*," from which all the salt (muriate of soda) used in New Mexico is procured. Large caravans go there every year from Santa Fe in the dry season, and return with as much as they can transport. They exchange, generally, one bushel of salt for one of Indian corn, or sell it for one and even two dollars a bushel.—pp. 24, 25.

Of the state of Chihuahua he observes:—

Its many and rich silver mines have been celebrated for several centuries. They are found principally in the western part of the state, throughout the length of the Sierra Madre, and in a mean breadth of thirty leagues. The silver ores occur generally as sulphurets, with iron or lead, sometimes as native silver and muriate of silver, and are found either entirely in porphyritic rocks, or in stratified rocks, (limestone,) passing at greater depth into igneous rocks. They are worked either by amalgamation, or by fire in common furnaces. For the latter process they need generally an addition of greta, (litharge, or oxyd of lead,) which forms, therefore, a valuable article of trade. Besides the silver mines, rich mines also of copper, and some of gold, lead, iron, and tin, are found. The most noted mines of the state, of older and more recent date, are the following:

The mines of *Santa Eulalia*, near Chihuahua, have during the last century produced immense masses of silver, as the following fact may prove. The cathedral in Chihuahua, a most splendid building, was within the last century erected from a fund created from the proceeds of the Santa Eulalia mines, by a grant of one real (12½ cents) on every marc of silver (worth $8 25) obtained from the mines. This fund was created in 1717, and in 1789 the cathedral was finished, at an expense of $800,000. The amount of silver taken in these seventy-two years from the mines would, therefore, be $52,800,000. The abundance of lead found in Santa Eulalia, makes the smelting of the silver ore very convenient. The mines are not yet exhausted; but from intrusion of water, want of capital, and the attraction of new mines, they are but little worked.

The mines of *Parral* (Hidalgo) are the oldest of the state, and have also been extremely productive in silver; but for want of regular mining, most of them, though not exhausted, are made inaccessible and worthless.

The mines of *Santa Barbara*, discovered in 1547, were renowned for both silver and gold ores, but are now entirely abandoned.

The mines of *Batopilas* were celebrated for the large masses of native silver, and the unusual richness of the ore.

South of Batopilas lies the rich mine of *Morelos*, discovered in 1826, where one mass of native silver was found weighing two hundred and thirty marcs.

The mine of *Sierra Rica*, west of the old Presidio de San Carlos, was begun to be worked by a company in 1829. The prospects at first were most flattering: the superficial layers of the silver ore produced from one to a hundred marcs in the carga, sometimes one hundred and fifty, and in one instance even three hundred and twenty-seven marcs;

but at the depth of eighty varas the mine seemed to give out, and the invasions of hostile Indians became at the same time so troublesome, that the mine was abandoned.

Such extreme richness of ore is of course not a common occurrence; and the result, found by comparison of Mexican and European mines, that the mines in Mexico are generally poorer as to the relative amount of silver, but far superior as to abundance and extent of the ore, seems also to correspond with the mines in the state of Chihuahua; because a silver mine furnishing from three to four ounces of silver in the carga, is generally considered good enough to be worked with advantage; and many with less per cent. are rendered profitable.

In recent times, the mines of *Guazapares* and of *Jesus Maria* have attracted most of the capital of the state. The latter, southwest from Chihuahua, on the height of the Sierra Madre, were discovered in 1821; and so many valuable silver mines, beside some gold mines, have since that time been opened, that it promises to be for a long time one of the richest mining districts in the state.

Of the copper mines in the state of Chihuahua, the most celebrated is the "*Santa Rita de Cobre*," in the western angle of the Sierra de Mogoyon, near the headwaters of the Gila. The mine, known for a long time to the Apaches, passed through the hands of several proprietors, till in 1828 it was effectually worked by Mr. Coursier, a French resident in Chihuahua, who is reported and generally believed to have cleared from it in seven years about half a million of dollars. The ore looks extremely rich; it is a remarkably pure oxyd of copper, accompanied sometimes with the native metal, and said to contain some gold. Mr. Coursier soon monopolized the whole copper trade in Chihuahua; and as the state at that time coined a great deal of this metal, he made a very profitable business of it; but at last the mine, which seems to be inexhaustible, had to be abandoned on account of hostile Indians, who killed some of the workmen, and attacked the trains. These copper mines are claimed by the state of Chihuahua, as belonging to its territory; but as not even the latitude of the city of Chihuahua had been well determined by the Mexicans, more exact astronomical observations may perhaps prove that they fall within the territory of New Mexico. This question may become of importance, because this whole range of mountains is intersected with veins of copper and placers of gold. Cinnabar also, says rumor, was discovered there in 1824, but nothing positive is known in relation to it.

Coal has been found at present only in two places in the state, near the mines of Carmen and near those of Sierra Rica; but it will probably occur in other localities.

After this short review of the mines in the state of Chihuahua, the question of course will arise, What is *the annual production of these mines?* The only data to which I can refer, are the following: In the twenty-four years from 1738 to 1761, the amount of silver produced in the state of Chihuahua was 3,428,278 marcs, or $28,283,293; and in the seventeen years from 1777 to 1793, 1,394,161 marcs, or $12,501,828.

The following is the estimated amount for later years:

In 1824	69,816	marcs, or	575,982	dollars.
1826 . . .	138,015	"	1,138,623	"
1827	129,402	"	1,067,566	"
1828 . . .	142,785	"	1,177,976	"
1830	128,747	"	1,062,163	"
1831 . . .	138,916	"	1,146,057	"
1832	117,484	"	969,243	"
1833 . . .	116,802	"	963,616	"
1834	109,419	"	902,707	"

More recent dates I was unable to get, though I understood from competent persons that the amount of silver had in the last twelve years considerably increased. The computator of the above tables estimates that the annual average amount of the production of silver and gold in the state of Chihuahua is 125,000 marcs, or $1,031,251; but he supposes that but 100,000 marcs of that sum pass through the mint, and that 25,000 marcs are every year smuggled out of the country.

There is a well managed mint (casa de moneda) in Chihuahua, coining gold, silver, and copper. Mr. J. Potts and brother are the present proprietors, in consequence of a contract made with the government of Chihuahua. As all the silver ore in the state contains more or less gold, they separate it before coining, in large platina vessels, with sulphuric acid. For coining a marc of silver without separating the gold, they receive two reals, (25 cents;) for coining and separating the gold, five reals; but the marc of silver from which the gold is to be separated must contain at least sixteen grains of gold.—pp. 56, 57, 58.

This valuable document contains also a Botanical Report of much interest, in the preparation of which Dr. Wislizenus was assisted by Dr. G. Englemann of St. Louis.

Brevet Major W. H. Emory, on his way to Santa Fe, left Fort Leavenworth, on the Missouri River (39° 21′ N.), and went by Council Grove to the Arkansas and thence along this river to Bent's Fort (38° 3′ N., 103° 1′ W.); thence southwest, crossing the Purgatory near its head, the Raton pass at a height of 7500 feet above the sea, to Vegas, San Miguel and Santa Fe. From here the Expedition followed down the Rio del Norte to latitude 33°, and thence turned westward, taking the head waters of the Rio Gila, following it to the Colorado which it meets in longitude 114° 37′; thence still westward, crossing a sandy desert ninety miles in breadth, to the Cordilleras of California, and surmounting these heights, to San Diego (lat. 32° 45′ N.) and other places on the Pacific coast.

The company belonged to the first dragoons under the command of Col. Kearney. They started from Fort Leavenworth on the 27th of June, 1846.

Between Fort Leavenworth and Pawnee Fork, the rolling prairies are traversed by many streams, the beds of which lie deep with almost vertical banks, "developing where the streams make their incisions in the earth, strata of fossiliferous limestone, filled with remains of crinoidea."

About thirty miles from Fort Leavenworth, on a branch of the Wah-karussi, a bed of bituminous coal outcrops, which is worked by the Indians. Approaching the Pawnee Fork, the country changes imperceptibly, and merges into the arid wastes of that section. Cacti and other spinose plants first made their appearance in 98° W., and near the same region the buffalo grass (Sesleria? dactyloides, *Nutt.*) begins.

Bent's Fort is about 3958 feet above the sea, which gives for the Arkansas a fall of $7\frac{4}{10}$ feet per mile between this point and the meridian of 98° W., a distance of 311 miles. The river has grassy flats of half to two miles in width; but "beyond this the ground rises by gentle slopes into a wilderness of sand-hills on the south, and into prairie on the north." A conglomerate of pebbles was observed along the river in this part, and higher up an argillaceous limestone containing ammonites, &c. "The soil of the plains is a granitic sand, intermixed with the exuviæ of animals and vegetable matter, supporting a scanty vegetation. The eye wanders in vain over these immense wastes in search of trees. The principal growth is the buffalo grass, Cacti in endless variety, Yucca angustifolia (soap plant), Darlingtonia brachyloba, Schrankia uncinata, Cucurbita aurantia (prairie gourd), and very rarely that wonderful plant, the Ipomea leptophylla, called by the hunter, man-root, from the similarity of the root in size and shape to the body of a man. It is esculent, and serves to sustain human life in some of the many vicissitudes of hunger and privation to which men who roam the prairies are subjected." The only tree of any magnitude along the Arkansas, is the cottonwood (Populus canadensis).

From Bent's Fort south, they met with beds of limestone, sandstone, basalt and a porous volcanic rock. On the Moro, in latitude 35° 54′, "the plains were strewed with fragments of brick-dust colored lava and scoria, and the hills to the left were capped with white granular quartz."

On either side of the narrow valley of the Santa Fe—which varies from 1000 feet to a mile or two in width—"the country presents nothing but barren hills, utterly incapable, both from soil and climate, of producing anything useful. The valley is entirely cultivated by irrigation." "Five miles below the town, the stream disappears in the granitic sands" (p. 34). The height of Santa Fé above the sea, according to the barometric observations taken, is 6846 feet; the neighboring peaks to the north are many thousand feet higher. The valley of the Del Norte to the south as far as Angosturas, was narrow with no interval for agriculture. Below the last mentioned place, the valley opens into a plain which is cultivated by irrigation. Farther south the river valley affords little land for cultivation, and the country either side is as dry as before described. The sandy plains terminate in steep hills, in some places capped with basalt ($34\frac{1}{2}°$ N).

On leaving the Del Norte, for the west, they mounted the table land, "some 200 feet above the valley, and found the country very level, except where indented by water-courses. The table land stretched off far to the south." Pebbles of chalcedony were common in the plains and in the dry valleys. Near the headwaters of the Mimbres, near 108° W., there was a dome-shaped mountain, and amygdaloidal rocks and volcanic glass were observed. There were also some deserted copper mines in the region, from which specimens of native copper, sulphuret of copper, and a silver ore, were obtained. Twenty miles beyond they found a blue limestone, and magnetic iron ore. The Gila, a rapid river, was soon after reached. Granite, sandstone and volcanic rocks were observed along its course. Near longitude 111° W., ores of copper and iron were met with. About the mouth of the Gila, where it enters the Colorado, the mountains were of grayish granite, traversed by seams of white quartz; they rose abruptly from the plains.

Reviewing the region passed over since leaving the Arkansas, a distance of about 1200 miles, the author observes, that there is a general uniformity of physical character and climate. "In no part of this vast tract can the rains be relied on, to any extent, for the cultivation of the soil. The earth is destitute of trees, and in great part also, of any vegetation whatever. A few feeble streams flow from the mountains, which in many places traverse this region. Between these streams the plains and mountains are without water and vegetation, and may be called deserts, so far as they perform any useful part in the sustenance of animal life. Cultivation is therefore confined to the narrow strips of land within the level of the waters of the stream; and wherever practiced in a community with any success, or to any extent, it involves a degree of subordination and absolute obedience to a chief, repugnant to the habits of our people. The chief who directs the time and the quantity of the precious irrigating water, must be implicitly obeyed by the whole community." (p. 98). "No one who has ever visited this country, and who is acquainted with the character and value of slave labor in the United States, would ever think of bringing his own slaves here with any view to profit, much less would he purchase slaves for such a purpose. Their labor here, if they could be retained as slaves, among peons nearly of their own color, would never repay the cost of transportation, much less the additional purchase money." —(p. 99.)

After fording the Colorado, the party entered a dreary desert, and for 90 miles found no freshwater, except a little from pools; the surface was loose sand, with only two patches of grass. A salt lake was passed, about half a mile in length. On leaving the desert region and entering a valley in the mountains, they came upon a large sulphur spring, around which were efflorescences of sulphate of lime, sulphate of magnesia and common salt. Ascending the mountains, they were led to a hot spring near Warner's rancheria, having a temperature of 137° F., which discharged from the fissure of a granite rock, a large volume of water; and for a long distance down, it charged the air with fumes of sulphuretted hydrogen.

The accompanying cut is a much reduced copy of a sectional view of the Rocky mountains, made from the barometrical observations of the party.

Section from Fort Leavenworth, Mo., to San Diego, on the Pacific. Spaces between the parallel lines each 1000 feet—horizontal scale *one-sixtieth* the vertical.

1. Fort Leavenworth.—2. Pawnee Fork.—3. Jackson's Grove.—3 to 4. Valley of the Arkansas.—4. Bent's Fort,—5. Raton Summit.—6. Santa Fé.—7. Rio del Norte.—7-8. Valley of the Rio del Norte.—9. Ben Moore.—10-11. Valley of the Gila.—11. Mouth of Gila.—12. Salt Lake.—13. Cordilleras of California.—14. San Diego on the Pacific.—*a*. Mt. Turnbull.—*b*. Mt. Graham.—*c*. Zandia.

Many new plants were collected in the course of this expedition, which are partly described in an appendix by Prof. Torrey, with an account of the ferns by Dr. Engelmann. Several lithographic plates are inserted in the volume, illustrating the regions visited, besides upwards of thirty species of plants.

Lieutenant Abert was attached to the party under Lieutenant Colonel Emory, and was principally employed in exploring the region of New Mexico.

This report, like the preceding, contains much scientific information, both geological, botanical, and also zoological, illustrated by plates of fossils, etc. There is besides a vocabulary of the language of the Cheyenne Indians, who live near Bent's Fort. The author mentions the loss of many valuable papers, and among them a grammar of the Cheyenne language, while on his winter's return to St. Louis.

We cite from the report some of the facts bearing on geology, referring to it for information on its many other topics.

At Bent's Fort specimens of selenite were brought in, besides quartz crystals. Near the Raton Pass, in latitude 37° 15′, longitude 104° 35′, a bed of bituminous coal was discovered, in a high bluff bank. The fossil leaves associated were dicotyledonous, (one a large cordate leaf like Catalpa, and the other lanceolate), which indicates the comparatively modern age of the deposit. Not far from this place a dike of cellular rock was seen, six feet in width. From Santa Fe, Lieutenant Abert visited the gold mines in the vicinity.

Eighty miles north of Santa Fe, in the Puebla de Taos, are a few small settlements, situated in a valley eight or nine miles long, cultivated as far as practicable by irrigation; the supply of water is scanty except during the wet season. Snow is seen on the neighboring heights in every month of the year; yet wheat and corn ripen well in the plains. Southwest of Taos, a ridge 2000 to 2500 feet high, of hard slaty rock, breaking into angular fragments, was passed. On the west bank of the Del Norte, 40 miles above Santa Fe, the table land reaches to the river, and terminates in a bluff 300 to 400 feet in height. The section exhibits layers of horizontal sandstone capped by dark vesicular lava. To the east, the country rolls away to the base of the mountains, presenting little else than a succession of gravelly hills, covered with dwarf cedars. The lava alluded to forms the capping of all the table lands in Upper New Mexico. To the west of the river in this part, at a place called Ojo Caliente, there are several mineral springs, from which sulphuretted hydrogen escapes freely.

Going south from Santa Fe, volcanic rock was often met with over the country.

On the Rio Puerco, a few miles west of the del Norte, at Poblazon, (lat. 35° 13′,) the sandstone rocks were in some places six hundred feet in height. "The beds had an anticlinal dip, with reference to the axis of the valley." Besides calc spar crystallized and uncrystallized, fragments of large ammonites, hippurites and Inocerami were found, and "the little knobs around glittered with plates of selenite," an abundant mineral in that region. The species of Inoceramus is identical with one figured in Fremont's Report, plate iv. fig. 2. These *cretaceous* fossils occur about 6000 feet above the sea. Farther to the westward, a volcanic country was entered, and in some places a bed of volcanic rock overlay sandstone. To the northward, the village of Acoma is situated "high on a lofty rock of sandstone." "Quantities of fine large clingstone peaches were spread out on the ground, as the owners were dividing their loads."

Again, east of the del Norte, near 34° 50′ N., they met with beds of limestone containing patches of hornstone, and afterward with lofty masses of greenstone. About seventy miles east of the Del Norte, are saline lakes that afford all the salt used in the region. Just east of the river, near latitude 35° 15′, they encamped on a salt plain, where the salt formed a white efflorescence over the surface. The explorations were continued south to Valverde, near latitude 33° 40′.

The return of the party to Bent's Fort, and from there to St. Louis was attended with extreme hardship. They left the Fort on the 20th of January, where the thermometer had stood all day at 7° F., and were travelling till the 1st of March. As a winter on this route is unknown to our readers, we cite, in closing, a few paragraphs from this part of the Report. Such suffering as is here detailed in a few brief statements of facts, has rarely been exceeded.

February 2.—All night the storm raged with a fury as awful as that of the "tormentes" of Mt. Blanc. The particles of snow beat with wild rage against my tent, while the frail structure quivered, and the poles that supported it creaked and groaned so much that it was impossible for me to sleep. Such was the force of the wind, that it drove the snow through the canvass walls of my tent, and I found my bed and papers covered with it. During the night I heard one of the men, who had got his feet wet in attempting to cross the river, imploring some of his companions to let him get into the wagon with them. The night was terribly cold, and I feared that all of our animals would be frozen to death before morning. At length morning came, but when I looked out the snow was drifting along in dense clouds of hard icy particles, that flew along with extreme velocity. As the sun began to appear the storm ceased, and it was most fortunate for us that it did cease. I now forced my way out of the tent, which was banked with snow. When I looked around, a scene of utter desolation presented itself; most of my men had lain down on the ground to sleep, but now not one of them could be seen. I called aloud; they heard me not, being covered beneath the deep snow. I now went to the wagons; in one I found Pilka and Laing; in the other, two or three men, one of whom had been very ill ever since leaving Bent's Fort. He came rushing towards me half distracted, his shirt covered with snow, his head bare, and crouching at my feet, he implored me to take him to a house. "O, Lieutenant, take me to a house! I shall freeze to death! I'm freezing! I'm freezing!" His arms were drawn up and stiffened, his body almost paralyzed with cold. I took the poor fellow and put him in my own bed, and covered him with blankets and buffalo robes; it was all I could do.

We now searched about and found the men by the aid of the cracks on the surface of the snow, caused by the movements of the restless sleepers; covered by the heavy mantle of snow they had kept extremely warm, and now the chill air felt to them more intolerable.—pp. 115, 116.

February 21.—This morning is the first time for thirty-six hours that any one has ventured out. My men had their provisions ready cooked, and shared them with Mr. Brown's party; of all the tents that had been pitched Friday night, mine was the only one which still remained. The snow had heaped up around the rest so that the inmates were obliged to desert them, and take refuge in the wagons. About mine, the wind had swept in such a way as to keep open a path around it, although the snow was on a level with the ridge pole of the tent. We now broke up some boards that were in the wagons, and kindled a little fire. Soon the sun rose; but, instead of one sun, we had three; all seemed of equal brilliancy, but, as they continued to rise, the middle one only retained its circular form, while the others shot into huge columns of fire, which blended with the air near their summits. The breadth of the columns was that of the sun's apparent diameter, and their height about twelve times the same diameter; they were between twenty and thirty degrees distant from the sun. Before the sun had risen more than ten degrees, this phenomenon entirely disappeared. Some of the men called my attention to this strange appearance, but so engrossed were they with their own calamities, that they hardly seemed to be in the least astonished at what they saw.

After some little while we missed Preston and the sick man; we inquired, but no one knew anything about them. It was now evident that they had been buried beneath the snow drift, which, for some distance around had filled up the nook in which we had encamped to the level of the prairie; as the drift was of considerable extent, much time would be wasted in examining it, unless we could find where they had pitched their tent. At last I noticed one poor fellow digging away to find his boots; he showed me where the sick man had been. I called the men, and immediately set to work. The snow was six feet deep, and we had only a little piece of board to dig with, and the cold was so great that no one could work very long before his hands became perfectly rigid. After a good deal of hard digging, we found a pair of boots, which were recognized by the men as Preston's property. This urged us to renewed exertions: at length we cleared the snow from a portion of his buffalo robe, and lifting it up, we got sight of the poor fellow's face; he cried out in a weak voice, begging us for God's sake not to leave him to die. We assured him that we would not forsake him, and again covered his face until we could remove more of the snow; having dug as far as his waist, five men caught hold of him to drag him out, but the snow had been moist and was packed very hard, and he was held tight by the tent which had been broken down by the pressure of the snow; however, we dug a little more until we could get at the ridge pole of the tent, which we cut in two with our axes. We now drew Preston out of the drift, which had like to have proved his grave. His bed-fellow, who had been much weakened by sickness, was already dead; he was the man whom we had dragged from Jackson's grove to "Pawnee fork;" where he had been picked up by Mr. Brown; since which time he had been recovering fast. Poor fellow! it was his destiny to leave his bones on the desert prairies, where wolves howl his requiem. I caused the men to dig him also out of the drift, and to put his body into a wagon, in order that we might bury him at the Cotton Wood fork.

Several mules had already been frozen to death. As we proceeded, mules, that had started off in apparently good condition, would drop down in the harness, and their limbs would become perfectly rigid. Even one of the oxen fell down benumbed with cold. In a few hours we lost six mules and one ox, so that our road was marked out with dying animals. As we approached our destined camp ground, we saw a wolf that was so badly frozen as to be unable to move. One of the men put an end to its sufferings by a bullet from his rifle.—pp. 126, 127.

In connection with the above, we refer here to a former Report by Fremont, noticed in vol. iii, pp. 172, 173; also to the account of quicksilver mines in California, in this volume, p. 270.

ART. XXXVII.—*Notice of the Meeting of the American Association for the Promotion of Science, held at Philadelphia, September* 20-25, 1848.

THOSE who had the pleasure of joining in this scientific reunion, will long remember the harmony of the occasion, the ardor of the various members in the prosecution and presentation of their favorite branches—and the real progress which the general high character of the session evinced. The number in attendance was much larger than on any former occasion, when the association met under its old organization, and with its former more restricted plan. And yet many who before have often met on these occasions, were unavoidably detained from the present meeting. The division into two sections—of General Physics, and of Natural History,—proved highly advantageous to the rapid progress of business, and was much approved, although many were thus unavoidably prevented from enjoying the advantages of hearing all that passed in both sections.

The plan of organization, the charter and by-laws, reported by the committee appointed last year for this purpose, were unanimously adopted, and will be the basis of all future operations.

The communications made at the present session were as follows:—

Centripetal force indispensable to whirlwinds. By Professor HARE.

Some notice of the Fossil Cephalopoda, long known by the name of Belemnites, and of the diphosphate of iron, called mullicite, found together at Mullica Hill. By PETER A. BROWNE, Esq.

Report on Meteorites. By Professor C. U. SHEPARD, communicated by Professor B. SILLMAN, Jr.

Report on Winds, or the Laws of Atmospheric circulation in the Northern Hemisphere. By Professor J. H. COFFIN.

Forces in nature, which tend to rupture, contort, depress, and upheave the superficial strata of the earth. By Professor L. G. GERMAIN.

On the Volatility of Potassa and Soda, and their Carbonates. By Professors W. B. and R. E. ROGERS.

On the alleged insolubility of copper, in hydrochloric acid, and on Fuchs's Method of analysis of Iron and Copper Ores. By Professors W. B. and R. E. ROGERS.

Fossil Zoophytes of Western Ohio, with a few additions from other Western localities. By Professor J. W. VAN CLEVE.

On the Sediment of the Mississippi River. By Professor M. W. DICKERSON.

The present tendency of Chemical Philosophy. By T. S. HUNT, Esq.

The Zodiacs of the Asteroids. By Professor J. J. HUBBARD, U. S. N.

On Supposed Indian Antiquities in New York. By Professor O. KELLOGG.

Account of the present state of the Smithsonian Institute. By Professor JOSEPH HENRY.

Fundamental principles of Mathematics. By Professor STEPHEN ALEXANDER.

On the identity of the Atops trilineatus and the Triarthrus Beckii, (Green,) with remarks upon the Elliptocephalus asaphoides. By Professor E. EMMONS.

Report on the Foraminifera dredged in the coast survey. By Professor BAILEY.

Theory of the Geological action of the tides. By Lieutenant C. H. DAVIS. Communicated by Professor PEIRCE.

Observations upon the local distribution of marine animals. By Mr. DESOR. Communicated by Professor PEIRCE.

Discussion of the Flexible Surface. By Professor J. E. OLIVER. Communicated by Professor PEIRCE.

On the principles of analytical mechanics. By Professor PIERCE.

On certain methods of finding the real roots of equations. By Professor PEIRCE.

Theory of the mutual action of two planets, the ratio of whose mean motions is nearly or exactly two to one. By Professor PEIRCE.

On the decomposition of rocks, by meteoric agents. By Professors W. B. and R. E. ROGERS.

On the comparative solubility of carbonate of lime, and carbonate of magnesia. By Professors W. B. and R. E. ROGERS.

On the Fishes of Lake Superior. By Professor AGASSIZ.

On some Improvements in recording Magnetic Telegraphs. By Professor JOHNSON.

Comparison of the Alpine and the Northern Vegetation. By Professor AGASSIZ.

On the Structure of the Phonetic Apparatus of the Crickets. By Professor AGASSIZ.

On the Origin of the Actual Outlines of Lake Superior. By Professor AGASSIZ.

On the Terraces and Ancient River Harbors, the Drift, the Boulders, and the Polished Surfaces around Lake Superior and Lake Huron. By Professor AGASSIZ.

On the Classification of the Animal Kingdom. By Professor AGASSIZ.

A Monograph of the Garpikes. By Professor AGASSIZ.

Critical Remarks upon the Black-banded Cyprinids. By Professor AGASSIZ.

Notices of some new Cyprinodonts. By Professor AGASSIZ.

On the Fossil Cetacea of South Carolina. By Professor AGASSIZ.

Comparison of the Structure of Crinoides, with the Embryonic State of the Star Fishes. By Professor AGASSIZ.

On the Currents of the Ocean. By Lieut. M. F. MAURY.

Mean values of different powers of the radii vectors of an Ellipse. By Professor J. H. COFFIN.

On the absorption of carbonic acid by Liebig's dilute solution of phosphate of soda. By Professors W. B. and R. E. ROGERS.

On the composition of the bittern of some of the salines of Western Pennsylvania. By Professor MARTIN H. BOYÉ, M.D.

On the opposition of Neptune of 1848. By Professor STEPHEN ALEXANDER.

On the Topography of the states of Pennsylvania and Ohio with reference to the construction of railroad communications. By SOLOMON W. ROBERTS, Civil Engineer.

Definitions of Nihility, Space and Matter. By ROBERT HARE, M.D.

On acid springs and the gypsum deposits of the Onondaga salt group. By T. S. HUNT, Esq.

Observations on the physical geography and geology of the North Mississippi. By RICHARD BOLTON. Communicated by Prof. BOOTH.

On a simple mode of alkalimetry and acidimetry. By Professor R. E. ROGERS.

On a new description of self-registering apparatus for meteorological purposes. By Professor J. H. COFFIN.

On the use of Sulphuric acid in certain processes of gaseous analysis. By Professors W. B. and R. E. ROGERS.

On the geological and chemical relations of certain acid and alkaline springs. By Professor W. B. ROGERS.

On calculi found in the whale with results of their chemical analysis. By Dr. KELLER, of Cambridge.

On the two forms of Rhamnus lanceolatus. By T. GREEN.

Antiquities of North America. By M. W. DICKESON.

Comparison of the written and spoken languages of the Chinese. By L. P. ANDREWS, Esq.

Reports on the progress of geographical discovery during the year 1847 and part of 1848. By Professor ALEXANDER, of Baltimore.

Analyses of "Fairmount" or Schuylkill Water. By M. H. BOYÉ and B. SILLIMAN, Jr.

On the dolomization of the recent coral limestone of the Pacific. By Professor B. SILLIMAN, Jr.

The foregoing list is made up without the aid of the returns from the several Secretaries, and may not be quite correct in all respects, although it is believed that it contains all the subjects discussed, relating properly to science.

We are at present able to present only a few authentic abstracts of the several papers, and these are confined to the physical section. We shall, in succeeding numbers and as we can procure the matter from the authors or Secretaries, make such further selections as may be most interesting to our readers. Many of the papers will, no doubt, appear in full from time to time in our pages—as is true of Prof. Shepard's report on meteorites, in our present number.

Abstracts, &c.

On the Alleged Insolubility of Copper in Hydrochloric Acid; with an examination of Fuchs's method for analyzing Iron Ores, Metallic Iron, &c. By Professors R. E. and J. B. ROGERS.

Prof. R. E. ROGERS, in presenting this communication, referred to the opinion received among chemists, that metallic copper is almost entirely insoluble in pure hydrochloric acid, when oxygen is absent. This which has been made the foundation of an analytical process, first recommended by Fuchs, and since by Fresenius, was proved to be inaccurate. By a particular apparatus, in which carbonic acid gas in one case, and hydrogen gas in another, was made to flow into the space above the liquid and metal, so as effectually to exclude the atmosphere, it was found that continued boiling caused the copper to be dissolved in marked quantity. Even when exposed to the acid at ordinary temperatures, the atmosphere being entirely excluded, it was found that after a prolonged time the metal underwent partial solution, bubbles of hydrogen were evolved, and the dichlorid of copper was formed. The Professors Rogers regard these results as clearly proving the incompetency of Fuchs's method, to afford accurate results.

Professor Peirce read a paper upon certain methods of determining the number of real roots of equations applicable to transcendental as well as to algebraic equations. Sturm's theorem is perfect for algebraic equations, but is generally too cumbrous for practical use. By stopping, however, at the first, second, or third, of his functions, whenever either of these is sufficiently simple for direct discussion, the number and nature of the real roots of the given equation can be readily ascertained. Professor Peirce illustrated this method by geometrical diagrams and applied it to some very general cases of algebraic equations.

Mr. Sears C. Walker communicated to the Physical section, through Prof. Alexander, the comparison of his ephemeris of Neptune for the opposition of 1848, with the observations received from Hamburg, and Cambridge, England. After applying to the ephemeris a correction published by Mr. W. in the American Journal of Science, the differences between the computed and observed places of Neptune are as follows:

		Obs.—Eph. R. A.	Obs.—Eph. Decl.
Hamburg,	July 10	—0·″06	—0·″83
"	" 11	+2· 51	—0· 68
"	" 12	+0· 78	+1· 86
Cambridge, E.,	" 12	—0· 39	+1· 25
"	" 13	—2· 55	+0· 07
"	" 15	—1· 86	. .
	Mean,	—0· 26	+0· 34

This comparison shows that no correction is needed as yet, either to Mr. Walker's elements of Neptune's orbit, or to the perturbations of the planet as computed by Prof. Peirce.

On the decomposition of rocks, &c., by Meteoric Waters, and on the action of the Mineral Acids upon Feldspar, &c. By Prof. W. B. Rogers and Prof. R. E. Rogers.

An abstract of part of this memoir may be found in the last volume of this Journal, page 401.

Experiments were also cited disproving the opinion which appears to be received among chemists, that the feldspars, hornblendes, &c.,

are entirely unacted on by sulphuric or hydrochloric acids. By exposing these materials in fine powder to prolonged digestion in the acid, even at common temperatures, a partial solution was found to result. Thus thirty grains of potash feldspar, by digestion for twelve hours in hydrochloric acid at temperature 60°F., lost nearly one grain, and the liquid furnished chlorid of potassium with chlorid of aluminium.

This communication drew forth some interesting remarks and confirmatory statements from Professors Hare, Henry, W. B. Rogers, R. E. Rogers, Silliman, and Mr. Hunt.

On some Physical Phenomena dependent upon the Progressive Motion of Light. By Prof. STEPHEN ALEXANDER of Princeton, N. J.

After adverting to the recognized effect of the annual aberration of light, and that which is ordinarily termed planetary aberration, the author more particularly explained the dragging of the shadows of the earth and other planets, first previously noticed by himself in a communication to the American Philosophical Society. Prof. A. then proceeded to the consideration of the case in which light passed through the transparent envelop of a body in motion, and observed that inasmuch as the theory of undulations required that the ether should be possessed of inertia, and the inertia of our atmosphere must be incomparably greater than that of the ether, it would seem to follow, that the velocity of the earth's atmosphere, due to its annual motion, must be impressed upon the light of the sun and stars in the passage of the same through the atmosphere, and thus produce an aberration, which, in so far as the earth's motion was concerned, would be the opposite to that which actually exists, aberration being both in mode and measure, what it ought to be, if the earth had no atmosphere. Prof. A. suggested that the explanation of this was to be found in the enormous porosity of the atmosphere; by far the greater portion of the rays so passing through as to escape the mechanical action of the molecules. When, however, the quantity of atmosphere to be traversed was so great that light must be nearly absorbed, some sensible portion of it might be subject to the influence in question. Prof. A. then referred to the phenomenon of a blue band, seen by himself and others, bordering that edge of the earth's shadow, into which the moon entered, at the time of the last lunar eclipse, but which was less distinct on the side at which the moon emerged; and showed that these phenomena were consistent with the supposition of such an impulse, accompanied by the dragging of the shadow.

Lastly, Prof. A. suggested that these considerations might have a bearing upon the question of a systematic aberration of the double stars; for if the nature of the envelope of a star were such, that its mechanical impulse could be communicated to the light of the star, the theory of emissions, with reference to such a star, would be quasi true, and the aberration admissible.

On the Topography of the States of Pennsylvania and Ohio, with reference to the construction of Railroad communications. By SOLOMON W. ROBERTS, Civil Engineer.—The author commenced by saying that the maps which he exhibited, showed the results of numerous and extensive surveys which had recently been made. A railroad is in use from Philadelphia to Harrisburg, on the Susquehanna, a distance of 107 miles, passing over a rolling and highly cultivated country but not crossing any high ridges. The Pennsylvania railroad, now in course of construction, from Harrisburg to Pittsburg, at the head of the Ohio river, will be 251 miles in length, making the whole distance from Philadelphia to Pittsburg 358 miles. This line crosses the Alleghany Mountain at Sugar Run Gap; and from Harrisburg to the base of the mountain, a distance of 133 miles, the line follows the valley of the Juniata river, and has no grade greater than twenty-one feet per mile. The curvatures are easy and the road adapted to high velocities. The mountain is ascended on the eastern side by $12\frac{3}{10}$ miles of a grade of eighty feet per mile, similar to that on the Western railroad of Massachusetts. The summit of the mountain is then passed by a tunnel 700 yards long, and the line from the summit to Pittsburg is 106 miles long, with a maximum grade of fifty-two feet per mile.

The railroad distance from Pittsburg to Cincinnati will be 330 miles, by the way of Massillon, Wooster, and Columbus. While the distance by the Ohio river is 495 miles, or one half longer than the railroad, and the railroad may be traversed in about one-fourth of the time required by steamboats on the river. The railroad in Ohio for the greater part of its length will traverse the elevated table lands of that state, which are very favorable for railroad construction.

The speaker described the principal topographical features of the states of Pennsylvania and Ohio, and exhibited a profile of the crest line of the Alleghany mountain for a distance of forty-four miles.

In conclusion, he explained that the best and shortest railroad route from Cincinnati to New York and Boston passed through Pennsylvania and Philadelphia; and that the same was true of a road from St. Louis. And also that from Cleveland on Lake Erie to New York, the distance by the railroad through Pittsburg and Philadelphia, will be eighty miles shorter than by the way of Dunkirk and Piermont.

Report on the Winds of the Northern Hemisphere. By Professor J. H. Coffin.—After some remarks upon the importance in investigations of that kind, of lengthened periods of observation for the purpose of eliminating accidental errors, and of extending the field of research over as wide a field as possible, he proceeded to classify the observations which formed the basis of the report, according to the regions or countries in which they were taken. These were widely scattered over both continents, and the Atlantic, Pacific and Arctic oceans, and embraced an aggregate period of over two thousand years, at five hundred and fifty fixed stations, beside numerous voyages and tours—a more extensive collection, he remarked, than had ever before been brought together for the purpose.

He next pointed out the method he adopted to determine from these observations, the mean course of the wind, which was the same as that by which the traverse of a ship at sea is resolved.

By the aid of extensive diagrams he then proceeded to establish the fact that between lat. $33\frac{1}{2}°$ and lat. 60°, there is a general current from the west, (or rather from a little to the south of west,) extending entirely round the globe, but that as we approach those limits (particularly on the south) it gradually loses its decided character, and at the limit all trace of a fixed direction disappears, the current at any place being controlled entirely by local influences. This he illustrated by a separate diagram of the winds at Augusta, Georgia. After passing this limit on the south, he showed that a current from the opposite direction sets in, which, as we go south, gradually assumed a more decided character till we come fully within the limits of the trade winds. He alluded, in passing, to a peculiarity in the winds west of the Mississippi, between lat. 30° and lat. 40°, as explaining the tracks of storms in those regions.

North of latitude 60° he showed that there are indications that the strong current that comes down from the north in the polar regions veers toward the west; thus establishing a third system, which breaks up about at latitude 60°. The observations taken at various places in Russia and British America, Norway and St. Petersburg in Russia, were alluded to as indicating this fact.

After having gone through with his remarks upon the general course of the winds, he took up the subject of the annual curve which they describe, and showed that while on the eastern coast of Asia it is the same as here, in Europe the curvature seems to be in the opposite direction—also that a curvature physically similar exists in both the easterly and westerly systems of winds.

He next spoke of the relative force of the different winds, showing how far the general results are modified from this cause.

After remarking that he was compelled for want of time to omit several matters embraced in the report, he closed with an expression of thanks to the numerous friends who had aided him in obtaining the necessary data, and whom he mentioned by name, with the kind of aid received from each.

LT. M. F. MAURY, U.S.N., *on the Winds and Currents of the Ocean.*—Lt. MAURY reminded the Association that in 1844, they appointed a committee to represent to the Secretary of the Navy, the importance of the services which our armed cruisers might render to the cause of science, by a systematic series of observations upon the currents, temperature and other phenomena of the sea. Judge Mason was a man of enlarged mind and liberal views; he received the representations of the committee as a friend of science and a statesman should do.

It was owing to the impulse thus given, that Lt. Maury had been enabled to carry out a plan which he had long entertained, of constructing a series of charts which should give to each navigator the benefit of the combined experience of all who had gone before him, as to the winds and currents in every part of the ocean. Charts upon this plan, of the North Atlantic, were exhibited before the Association.

They are so constructed as to shew at a glance the prevailing winds, currents, temperatures, &c. for every month in all parts of the ocean. The characters or symbols for the winds are so contrived, that they shew at once both the direction and strength of the wind.

To obtain the results exhibited before the Association, involved immense labor: many thousand old log-books had been overhauled, and the records of each as to winds, temperature of the sea, variation of the compass, and force and set of currents, compared with all the rest: but the results were of high interest and great value. They shew that the trade winds in the North Atlantic blow with much more regularity on the American, than on the African side of the Atlantic, owing to the fact that in the latter case the sands and deserts which heat and rarefy the air, are to windward; while in the former, they are to leeward. It was also shewn that the trade winds prevail more from the northward on the American, than they do on the African side; and that calms are much less frequent on this, than on that side of the ocean.

By an ingenious manner of discussing the records with regard to winds, Lt. Maury has been led to the discovery of a region near the equator, and extending midway the Atlantic from the shores of Africa, in which, instead of a northeast trade-wind, as there is between the same parallels in other parts of the ocean, there are regular southeast and southwest monsoons.

He pointed out the usual route of vessels bound across the equator from the United States, and shewed that it is over towards the coast of Africa, near the Canary and Cape de Verde islands. It lies through this anomalous region, which it is difficult to cross under sail, owing to the fact that the winds there are mostly head winds. This circumstance led Lt. Maury to the discovery of a shorter route to the Equator through a region of better winds. He had made known this new route to navigators. He had received the returns of seven who had tried it; and the average length of their voyage to the equator was ELEVEN days less than the average by the usual route.

The manner in which his charts were cut up by the tracks of vessels, enabled him to speak confidently as to the existence of a number of *vigias* and other dangers of doubtful position, which disfigure our best and most accurate general charts. Many of these, he pronounced to have no real existence. He is preparing a list of such as may be erased from the charts of the North Atlantic.

Many curious and interesting facts were exhibited concerning the temperature of the ocean. Among these, Lt. Maury pointed out, off the shores of South America, between the parallels of 35° and 40° S., a region of storms, and of ocean temperature as high as that of our own Gulf Stream, whereas in the middle of the ocean and between the same parallels, the temperature of the water was not so great by 22°, and storms by no means so frequent.

Lt. Maury lamented the neglect of the thermometer—a most useful little instrument—among navigators generally. New York, he said, owed her commercial supremacy in a great degree to the water-thermometer. Up to the time when Dr. Franklin with this instrument discovered the Gulf Stream, Charleston had more foreign trade than New York and all the New England states together. Charleston then was the half-way house between them and Europe. When a vessel, attempting to enter the Delaware or Sandy Hook, met a northwest gale or snow storm, instead of running off a few hours into the Gulf Stream, to thaw and get refreshed by the genial warmth of its waters, as she now does, she put off for Charleston or the West Indies, and there remained till the return of spring before making another attempt.

New York now has more direct trade in a week than Charleston has in a year. Perhaps Dr. Franklin with his water-thermometer, and Jeremiah Thompson & Co. with their packet-ships, may be regarded as the two most powerful agents of the many concerned in this revolution.

The frequent and general use of the water-thermometer by navigators, is the only means by which we can arrive at a proper knowledge of the aqueous circulation of the globe, of the currents and isothermal lines of the ocean.

The Secretary of the Navy has authorized copies of these charts to be given to every navigator who would return to the National Observatory, according to form, an abstract of his voyage. Several thousand sheets of the chart have already been distributed upon these terms, and there are now engaged upon all parts of the ocean, hundreds of vessels making and recording observations for this work. Never before was such a corps of observers known. The commercial marine of no country can boast of more accomplished navigators than those of the United States.

The importance of simultaneous observations in all parts of the ocean, was dwelt upon with much earnestness. The field is as wide as the ocean, and there is room in it yet for multitudes of laborers. The work is not exclusively for the benefit of any one nation or age, and it was suggested whether the states of Christendom might not be induced to coöperate by their navies in the undertaking.

The next annual meeting of this Association, stands adjourned to Cambridge, Mass., on the 2d Tuesday (14th) of August, 1849. President, JOSEPH HENRY; Secretary, Dr. JEFFRIES WYMAN. The auspicious character of the Philadelphia meeting—the great interest it has excited in the minds of those who were present—the advantages offered by Cambridge to draw together men of science—all contribute to support the opinion that much may be expected of the session of 1849. In the matter of publication, the Association have ordered the Secretaries of the Sections, and the general Secretary, to prepare a full report of all the papers read before their several meetings, and to submit them to a Publishing Committee, who are charged with the issue of a volume of proceedings. No abstracts of papers read, or remarks made before the sections, will be published, unless the same have been furnished or approved by the authors. It is hoped that another year may enable the Association to publish a volume with full memoirs and reports, as well as abstracts. For this purpose, a much more general enrollment of members will be necessary.

The present session of the Association lasted five days, during which time, three daily sessions were held, in the halls of the University of Pennsylvania on Ninth street.

ART. XXXVIII.—*Report on Meteorites;* by CHARLES UPHAM SHEPARD, M.D.

[Read before the American Association for the Promotion of Science, at Philadelphia, Sept. 20, 1848.]

HAVING completed the description of the meteoric iron-masses of the United States, it now remains to describe the American meteoric stones. As a result of new observations respecting these bodies generally, it becomes necessary to propose a slight modification of the classification previously adopted.

CLASS II. *Stony.*

Order 1st, Trachytic.	Section 1. Fine grained.	Iowa. Tennessee.
	Section 2. Coarse grained.	Weston, Conn. Richmond, Va.
Order 2d, Chladnitic.	Bishopsville, S. C.	
Order 3d, Carbonaceous.	Cold Bokkeweld, South Africa.	
Order 4th, Trappean.	Chantonnay. Renazzo.	

APPENDIX.

Pumice-like.

a. Waterville, Me.
b. Concord, N. H.

The localities to be described under the above classification, with the dates of fall, &c., are as follows:

CLASS II.

Order 1*st.* Section 1st. *Fine grained.*

1. Linn Co., Iowa. Fell Feb. 25th, 1847, 2h. 50m. P.M. Described by SHEPARD. Weight about 75 lbs.
2. Castine, Maine. Fell May 20, 1848. Described by SHEPARD. Weight 1½ oz.
3. Nanjemoy, Maryland. Fell Feb. 10, 1825. Described by CARVER and CHILTON. Weight about 16 lbs.
4. Sumner Co., Tennessee. Fell May 9, 1827. Described by SEYBERT. Weight 11 lbs.
5. Forsyth, Georgia. Fell May 8, 1829. Described by SILLIMAN, Sen., and SHEPARD. Weight about 36 lbs.
6. Nobleboro, Maine. Fell Aug. 7, 1823. Described by CLEAVELAND and WEBSTER. Weight about 5 lbs.

7. Little Piney, Missouri. Fell Feb. 13, 1839. Described by HERRICK and SHEPARD. Weight about 50 lbs.

Section 2d. *Coarse grained.*

8. Weston, Connecticut. Fell Dec. 14, 1807. Described by SILLIMAN, Sen., and KINGSLEY. Weight about 300 lbs.

9. Richmond, Virginia. Fell June 4, 1828. Described by SHEPARD. Weight 4 lbs.

Order 2d.

10. Bishopsville, South Carolina. Fell March, 1843. Described by SHEPARD. Weight 13 lbs.

APPENDIX.

a. Waterville, Maine. Fell March, 1843. Described by SHEPARD. Weight about 3 oz.

b. Concord, New Hampshire. Fell Oct., 1846. Described by SILLIMAN, Jr. Weight 370½ grs.

Before treating of these different localities, it must be observed, that the ingredient of meteoric stones called olivinite in the preceding report, will hereafter be spoken of as *olivinoid;* since reasons of sufficient weight have presented themselves, in the examination of the substance in question, to authorize its separation from the common volcanic mineral (as well as from the transparent crystals and grains contained in the Siberian and the Atacama meteoric irons). The olivinoid has a hardness equal only to 5·5....6; while olivine is from 6·5....7. The former turns black, and fuses easily before the blowpipe; while the latter grows pale and is infusible. Olivinoid is more easily attacked by the acids than olivine: moreover, it seems most probable, from what is at present known of its composition, that the olivinoid is throughout, a bisilicate, and not a simple silicate.

I have distinguished another equally abundant earthy mineral in meteoric stones as new, under the name of *howardite*, which was detected in consequence of its existing in an almost perfectly insulated state in the Iowa stone. This will be described under the account now to be given of that meteorite.

1. *Linn Co., Iowa.*

I have given the principal facts attending the fall of stones at this locality, in the Amer. Journ. of Science, ii ser., Vol. iv, p. 288. It is only requisite to add, that the small stone seen to fall, was picked up on the land of Mr. Daniel C. Rogers, situated on section 21, township 82 north, range 6 west. The larger portion of the fallen meteor was found in section 20, from a mile to a mile and a half, west. This consisted of two masses and not as first supposed, of the fragments of a single stone. The larger of the two (whose weight was estimated at above 40 lbs.) was cracked through the centre, by its fall upon the frozen ground. One of these halves (weighing 21 lbs. 7 oz.) is in my possession. The smaller perfect stone is represented, by the finder of it, to have been pyramidal in its shape; and to have measured not far from 10 inches in length, by 8 at its base, and 4 at the smaller extremity. It was completely coated by a black crust, like the other two stones. This stone (as well as one-half of the larger mass) has been broken up, and for the most part entirely lost. The few fragments of it in my possession, sufficiently evince that it differs in no sensible manner from the other two, which are now to be more particularly described.

The smaller stone will be best described, by comparing it to a short rectangular prism (the longer side measuring 4 inches, the shorter, 2½ inches) surmounted at one extremity by a four-sided pyramid of unequal and much curved faces, and terminated at the opposite end by an oblique, waving plane, upon which the stone is most conveniently placed for inspection. When in this position, the apex of the pyramid is 3½ inches from the base. The angles and edges of the mass, as is usual in such bodies, are rounded and blunt. It has but few depressions in its surface. The crust is perfect in its continuity, and is smooth and black, though not shining. The stone weighs 2 lbs. 8¼ oz.

The large mass (of 21 lbs. 7 oz.) is an irregularly shaped, four-sided pyramid, the summit of which, in place of being a point, is an edge of four or five inches in length. The base of the pyramid is formed by the fractured surface, which is nearly plane, and strikingly resembles the face produced by fracturing a similarly sized block of fine grained granite. The natural outside of the stone presents the customary depressions, though they are less distinct than we sometimes observe in these productions. The crust is similar to that in the small stone already described, only it remains to be noticed, that its thickness is greater than common, (being that of bonnet-pasteboard,) its adhesion to the unaltered stone strong, while its line of junction with the same, is perfectly defined throughout. When narrowly observed, it is discovered that the surface of this crust is divided off, by cracks, into polygonal areas, of from ¼ to ½ an inch in diameter, a consequence no doubt of sudden cooling.

The color of the stone within, is an uniform pearl grey. A closer inspection renders visible specks of iron rust, (though less abundant than common,) and numerous highly brilliant globules of nickeliferous iron. It requires a still nearer search to detect the magnetic pyrites, which is far less abundant than the metallic grains. Blackish veins and glazed joints are nearly obsolete in the Iowa stones. The same may be said of the little ovoid masses, which are also so frequent in most other stones.

The most remarkable feature of the Iowa stone, however, consists in the homogeneousness of its earthy composition. It appears to contain but a single mineral species of this description, and this is one which, though perhaps the most common in other meteoric stones, has until now escaped a separate recognition. I have therefore ventured to bestow upon it a distinct name, that of *howardite*, in honor of an individual whose early scientific labors in this branch of meteorology, rank next in importance to those of Chladni himself.

The proportions of the ingredients in this stone, approach the following:

Howardite, ...	83·00
Nickel-iron, ...	10·44
Magnetic pyrites, ...	5·
Olivinoid and anorthite, . . .	in traces.

A portion of the stone was carefully cleared of the nickel-iron by means of the magnet, which however was inadequate to the separation of the pyrites.

The stone (well cleared of foreign substances) fused easily before the blowpipe into a black, scoriaceous glass, which was attractable by the magnet.

The powdered stone (cleared of the nickel-iron as above) readily yielded to the action of warm dilute hydrochloric acid; and was quickly brought into solution, with the separation of flocculent silica. Its analysis gave the following result:

Silicic acid, ...	60·16
Protoxyd iron, ...	23·50
Magnesia, ...	11·20
Magnetic pyrites, ...	4·66
Soda and potassa, ...	0·30
	99·82
Lime and nickel, ...	in traces.

Omitting the pyrites, the composition of the mineral may be stated thus:

		Oxygen.	Ratio of oxygen.
Silicic acid, . . .	63·06	31·53	3
Protoxyd iron, . . .	24·60	5·46	1
Magnesia, . . .	11·74	4·70	
Soda and potassa, .	·31		
	99·71		

It is therefore a tersilicate of protoxyd of iron and magnesia, $\dot{Fe}\,\dddot{Si}+\dot{Mg}\,\dddot{Si}$.

The composition of the nickel-iron approaches very closely to that of iron 86, nickel 14,—a peculiar alloy, which I have reason to regard as very common in meteor-masses.

2. *Castine, Maine.*

For description of this stone, see this Journal, ii ser., vol. vi, p. 251, 1848.

3. *Nänjemoy, Maryland.*

For a description of this stone, see this Journal, Vol. ix, p. 351, and Vol. x, p. 131. Meteoriten von P. Partsch, s. 63, Wien, 1843.

Its crust resembles that of the Iowa stone, without however possessing its uniformity of thickness, or its deep black color. The proportion and mode of dissemination of the nickel-iron and of the pyrites, is very similar in both; but the color of the earthy mineral in the Maryland, is several shades darker, and more inclining to blue. The iron-rust points are less frequent than in the Iowa meteorite. Like the latter, it is principally composed of howardite; although rounded grains of olivinoid, to the amount perhaps of 15 per cent., are distinguishable with the aid of the microscope.

4. *Sumner Co., Tennessee.*

For accounts of this meteorite, see this Journal, vol. xvii, p. 326, and vol. xviii, p. 200. Die Meteoriten, von P. Partsch, s. 47, Wien, 1843.

The crust much resembles that of the Maryland stone, though it is somewhat remarkable in possessing an uniform brownish black color. Within, the stone is of a light grey, more inclining to white than any meteoric stone of the United States, excepting that of Bishopsville. It abounds in pale yellow grains, which are probably olivinoid. In addition also to the howardite, it contains anorthite in small quantity. The nickel-iron and magnetic pyrites are very minutely diffused; while here and there, little specks of chrome iron may be detected.

5. *Forsyth, Georgia.*

For a brief notice of this stone, see this Journal, Vol. xviii, p. 388; and Die Meteoriten von P. Partsch, s. 57, Wien, 1847.

Having been supplied, through the kindness of President Church, and Prof. Jackson, of the University of Athens, with a specimen weighing half a pound, of this scarce stone, I have been able to subject it to analysis, as well as to determine its specific gravity more accurately than I had been able to do before. It is 3·52.

It contains the following ingredients:

Nickel-iron, ...	10 per cent.
Howardite, ...	70 "
Olivinoid, Anorthite, }	10 to 15 per cent.
Magnetic pyrites, ...	2 to 5 "
Apatite, ...	in traces.

The nickel-iron consists of

Iron, ...	89·00
Nickel, ...	9·60
Chromium and loss, ...	1·40
	100·00

The mixture of the earthy minerals in the stone, gave as follows:

Silicic acid, ...	50·00
Protoxyd iron, ...	33·33
Magnesia, ...	9·30
Lime, ...	5·30
Alumina, ...	1·80
	99·73

6. *Nobleboro, Maine.*

Notices of this stone are contained in Vols. vii, p. 170, and ix, p. 400, also in Boston Journal of Philosophy and the Arts, and Die Meteoriten von P. Partsch, s. 29, Wien, 1843. The crust is a perfectly fused and shining glass, similar to the Juvenas and Stannern stones. The color of the interior is a light ash-grey. When examined by the aid of a lens, it is found to be highly composite in character, although the small fragment in my possession shows neither nickel-iron nor magnetic pyrites. The most abundant ingredient is howardite, through which are disseminated grains of greenish transparent olivinoid, white particles of anorthite, black grains of chantonnite, and a red colored, vitreous, hard mineral, which appears to be either garnet or idocrase.

7. *Little Piney, Missouri.*

Brief accounts of this stone are contained in Vols. xxxvii, p. 385, and xxxix, p. 254.

I have been favored with several additional particulars respecting its fall, from persons who reside in the vicinity of the locality.

It fell near a place known as Pine Bluff, on Gasconade river, in township 37, range 11, W. of the principal meridian, in Pulaski county. Some persons were abroad in the woods at a sugar-camp (a place for making maple-sugar), when their attention was suddenly arrested by a rushing sound, proceeding from a dark colored body, partially enveloped in smoke, which was moving horizontally through the air, at a distance apparently of only 400 feet above the tops of the trees. They compared its size and shape to those of a blacksmith's bellows, moving with the large end foremost. A bright light or blaze was noticed to hover around the blowpipe extremity of the mass, which vibrated up and down through the space of a few inches. A streak of bright light, 100 yards in length, followed the blaze. Before there was time to utter a word, the meteor had passed behind a neighboring hill, when a loud explosion ensued. At a place about one mile distant, in the direction of the meteor's passage, two men were at work in a field. They heard the explosion, and saw the stone strike the earth, at a distance of two hundred yards from where they were standing. It hit the trunk of a tree, eighteen inches above the ground; and when first discovered, seemed enveloped in smoke. (The foregoing statement was supplied by Mr. T. MacDonald.)

The following letter, dated Sept. 12, 1846, describing the phenomenon, is from Mr. B. B. Harrison, a merchant residing in Little Piney, distant about ten miles from Pine Bluff, where the stone fell. "I recollect the state of the weather on the afternoon of the occurrence. It was perfectly clear and calm. On going out from dinner, I met a man in my door yard who was much alarmed at the sound of distant cannon, as he supposed, proceeding from a northwesterly direction. On the following day I visited a place, twenty miles to the east of this, where the people spoke not only of hearing the same noise, but of seeing a body like a blazing churn pass through the heavens, in a southwesterly direction, the noise, however, proceeding from the northwest. They supposed that something must have fallen from the body within a mile or two of their place. At a place thirty miles farther to the north, the people described the motion of the body as being from the south to the north. I continued travelling about from place to place, for several weeks, in the southwestern part of Missouri, and almost every day heard the same object spoken of, although the statements were very discordant in respect to the direction of the meteor. They generally agreed as to the hour of the day. To the citizens of Potosi (which is eighty miles east of this place), the report appeared to proceed from the south.

"After the lapse of some weeks, I was presented with a fragment of the stone, which led me to visit the place of its fall. It was at the foot of a hill of very gradual slope, about half a mile from the Gasconade river, two miles from Pine Bluff post-office, ten miles from Little Piney post-office, and the same distance from Waynesville. I saw where the stone had struck an oak tree, eighteen inches in diameter. The tree was much mangled, though not broken. I saw small particles of the stone still adhering to the tree, and the wood of the tree in the vicinity of the spot where struck, had the appearance of having been burned by gunpowder. The stone was principally carried away, though I was able to procure many pieces, scattered at a distance from the tree. That which I supposed to have been the outside of the stone, had a dark brown color, and formed a crust of the thickness of coarse wrapping paper. It had evidently been exposed to intense heat. The injured side of the tree was to the southwest, from which side I was informed that fragments of the stone were projected to a very great distance (three fourths of a mile).

"Those who first visited the place differ greatly as to the weight of the stone, the estimates varying from fifty to one hundred and fifty pounds; my own opinion is, that it must have weighed at least fifty pounds. The place not being far from the public road, the fragments were soon gathered up by travellers, and have been dispersed very widely through the country. It may be proper to add, that I am a native of this place, and that I never saw any other stone resembling the one I send you, here or elsewhere; and that it is quite impossible to account for the injury to the tree, except on the supposition of its being produced by a stone falling from the atmosphere."

The following communication is from M. Frissell, Esq., of Potosi, Mo., dated March 12, 1842:—"The meteor, of which the stone in my possession formed a part, passed in a westerly direction. It must have been large, and I presume that the main body passed on, the piece that fell having formed but a small part of the whole. I did not witness the meteor. Some persons who did, compared it to a trumpet in shape, moving with the expanded end foremost. The time of its passage was between two and three o'clock, P. M. Shortly after it had passed the meridian of this place, it exploded with the noise of a heavy piece of ordnance, at two or three miles distance. I was in my office at the time. My first impression was, that it was an earthquake. I was soon apprised however of what had passed through the air, when I became convinced that the report had proceeded from a meteor. The report was double; like two cannons fired at nearly the same instant, the second being louder than the first. The meteor must have been twenty miles from this place when the explosion took place. I expected that fragments would have been found in this immediate vicinity, but the only one discovered was at Pine Bluff, about eighty miles distant."*

The crust to this stone has about the same thickness as that of the Iowa meteorite, though its line of junction with the mass beneath is less perfectly defined. Its color is rather less black, and its surface less smooth and duller. Judging from one specimen

---

* Mr. Frissell was so obliging as to present me the specimen here referred to.

in my possession, which exhibits nearly two square inches of natural outside, it would appear that its surface must have been marked by very distinct depressions. The color within also, resembles that of the Iowa stone. The stone consist of

Olivinoid, ...	40 per cent.
Howardite, ...	40 "
Meteoric Iron, Magnetic Pyrites, } . .	15 "
Anorthite, ...	5 "
Apatite in traces.	

8. *Weston, Connecticut.*

For an account of this stone, see Memoirs of the Connecticut Academy, Vol. i, p. 141; Trans. Amer. Phil. Soc., Vol. vi, p. 323; Medical Repertory, Vol. xi, p. 202; Trans. Amer. Acad., Vol. iii, p. 213; Amer. Journ. Science, Vol. xxxvii, p. 130; Journal de Physique, Vol. lxx, p. 429; Die Meteoriten von P. Partsch, s. 41, Wien, 1843.

Its crust is thicker than in the majority of our meteoric stones, though less perfectly continuous and well formed,—being rough, dull, and filled with crevices. Its color is brownish black. When broken, the interior shows occasional joints, with plumbaginous coatings. The prevailing color within is a dark pearl gray. Scattered through the mass, at frequent intervals, are patches of a lighter color, imparting to it a sub-porphyritic aspect. These lighter portions do not consist of a perfectly homogeneous mineral, but rather of a semi-pulverulent substance, which is probably decomposing howardite. The main ingredient of the meteorite is a purplish gray (sometimes greenish gray) mineral, in rounded grains, which appear to be olivinoid. These again are mixed with other imperfectly formed grains of a lighter colored yellowish mineral (often stained by oxyd of iron). This latter substance is taken for howardite also. Magnetic pyrites (less abundant than in most stones) is irregularly disseminated, in highly tarnished grains.

The nickel-iron is more abundant than in any meteoric stone yet described, presenting itself not only in little points, but in continuous threads and veins and in oval pitted masses, sometimes of more than fifty grs. weight. One of these, in my possession, strikingly resembles in shape some of the lumps of meteoric iron in their natural state.*

* The striking analogy in external figure between meteoric iron-masses generally, and bedded masses of native copper and native gold, (independently of the diminutive cases here referred to,) suggests the idea that the great iron-masses themselves have, at some period, been embraced in an earthy gangue.

9. *Richmond, Virginia.*

For an account of this stone see Vols. xv, p. 196, xvi, 191, and Die Meteoriten von P. Partsch, s. 40, Wien, 1843.

This small and highly interesting stone appears to have been but imperfectly invested by the customary black crust. The natural outside of the fragments which I have examined, possessed the usual smoothness of surface, but were but partially melted. Nor did it appear that any more perfect coating had ever been attached to the surface. Within, the general color is a dark ash gray. Interspersed through the mass, however, are freckles of a whitish mineral, which are probably howardite. The gray portion consists of olivinoid, and forms at least nine-tenths of the earthy portion of the stone.

10. *Bishopsville, South Carolina.*

For my first knowledge of this, the most remarkable of all the hitherto described meteorites of the United States, I am indebted to Dr. J. C. Haynsworth, of Sumterville, South Carolina. His letter to me, (dated April 7, 1846,) which is here given, contains all the information respecting its fall, which I have thus far been able to obtain. "I have in possession a meteoric stone which fell in March, 1843, near Bishopsville, in the northern part of Sumter District. The passage of the meteor and its explosion were witnessed by many spectators, over a region of country of thirty or forty miles in diameter. The descent of the stone itself also, was observed by a number of negroes. Their terror was so great on seeing the excavation it produced, the scattering of the soil, and more than all, by the insupportable sulphurous odors with which the air was filled, that they fled in a panic from the field. On the following morning, however, headed by a white man they returned to the spot; and after digging three feet or more, in a sandy soil, they came upon the stone which I now possess. That it is meteoric is as well known as possible perhaps, in the absence of a scientific analysis. It has more the appearance of limestone than of any other rock with which I am acquainted, though it is much heavier than the same bulk of limerock. It has, moreover, numerous particles resembling oxyd of iron, diffused through it. It is coated with a dark shining surface, resembling glass that has been stained with some metallic oxyd. When first dug up, the sulphurous odor was said to have been overpowering. This has now subsided, though it can be reproduced by friction or slight warmth. It begins to suffer decomposition, from the access of air and moisture to the interior, as portions of the vitreous coating have been removed for specimens, by persons who have examined it."

The stone was purchased for me by Dr. Haynsworth, and is now in my possession. Its weight was thirteen pounds. Its shape may be judged of from the annexed figure 1.

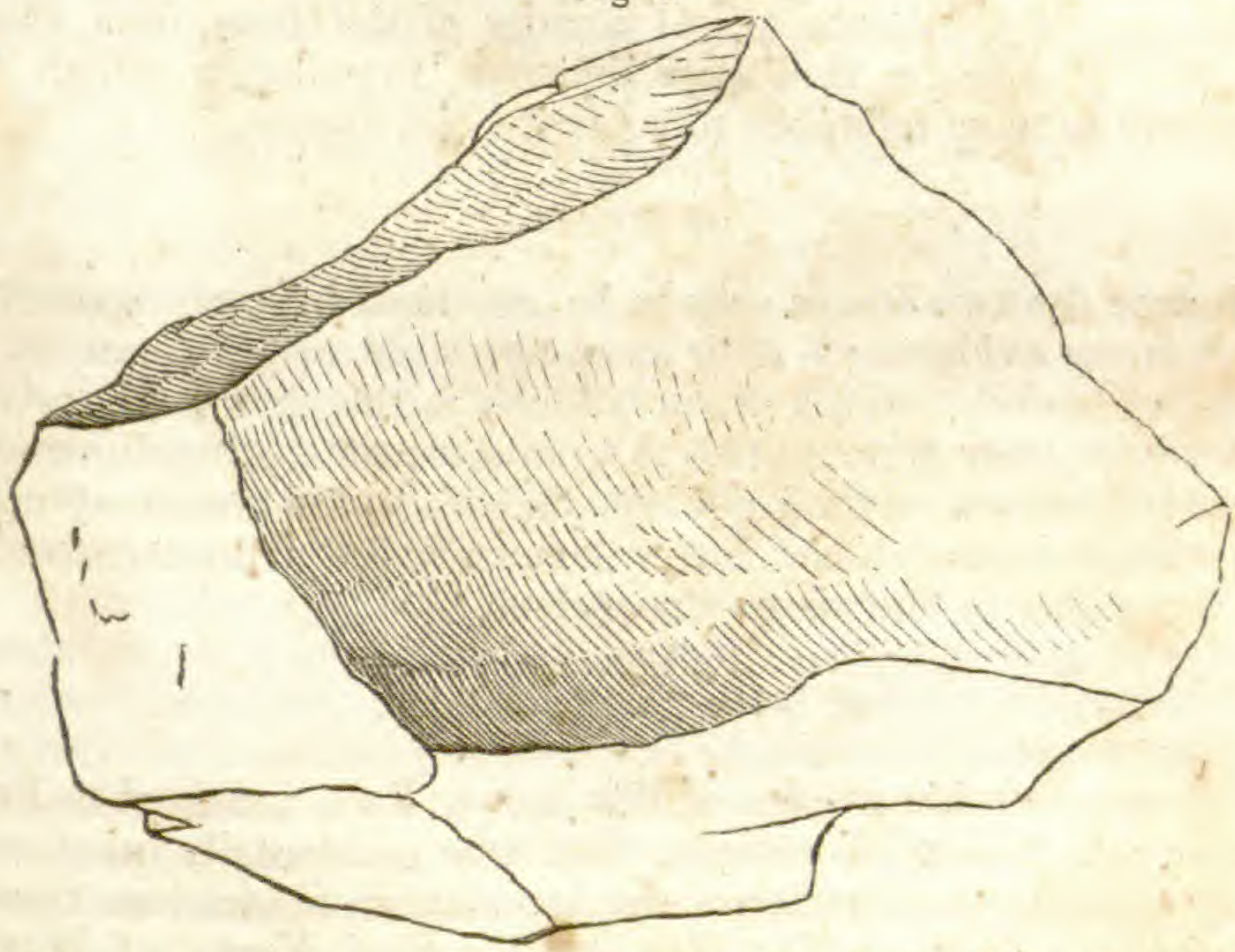
Fig. 1.

It measures 9 inches in its longest diameter, by $5\frac{3}{4}$ and 5, in its transverse dimensions. It is rounded at its thicker extremity, from whence, after bulging somewhat, it gradually tapers to the smaller end, which is obviously pyramidal, with four sides. This is exhibited in fig. 2, where the stone rests on its side.

Being an uncommonly fragile stone, the glazed coating had disappeared from the angles and the ends of the mass, leaving not more than two-thirds of the surface protected by the original crust, which is generally smooth, of a mottled aspect, the colors being black, white, and bluish gray, not unlike certain clouded marbles. The black portions are glossy and obsidian-like, the gray and white for the most part, dull, though the white is sometimes shining and transparent like enamel on porcelain. It is traversed by frequent cracks or fissures, which penetrate for some distance into the stone; the walls of these fissures being themselves partially fused for a little way inward from the exterior.

An interior view of the stone is no less peculiar. The pearly white color of its basis and its feldspathic crystallization, at first view, make it difficult to regard it as any thing else than a decomposing mass of albitic granite. A nearer inspection, however, satisfies the observer, that the white substance (chladnite, which is nearly as tender as laumonite) is different from any terrestrial mineral. It is seen, moreover, to be traversed with little black veins, and here and there to include little grains of deeply rusted nickeliferous iron, some of which are as large as a pea. Black grains and even crystals of sulphuret of chromium (*schreibersite* resembling allanite in form and color) are occasionally visible. Brown colored pyrites, in very minute quantity, is diffused through the stone; and especially is it visible in contact with the sulphuret of chromium. A peculiar blue mineral (iodolite), and a honey-yellow one (apatoid), as well as traces of sulphur, are likewise present in traces in the stone.

Fig. 2.



Whenever the stone is broken or rubbed, it emits the odor of sulphurous acid. Water dissolves from it decided traces of hyposulphite of soda, hyposulphite of magnesia, sulphate of magnesia, chlorid of magnesium, chlorid of sodium, and silicic acid.

The proportions in which the different visible minerals are present may be thus expressed:

Chladnite, ...	90 per cent.
Anorthite,*	6 "

* To this species I refer the globular grains of a gray color. They are less frangible and much harder than the chladnite. In a strong heat, before the blowpipe, it turns white upon the edges, slightly vitrifying, but does not melt. With borax, it slowly disappears, without more than tinging the color of the bead.

Nickel-iron,	2 per cent.
Magnetic pyrites, Schreibersite, Sulphur, Iodolite and apatoid,	2 "

The above minerals have been described mineralogically in my previous report. It only remains to state the results obtained in the analysis of the chladnite. They are the following:

		Oxygen.	Ratio of oxygen.
Silicic acid,	70·41	35·205	3
Magnesia,	28·25	11·300	1
Soda,	1·39	·338	
	100·00		

It consists, therefore, of $11\frac{1}{3}$ atoms tersilicate of magnesia $+\frac{1}{3}$ of an atom of tersilicate of soda.

In operating upon the mixed powder of the stone, lime, alumina, and phosphoric acid were detected, ingredients which are supposed to have reference to anorthite and apatite.

APPENDIX.

I place the two stones now to be mentioned in an appendix, because the evidence of their extra-terrestrial origin is not, in all respects, perfect. While there is much in the circumstances under which they were found to countenance their genuineness, there still remain several obvious defects in the testimony upon which this depends; nor is this deficiency fully counterbalanced by the nature of the stones themselves.

a. Waterville, Maine.

For my first knowledge of this stone, I am indebted to Prof. Loomis, of Waterville college, Me., who incidentally mentioned to me, (during the meeting of the Association of American Geologists in May, 1845, at New Haven,) that Prof. Keely, of Waterville, had in his possession a portion of a stone that had fallen in that place. The latter gentleman has favored me with a specimen of the stone, and several communications relative to its discovery. He observes that its finder was Capt. Josiah Crosby, of Waterville, that he is a good observer of natural phenomena, has paid considerable attention to mineralogy, and that his character is beyond question. His statement is as follows:

"On a clear, star-light night in Sept., 1826, about midnight, a luminous fireball or meteor came from a southeasterly direction, apparently one-third or half as large as the moon, and proceeded with great velocity, (with a kind of rushing noise like the approach of a high wind,) in a curved line and with a regular motion towards the earth. The light was intense and the tail or train was of a conical form, like the blaze of a lighted candle. It disappeared from my view, a moment before I heard a report, like that of a small cannon. A few days after, about one-third of a mile distant from the place where I witnessed the appearance described, I found, as I suppose, a fragment of this meteor." Several inquiries were, at my request, proposed to Capt. C., to which he replied in the following note, addressed to Prof. K.: "There has never been a glass-house in this section of the state. The nearest iron works are sixteen miles distant. Common brown earthen ware was manufactured formerly at a place one-third of a mile distant from the spot in a straight line. I have traversed the land a great number of times, bearing the circumstance in mind, yet I have never seen the like substance before or since. It was a solitary stone, the soil consisting entirely of a sandy loam. There was no stone wall, or accumulation of stones within two miles The specimen, when picked up, appeared to be a newly detached mass. The grass upon which it lay was short and close to the ground, and was entirely unchanged in appearance."

Capt. Crosby presented the mass (whose weight appears not to have exceeded three ounces) to Virgil D. Parris, Esq., formerly a member of Congress, and now United States Marshal at Portland. Mr. Parris gave Prof. Keely the fragment which was presented to me for examination, and subsequently has presented to him the remainder of the mass. Such is the history of this stone.

Its appearance is that of an imperfectly stratified or laminated pumice stone, with double the ordinary compactness of this substance,—the layers being one-sixth of an inch in thickness. It has very little tendency however to separate at these joints; and their existence even is chiefly denoted by a difference of color. The body of the stone is a light ash-grey, while at and near the joints it is iron-black. Indeed the powder of the black matter is attracted by the magnet. The outside of the stone has evidently undergone fusion, subsequently to the interior; and is coated by a thin red-brown crust. It is too vesicular in its texture to allow of a satisfactory determination of its specific gravity.

The stone is composed of the following ingredients:

Silicic acid,	70·00
Protoxyd iron,	8·00
Alumina,	18·50
Magnesia,	2·59
Lime,	1·90
	100·99

b. Concord, New Hampshire.

For a description of this stone see Vol. iv, ii ser., p. 353.

In his account of this body, Prof. Silliman has made an inference in favor of its meteoric character, founded upon the supposed identity of its composition with the Bishopsville stone, or rather with the chladnite, which forms 90 per cent. of this stone. So far as the elements are concerned in the two bodies, the analogy is striking; but the analysis of chladnite, (not then published,) on which I asserted that it was a tersilicate, was based on Dr. Thomson's view of the constitution of silicic acid, whereas Prof. Silliman has adopted the atomic weight of Berzelius. The results of analysis, however, placed side by side, stand thus:

	Concord Stone.	Chladnite.
Silicic acid,	84·973	70·41
Magnesia,	12·076	28·25
Soda,	2·218	1·34
	99·767	100·00

In addition to the analogy of elements found in the composition of these substances, it remains to be stated that there is a manifest resemblance between the melted surface of the Concord stone and certain parts of that of the Bishopsville meteorite, in color, lustre, translucency, and hardness, as well as in behavior before the blowpipe.

The extra-terrestrial origin of meteoric stones and iron-masses, seems likely to be more and more called in question, with the advance of knowledge respecting such substances, and as additions continue to be made to the connected sciences; I may therefore take an early occasion to present the Association with some views, founded in part upon Biot's theory of the aurora borealis, which seem to favor such an origin of meteorites.

The recent study of those frequently occurring and wide spread atmospheric accumulations of meteoric dust, (a single case being recorded where the area must have been thousands of square miles in extent, and where the quantity of earthy matter precipitated must have been from 50 to 100,000 tons in weight,) makes known to us the vast scale on which terrestrial matter is often pervading the regions of the upper atmosphere; and prepares us to appreciate the mode in which the peculiar constituents of meteorites may be translated to those remote distances, where according to the theory of Biot, the clouds of metallic dust are retained.

Great electrical excitation is known to accompany volcanic eruptions, which may reasonably be supposed to occasion some chemical changes in the volcanic ashes ejected; these being wafted by the ascensional force of the eruption into the regions of the magneto-polar influence, may there undergo a species of magnetic analysis. The most highly magnetic elements, (iron, nickel, cobalt, chromium, &c.,) or compounds in which these predominate, would thereby be separated, and become suspended in the form of metallic dust, forming those columnar clouds so often illuminated in auroral displays, and whose position conforms to the direction of the dipping needle. While certain of the diamagnetic elements, (or combinations of them,) on the other hand, may under the control of the same force be collected into different masses, taking up a position at right angles to the former, (which Faraday has shown to be the fact in respect to such bodies,) and thus produce those more or less regular arches, transverse to the magnetic meridian, that are often recognized in the phenomena of the aurora borealis.

Any great disturbance of the forces maintaining these clouds of meteor-dust, like that produced by a magnetic storm, might lead to the precipitation of portions of the matter thus suspended. If the disturbance was confined to the magnetic dust, iron-masses would fall; if to the diamagnetic dust, a non-ferruginous stone; if it should extend to both classes simultaneously, a blending of the two characters would ensue in the precipitate, and a rain of ordinary meteoric stones would take place.

As favoring this view, we are struck with the rounded, hailstone-like form of many of the particles of composition (even though consisting of widely different substances) in nearly all stones, and even in many of the iron-masses. Nor are these shapes to be referred to fusion; they evidently depend upon a cause, analogous to that which determines the same configuration in hailstones themselves.

The occasional raining of meteorites might therefore be as much expected, as the ordinary deposition of moisture from the atmosphere. The former would originate in a mechanical elevation of volcanic ashes and in matter swept into the air by tornadoes, the latter from simple evaporation. In the one case, the matter is upheld by magneto-electric force; in the other, by the law of diffusion which regulates the blending of vapors and gases, and by temperature. A precipitation of metallic and earthy matter would happen on any reduction of the magnetic tension; one of rain, hail or snow, on a fall of temperature. The materials of both originate in our earth. In the one instance they are elevated but to a short distance from its surface, while in the other, they appear to penetrate beyond its farthest limits, and possibly to enter the inter-planetary space; in both cases, however, they are destined, through the operation of invariable laws, to return to their original repository.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On Nocturnal Radiation, &c.;* by M. Melloni, (Ann. de Chim. et de Phys., Feb., 1848.)—Previous experiments have determined the amount of radiation by thermometers at different distances from the ground, the lower thermometer being surrounded by the radiating substance. The lower strata of air being cooler than those above, reduce the temperature of the lower thermometer—while the naked instrument having itself a high radiating power, does not correctly indicate the temperature of the air in which it is placed.

To avoid these sources of error, the instruments should be placed at the same level, and that intended to measure the temperature of the air should have its radiation reduced to a minimum. As metal foil cannot be applied neatly to the bulbs, the author devised the following mode of experimenting.

A sound bottle cork is pierced with a hole to admit the stem of a thermometer, which is pushed through until the bulb is within $\frac{1}{4}$ of an inch of the cork. It must then be fastened with a little wax and with wedges of wood. The scale which should be marked upon the tube is taken off on a piece of paper and transferred to a *thin* slip of ivory. This is then fastened in a slit in the cork so that it shall coincide with the scale on the tube, and secured in its place. The end of the column of mercury and the corresponding degree on the scale can be easily seen at night, by holding a light behind the strip of ivory.

A little vessel of silver or brass, resembling a thimble, and with a polished surface, is next to be made; it must be large enough to hold the bulb of the thermometer, and to fit tightly on the end of the cork. A similar cap of thin tin plate is to be provided for the scale and tube.

The instrument thus prepared, was proved by experiment to be almost free from the influence of radiation, and consequently a true measure of the temperature of the air—on the other hand a coating of lampblack raised the radiation to a maximum. In the use of these thermometers, they were placed horizontally in tin vessels, having the form of a truncated cone two inches in diameter below, and seven inches above, about four inches deep, and supported on three feet formed by thin tubes of sheet tin two feet long. A hole at the side with a short tube to embrace the cork, allowed the introduction of the thermometer, its bulb being in the centre of the dish, and at little distance from the bottom; plates of tin served as covers.

We have been thus particular in describing these instruments, as they are decidedly the most suitable for this kind of investigation, which have ever been described.

Two thermometers furnished with polished caps, and a third with one coated with lampblack, were exposed in the tin vessels. While *covered*, they stood at the same height, but when the covers were removed from one of the two with polished caps and from the third, the latter (covered with lampblack) immediately fell, and in ten minutes was 3°·4 Cent. below the other two, which remained stationary. This experiment proved, that the tin vessels completely cut off the radiation, (even of the lampblack,) and that the polished caps had the same effect.

In like manner the radiation of silver was determined by two thermometers capped with that metal—one in a covered, the other in an open vessel, and a third blackened and also in an open vessel. The first showed the temperature of the air, the second the radiation of the silver, and the third that of lampblack. The results of a series of careful observations gave the radiating power of silver 3·026, that of lampblack being 100.—being not far from the recent determination of MM. de la Provostaye and Dessains, by a quite different method.

One important precaution to be observed in all these experiments is suggested by M. Melloni, we believe for the first time. We should not experiment except *at some distance from the ground and in dry weather*—otherwise the instruments soon become bedewed, and the high radiating power of water soon brings them all to the same degree, whatever be the nature of the coating. If the stems are left uncovered, the thermometers are cooled down to the bulb, and the same effect will be noticed.

The radiating power of the following substances was obtained by applying them to the caps of the thermometers.

Lampblack,	100	Isinglass,	96
Carbonate of lead,	99	Glass,	93
Varnish,	97	Plumbago,	86

The following comparisons were made by placing the substances in a little heap on the bottom of the tin dish, and high enough just to cover the cap of the thermometer.

Lampblack,	100	Sawdust of poplar,	99
Smooth leaves from various plants,	103	" " mahogany,	95
Leaves of elm and poplar,	101	Silicious sand,	93
		Mould,	92

The portion of the sky concerned in the radiation is included within 30° or 35° of the zenith. Even clouds beyond this have but little interfering effect.

That radiation takes place not only from the surface but from the parts beneath, was proved by the greater radiation of several coats of varnish than of a single one.

This explains a phenomenon which has been brought as an argument against Wells' theory. It is objected that very thin bodies, such as spider webs, should recover their temperature from the air as fast as they lose it by radiation. Hence such substances should not be covered by the dew. But spider webs are notoriously productive of dew. M. Melloni contends that the webs radiate from all portions of their substance, and therefore lose much more than they can receive, in proportion to other bodies.

A long continued course of experiment has satisfied M. Melloni, that the amount of radiation is usually stated far too high—that while under certain circumstances some bodies can be cooled to 8° Cent. below the temperature of the air four or five feet above—in general the effect of radiation is to reduce the temperature of vegetation, &c., not more than 2° Cent. below that of the surrounding air. The dampness of the air is such as readily to allow of the deposition of dew with even this small change.

Another important conclusion of our author, is a confirmation of the law just announced by Wilson, that the loss of heat from radiation in a calm, clear night, is uniform at all temperatures of the air.

The whole of this investigation, while it corrects certain inaccuracies and improves the methods of experiment, in every respect confirms the theory of dew, laid down by Wells. G. C. SCHAEFFER.

2. *On the Composition of the Organic Alkalies;* by M. AUG. LAURENT, (Ann. de Chim. et de Phys., May, 1847.)—This distinguished chemist has reëxamined the vegetable alkalies, since much uncertainty prevailed as to their true formulæ, and as for many of them, formulæ have been received, which according to the views of M. Laurent, cannot represent any chemical compound. The error in most cases arises from the fact, that a difference of ·002 to ·003 of hydrogen is sufficient to change their constitution.

By means of a modification of the usual process for organic analysis, he has found that he can determine the hydrogen to ·001. By this process, the following formulæ were established.

We give the notation adopted by the author, as a translation to our system would in some cases involve the use of fractions. It is only needful to remember that H_2 and N_2 of the French authors, are H and N with us.

Quina	$C_{19}H_{22}N_2O_2$	Narcogenina	$C_{18}H_{19}NO_5$
Cinconia	$C_{19}H_{22}N_2O$	Opianic acid	$C_{10}H_{10}O_5$
Morphia	$C_{17}H_{19}NO_3$	Opianate of amm.	$C_{10}H_{13}NO_5$
Quinoleina	C_9H_7N	Hemipinic acid	$C_{10}H_{10}O_6$
Lophia	$C_{23}H_{16}N_2$	Hemipinate of am.	$C_{10}H_{16}N_2O_6$
Picryle	$C_{21}H_{15}NO_2$	Starch	$C_{12}H_{20}O_{10}$
Narcotina	$C_{23}H_{25}NO_7$	Pyroxyline	$C_{12}H_{17}N_5O_{27}$
Cotarnina	$C_{12}H_{13}NO_3$	Conina	$C_8H_{15}N$

G. C. S.

3. *Researches on the Chemical Constitution of Asparagine and Aspartic Acid;* by M. R. PIRIA, (Ann. de Chim. et de Phys., Feb., 1848, trans. from the Italian.)—The chief results of M. Piria's remarkable discoveries in relation to these substances, have already from time to time appeared in various journals; but we now for the first time find the complete memoir, of which we shall give a brief abstract.

Process for obtaining Asparagine.—About 22 pounds of vetches were allowed to germinate in a dark apartment. When the plants were two feet high, they were cut up, the juice expressed and evaporated, after filtration from albumen coagulated by the heat. The almost syrupy liquid deposited an abundant crop of crystals of asparagine. These were purified by two or three re-crystallizations from boiling water, the last time using animal charcoal. The crystals were of uncommon beauty, not unlike those of sugar candy. Copper vessels impart a blue tint, and sulphuretted hydrogen causes this to disappear.

The product of asparagine is 1½ per cent. for the vetches used. The same quantity was obtained from the plants germinated in the light;

but none from the seeds themselves, nor from the plants when the flowers had formed.

The constant acid reaction of the liquid even when concentrated, induced M. Piria to suspect the presence of some foreign acid; but at last he arrived at the conclusion, that the asparagine itself (contrary to all former statements) is really an acid of some power. A saturated solution of asparagine gives when heated with acetate of copper, a rich ultramarine blue precipitate, increasing in quantity on cooling. Its composition is $C_8(H_7Cu)N_2O_6$—that of asparagine free from water of crystallization, $C_8H_8N_2O_6$. The asparagine may be obtained unaltered from this substance, by the use of HS. A similar compound with potassium has been noticed in this Journal for March, 1847, p. 258.

Action of Ferments.—Under the influence of an azotised principle in the plants, the impure asparagine in solution, or the juice itself, undergoes fermentation, emitting a putrid odor; and there is found remaining a quantity of *succinate of ammonia*, formed by the fixation of $2HO+H_2$.

Asparagine $C_8H_8N_2O_6+2HO+H_2=C_8H_{12}N_2O_8$ succ. amm.

Action of Acids and Alkalies.—It is well known that these agents decompose asparagine into aspartic acid $C_8H_7NO_8$ and ammonia—2HO being added.

It is incorrectly stated that concentrated hydrochloric acid produces a new and more soluble acid. Our author has found that this is only aspartic acid retained in solution by the hydrochloric acid.

Even nitric acid when pure, forms only aspartic acid; from the solution under certain circumstances, acetate of lead precipitates a double nitrate and aspartate of lead; which however cannot always be obtained.

The reaction of nitric acid containing hyponitric, was quite remarkable; a large quantity of pure nitrogen was given off, when either the asparagine or aspartic acid was used. The complete decomposition was effected by dissolving in nitric acid, and passing a current of binoxyd of nitrogen until no more nitrogen was disengaged; the acid liquid saturated with carbonate of lime gave with acetate of lead, the well known crystalline and fusible *malate of lead.* Analysis confirmed this.

Hence asparagine is an amid analogous to oxamid, and aspartic acid another corresponding to oxamic acid. Their names should be malamid and malamic acid.

M. Piria proved the analogy of this reaction of hyponitric acid upon oxamid, succinamid and butyramid. In all cases nitrogen was given off, and the oxalic or other acid remained in solution. Urea too is transformed, as is well known, into nitrogen and carbonic acid.

The remarkable facility of this decomposition, which takes place even in the cold solutions, is strikingly contrasted with the tedious and never definite decomposition of the amids by heating with caustic potash.

[The distinctness of the reaction of hyponitric acid with the amids, seems to afford us a means of research of vast promise. Most of the azotised compounds of unknown relation, are undoubtedly amids; their decomposition by means of caustic potash is slow, and always affords a variety of products. With hyponitric acid, we shall only have to make allowance for the oxydation by the nitric acid, which would in some instances take place; but this is in general an easy matter for the oxydation by nitric acid has been well investigated for most of the substances likely to be found.] G. C. S.

4. *On the presence of Copper in the Bodies of Animals;* by M. DESCHAMPS, (Comptes Rendus, Jan., 1848.)—This metal is constantly present in most of the formations in the vicinity of Paris, and seems to be derived from the decomposition of cupriferous sulphuret of iron. It is taken from the soil by plants, and from them by men and animals. Copper and also lead are received in part from cooking utensils, &c. Soils free from copper soon obtain a portion by manures, &c.

Carbonate of ammonia is the means of carrying copper from the soil into plants, and in the azotised compounds of this metal, seems to enter by a replacement similar to that which takes place in certain ammoniacal salts.

These are a few of the conclusions drawn by M. Deschamps from his curious investigations. G. C. S.

5. *On the presence of Arsenic in certain Chalybeate Waters;* by M. AUDOUARD, (Comptes Rendus, Jan., 1848: and by M. FILHOL, Journ. de Pharm. et de Chim., Jan., 1848.)—Both of these authors have proved the existence of arsenic in very minute quantities in chalybeates. The latter found the deposits from springs of the Pyrenees to contain from 0·03 to 0·058 per cent. of arsenic, and sometimes a trace of copper. Both remark that this minute quantity can never give rise to mistakes in case of poisoning.

[Can it have any effect upon the medicinal properties of the waters in which it is found?] G. C. S.

6. *On a new method of analysis of Inorganic matter in Blood: and on the constant presence of several metals in this fluid;* by M. E. MILLON, (Comptes Rendus, Jan., 1848.)—The blood is received in a vessel containing about three volumes of water to one of blood, and introduced into a flask containing chlorine. The organic matter immediately coagulates, changes color and loses all traces of organization. By expressing the clot and washing, the whole inorganic matter is removed and is found in the clear and limpid solution. Not more than one per cent. of organic matter is carried off in solution. The reaction with chlorine is complete in two or three minutes; the separation of the iron in this way is therefore a neat class experiment. The saline ingredients after ignition are examined as usual. Of this residue, 100 parts contain—

Silica,	from	1	to	3	Copper,	from	1·5	to	2·5
Lead,	"	1	"	5	Magnesia,	"	20·	"	24· ?

Experiment shows that these metals, like iron, are found only in the globules. This method of analysis is suggested as suitable for all the fluids, &c. of the animal economy. The most repulsive matters furnish immediately a clear saline solution. G. C. S.

7. *New mode of estimating the Sulphur in Organic Substances;* by H. WEIDENBUSCH, (Chem. Gaz., June, 1847, from Lieb. Ann.)—The substance is heated with the strongest nitric acid, and an excess of nitrate of baryta, until all organic matter is destroyed. The mass is dried in a platinum dish at 212°, and then fused, avoiding a deflagration. The fused mass is to be treated with dilute acetic acid, and heated to remove carbonate of baryta. After filtering and washing, a second treatment with acetic acid furnishes the sulphate of baryta perfectly pure. G. C. S.

8. *Preparation of pure Barytic Water and Salts of Baryta;* by H. Wackenroder, (Chem. Gaz., July, 1847.)—Mix intimately 240 grms. of finely ground sulphate of baryta, with 60 grms. rosin and 20 grms. powdered charcoal. Heat to redness from half to three quarters of an hour. Salts of baryta are prepared by precipitating the solution of the sulphuret, by carbonate of soda.

To obtain the chlorid pure, crude muriatic acid is added to the solution of sulphuret to slight excess; the precipitated sulphur, sulphate of baryta, &c., is filtered off, and the solution evaporated nearly to dryness. The impurities remain in the mother-liquid; adhering chlorid of iron is removed by a faint red heat.

Barytic water is prepared as usual by oxyd of copper. If this metal is found in the liquid after boiling, a small quantity of recently precipitated hydrated oxyd of silver, or its carbonate, will on digestion, remove the copper and hypo-sulphurous acid.

The originality of this process, is in the use of rosin and powdered charcoal instead of meal, and also in a less degree of heat than is usually recommended. About one-third the sulphate is decomposed. The remainder can be used over again. G. C. S.

9. *On the Fusion of Rocks;* by A. Delesse, (Jour. de Pharm. et de Chem., Jan., 1848.)—The author has observed that the igneous rocks on fusion undergo a diminution in density, when they cool into a vitrified mass, which is the greater in amount as the rocks contain more of silica and alkali, and less when more iron, lime or alumina are present.

As a general rule, the older rocks, as granite, &c., decrease most in density; the order is nearly that of their age down to the most modern volcanic rocks, which undergo but little change. This is of course the reverse of the order of their fusibility.

The author suggests that the crystallization of these rocks has decreased the radius of the earth, as a diminution of volume is the inevitable result of crystallization, whether from fusion or aqueous solution. G. C. S.

10. *On a new Process for covering different Metals with Brass or Bronze*, (Chem. Gaz., May 15, 1848, from Newton's Journal, May, 1848.)—MM. Brunel, Bisson and Gaugain, instead of the cyanids before used, employ a solution in water, composed of 500 parts of carbonate of potash, 20 parts of chlorid of copper, 40 parts of sulphate of zinc, and 250 parts of nitrate of ammonia.

In order to obtain bronze, a salt of tin is substituted for the sulphate of zinc.

By means of these solutions, wrought or cast iron, steel, lead, zinc, tin, and the alloys of those metals, either with each other or with bismuth and antimony, may with facility be coated with brass or bronze, after being scoured in a suitable manner, according to the nature of the metal. The operation is performed at the ordinary temperature. The article to be coated is put in communication with the negative pole of a Bunsen battery, the positive decomposing pole being a plate of brass or bronze.

When large surfaces are to be coated, experience has proved that it is requisite to increase the number of pairs of plates, and not their size.

When the articles have been coated, and have undergone the usual coloring process, they equal in beauty the finest bronzes.

Rough cast iron may, by these means, be made to assume a very beautiful appearance; and articles thus coated will be preserved from oxydation in the interior of habitations. With regard to those intended for the open air, they must be covered with a suitable varnish, in order to protect them. This process is recommended by M. Becquerel.

11. *New Property of Coke;* by James Nasmyth, (Mining Journal, July 29, 1848.)—Having just read in your Journal of the 22d, some observations on the important experiments of M. Jacquelain, in reference to the conversion of diamond into coke, it occurs to me, that it may be interesting to some of your readers to be made aware of a discovery in close connection with this subject, which I made several years ago, and which Professor Faraday has done me the honor to communicate to the Royal Institution. The grand distinction between the discovery of M. Jacquelain and mine is simply this, that while he discovers that diamond can be made into coke, I had long since discovered that *coke was diamond;* in as far as that coke is possessed of one of the most *useful* and remarkable properties of diamond in respect to its power of *cutting* glass, owing, doubtless, to the extreme hardness of its ultimate particles, or minute crystals of which a mass of coke is formed. We are apt to consider coke as a soft substance, because we can crush it, and pulverize it with facility; but if we examine into the actual hardness of the minute, plate-formed, crystals, which compose a mass of that substance, we shall find that they are possessed of a most remarkable degree of hardness, and can *cut* glass with that clean looking cut which is so peculiar to the diamond. I use the term *cut* with all due consideration, in contra-distinction to the scratching property which is possessed by all substances harder than glass; but it will be found that coke does not scratch, but really and truly *cuts* the glass, which any of our readers may prove, by taking a small fragment of coke, and switching it at random, across and across, a pane of glass while the sun is shining through it, which will render the beautifully clear, diamond-like cuts more distinct; they will be found to penetrate pretty deep into the body of the glass, and give forth most beautiful prismatic colors, as the light of the sun falls on them. So far this may be all very pretty and interesting, as tending to still further identify the diamond with carbon; but, as I always like to have an eye to practical application of scientific discovery, I am anxious to make these facts known to your readers, so as, together with the following remarks, they may, peradventure, turn this discovery to some useful application; for, although I do not expect to see our glaziers using a cinder to cut the glass for the repair of broken windows, in lieu of a chip of the queen of gems, yet I cannot but feel certain that, when the extreme diamond-like hardness of coke is made known, that the fact will be laid hold of, and turned to good account as a most cheap material for all grinding purposes, such as required for many processes in the arts—to say nothing of its useful application to the sharpening of a razor, as a very superior strop powder, for which purpose, however, the coke must be reduced by *levigation* to the most minute and impalpable powder. I shall leave the matter of application in the hands of your readers, now that they are made aware of the fact which I have endeavored to communicate to them.

II. Mineralogy and Geology.

1. *New Locality of Idocrase, Anorthite? and Molybdenite;* by Prof. J. H. Webster, (communicated for this Journal.)—During the past summer I have discovered a new and very interesting locality of idocrase in York County, Maine. It is in the town of Sanford, about four miles north of the Wells railroad station, and about one mile east of Sanford meeting-house.

The idocrase composes a bed, (or vein?) extending upwards of two hundred feet in a direction north and south, projecting in several places a few feet above the soil. At one extremity it is bounded by granite, and at the other by trap. The thickness of this bed, or vein, could not be determined. The entire mass is idocrase in more or less perfect crystals, crossing one another and interlacing, or projecting into cavities. These cavities are here and there partially filled with white carbonate of lime and a few crystals of what will probably prove to be anorthite, with albite.

Since this discovery, further exploration has brought to light more perfect and brilliant crystals in white quartz, in the same field, at a distance of a few rods.

By the action of an acid, the carbonate of lime has been removed from several masses, and the crystals of idocrase uncovered present brilliant planes, and stand out in bold relief. The crystals are often finely terminated, and present the usual modifications of form; they vary in size from a tenth of an inch in diameter, to an inch and a half; part of one crystal that was unfortunately broken, is now two and a half inches in diameter, and four and a half in length.

Here and there I found molybdenum and epidote in the masses.

I have revisited the well known locality of beryls at Royalston, and after ten days labor with three men drilling and blasting, and removing some tons of the granite, obtained but half a dozen broken crystals. The old workings were thoroughly cleared out, and the termination of the original vein that afforded so many fine beryls, was arrived at. This spot I think may now be said to be exhausted.

During these operations, I found four crystals of feldspar of enormous size and beautifully perfect; one was found projecting from the granite twenty-three inches, and its diameter was eleven and a half inches. This was unfortunately broken in the attempt to disengage it; the terminal portion of ten inches in length, was however removed nearly perfect.

Cambridge, September, 1848.

2. *Lapis Lazuli and Mica.*—Both of these minerals are found near Lake Baikal, especially in the river Hindianka and all the rivers flowing from Mt. Khamardaban. The lapis lazuli is obtained in fragments from the valleys, and according to the natives, it is found after the heavy rains; but all attempts to discover its original locality has hitherto been unsuccessful. Mica is abundant and is used by the natives for windows in place of glass.

3. *Mica originating from Hornblende*, (in a letter to Prof. Silliman from T. H. Fergus, dated Westchester, Pa.)—In an examination of the

greenstone rocks near Boston, two or three years since, I observed the surface, where long exposed to the weather, to be covered with scales of mica, while the interior did not contain that mineral, but hornblende instead, I therefore surmised that the change had been wrought by some action of the atmosphere.

I selected specimens from the different portions of the rock and from several others, and on my return home experimented upon them with the blowpipe: I found that every specimen of hornblende, whether from the outside or the interior of syenite or any rock which contained that mineral, when presented to the inner flame, gave the result usually described in the books; but weathered particles of the hornblende, in the outer flame, took a lighter color, and when cold, the slightest blow caused them to separate into gold colored scales which presented every characteristic of mica.

4. *Meteoric Iron of Seeläsgen in Brandenburg.*—The Annalen der Physik und Chemie, von J. C. Poggendorff, Band lxxiii, Stuck 2, s. 329, (1848,) contains a brief notice of the discovery of a considerable mass of meteoric iron near the village of Seeläsgen, between Schwiebus and Züllichau in the provinces of Brandenburg. It had remained until lately unobserved beneath a heap of stones before the house of a farmer. It has an irregular roundish figure, with many deep pits or depressions, measures about a foot in diameter, and weighs (apparently) near two hundred pounds. It is black on the outside, though coated in many spots with hydrated oxyd of iron, perfectly compact within, homogeneous, and of a steel-gray color; and resembles so much in these points, as well as in its malleability, the meteoric iron of Braunau (Bohemia), that, in all probability, it possesses the same chemical composition. Prof. Duflos has already detected, in addition to the iron, the presence of phosphorus, nickel and cobalt. It is soon to receive a full and complete analysis. C. U. S.

5. *Carbonate of Copper and Zinc;* by Prof. A. Connell, (Jameson's Jour., vol. xlv, p. 36, July 1848.)—This carbonate from Matlock has a pale green color with a laminated structure and pearly lustre; it is disseminated in small portions through the matrix. Analysis afforded carbonic acid and water 27·5, oxyd of copper 32·5, oxyd of zinc 42·7, magnesia and lime, *a trace* =102·7. This result may correspond to an atom of dicarbonate of copper and zinc combined with an atom of water or $2(Cu, Zn)\,O\,CO^2+HO$; but the smallness of the quantity prevented the determination of the relative quantities of carbonic acid and water. This mineral seems to be either identical with aurichalcite or nearly allied to it.

6. *On the Occurrence of Ores of Mercury in the Coal Formation of Saarbrück;* by Herr Von Dechen, (Geological Journal, No. 14, p. 33.)—In a lecture before the Society of the Lower Rhine, Herr Von Dechen notices this singular fact. These ores are, in general, very rare, and, in this place, occur in the upper division of the carboniferous group in beds belonging to the productive coal formation, or even to a higher part of the series, in which previously they were not known to be found in any part of the earth. In this district they are confined to its eastern portion; Baumholder, in the district of St. Wendel, being the most western point where they have been found, the Kellerberg,

near Weinsheim, the most northern, Nack, near Erbeslüdesheim, the most eastern. They occur in veins in the normal beds of the coal formation, in the melaphyres, the amygdaloids, and the feldspar porphyries; these massive rocks lying within the range of the carboniferous strata. They are also found disseminated and in fissures in beds of sandstone of this formation, as at Münster-Appel and Waldgrehweiler, wholly unconnected with true veins. The association with the ores of mercury of certain claystones and hornstones, which are not in general found so much developed in this formation, is very remarkable. Within the limits mentioned, ores of mercury have been observed in thirteen different localities, some of which range in straight lines. The longest of these lines reaches from Katzenback, over the Stahlberg, Landsberg, near Obermoschel, to the Kellerberg, and is about fourteen (three German) miles in extent.

7. *Notes on the Mines of a portion of the State of Mexico;* by Lieut. G. W. Raines, U.S.N., (from the American Star, city of Mexico.)—The general method of mining is probably the same in most of the mines of Mexico; some point is selected in the vicinity of one or more veins, which indicate sufficient richness of ore, and contiguous to fuel and other necessaries, and whose elevation allows the water to be drawn off by subterranean passages, or adits, cut through the adjacent valley to avoid the great expense of drawing it to the surface. The perpendicular shaft is made of sufficient size to accommodate the ropes and bags, by which the ore is raised to the surface, by animals or machinery, and space for the ladders for the descent and ascent of the miners; and also for the pump apparatus, for clearing the mine of the copious streams of water, which, at a considerable depth, pour in from different directions, and the removal of which, constitutes one of the principal items of expense.

From this shaft, horizontal galleries are excavated in the direction of the vein, of a size large enough for the passage of the miners with ore; when the vein is reached, the rocky gangue containing the metal is blasted off, the fragments are broken up, and being placed in small bags about one foot in diameter, are then taken to the foot of the shaft; here some four or five are placed in a bag of skin, which being attached to the vertical rope, is thus drawn to the surface. When a horizontal gallery, or level, has followed the vein so far as to make the air impure, either a new gallery must be made, or a vertical aperture pierced for a proper circulation of the air; in large mines these ventilating shafts are numerous and expensive.

The ore having arrived at the surface, is carried to the pounding mills, where by the action of vertical beams of wood shod with iron, which are raised and let fall by machinery, it is reduced to powder: the coarser particles being separated by a sieve over which the powder falls, are returned to the mills for further action. The finely divided ore is then removed to a rolling or grinding mill, to reduce it to the finest possible state of division; at the works at Sanches, some four miles from Real del Monte, it is mixed with water and submitted to the rolling action, in a circular trough, of two solid cylinders of stone, similarly to the action of the mortar mill.

At Regla the powdered ore is also placed in a circular stone trough, in the centre of which a vertical shaft turns, with two horizontal arms, whose extremities have each a block of basalt attached by chains, which, in the rotary motion, is dragged round, grinding against the bottom and sides of the trough, and by which action, the wet ore is reduced to its finest state. At this stage of the process there are different methods for extracting the silver, depending on the richness of the ore, its constitution, and the fact that modern improvements are as yet but partially adopted.

First method.- The wet powdered ore (or schlich) is mixed intimately with a certain proportion of common salt, (chlorid of sodium,) the amount depending upon the kind of ore, and the quantity of sulphur, &c. with which the silver is mineralized; the mass is then spread out on the floor of a reverberatory furnace, and there kept in a red hot state for about six hours. By this means, a portion of the sulphur is driven off in the form of sulphurous acid gas, whilst the remainder unites with the sodium, and the chlorine with the silver; thus the result is a combined mass of chlorid of silver with sulphuret of sodium. The mass is then mixed with salt and water, and placed in revolving barrels, with pieces of iron and a quantity of mercury—about two hundred weight in fifteen hundred pounds of the mass; at the end of about twenty-four hours, it is found that the chlorine of the chlorid of silver has united with the iron, and the silver thus reduced is with the mercury. This amalgam of silver is then washed free from the other substances, which are either dissolved or carried off by the current; it is then pressed in close canvas bags, which thus remove the superabundant mercury; the semi-solid mass is then moulded in iron triangular forms, and distilled in an iron vessel, which separates the mercury and the silver remains pure.

In this process,—which is employed for the poorer ores,—about four ounces of mercury are lost in obtaining eight ounces of silver; this loss arises principally from the oxydation of the sulphur, &c., which being converted thus into acids combine with the mercury, and the resulting salts are carried off in the washings.

Second method. The wet powdered ore is intimately mixed with common salt and pieces of copper, or the protochlorid or sulphate of copper, and a quantity of mercury; the wet mass is spread out on a floor of boards in the open air, about six or eight inches in thickness, and mules are occasionally driven over it, for the purpose of thoroughly mixing the ingredients as the chemical action proceeds.

In not less than twenty days, the process is completed, when it is found, that by the action of the air and moisture, the sulphur has been oxydized at the expense of both, and the hydrogen of the water uniting with the chlorine of the copper or sodium, has formed hydrochloric acid; and any portions of chlorid of silver, formed in the process, are reduced to the metallic state by the copper. The whole is then well washed, when nothing remains but an amalgam of silver with the pieces of copper.

The foregoing is the principal process for the extraction of the silver at most of the mines of Mexico, though mostly applicable to the poorer ores; the loss of mercury, which is probably much greater than that by the preceding process, is an objection, though it has the advantage of being applicable on a larger scale, and requires no fuel but for the distillation of the amalgam; it is the old method.

Third method. The finely divided ore is roasted with common salt as in the first method, then placed in a vat with salt and water; the silver is thus converted into a chlorid, which is stirred up and then passed into a smaller vessel, to collect the heavy earthy particles, and thence into a third, where pieces of copper cause a decomposition of the chlorid of silver, the pure metal being precipitated and a chlorid of copper formed; this is passed into a fourth vessel where fragments of iron cause a precipitation of the copper. By this process, which is simple, the copper—of which there is generally a considerable quantity—is also saved; it is as yet employed but on a small scale at Sanche, near the mine of Moran, to test its value.

Fourth method. The fine powder from the pounding mills is mixed with lime, scoria, iron and oxyd of lead (litharge), and then thrown into a smelting furnace with alternate layers of coal; a portion of the sulphur combines with the oxygen of the lime and litharge, and with the iron, passing off in the first two cases as sulphurous acid gas, and in the third forming sulphuret of iron; whilst the remainder, uniting with the base of the lime, forms sulphuret of calcium; this with the scoria forms a melted mass, which falls to the bottom of the furnace, and flows off at a lateral orifice. By this process the silver is reduced to the metallic state, but as the amount is small and disseminated through the mass, it would, to a considerable extent, be carried off by the scoria and lost; hence the lead is employed, to collect the particles of silver and thus form an alloy, which flows out at the lower portion of the smelting furnace.

This alloy is now placed in shallow basin furnaces, and whilst in a melted state, strong currents of air are forced over its surface, which oxydize the lead and with it all the baser metals, and the silver remains pure; the dross being blown away by the draughts of air. This is the best process for the rich ores, and in the works of the English mining company, is, I believe, always employed for their reduction.

The silver is frequently alloyed with gold, which, when of sufficient value, is separated at the mint, and after deducting expenses, the remainder is returned in coin to the owners.

III. Zoology.

1. *On the Structure of the Jaws and Teeth of the Iguanodon;* by Dr. Mantell, (Proc. Royal Society; Lit. Gaz., London, June 17, 1848.)—The recent discovery of a portion of the lower jaw with teeth of an adult Iguanodon, having enabled the author to obtain decisive evidence as to the structure of the maxillary organs of that gigantic herbivorous reptile, the results of his investigations are embodied in the present communication. The first memoir on the teeth of the Iguanodon was published in the "Philosophical Transactions for 1825;" but, owing to the fragmentary and water-worn condition in which bones of terrestrial vertebrated animals occur in fluviatile deposits, from their being composed of materials transported from far-distant

lands by powerful streams and currents, nearly a quarter of a century elapsed before any portion of a jaw retaining teeth was discovered. The most important relic of this kind is described in this memoir; it consists of the anterior part of the right side of the lower jaw, comprising about two-thirds of the dentary bone, and was discovered by Captain Lambart Brickenden, who, in the true spirit of a man of science, liberally placed it at the disposal of Dr. Mantell, as the original discoverer of the fluviatile origin of the wealden formation of the south-east of England.

This bone is eighteen inches long; and if the proportions of the maxillary elements in the Iguanodon were the same as in the recent Iguana, the entire jaw must have been four feet in length. It contains several of the new or successional teeth in their natural position, and there are sockets in the alveolar plate for nineteen or twenty mature molars; but all these teeth are wanting, having evidently been dislodged before the bone was imbedded in the stone. The mature teeth, which in their abraded state resemble those of the used molars of herbivorous mammalia, appear to have been arranged in a closely set series. The teeth in the lower jaw were placed with their flat enamelled striated face towards the inside of the mouth, while those in the upper were disposed in the opposite position—namely, with the enamelled ridged face of the crown externally; and the teeth of the upper and lower series were subalternate or intermediate in their relation to each other, as in the ruminants.

The anterior part of the lower jaw, which forms the symphysis, presents a most remarkable deviation from all known reptilian types; the alveolar parapet, instead of being continued round the front of the mouth, and bearing teeth, as is the case in all saurians, is edentulous, and at the distance of four or five inches from the front of the chin, suddenly contracts in a vertical direction, becomes procumbent, and expands horizontally to meet the corresponding portion of the opposite ramus of the jaw: the two symphysial portions when united, forming a deep scoop, bear considerable analogy to the corresponding part in the Edentata, especially in the extinct colossal Mylodon.

Along the external surface of the jaw there is a row of very large vascular foramina; and the symphysial margin is also perforated by numerous similar openings for the passage of blood-vessels and nerves to the integuments and lips—a certain indication of the great development of the soft parts which covered the maxillary organs. The upper jaw, of which a considerable part, collected by the author, is now in the British Museum, confirms the inferences deduced from the examination of the lower jaw and teeth. The author, with the able assistance of Dr. Melville, instituted a comparison between the fossil teeth in his own, and in the British Museum, with those of existing lizards, and the result of their labors is fully detailed in this memoir.

The light shed on the structure and functions of the dental organs of the Iguanodon by these recent discoveries, confirms in every essential particular the inferences deduced by Dr. Mantell from the detached teeth alone, and detailed in his memoir in 1825; and it also reveals the remarkable fact, that this saurian herbivore, which equalled in bulk the gigantic Megatherium and Mylodon, and was destined, like them, to obtain support by the comminution of vegetable substances, was also furnished with a large prehensile tongue and fleshy lips, to seize and retain the foliage and young branches which constituted its food.

Among the many extraordinary deviations from known forms disclosed by palæontology, there is not one more remarkable than this modification of the type of organization peculiar to the class of reptiles, to meet the exigencies required by the economy of a lizard, placed under similar conditions with the colossal Edentata of the tertiary periods and the herbivorous mammalia of more modern times, and designed to hold the same relative position in the economy of nature.

From the recently discovered specimens, the author states he has been able to determine that the portion of a lower jaw of a Saurian, with numerous fangs of teeth, described in his memoir in 1845, as probably that of a young Iguanodon, belongs to a distinct genus of the same family; and he proposes to distinguish it by the name of ***Regnosaurus Northamptoni;*** the specific designation being a tribute of respect to the noble President of the Royal Society.

2. *Notice of Fragments of Trilobites of gigantic size in the Cabinet of Dr. Julius S. Taylor., Carrollton, Montgomery County, Ohio.* —During the year 1847, Dr. Taylor kindly furnished us with a cast of the most remarkable fragmentary portions of the "Isotelus megistus" that we have ever seen. A notice of which we inadvertently failed to give at the time of the donation.

Dr. Taylor said, "that the specimen from which this cast was made was found in the blue limestone resting upon a stratum of greenish 'marlite' clay," about fifty feet from the upper surface of the blue limestone, which limestone is said to be the equivalent of the Trenton of New York and Silurian of England.

The cast presents five or more portions of the shield, the post-abdomen and other portions of the Isotelus which bear the most indubitable evidence of having belonged to trilobites of the most gigantic size on record. Professor Locke, M. DeVerneuil and other scientific gentlemen having visited my cabinet concur this opinion.—(I am indebted to Professor Locke for the cast.)

At the time of my finding the specimens, I also found *portions* of at least one hundred different individuals of the same species, varying in size from one half an inch to six inches in length, proving, that the trilobites like the limulus were gregarious. In connection with this specimen, I also found a most delicate and beautiful "Retepora," entirely new, which has been described and figured by my friend, John W. Van Cleve, Esq., of Dayton, and called "Retepora nitida."

We have also received from Dr. Taylor, years ago, a full suite of fossils descriptive of the geology of the county of Montgomery, Ohio, in a most beautiful state of preservation, of which he informed us that he had numerous duplicate specimens which he would most gladly exchange for fossils or minerals of any other section of country.

3. *Water Tubes in Fishes*, (Proc. Bost. Soc. Nat. Hist., April 19, 1848, p. 27.)—Prof. Agassiz made some remarks on the existence of numerous minute tubes in fishes, opening externally, which have hitherto been considered mucous tubes, but which he is convinced are tubes for the introduction of water into the body. These openings in some

fishes are extremely numerous, existing over the whole external surface. In freshwater fishes, and in those living in shallow waters, they are comparatively few. They are most numerous in fishes which swim at great depths.

In reply to a question of Dr. Wyman, he said that he had not as yet found them in the sharks and rays. These openings are sometimes visible to the naked eye, and sometimes require a magnifying power for their detection. They are very large and numerous, and easily seen, in the head of the common shad. These minute tubes unite into larger ones, in a manner which seems to be the same in each class. He thought this circumstance might be of some value in the classification of fishes. The tubes grow larger and larger as they approach the heart. They open into the circulating system near the heart. Prof. A. had injected the heart through these tubes, and had drawn blood from them by a syringe. He had injected the external surface through a *single* tube, and that whether opening near the head or the tail, or in other parts of the body. He believes these tubes an apparatus for the safety of fishes living at great depths, to enable them to resist the pressure to which they must there be subjected. He did not deny the existence of mucous tubes in fishes, for there are such, about the heads of sharks for instance, from which mucus may be obtained by pressure; but he is sure, that what have been hitherto considered as mucous tubes, are in reality water tubes.

4. *Structure of the Foot in Embryo-Birds*, (ibid, June 7, p. 42.)—Prof. AGASSIZ had recently made some observations on the structure of the foot in the embryo of birds, which he thought would throw new light on the classification of birds, and perhaps call for radical changes in the system now in use. He had examined the feet of the embryo of *Turdus migratorius*, *Hirundo riparia*, *Sylvia æstiva*, and *Fringilla melodia*, and found the following appearances in all.

The four toes, which in the mature bird are separate, three being directed forwards and one backwards, are in this state all directed forwards, and webbed. There is as yet no trace of bone in them; there are only rows of cartilaginous cells in the position to be occupied by bone, which are more closely grouped together at the points where the joints are destined to appear. The lower extremity is, in fact, at this time, a fin. The upper extremity is in a similar condition, presenting, however, only three rows of cartilaginous cells, united by a membrane. As this condition of the extremities exists in different families, Prof. A. thinks that the present grouping of all web-footed birds together, may be incorrect; particularly since they differ as much among themselves in other respects as they do from land birds. He found that the bill of the immature robin resembled that of a vulturine bird, being straight near the base, and curved at the extremity, the upper mandible being longer than the lower. This would seem to indicate that the vulturine form is a lower type than it has usually been considered. This appeared to derive confirmation from the great resemblance of the bill of some of the water birds to that of some of the vulturine family, that of the genus *Lestris*, for example. Some of the birds of prey also have another point of resemblance to water birds, in a rudiment of a web between two of the toes. Hereafter, birds having all their toes directed forwards, must be regarded as of a lower type than those which have one directed backwards; as, for instance, the pelicans and cormorants among water birds, and the genus *Cypselus* among swallows. From the result of his examinations of the embryos of birds, Prof. A. had recently, before a scientific society, ventured to predict that hereafter, among the higher mammalia, the foot of the embryo would in the same way be found to be webbed, like that of the seals and cetacea. Prof. Jeffries Wyman immediately afterward confirmed the truth of the prediction in the case of the fœtus of a cat. A similar appearance had been figured as existing in the human embryo, but its philosophical bearing had not been before noticed.

5. *American and European Oyster-catcher*, (ibid, p. 43.)—Dr. CABOT read a statement of the comparative measurements of the American and European oyster-catcher. His observations tend to confirm the opinion of the distinctness of the two species, which have sometimes been confounded with each other.

	Hæmatopus palliatus. Female. inches.	*Hæmatopus ostralegus.* Female. inches.
Length from tip of bill to tip of tail	21	$18\frac{1}{4}$
Extent " " " "	36	$32\frac{3}{8}$
Length of tongue	$\frac{6}{8}$	$\frac{7}{8}$
Œsophagus to proventriculus	$7\frac{2}{8}$	7
Proventriculus in length	1	$1\frac{3}{8}$
Intestines to vent*	40	59
Cœca enter intestine at	$2\frac{1}{2}$ from vent.	3
Length of cœca	$2\frac{3}{4}$	$4\frac{1}{8}$
Trachea to bronchi	$4\frac{10}{16}$	$4\frac{1}{16}$
Keel of sternum in depth, not quite	1	1
" " in length	$2\frac{1}{2}$	$2\frac{1}{4}$

6. *Dr. M. Barry's Physiological Discoveries*, (Jameson's Jour., July, 1848, p. 194.)—In the last number of the British and Foreign Medical Review, edited by Dr. Forbes, a distinguished physiologist has the following remarks in regard to Dr. Martin Barry's important physiological discoveries :—

"The writer of the remarks in question, after shewing the importance of the combination of anatomical and physiological investigations with zoological researches, states that M. Milne Edwards, in several of his later Memoirs, 'has even adopted the principle, that embryology affords our best and surest guide in classification; as it is by the study of development that we are enabled most certainly to distinguish between those *essential* characters on which affinity depends, and those *accessory* characters which are engrafted (so to speak) on the original type for some special purpose. This doctrine was first formally enunciated by him in a Memoir on the Principles of the Natural Classification of Animals, published by him in 1844:† in which he points out that the condition of the earliest germ of all animals is the same; namely, the simple cell: that the earliest phases of its development differ according to the sub-kingdom to which it belongs, whether radi-

* A very minute remnant of vitelline duct found at $18\frac{1}{2}$ inches from vent.

† Annales des Sciences Naturelles, iii Ser., Zool., tome i, p. 65.

ated, molluscous, articulated, or vertebrated, and that the distinctive characters of these *sub-kingdoms* are consequently those first evolved; —that, in the further progress of development, the characters of the *classes* next present themselves, then those of the *orders*, then those of the *families*, *genera*, and *species* consecutively, and lastly those of the *individual*. We are quite sure,' continues the writer, 'that Professor Milne Edwards could not have been aware that he had been completely anticipated in this doctrine by Dr. Martin Barry; or, with his accustomed candor, he would have alluded to the circumstances.'

"Dr. Barry's views, contained in two papers in Professor Jameson's Edinburgh New Philosophical Journal for January and April, 1837, are most clearly expressed. * * * In the first of these papers, he works out the important principle of Von Baer,—that 'a heterogeneous or special structure can arise only out of one more homogeneous or general, and this by a gradual change;' and applies this to the different *directions* of development, which present themselves in the primary subdivisions of the animal kingdom at a very early period of the history of the embryo, pointing out at the same time (as M. Milne Edwards has subsequently done) that this fact completely negatives the idea that the vertebrated animal ever passes through the conditions which are characteristic of the radiated, the molluscous, or the articulated. He further shews that the order in which the distinctive characters of the germ are evolved, is that of their generality in the animal kingdom. 'Thus, in development, the structure characteristic of the *vertebrata* only cannot manifest itself until there has been assumed essentially a structure common to *animals*, of which the vertebrata are but a part, and to whose type the type of the vertebrata is subordinate. In like manner, structures subordinate to the type of the vertebrata cannot manifest themselves, until after a modified appearance of the *general type*, of which they are but partial metamorphoses. More and more special forms are thus reached in succession, until the one most special is at length attained.' In his second paper, he expresses this view still more clearly, in the following table of the history of development of any single organism:—

1. No *appreciable* difference in the germs of all animals (fundamental unity.)
2. The *class* manifest, but the *order* not distinguishable.
3. The *order* manifest, but not the *family*.
4. The *family* manifest, but the *genus* not known.
5. The *genus* obvious, but not the *species*.
6. The *species* manifest, but the *variety* unpronounced.
7. The *variety* obvious, but the *sexual* difference scarcely apparent.
8. The *sexual* character obvious, but the *individual* character obscure.
9. The *individual* character in its most special form.

"In both papers, Dr. Barry continually puts forth this principle as the groundwork of classification. Thus he says: 'The only sure basis for classification is—not structure, as met with in the perfect state, when function tends to embarrass, but—the *history of the development*, at that period when structure presents itself alone.' And again: 'the fact is, that naturalists have begun just where they should have ended.

They have attended to details, but neglected general principles. Instead of analyzing, their process has been one of synthesis. Their attention has been directed to the grouping of the twigs,—as if they were thus to find their natural connexions, without even looking for assistance towards the branches, or the trunk that gave them forth. But the simile is inadequate; the labor lost has been greater than even this supposes. For in the *grown tree* of *animal* structure, parts, once essentially the same, have not only diverged in their development, and become elaborated into very different forms,—but, as before said, perform very different functions also. Hence a positive in addition to a negative source of error. But what other course *could* naturalists have taken? Truly none: their 'circumstance' allowed no other. It is only now that a way is beginning to be opened, by which it may, by and by, be possible to proceed in an opposite direction, viz., from trunk to branches and twigs. This, if ever accomplished, must be by means of the *History of Development* or *Embryology*.'

"We have thought it right to bring forward Dr. Barry's claim as the first distinct enunciator of this doctrine, because we perceive that its truth is being more and more generally recognized, and that it must ultimately become the foundation of all philosophical zöology."

IV. Astronomy.

1. *Observations during the Lunar Eclipse, September* 12, 1848; by Lewis M. Rutherford, (in a letter to the Editors, dated New York, Sept. 28, 1848.)—In the course of some observations made during the occurrence of the lunar eclipse, on the night of the 12th inst., I was struck with the arrangement of the colors visible in the earth's shadow. In the penumbra, I could not detect the prevalence of any particular one of the prismatic hues, but it appeared as a mere diminution of the moon's brilliancy, without any apparent change of color, except a grey shade as it deepened immediately preceding the true shadow. The shadow of the earth had a diameter not far from three times that of the moon; and if it had been projected upon a plane surface of uniform color, sufficiently large to present the whole at one view, it would have appeared with a circle in the centre, rather less than the moon, of a deep red copper color; the reddish tinge of this central disk was plainly visible to the unassisted vision, became much plainer in a telescope of three inches aperture, and with one of six inches, the red almost predominated over the brown in the copper hue. This disk was surrounded by a belt of yellowish orange, leaving a margin of greyish green occupying rather less of the diameter of the shadow than the annulus of yellowish tinge: these three divisions, although shading gradually into each other, were almost as well defined in their limits as was the exterior of the shadow itself, and although not at all comparable to the solar spectrum as shown by an ordinary prism, in clearness and brilliancy of color, were yet too apparent to have been overlooked by the most casual observer, the first two being easily seen by the naked eye, and the last detected by the slightest optical assistance, and all evincing a remarkable increase of depth and individuality as a larger aperture was applied.

The translucent atmosphere which surrounds the earth, in this case acting as a spherical lens, refracted the sun's rays to a focus at some point between us and the moon, and in this process dispersed them into their primary colors; and these having crossed at the focal point, we find, as might have been expected, the red or least refrangible ray covering the centre of the disk, surrounded in the proper order of refrangibility by the orange, yellow and green; but in no part either of the umbra or penumbra, could I detect any traces of the remaining colors of the spectrum, the blue, indigo, or violet. It was the absence of these tints which struck me as remarkable, and as being a subject upon which I had never met with any remarks either of notice or explanation; in the few printed accounts of lunar eclipses which I have seen, not one of the observers has mentioned the occurrence of any of the blue tints, while all have noticed the green, orange and copper red, although without speaking of their order as portions of the spectrum, or noticing the absence of the remaining three. The appearances above detailed, brought to my recollection a circumstance before observed but never heeded. It is this, that in looking at one of the planets or a bright star within a few degrees of the horizon, with a reflector or well corrected achromatic, the object is tinged with prismatic colors, the red, orange, yellow and green being very bright, while the others are absent as in the case of the lunar eclipse. I am unable to suggest any mode of accounting for these phenomena, which is exempt from strong objections; the most obvious are the following. The violet, indigo and blue rays being much the most refrangible, may be lost by being thrown so far from the umbra of the earth, as to be unseen in the brilliancy of that part of the moon which receives the full splendor of the sun; this would be the case with the extreme violet ray, which would precede the green by a distance nearly equal to the interval between it and the red, and consequently would be well without the circle of the penumbra; this would not be the case however, with the indigo, and still less with the blue, which last would (if it occupied its proper proportionate space in the concentric prismatic annuli) adjoin the green in that part of the penumbra which is so dark, as readily to betray the preponderance of any color, it being in truth difficult to mark the line which separates the shadow from the penumbra. The only other hypothesis which occurs to me is, that the earth's atmosphere, although to us transparent, has in reality an intrinsic color, such as would be formed by the combination of red, orange, yellow and green; in consequence of which these colors are transmitted, while the others are absorbed: the same cause may operate to impart to the heavenly bodies, when near the horizon, the ruddy hue they always wear when setting or rising; and it will be remembered, that a ray passing from the sun along the surface of the earth, and reaching by refraction the umbra on the moon, passes through an extent of atmosphere double that traversed by any ray which reaches us from the rising sun, and would consequently render much more visible the effect of chromatic absorption, if it existed. The objection to this theory, is the blue vault above us often deepening into an indigo, and always too palpable to be explained away by any theory of complementary colors. The night of the 12th was beautifully clear and quite cold, and as the silver surface of the moon was veiled, the milky way and the smaller stars gradually shone out, the nebula in Andromeda and the cluster in Hercules became visible to the naked eye. Saturn was within a few degrees of the moon at the time; before the commencement of the eclipse, with my largest telescope the ring could with difficulty be discerued, with but two satellites. During the period of the moon's greatest obscuration, the planet seemed pierced by a bright silver wire of infinite tenuity, attended by five satellites, one of which was impaled upon the following ansa of the ring, but moved off with very appreciable speed.

I will not trouble you with the time at which the various points of the eclipse occurred, as they are at best but rough and useless subjects of observation. I would however trespass a little further upon your indulgence, while I say something of the instrument with which these observations were made. My largest is an achromatic telescope, equatorially mounted, of six inches aperture and eight feet focus. The object-glass is the workmanship of Mr. Henry Fitz of this city, an optician of great skill and rising reputation; the flint glass, which is quite pure, he obtained from Guinand's establishment in Paris. I believe this object-glass to be free from aberrations, both spherical and chromatic, saving the secondary spectrum which is present in all achromatics in proportion to their apertures; its light is sufficient to shew plainly under favorable circumstances, the stars called by Capt. Smythe, in the Bedford catalogue, the 16th magnitude, and which he says are only caught by occasional glimpses under the most favorable circumstances by his instrument. It renders the companion of α Lyræ, and the fifth star in the trapezium of Orion, visible under sufficient illumination for micrometric measurement; its defining power enables me to see the rugged cliffs and volcanic chasms of the moon most beautifully; it has shewn me at one time last winter, the disk of Jupiter covered with small belts, in addition to the two usually seen, while two of his satellites were plainly seen projected upon the planet's disk, followed by their shadows, which were as distinct as black wafers upon white paper, the difference in their magnitude being easily seen without measurement; it very much elongates η Coronæ, and enables me readily to measure the position and distance of the close pair of the triplet of ζ Cancri with a power of 200, which is the highest my micrometer is provided with. I take great pleasure in bringing to your notice, the workmanship of Mr. Fitz, as he is an American and a self-taught artist, who places within our reach at home, those instruments which heretofore have been obtained from abroad, at a great cost.

2. *Eighth Satellite of Saturn.*—An eighth satellite of the planet Saturn has recently been discovered by Mr. Bond, of the Cambridge Observatory. Its orbit is exterior to that of *Titan*, which (in Sir J. Herschel's new nomenclature of these satellites) is the bright satellite discovered by Huyghens, and hitherto supposed to be the most remote but one from the planet.

3. *New Comet.*—Dr. Petersen, of Altona, discovered a new telescopic comet on the 7th of August, 1848.

4. *Elements of the orbit of the Planet Hebe*, (Comptes Rendus Acad. Sci., July 10, 1848.)—M. Yvon Villarceau, from a discussion of all the observations he could procure, has deduced the following elements of Hebe.

Mean anomaly, July 0, 1847, m. t. Paris,	272° 29′ 25″·0	
Longitude of perihelion, . . .	14 52 34 ·1	M. eqx.
" " ascending node, . .	138 30 55 ·5	July 0.
Inclination, ...	14 46 56 ·1	
Angle of excentricity, . .	11 31 52 ·7	
Mean daily heliocentric motion, . .	939″·3097	
From which are derived,		
Excentricity, ...	0·1999033	
Semi axis major, . . .	2·4254844	
Time of sidereal revolution, .	3 yrs. 777447	

5. *Elements of the Planet Metis*, (Institut, July 12, 1848.)—Mr. Graham, of Markree, Ireland, has furnished the following elements of the planet Metis, discovered by him, April 25, 1848. It is his second approximation, and is based on the observations made at Markree, April 26, May 5 and 19.

Epoch, 1848, May 0·0, m. t. Greenwich.

Mean anomaly, . . .	141° 54′ 11″·82	
Longitude of perihelion, . . .	72 50 8 ·16	M. eqx.
" " ascending node, . .	68 29 40 ·44	May 0.
Inclination, ...	5 35 23 ·98	
Angle of excentricity, . . .	7 13 36 ·92	
Log. of semi axis major, . .	0·3777174	
Mean daily motion, . . .	962″·5660	
Period of sidereal revolution, .	1346 days.	

6. *Speculations on the next Planet beyond Neptune;* by M. Babinet, (Institut, Aug. 23, 1848.)—The fact that the planet Neptune differs so essentially in its orbit and mass from the theoretical planet of Le Verrier and Adams, induced M. Babinet to undertake an investigation, having for its object to ascertain if the perturbations in the motions of Uranus could be made to indicate a second exterior planetary body, which with Neptune should explain all the anomalies.

Assuming that the effects of the theoretical planet of Le Verrier are the resultant of the combined action of Neptune and another planet more distant, M. Babinet proposes this problem. "Admitting as exact the mass, distance, period, position Jan. 1, 1847, of the theoretical planet of Le Verrier, by what union of two other planets, of which Neptune shall be one, can this theoretical planet be replaced, in order to obtain the same resultant effect; and consequently what must be the mass, the distance, the longitude, and the apparent size of a new planet which combined with Neptune, will represent the theoretical planet of Le Verrier?"

M. Babinet gives the following results of his investigations, as probable within certain limits.

1. The planet complementary to Neptune is in mass, size, and brilliancy, at an equal distance, little different from Uranus. *Hyperion* is proposed as its name.

2. Its distance from the sun is forty-seven or forty-eight times that of the earth's distance.

3. Its period of revolution is double that of Neptune, as that of Neptune is double that of Uranus.

4. At any given epoch, its heliocentric longitude is equal to the longitude of Neptune Jan. 1, 1847, viz. 327° 24′, diminished by the quantity 1° 53′, and also by half of the quantity $n - 327° 24'$, which is half of the arc of longitude traversed by Neptune from Jan. 1, 1847, to the given epoch.

5. The brilliancy of the planet may be presumed to be equal to that of a star of the 10th or 11th magnitude.

6. If the planet is found in the position indicated, we may empirically substitute for the law of Bode, the law of double revolutions for the planets exterior to Saturn.

7. A planet yet more distant, with a period of 672 years, and a distance of 77 from the sun, would probably not appear larger than a star of the 18th magnitude, and could with difficulty be found by direct observation.

In remarking upon this communication, M. Le Verrier states that he had been engaged in similar researches, but he had abandoned them when he found that the planet Neptune completely satisfied the theory of Uranus. He saw no reason to believe in the existence of such a planet as M. Babinet supposes, or to warrant astronomers in searching for it.

7. *Shooting Stars of August* 10, 1848.—In our last number, (see p. 279,) we gave the observations made at New Haven upon the shooting stars of August 10, 1848, which showed that the meteors appeared at that season in their usual abundance. Observations made in France give the same result. M. Coulvier Gravier, with an assistant, counted on the night of August 9–10, 1848, from $11^h 30^m$ to $12^h 30^m$, *eighty-six* shooting stars: the whole number counted from $11^h 30^m$ to $2^h 45^m$, was *four hundred and fourteen.* For the sake of comparison, M. Gravier gives the following observations made at the same hour of night, viz. $11^h 30^m$ to $12^h 30^m$.

July 26, . .	22 meteors.	Aug. 6, . .	27 meteors.
" 27, . .	15 "	" 7, . .	30 "
" 30, . .	25 "	" 8, . .	40 "
Aug. 2, . .	17 "	" 9, . .	86 "
" 5, . .	16 "	" 10, . .	81 "

These observations confirm the statements heretofore published in this Journal, that shooting stars increase in frequency during several days, becoming most abundant about the 10th of August, and after that decrease at a similar rate.

V. Miscellaneous Intelligence.

1. *Electricity, as applied to Telegraphic Purposes*, (Mining Journal, June 3, 1848.)—On Wednesday evening last, at the Royal College of Chemistry, Dr. Ryan delivered a lecture on the above subject, to a full and attentive audience. He introduced his lecture, by observing—that electricity could no longer be considered an abstract, or separate science; as, during the past few years, every discovery had proved that the whole phenomena were the results of chemical action, and it must be considered therefore, a branch of the science of chemistry.

In treating of this subject, the researches in which, had presented so many advantages to civilized life, particularly as to rapid means of communication and its results, he should have to consider it under four different heads:—1. Those telegraphs which were worked by free or frictional electricity.—2. Those employing a current of electricity from a voltaic battery.—3. Those which are worked by electro-magnetism, induced by a voltaic battery. 4. Those operated on by magneto-electricity.—Dr. Ryan then alluded to the process of obtaining a current of frictional electricity, by rubbing glass, shellac, sealing-wax, &c., so well known as to require no repetition; he then went into some statistical data, as to the progress of electric telegraphs. In 1744, the Germans employed this electricity in striking bells; in 1746, Granarth gave a shock to twenty persons at a great distance; Winkler and Monin passed a current through 4000 feet of wire, the water in the basin of the Tuilleries forming part of the circuit; in 1746, the celebrated Dr. Watson passed a current through four miles of wire, water forming half the circuit, and he observed that no time appeared to elapse during the passage of the shock. In 1787, Lomonde, in France, constructed a telegraph, by the aid of an electroscope at the end of the conductor, to be communicated with, in which two pith-balls covered each of the letters of the alphabet.* On completing the circuit at one end with any particular letter, the pith-balls were repelled, and opening asunder, showed a similar letter at the other end, and thus gave a means of communication; and, in 1793, the luminosity of electricity, on tin-foil letters, was proposed for telegraphic purposes. In 1798, Dr. Salva, in Spain, constructed an electric telegraph, between Madrid and Aranjuez, twenty-six miles, which must, at that time, have been a great and bold undertaking. The lecturer came now to the year 1800, which he described as a most important period, as it produced the investigations and correspondence between Galvani and Volta, which developed the properties of electricity from a metallic battery, and has immortalized their names. The difference between frictional and galvanic or voltaic electricity, was one of the most interesting considerations in natural philosophy. In 1803, Bassi passed a current of voltaic electricity through 4000 feet of water; in 1809, Sœmmering constructed a telegraph on the principle of the powers of voltaic currents in decomposing water; he had a number of small glass tubes inverted over a pneumatic trough, and representing the several letters of the alphabet, or conventional signs; and on completing the circuit, the water immediately sinking in any tube, showed the letter, or sign, communicated, which was easily and quickly read off. In 1803, Ronalds, of Hammersmith, constructed a telegraph by galvanism, through coils of eight miles of wire, a description of which he published at the time.† In 1817, the celebrated Wedgewood also formed a voltaic telegraph; but no descrip-

* Here should also have been noticed the attempts of Lesage in 1774, who made a telegraphic instrument, consisting of twenty-four insulated wires, terminating at one end in a pith-ball electroscope. (See Encyc. Amer. Sup.)—Eds.

† In 1810, Dr. Coxe passed signals along a wire a mile long, extended around his lecture room at the University of Pennsylvania, and proposed to use it as a telegraph, by producing chemical changes on prepared paper. His proposal was published in 1816, in Thomson's Annals of Philosophy. Ibid.—Eds.

tion of it appears to be extant. Soon after this, Oersted, of Copenhagen, and Ampère, discovered the properties of this electricity, in deflecting the magnetic needle from the magnetic meridian to a position due east and west, or at right angles with it. This laid the foundation for the several sytems of telegraphic communication which he should then proceed to describe. In 1837, Professor Wheatstone had greatly improved his telegraph by reducing the number of needles to five, which have since been reduced to two. The lecturer then proceeded to describe the various modes of communication adopted by Bain, Wheatstone, Brett and Little, and Gamble and Nott, the latter of which worked entirely by electro-magnetism.

[Prof. Morse's method, brought forward in 1837, should have been added; it is far better than any here mentioned, and is beginning to be adopted in England.]

2. *The Dead Sea Expedition*, (Southern Literary Messenger, for September, 1848.)—This Expedition, under Lieut. Lynch, after encountering many difficulties in transporting their two boats, finally reached the sea of Galilee. Here they purchased a small boat and with the two "Fannies"* they pursued their course down the Jordan. There were many dangerous rapids in their way; but they passed safely and reached at last the Dead Sea.† We continue this notice by citations from an interesting article in the Southern Literary Messenger for September, 1848.

The water of the river [Jordan] was sweet to within a few hundred yards of its mouth. The waters of the sea were devoid of smell, but they were bitter, salt, and nauseous.

"As we rounded to the westward," writes Lieut. Lynch, "the agitated sea presented a sheet of foaming brine. The spray, separating as it fell, left incrustations of salt upon our faces and clothes, and while it caused a pricking sensation wherever it touched the skin, was above all exceedingly painful to the eyes.

"The boats heavily laden, struggled sluggishly at first, but when the wind freshened to a gale, it seemed as if the bows, so dense was the water, were encountering the sledge hammers of the Titans, instead of the opposing waves of an agitated sea.

"At the expiration of an hour and a half, we were driven far to leeward, and I was compelled to bear away for the shore. When we were near to it, and while I was weighing the practicability of landing the boats through the surf, the wind suddenly ceased and with it the sea rapidly fell—the ponderous quality of the water causing it to settle as soon as the agitating power had ceased to act. Within five minutes there was a perfect calm, and the sea was unmoved even by undulations. At 8 P. M., weary and exhausted, we reached a place of rendezvous upon the northwestern shore."

---

* "Fanny Mason," and "Fanny Skinner," the names of their two boats. The former of copper, and the latter of iron.

† The descent of the Jordan is estimated by Lieut. Lynch, at six feet per mile. "The great secret of the depression between Lake Tiberias and the Dead Sea, is solved in the opinion of Lieut. Lynch, by the tortuous course of the Jordan. In a distance of about sixty miles that river winds along through a course of about two hundred miles. Within that distance he and his party plunged down no less than twenty-seven threatening rapids, besides many others of less descent."

The three succeeding days were devoted to sounding.

Resting over Easter Sunday, the party resumed operations the next day, making topographical sketches as they went, and touching at a copious stream issuing from hot springs, and the mouth of the river Amon of antiquity. They proceeded thence by degrees to the southern extremity of the sea, where the most wonderful sight that they had yet seen awaited them.

"In passing the mountain of Uzdom, (Sodom,) we unexpectedly and much to our astonishment," continues our adventurous explorer, "saw a large, rounded, turret-shaped column facing towards southeast which proved to be of solid rock salt, capped with carbonate of lime; one mass of crystallization. Mr. Dale took a sketch of it, and Dr. Anderson and I with great difficulty landed and procured specimens from it."

The sea soon proved so shallow that they could proceed no further. Half a mile from the southern shore they found but six inches water, and beyond, an extensive marsh too yielding for a foot-hold.

Near the eastern shore they encountered a sirocco, which came sweeping from the southeast across the desert of Arabia with a stifling heat. At 8 P. M. their thermometer, which before had ranged from 88° to 97°, stood at 106°. "We could not take our tents with us," says the interesting letter from which we are quoting, "nor did we need them, as we found it more agreeable sleeping in the open air upon the beach."

Having circumnavigated the lake and returning to their place of departure, they found the sad intelligence of Mr. Adams's death awaiting their arrival. Their colors were lowered at half mast, and there out upon the dark waters of this mysterious sea, this little band of true-hearted Americans paid a tribute to the memory of the patriot and statesman, with twenty-one minute guns fired from their frail vessels. The echoes from the cavernous recesses of the lofty and barren mountains which surrounded them, startled the Arabs, and reverberated loudly and strangely upon the ears of the mourners.

The letters of Lieut. Lynch giving an account, *currente calamo*, of his proceedings, are of great value and exceeding interest. We hope soon to have the pleasure of announcing his return to the United States and of welcoming him and his companions back to country, home and friends.

"We have," says he, "elicited several facts of interest to the man of science and the Christian.

"The bottom of the northern half of this sea is almost *an entire plain*. Its meridional lines at a short distance from the shore scarce vary in depth. Near the shore, the bottom is generally an incrustation of salt, but the intermediate one is soft mud with many rectangular crystals—mostly cubes—of pure salt. At one time Stellwagen's lead brought up nothing but crystals.

"The southern half of the sea is very shallow although the northern is so deep; for about one-fourth of its entire length the depth does not exceed three fathoms—(eighteen feet.) Its southern bed presented no crystals, but the shores were lined with incrustations of salt, and when we landed at Uzdom, in the space of an hour, our footprints were coated with crystallizations.

"The opposite shores of the peninsula and the western coast present evident marks of disruption.

"There are unquestionably birds and insects upon the shores, and ducks are sometimes upon the sea, for we have seen them—but cannot detect any living thing within it; although the salt streams flowing into it, contain small fish. My hopes have been strengthened into conviction, and I feel sure that the results of this survey will fully sustain the scriptural account of the cities of the plain."

The greatest depth obtained was two hundred and eighteen fathoms, (1308 feet.) Having completed the survey of the sea, the party proceeded to determine the height of mountains on its shores, and to run a level thence via Jerusalem to the Mediteranean. They found the summit of the precipitous ridge which forms the west bank of the Dead Sea, to be more than a thousand feet above its surface, and very nearly on a level with the Mediterranean.

It is a curious fact, that the distance from the top to the bottom of the Dead Sea, should measure the height of its banks, the elevation of the Mediterranean, and the difference of level between the bottom of the two seas, and that the depth of the Dead Sea should be also an exact multiple of the height of Jerusalem above it.

Another not less singular fact, in the opinion of Lieut. Lynch, "is that the bottom of the Dead Sea forms two submerged plains, an elevated and a depressed one. The first, its southern part, of slimy mud covered by a shallow bay; the last, its northern and largest portion, of mud and incrustations and rectangular crystals of salt—at a great depth with a narrow ravine running through it, corresponding with the bed of the river Jordan at one extremity and the Wady 'el Jeib,' or wady within a wady at the other."

The *slimy* ooze upon that plain at the bottom of the Dead Sea will not fail to remind the sacred historian of the "slime pits" in the vale, where were joined in battle "four kings with five."

June the 9th, the whole party after an absence of a little over two months, had returned to St. Jean d'Acre on the Mediterranean. They brought back their boats in as complete order as they received them on board at New York. The party were in fine health. Save a flesh wound to one man from the accidental discharge of his piece, not an accident or mishap had occurred to any one. The Arabs would point to them and say, "God is with them."*

3. *On a remarkable Slide of a Rock in Fairfield District, S. C.,* (communicated in a letter to Prof. C. U. Shepard by Dr. Wm. D. Kersh.)—The occurrence here described took place on the night of March 12th, 1847. The sliding mass consisted of granitic gneiss, and was of an irregular figure, somewhat flat and oval, with a base approaching quadrilateral. The four edges of the broad side upon which it rested, both prior and subsequent to its translation, measured 7, 17, 7 and 15 feet. It is nine feet in height and forty-five in circumference. Its cubic contents are about four hundred and eighty feet; and

* We have since heard of the death of Lieut. Dale, one of the party, at Jerusalem. We look with much interest for the return of Lieut. Lynch and his final Report.

its weight by calculation between thirty-eight and thirty-nine tons. An overhanging ledge of the same kind of rock is situated up the hill, thirty feet above the spot whence the mass under consideration commenced its slide.

There could be nothing very remarkable in the movement which occurred on the night of the 12th, but for the nearly level surface across which it moved. It is agreed on all hands that the angle of declivity throughout the entire distance which was eighty feet, was only from 13° to 15° 40′. The entire descent for the distance, or the difference between the original and the present level of the mass, is but eighteen feet. The stone did not turn over in its course. The surface over which the mass moved is a gradually inclined plane, unmarked by any natural furrow or depression. The soil is a common loam, five or six inches in depth, while the subsoil is a cohesive red clay. The field had been under cultivation for several years. A crop of wheat was raised upon it the year previous; and of course the ground was not covered by green sward. A few coarse stones and pebbles are observable in the soil. The rock encountered several of these in its progress, some of which were crushed, while others were turned aside. There was much vegetable matter accumulated about the rock (in its original position) in a state of decomposition. The surface of the rock is not blackened as if it had been acted upon by fire, but is covered here and there with the customary growth of lichens. A magnetic needle brought near it is scarcely turned aside from the magnetic meridian.

In its descent, it cut through, or tore asunder numerous roots (of living trees), some of which were two or three inches in diameter. It cut a trench from ten to thirteen feet wide and about three feet in depth, spreading the soil to a distance on either side as it moved along. There is no very considerable accumulation of soil in advance of the stone as it now lies, although portions of the red subsoil appeared scattered down the hill from thirty to eighty feet in front of its present location.

There was rain attended by thunder and lightning on the night of the slide, but unaccompanied by wind; and nothing presented itself in the appearances near the spot to indicate a water-spout or any unusual fall of water.

The only suggestion to account for the removal of the stone which has thus far been made, is that of J. W. Hudson, Esq., the Principal of the Winsboro Academy; it is the following: at the lower side of the original bed of the mass stands a pyramidal rock, four feet in thickness, weighing eight or nine tons. Mr. H. supposes that the heavy end of the sliding rock was supported upon this, which, giving way, produced the motion, which on the ordinary laws of gravitation carried the mass down the inclined plane. From this opinion Dr. Kersh strongly dissents, as he thinks that the shape of the moving mass compared with that of the original bed it occupied, proves such a position to have been impossible.

4. *Contributions to the Mycology of North America.*—Mr. Curtis would make the following additional remark to his article, page 349. Under Helicoma Berkleyi:—add "I suspect that this fine species should form the type of a new genus, for which I propose the name *Systrephium*.

Until a fuller examination, however, it may remain under Helicoma." He observes also, that the number of Bosc's species (p. 350), should have been stated at "eight or ten."

5. *Yield of Lead in Great Britain*, (Mem. Geol. Surv. Great Britain, ii, p. 730).—The following table gives the amount of lead ore and lead afforded by the mines of the United Kingdom, for the years 1845, 1846, 1847 :—

	Lead ore.			Lead.		
	1845.	1846.	1847.	1845.	1846.	1847.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
England, . . .	56,479	54,468	59,614½	38,401	36,718	39,507½
Wales, . . .	16,412	14,978	18,147½	11,014½	10,027½	12,294
Scotland, . . .	1,173	1,161	2,251	901	942	7,380
Ireland, . . .	1,944	1,641	1,159	855½	811	822½
Isle of Man, . .	2,259	2,316	2,575	1,523	1.663	1.699
Total, . .	78,267	74,564	83,747	52,695	50,161½	55,703

It appears from the enquiries that the produce of merchantable lead from the ore throughout the kingdom averages about 68 per cent.; and that 7 to 8 ounces of silver is the average quantity at present procured from the ton of lead.

6. *British Association*, (Athenæum.)—This Association for the Advancement of Science, met at Swansea on Wednesday, the 9th of August. At 8 P. M. an address was delivered by the President of the meeting, the Marquis of Northampton. The summary of the proceedings is as follows: On Wednesday, the General Committee assembled.—On Thursday, business began in all the Sections, the Ethnological sub-section forming the only exception; and in the evening, Dr. Percy delivered a discourse on smelting iron, in the Baptist chapel.—On Friday, all the sections again met except the Ethnological; during the afternoon there were sailing matches and boat races; and after the ordinary, Mr. Vivian threw open his grounds, but the wet weather interfered with the general enjoyment of the Sections. On Saturday there was no meeting of the Sections; and a very large party set off at eight in the morning to visit the iron-works of Ystalyfera, and other points of interest in the Swansea valley. Another party made an excursion to the bone caves and cliffs of Gower; while a third, consisting of Lord Wrottesley, Sir Philip Egerton, Sir H. De la Beche, Prof. Owen, Prof. Forbes, Dr. Carpenter, Mr. Bowerbank, Lieut. Spratt and Mr. Jeffreys, went with Mr. M'Andrew in his yacht, the Osprey, on a dredging excursion in the Bristol Channel. Some of the Botanists, with Mr. Babington at their head, made an excursion around the coast from Oystermouth to Pennard Castle, and obtained many rare plants. The less energetic visited the zinc works of Mr. Vivian, and spent the remainder of the day in Mr. Llewellyn's grounds of Penllergare. Here a boat impelled by the electrical current was at work on one of the lakes. In the evening there was a promenade at the schoolroom, very fully attended.

On Monday, there was business in all the Sections. Dr. Carpenter lectured on microscopic structures in the evening, to a large audience. Tuesday, the Sections met; and the Mayor gave a dinner to the principal strangers. In the evening there was a promenade. On Wednesday some of the Sections met; and in the afternoon the concluding general meeting was held for the customary ceremonial proceedings.

The meeting was a good one, though the wet weather interfered somewhat with the comfort and pleasures of the occasion. The amount of scientific business accomplished was less than at many of the preceding meetings.

7. *Lithoceramic.*—MM. CHEUVREUSSE and BOUVERT of Paris, have proposed to replace the timber used for supporting the rails of a railroad, by a mineral compound, to which they have given the name Lithoceramic.

8. *Kumptolite*, (Athenæum.)—The courtyard of the Admirality, Whitehall, has been covered with a paving of India rubber. It is laid down in pieces about twelve inches square and one thick. The quadrangle at Buckingham palace, formed by the erection of the new wing, will also be covered by this material, which its projectors have named "kumptolite." Its chief recommendation is that it deadens all sound, rendering the passage of a vehicle or horses perfectly noiseless.

9. *Dip of Magnetic Needle.*—According to M. QUETELET, the dip of the magnetic needle at Brussels, on the morning of April 14, 1848, was 68° 0′·4 He has kept observations of twenty-two years, and states that in 1827, it was 68° 56′·5. The diminution amounts to three minutes a year.

10. *Arctic Expedition in search of Sir John Franklin*, (Athenæum, No. 1089, Sept. 9, 1848.)—A fishing cutter arrived at Stromness, brings the news that an American whaler visiting Lievely, in Disco Island, had learnt that on the 2d of July, Her Majesty's ships Investigagator and Enterprize, under Sir John Ross, had reached the harbor, and landed dispatches to the care of the Danish governor, to be forwarded by the first vessel to Europe. The expedition immediately proceeded in search of Sir John Franklin. The crews were all well.

11. *Lithographic Limestone*, (Athen.)—Indian papers notice the discovery in the Deccan, of a bed of lithographic limestone, of great extent and excellent quality.

12. *Ray Society*, (Athen., Aug. 26.)—The Ray Society held its fifth annual meeting at Swansea—the Marquis of Northampton filling the chair. The Report stated that although no great increase of numbers had occurred during the past year, the funds were larger, in consequence of most of the new members subscribing from the commencement. The remaining work for 1847, Prof. E. Forbes's "Monograph of the British Pulmograde Medusæ,"—with three new works, Part iv, of Messrs. Alder & Hancock's "Nudibranchiate Mollusca," the "Correspondence of John Ray," and vol. i, of the Bib. Zoologiæ et Geologiæ of Prof. Agassiz, for 1848, were stated to be ready for distribution. Though all the works for 1848 were ready, not a third of the subscriptions for that year had been paid. The meeting was well attended, and several new members were added.*

13. *Museum of Economic Geology, England.*—The building for this museum is nearly completed on an excellent site in Piccadilly; £30,000

* Subscribers in this country will hereafter receive their copies, through Mr. G. P. Putnam, publisher and bookseller, in New York and London, who has been appointed agent for the Society.

of the public money were voted for its construction some years ago. It is suggested that the Geological Society should be furnished with rooms in the building.

14. *Interesting Collections for sale.*—The attention of *colleges, academies, public schools, and private collectors* of objects of natural history, literature, &c., is invited to the following notice :—

A private gentleman who in the course of a long life, as opportunities have offered in Europe and America, and at considerable expense, has indulged his taste in collecting various objects of art, science and literature, and being now too infirm, as well as advanced in life, to prosecute these pursuits, and indeed feeling unable to take the necessary care, has concluded to relieve himself, by disposing of such a portion of his collections as he can spare, retaining only what may require less trouble, while contributing to his enjoyment during the rest of his life. He therefore takes this mode of offering it to the public and private institutions of his country, as an opportunity of obtaining rare and valuable objects, not often to be met with and not to be neglected. The first is

A collection of minerals made in this country as well as in Europe, containing most of the species and many of the varieties mentioned by Professor Cleaveland in his treatise, and many, perhaps more crystalline forms than are to be found in other American cabinets, with few exceptions; among them there is a fine crystal of gold, which attracted the notice of Professors Vanuxem and Shepard, a double terminated euclase, double terminated topazes, and two imbedded in quartz crystals, and a perfect crystal of the gieseckite brought from Greenland by Professor Giesecke of Copenhagen, probably the best in the country. Most of the specimens are of moderate cabinet size, calculated to be contained in a case convenient to occupy nearly one side of a room, and almost all are *ticketed;* many with the original labels of the Abbé Haüy, Brongniart, Brochant, Klaproth, Gillet Laumont, Lucas, and Patrin, as well as of other distinguished mineralogists. The duplicates which are not arranged, containing larger specimens, and one especially of the Ackworth Beryl, being a fragment of a crystal about fifteen inches long and near a foot in diameter, the sides of the prism are six inches across. There are also geological and fossil specimens.

Together with the minerals will be sold a set of crystalline forms in wood (with the angles all marked), and those illustrating crystallography. These models were made under the direction of the celebrated Abbé Haüy for the Emperor of Austria, but learning they were wanted for America, he yielded them to the present owner and ordered a new set for the Emperor.

Further information can be given by Professor Silliman, Professor B. Silliman, Jr., and C. U. Shepard, Professor in the Medical College of South Carolina, Charleston, and at Amherst College, who are acquainted with the collection and know its value. There is also

A cabinet of ancient and modern coins and medals, consisting of Greek, Roman, and Colonial coins in gold, silver, brass, bronze, copper, and lead, with Asiatic and African colonial coins, and several finely executed ones of the Brettii, an ancient people who occupied the lower part of Italy. The modern coins are of gold, silver, and bronze or brass, and some of them scarce and valuable. Among the gold coins of England there are three fine guinea pieces, of Charles II, Queen Anne and George I. Likewise

A collection of European and American autographs in forty quarto cases bound as books. They have been chiefly collected by purchase at considerable cost. The American includes a complete collection of the signers of the Declaration of Independance.

It is unnecessary to go into further details.—Those desirous of availing themselves of so good an opportunity of purchasing, either for private use or for endowing public institutions, will probably desire to examine for themselves, when the fullest information will be afforded.

OBITUARY.

15. *Berzelius*, (Athenæum, Aug. 26, 1848.)—On the 7th August, aged 69, died the eminent Swedish chemist, Berzelius. In a century which has produced a greater number of distinguished chemists than perhaps of any other class of men of science, Berzelius stood out as a star of the first magnitude. To him more than to any other man, belongs the honor of applying the great principles which had been established by Dalton, Davy, Wollaston, Gay-Lussac, and himself, in inorganic chemistry, to unfolding the laws which regulate the combinations forming the structures of the animal and vegetable kingdoms.

Berzelius was born in the village of Väfversunda, in the canonry of Linkogring, in Ostgothland, on the 29th of August, 1779,—not at Linkagring on the 20th of August, as is often erroneously stated in the many notices of him. His father kept the parish school in the village where young Berzelius was born, and there he appears to have received his early education. At the age of seventeen he commenced his studies at the University of Upsala, hoping to qualify himself for the medical profession.

In the year 1798, Berzelius passed his philosophical examination as preparatory to the final one for M.D. At this time he left the University; and in 1799 we find him assistant to a Dr. Hedin, a superintendent physician of the mineral waters of Medevi. The composition of these waters attracted the attention of Berzelius, and his first published essay was a dissertation in conjunction with Ekeberg on the mineral waters of Medevi. He underwent the examination for a license to practice medicine in 1801, and graduated at Upsal on the 24th May, 1804. On leaving Upsal, Berzelius repaired to Stockholm; where he became assistant to Andrew Spaurnau, who sailed with Cook in one of his voyages round the world, and was then professor there of medicine, botany, and chemical pharmacy. Spaurnau died in 1806,—and Berzelius by his inaugural dissertation on galvanism, and other papers, had already obtained for himself a sufficient degree of confidence to be appointed his successor. Although this chair embraced a very wide range of subjects, as was frequently the case with Swedish chairs at that time, Berzelius devoted himself more especially to chemistry. At first he was not more successful in teaching chemistry than his predecessors; but having received a hint from Dr. Marcet of London that chemical lectures should be illustrated by experiments, he adopted this plan, and likewise abandoned the old practice of reading lectures. He used to express himself very strongly on the inutility of merely reading lectures. Although he first adopted Dr. Marcet's experiments in his class-room, he soon so far improved upon these, that his own became a model for the chemical class-rooms of Europe.

During the early period of his residence at Stockholm, he practised the profession of medicine, and in 1807 was mainly instrumental in forming the Medical Society of that capital. In 1810 he was made President of the Royal Academy of Sciences at Stockholm; and in the same year received the appointment of Assessor of the Medical College; and was made a member of the Royal Sanitary Board. At this time, though scarcely more than thirty years of age, he had obtained great reputation as a chemist. He had published a work on animal chemistry, containing many original investigations on the fluids of the animal body, and which was subsequently translated—as, indeed, have been most of his works—into almost every language of Europe. In conjunction with Hisinger, he commenced, in 1806, the publication of a periodical work entitled, "Afhandlingar i Fysik, Kemi, och Mineralogi,"—which contained a series of papers by himself, constituting some of the most valuable contributions that had yet been made to analytical chemistry. His labors were regarded of so much importance by the Royal Academy of Stockholm, that that body decreed him, in 1811, 200 dollars yearly for his chemical researches. In 1812, Berzelius visited England, where he was most cordially received. In that year he communicated, through Dr. Marcet, a valuable paper to the Medico-Chirurgical Society of London, "On the Composition of the Animal Fluids." In 1818 he visited France and Germany—countries in which he was better known than in Great Britain, as most of his papers and works were published in the languages of those countries, as well as in that of Sweden. In the same year he was appointed Secretary to the Academy of Sciences—a post which he held till his death. In 1831 he was allowed to retire from the active duties of his professorship at the Caroline Institute, but he still held the title of honorary professor. Up to this time he had resided in apartments provided for him at the building occupied by the Academy of Sciences,—where, on the same floor, he had his study and laboratory, so that he could with little difficulty pass from his desk to his crucible, and husband his time to the greatest possible extent. He now, however, moved to a house of his own,—and in 1835, married a daughter of the town-councillor (Staatsrathe) Poppius. In 1837 he received the Great Gold Medal of the Royal Academy of Stockholm,—and in 1840 the Diet of Sweden voted him a pension of 2,000 dollars per annum. The scientific societies of Europe and America contended for the honor of enrolling his name among their members,—and with eighty-eight of these bodies it was connected. Nor was his sovereign, Charles John, behindhand in recognizing the most distinguished of his adopted countrymen. In 1815 Berzelius was made a Knight, and in 1821 a Knight Commander, of the Order of Vasa. In 1829 he received the Grand Cross, and in 1835 was made a Baron. The intelligence of this honor was conveyed to Berzelius by the hand of the King; who wrote himself a letter intimating his deep sense of the merits of the philosopher, and expressing a hope that in this nomination the world would recognize an homage paid to the man who had consecrated his life to those useful researches which had been already recognized by Europe, and which it was the glory of Sweden to be able to appropriate as the patrimony of one of her children. This letter was sent to Berzelius on his wedding-day. How few men of science have married with a patent of nobility on the breakfast table! Sweden had, however, yet one more ovation for her beloved son. In 1843 he had been a quarter of a century Secretary to the Academy, and on this occasion a festival was given in his honor. The Crown-Prince was in the chair,—and a portrait of the chemist painted by Lieut. Col. Lodemark was presented to the Academy.

In addition to the works already mentioned, he published a "Manual of Chemistry," which went through several editions, that of 1841 consisting of ten volumes,—and, we believe, another larger edition has since been published. In 1822 he commenced the publication of an Annual Report on the Progress of the Physical Sciences, which has been published every year to the present time.

The name of Berzelius has been too intimately connected with the history of chemistry for the last forty years, for us in this slight sketch to give an adequate idea of the influence which his discoveries and generalizations have exerted upon the science. To him it is indebted for the discovery of several new elementary bodies,—more especially selenium, thorium and cerium. He first demonstrated the acid nature of silica, and was thus enabled to throw light on the composition of a series of interesting mineral compounds of silica with the metallic oxyds. This subsequently led to a whole re-arrangement of mineral bodies, and contributed greatly to the advance of mineralogy. His discovery of selenium led him to investigate its various compounds, and compare them with the sulphurets. These investigations again resulted in his generalizations on the nature of the sulphur salts, and a new classification of the various salts. Subsequently, he investigated the compounds of fluorine, and arrived at some of the most important and valuable results that have yet been obtained by the analytical chemist.

Whilst Berzelius was writing the first edition of his "Manual of Chemistry," Dalton had promulgated his idea of the atomic constitution of matter, and Davy had made his great discovery of the metallic bases of the alkalies. These directed his attention to the laws of combination. He was led to institute researches with the most scrupulous care into the combining proportions of the various elements, giving to each its correct number, and was enabled to obtain results perfectly harmonious with theoretical calculations made on Dalton's laws. He was enabled to extend Dalton's law that one atom of one body unites with one, two, or three, &c., atoms of another body, and showed that two atoms would unite with three and five. He also pointed out the great fact, that two compounds which contain the same electro-negative body always combine in such proportions, that the electro-negative element of one is a multiple by a whole number of the same element of the other. He not only gave to the elementary bodies their combining numbers, but introduced the system of symbols, by which chemical labor has been so greatly facilitated. Till the time of Berzelius, organic chemistry was a waste, with here and there an attempt to explain the phenomena of living beings upon chemical principles,—and which from the entire want of experimental foundation, was even worse than useless. The compounds found in plants and animals were not supposed to come within the category to which the laws of combination applied. Berzelius was the first to show that these laws could be applied to animal and vegetable products; and in so doing, he opened the way for the discoveries of Mulder, Liebig, Dumas, Boussingault, and others.

As a skilful manipulator, Berzelius has had few equals in the history of chemistry. To this we are indebted for the immense variety, number and success of his analyses. Many of the analytical processes in use at the present time, have had their origin with him.

The personal appearance of Berzelius was that of a strong, healthy man, with nothing in his habits or manners to impress a stranger with a sense of his powers. A chemist who visited him says, "He has nothing of pretense, reserve, or singularity about him; so that his plainness drew from a fellow-traveller of mine, whom he allowed me to introduce to him, the observation, 'I would never have thought him the great man he is said to be.'" His attention to strangers was very great,—especially to those who took an interest in chemistry. With these he would frequently spend hours in his laboratory, explaining his methods of working,—and on their departure, he left the impression that he was the honored party. He was an early riser, and gave the first part of the day to his most important work, whatever that might be. He seldom either wrote or experimented in the evening, leaving that part of the day for reading and social relaxation. He had no particular times for writing or experimenting; when he had a work to finish, he would write sometimes for months without performing an experiment,—but if anything of importance occurred to him during his writing, requiring further investigation, he would at once give up the pen, and work perhaps for weeks in his laboratory. Few men were more beloved in the city of Stockholm than Berzelius.

Were the merits of this great chemist less, we might not be able to afford to hint at any defects. But regarding him at a distance, he appears to us to have carried his caution beyond the requirements of scientific research. His feelings were conservative, and though constantly going forward to the new, he still clung with tenacity to the old. He was almost the last chemist of eminence that admitted Davy's theory of the elementary nature of chlorine. Even after envy and prejudice had given up their opposition, the caution of Berzelius withheld assent. In the recent advances of organic chemistry, also, and more especially in its applications to the physiology of plants and animals, Berzelius has looked on with the eye of a critic, and withheld to the last his adhesion to some of the advanced positions of this department of the science.

A letter from Retzius, (L'Institut, No. 764,) speaking of Berzelius, states that on examination, it was found that there was a softening of the posterior half of the spinal marrow corresponding to the tenth dorsal vertebra.

VI. Bibliography.

1. *Rare and Remarkable Animals of Scotland, represented from living Subjects, with practical observations on their nature;* by Sir John Graham Dalyell, Bart. Volume first, containing fifty-three colored plates. London: John Van Voorst, Paternoster Row, 1847. 4to, pp. 270, (Ann. Mag. Nat. Hist., ii Ser., i, 311, 1848.)—The most interesting chapter in this interesting volume is that which narrates the history of the *Hydra tuba*. This marine animal is called a Hydra by our author because it has the form and the characters of the freshwater polyps, and possesses also their qualities—their greed of living prey (p. 87), their proliferous evolution of young, their endurance of privations, their power to recover from apparently immedicable wounds, and their strange germinations and monstrosities under the influence and direction of the experimentalist (p. 93). This hydra is found attached to submarine bodies; the body is fleshy, inversely conical, encircled about the oral disc with a series of long slender thread-like tentacles,—and thus it lives apparently for an indeterminate period, exercising all the functions of a perfect and adult animal even to the repeated production of young in all respects alike the parent. So it lives until, from some unknown causes, a change comes over it, and it begins to unveil itself, and to exhibit one of the most wonderful revelations in animal transmutations. A pendulous column or roll is observed as if implanted on the disc of the hydra; at first it is faintly indented by circles and is terminated by a circular row of tentacles; the indenting circles become more deeply waved, the tentacles shorter until they are obliterated; and then each roll of the column is successively separated and liberated from the others until the whole embryonic column is dissolved, the individual rolls floating at freedom in the bosom of the waters, obviously the young of one of those large Medusæ which swarm our seas in the months of the latter summer and autumn! —Now this short sketch of the metamorphosis is not of any new discovery, for Sars had made us in some degree acquainted with it, but the account of it given by Sir John Dalyell excels all others in fullness and completeness, and in its freedom from conjectural explications. The metamorphosis itself is wonderfully curious, but what strikes us as the most unaccountable fact in the process is the uncertainty of the periods at which the change takes place. The *Hydra tuba* may remain for years a hydra propagating its kind, and we know of no data to fix the period when it shall begin the process of change into its mature and final state; and, to add wonder to wonder, having cast off several of these medusean embryos, a basis remains out of which another *Hydra tuba* shall arise, to go through the same hydra life and the same medusean metamorphoses as its predecessor. We suppose that these facts—for facts they are—will not support the opinions of Steenstrup on alternating generations, nor can even be reconciled with them.

The way in which Sir John discovered that the *Hydra tuba* was the embryo of a Medusa was this: he took a large Medusa, of undetermined species but beautifully figured on plate 15, and placing it in a vase of sea-water the spawn—"a brownish matter like dust"—was shed from its ovarian fringes and settled at the bottom. This spawn consisted of "an host of animated creatures in quick and varied motion," partaking much of the nature of the *planules* of the Sertularians. The changes they rapidly underwent were noted and delineated; and in eleven or twelve days after "the planule had been discharged from the unwieldy Medusa, it was converted to a stationary hydra," (p. 105.) "This new animal was provided with a complement of eight arms, yet so immature as to be of unequal dimensions. Different groups, under metamorphosis, showed the utmost irregularity in respect to evolution, in their shape and proportions: nor was it until thirteen days later, or three weeks after their birth, that any appeared with eight regular tentacles. Thus was a most perplexing problem solved—the *Hydra tuba* proved to have sprung of a Medusa." (p. 105.)

The progress of discovery went on. Sir John had "remarked colonies of minute transparent animals swimming in vessels of sea-water, during the months of February, March and April. Their general aspect very much resembled a flock of birds in distant flight, as represented by landscape painters. After being transferred to vessels free of other subjects, they continued several days in activity and then disappeared. I could not account either for their origin or their transience. They occurred only at rare intervals, and always identically under the same form." (p. 111.) These very minute beings, for the expansion of an individual is only between one and two lines, were evidently allied to the Medusæ "both in configuration and in habits," but they differed from the Medusæ in the early date of their appearance. To distinguish them Sir John called the species *Medusa bifida*, and we have it minutely described and variously figured. Sir John was first led to remark that it was chiefly observed in vessels containing the *Hydra tuba* (p. 114); and subsequently, and as it were by accident, he discovered that the hydra was in fact their source; and moreover that the hydra was identical with the *Strobila* of Sars! The discovery is told in a most interesting manner, and with a truthfulness which there is no gainsaying.

We shall quote only a few of the many passages we have marked, previously observing that the *Hydra tuba* in its strobila form is something like a fir-cone or a cylinder cut into several whorls, each whorl, when detached, becoming what is named the *Medusa bifida*. The strobila throws off these whorls in succession to the number of from ten to twenty, when the basis, as already stated, resumes the form and habits of the hydra.

"First, a smooth fleshy bulb sustained a cylinder of about half its own diameter, indented by plain circles, which were soon converted to waving curvatures. A row of twenty or twenty-four tentacula crowned the summit of the cylinder, which row disappeared or was obliterated as the waving in its vicinity deepened, and the diameter of the cylinder there expanded, that is towards the summit. Concomitant on obliteration of the terminal row, a new circle of tentacula, at first few, but gradually augmenting, was emerging from around the bulb, while the struggles of Medusæ, into which the waving strata were evolving, accomplished their liberation to swim unconstrained in the surrounding element." (p. 121.)

"Certain facts admit of no dispute; such as the existence of a vigorous hydra attached to a solid substance, with long flowing silky tentacula; an alteration in the figure of the body, or the formation of an embryonic roll of Medusæ on the disc; the gradual maturity of each Medusa and its liberation from the roll; the disappearance of the original tentacula of the hydra; the emerging of a new circle of tentacula from a smooth fleshy bulb, sustaining the embryonic roll, as the former are obliterated, and as the Medusæ approach maturity; the evolution of this fleshy bulb as a perfect hydra, along with their departure, which becomes the parent of progeny by gemmation, and its permanence as an independent animal." (p. 122–3.)

"All the Medusæ in the embryonic roll are separate and distinct animals. Each is in close application to that which is next below, if itself be uppermost, or lies between two if intermediate. The proboscis is outermost if the individual be uppermost in the roll; thus all lie in the same direction, the proboscis outermost, as the Medusa escapes, from the next left behind. When the last remains in adhesion to the fleshy bulb, its proboscis projects outwards also. Thus the under surface of the embryo is always outwards, while a portion of the roll." (p. 124.)

"Although by repeated long, and painful observation, I have endeavored to learn the history of the *Hydra tuba* and the *Medusæ* originating from it, my purpose has been but partially attained. I have selected many individuals, and I have chosen colonies of both, to discover whatever changes they should undergo. The hydra grew, it fed, it bred, its existence was long. The Medusa lived, it neither fed nor bred, its existence was infinitely shorter; nor did it undergo the smallest change from the first moment of liberation for fifty-five days. Its life could not be protracted, on any occasion, beyond sixty days. Between the form and habits of these two animals there is not the smallest correspondence." (p. 128.)

2. *Recherches sur les Animaux Fossiles;* par L. DE KONINCK. Liége, 1847. *Première Partie*, *Monographie des genres Productus et Chonetes.* 4to, illustrated by 20 plates. (Ann. and Mag. Nat. Hist., ii Ser., i, 457, 1848.)—This is the first of a series of works entitled, 'Researches on Fossil Animals;' it contains monographs of the genera *Productus* and *Chonetes.* The series is intended to supply the geologist and naturalist with complete monographs of different genera, so as to embody in one work all the species of a genus which are now more or less distributed through many periodicals, memoirs and transactions of societies. The first part contains a list of 107 works and memoirs to which the author has referred in the subsequent pages. To this succeeds an historical introduction and observations on the generic characters, with a classification of the species. A detailed description of each species is given, to which is appended a very complete synonymy. From the geological and geographical distribution which follows we extract a few notes. The number of species of *Productus* described amounts to 62, of which 4 are Devonian, 47 Carboniferous, 10 Permian, and 1 Triassic. Of the 47 Carboniferous species, 35 only are found in the lower divisions.

Not any species belongs exclusively to the middle division, although 7 are common to the lower and middle portions, viz., *P. margaritaceus*, *undiferus*, *Flemingii*, *pustulosus*, *Keyserlingianus*, *aculeatus*, *mesolobus*. The *P. carbonarius* is found only in the upper division. The *P. cora*, *semireticulatus*, *scabriculus* and *punctatus* appear to have lived from the commencement to the close of the carboniferous period.

It is interesting to observe that all the Devonian species have common general characters, and may be arranged in the same group (Caperati): a similar remark also applies to the Permian species, which, with the exception of three, are nearly all comprised in the group (Horridi), so that the latter group is almost composed of Permian species, the *P. Orbignianus*, *P. Verneuilianus*, being the only carboniferous forms; and it is not a little singular, in consulting the table of classification (page 29), to find that the Permian species have a much greater affinity with the Devonian than with the carboniferous, notwithstanding the considerable period which must have elapsed between their development.

Under the geological distribution of the genus *Chonetes*, we find there are 23 species known at present, which number may probably be increased when the fossiliferous deposits of America, New Holland and Asia are more explored. Nevertheless the geological results to which the known species lead us are deserving of notice. From the observations of M. de Koninck it appears (contrary to the opinion generally admitted), that with the exception of one, not any of the 23 species pass from one system to another, or even from the lower to the upper beds of the same system.

E. G. Squier and E. H. Davis, M.D. Ancient Monuments of the Mississippi Valley; comprising the results of extensive original Surveys aud Explorations. 1 vol. imperial 4to. Subscription price, $10.

C. Pickering, M.D. The Races of Men and their Geographical Distribution: forming the xi. volume of the Reports of the United States Exploring Expedition.

Sears C. Walker. Ephemeris of Neptune for the Opposition of 1848: Smithsonian Contributions to Knowledge. 8 pp. 4to.

R. Chambers, Esq. Ancient Sea Margins, as Memorials of Changes in the Relative Level of Sea and Land. 8vo, 338 pp. with maps and illustrations. *Edinburgh* and *London*, 1848.

C. Campbell Cooper. Identities of Light and Heat, of Caloric and Electricity. 96 pp. 8vo. 1848. Philadelphia: Grigg & Elliott. 75*c*.

Memoirs of the Geological Survey of Great Britain, and of the Museum of Practical Geology in London, vol. ii, part ii, 8vo, pp. 387 to 720; with numerous plates of Mines, Machinery and Fossils. *London*, 1848. Contains the following Memoirs:

On the Vegetation of the Carboniferous Period as compared with that of the present day;—On some peculiarities in the Structure of Stigmaria; and Remarks on the Structure and Affinities of some Lepidostrobi; by Dr. Hooker, F.R.S., &c.

On the Asteriadæ found fossil in British strata;—On the Cystideæ of the Silurian rocks of the British Islands; by Prof. E. Forbes.

First report on the coals suited to the Steam Navy; by Sir H. De la Beche.

An experiment on the influence of a weak voltaic current upon matter;—Notices of the history of the lead mines of Cardiganshire; by R. Hunt.

On the mining district of Cardiganshire and Montgomeryshire; by Warrington W. Smyth.

On the composition of some of the Limestones used for Building Purposes, especially on those employed in the erection of the New Houses of Parliament; by T. Ransome and B. Cooper.

Produce of lead ore and lead in the United Kingdom for the years 1845 and 1846.—Produce of lead ore and lead for 1847.

W. F. Van Amringe. An investigation of the theories of the Natural History of Man, by Lawrence, Prichard, and others. 8vo. *New York*, 1848.

Deshayes. Mollusques de l'Algerie, 4to, in livraisons of 4 to 5 leaves of text, and six colored plates. 16 fr. each livr. 12 livrs. are on sale; 10 will appear each year.

L'Abbe D. Dupuy. Histoire Naturelle des Mollusques terrestres et d'eau douce qui vivent en France.

Lecoq et Lamotte. Catalogue Raisonné des Plantes Vasculaires du plateau central de la France. *Paris*, 1847. 1 vol., 8vo. 6 fr.

E. Renou. Geologie de l'Algerie, with descriptions of fossils by Deshayes. 1 fasc., 25 fr. The second will soon appear, and will contain the descriptions of the fossils.

B. Charlard and O. Henry. Analyse chimique des eaux qui alimentent les fontaines publiques de Paris. 3 *fr*.

Laurent. Precis de Cristallographie, suivie d'une méthode simple d'analyse au chalumeau. *Paris*, 1847. 1 vol. in large 18mo, with 175 figures in the text. 2 *fr*. 25*c*.

E. F. Glocker. Generum et specierum mineralium secundum ordines naturales digestorum Synopsis, etc. 348 pp. 8vo. *Halæ Saxonum*, 1847.

Memoirs of the American Academy, Boston, new ser., vol. iii.—Account of the nebula in Andromeda; *G. P. Bond*.—Account of the nebula about Orionis; *W. C. Bond*.—Method of computing the ratio of a comet's distances from the earth; *G. P. Bond*.

Proc. Bost. Soc. Nat. History.—Jan. 5, 1848. Motella, a genus of fish found in the waters of North America; *Storer*.—Jacksonite, a new mineral; *J. D. Whitney*.—Jan. 19. Vegetation of Anthracite; *J. E. Teschemacher*.—Feb. 2. Development of an Echinaster; *Desor*.—Experiments on animals with chloroform; *Desor*.—Feb. 15. Development of embryo starfish; *Desor*.—Infusorial deposits found at the mouths of rivers in the Southern States, caused by the influx of infusoria with the tide, which the freshwaters destroy; *H. D. Rogers*.—Eggs of Eolis; *Desor*.—March 15. On water in igneous minerals and metamorphic action.—April 19. Water tubes in fishes; *Agassiz*.—June 7. New species of American shells (of Succinea, 2 species, Helix 5, Pupa 2, Cylindrella 2); *A. A. Gould*.—The American oyster-catcher a different species from the European; *Cabot*.—June 21. On a peculiarity in the anatomy of a Leuciscus; *Ayres*.

Annales des Sciences Naturelles.—Fevrier, 1848. Researches on corals (continued); *M. Edwards* and *J. Haime*.—Organization and Development of the Linguatulæ; *Van Beneden*.—Anatomical researches on the exterior branchiæ of the Sialis lutarius; *L. Dufour*.—Natural classification of the Gasteropodous Molluscs; *M. Edwards*.—On the liver of the vertebrata; *N. Guillot*.—Mode of fecundation in the Œnothera; *M. W. Hofmeister*.—On the ovule and grain of the Acantheæ; *J. E. Planchon*.—On the Droseraceæ; *J. E. Planchon*.—Propagation of the Rhizocarpeæ; *C. Nægeli*.—On the Azolla; *G. Mettenius*.—Mycological fragments; *J. H. Léveillé*.

Ofversigt af Kongl. Vet.-Akad. Förhandlingar, 1847.—Includes the following, on Natural History topics:—p. 5. New Algæ from Mexico; *Agardh*.—p. 54. Specific gravity of Zircon; *Svanberg*.—p. 70. Neolite, a new mineral; *Scheerer*.—p. 85. Aphthonite, a new antimonial sulphuret of copper and silver; *Svanberg*.—p. 162. A new goniometer; *Wallmark*.—On the teeth and uncini of mollusca, with figures and descriptions of these appendages in over 80 species of different genera; *Loven*.

INDEX TO VOLUME VI.

P.

Q.

R.

S.

T.

U.

V.

W.

Z.

39