ART. XXVIII.—*On the Carbonates of Alumina, Glucina and the sesquioxyds of Iron, Chromium and Uranium;* by THEODORE PARKMAN, Ph.D.

THE precipitates, produced by the alkaline carbonates in solutions of alumina, glucina and the sesquioxyds of iron, chromium and uranium, have been investigated by a large number of observers; but their results are so discordant, that the true composition of the substances in question is still in doubt. The following investigation was undertaken at the suggestion of Prof. Charles W. Eliot, under the idea that the contradictory results, obtained by previous writers, may have been owing to a loss of carbonic acid, during the processes of washing and drying. This would be probable enough in itself, from the weak affinities of both acid and base, in each case, and is, I think, fully confirmed by the analyses which follow.

1. *Carbonate of the sesquioxyd of iron.*

Fe_2O_3, CO_2.

The precipitate, formed by mixing carbonate of potash with nitrate of the sesquioxyd of iron, after washing with cold water, consists, according to Gmelin,* of hydrated sesquioxyd of iron, free from carbonic acid. Berzelius† considers that the compound $Fe_2O_3, 3CO_2$ is formed, but that it exists only momentarily. Langlois‡ gives an analysis of a precipitate, produced by carbonated alkali in a sesqui-salt of iron, perfectly freed from alkali by washing and dried at 100° C. His results were 88·47 p. c. Fe_2O_3, 10·17 HO, 1·36 CO_2, from which he does not deduce any formula. Wallace§ finds the precipitate by carbonate of soda in sesquichlorid of iron, after drying over sulphuric acid, to be $3Fe_2O_3, CO_2, 6HO$: in the nitrate, $9Fe_2O_3, CO_2, 12HO$. According to Barratt,‖ the precipitate produced by carbonate of soda in sesquichlorid of iron, when dried in the air, has the formula $3Fe_2O_3, CO_2+8HO$; when dried at 100°, $3Fe_2O_3, CO_2+4HO$.

The carbonate of iron which I have examined was precipitated, at the ordinary temperature, from pure crystallized iron-potash-alum by carbonate of soda in slight excess. The precipitate was not washed or dried, but simply pressed between folds of porous paper, under a heavy weight, for about twelve hours, and while still moist, introduced into a bulbed tube of hard glass, and the whole weighed. It was then ignited in a slow stream of

* Handbook of Chem., v, 222.

† Lehrb. der Chem., iii, 626.

‡ Ann. Chim. et Phys., xlviii, 502.

§ Chem. Gaz., 1858, 410, in Jahresb., 1858, 70.

‖ Chem. News, i, 110, in J. pr. Chem., lxxxii, 61.

dry air and the water caught by a weighed chlorid of calcium tube. The loss of weight in the bulbed tube and substance, minus the increase of weight in the chlorid of calcium tube, would give the weight of carbonic acid corresponding to the carbonate of iron, while the carbonate of soda and sulphate of soda would remain unchanged. The sesquioxyd of iron, remaining in the bulb, was washed and weighed. Of course, by this method, the water cannot be estimated, which, according to all previous observers, exists in all the carbonates in question. In my first analyses the substances, though not washed, were dried over sulphuric acid: but three analyses of the same substance, which gave successively the percentages of carbonic acid, 15·74, 14·45 and 12·95, showed conclusively that the substance lost carbonic acid by standing. All the other analyses made, both of this and of the other carbonates, were therefore made with the precipitate, while still moist. The formulas obtained, therefore, express simply the relation between the acid and the base, and a certain amount of water must probably in every case be understood. In every case, more than one preparation was analyzed, to ascertain whether the precipitate had always the same composition.

Of the carbonate of iron four analyses were made, with the following results:

	Calculated.		Preparation I.	Prep. II.	Prep. III.	
					1.	2.
Fe_2O_3	80	78·43	79·88	79·47	79·09	80·52
CO_2	22	21·57	20·12	20·53	20·91	19·48
	102	100·00	100·00	100·00	100·00	100·00

Considering the ease with which the substance loses carbonic acid, the above results agree with the calculated percentage probably as closely as could be expected—closely enough, at any rate, to fix the composition of the substance with sufficient certainty.

2. *Carbonates of the sesquioxyd of chromium.*

$Cr_2O_3, 2CO_2$

Cr_2O_3, CO_2

The earliest analysis of carbonate of chromium is by Meissner,* who found it to contain 77·30 Cr_2O_3, 15·54 CO_2 and 7·16 HO. Meissner's analysis, however, is quite untrustworthy, as may be seen from his details of it. According to Lefort† the precipitate by carbonated alkalies in the violet salts of chromium is Cr_2O_3, CO_2+4HO; in the green modification only the hydrated oxyd. According to Langlois,‡ the precipitate by carbonated alkalies in the salts of chromium, dried at 100° C., is Cr_2O_3, CO_2+Cr_2O_3, 6HO. Wallace§ precipitates sesquichlorid of chromium by car-

* Gilbert's Annalen der Physik, lx, 366.

† Compt. Rend., xxvii, 269.

‡ Ann. Chim. et Phys., [3] xlviii, 502.

§ Chem. Gaz., 1858, 410, in Jahresb., 1858, 70.

bonate of soda, in very dilute solution, and dries the precipitate over sulphuric acid. His results give the formula Cr_2O_3, CO_2, 4HO. Barratt* proceeds in the same way as Wallace and obtains the same result, which is also that obtained by Lefort.

The substance which I analyzed was precipitated by carbonate of soda, in slight excess, from crystallized chrome-potash-alum, free from iron and alumina. In the first analysis, given below, the substance was dried over sulphuric acid: in the others not. The first analysis was made like those of carbonate of iron. The wash-water from the oxyd of chromium, left in the bulbed tube after ignition, was colored yellow from alkaline chromate. This must have arisen from oxydation of a little oxyd of chromium, by ignition in the air in contact with alkaline carbonate. The solution was reduced by hydrochloric acid and alcohol, precipitated by ammonia, and the oxyd of chromium thus obtained added to the rest. There still remained an error, however, from the chromic acid having driven out carbonic acid from the carbonate of soda; and to avoid this, the other determinations were made in a stream of hydrogen. In this latter method there would be a possible source of error, viz., a reduction of the alkaline sulphate to sulphid. This, however, was extremely small, as the wash-water, on heating it with hydrochloric acid, gave off in every case only a trace of sulphuretted hydrogen and either remained clear, or became only very slightly milky, from precipitated sulphur.

The analyses of a large number of preparations gave the following results:

	Calculated.		Prep. I.	Prep. II.		Prep. III.		Prep. IV.		Prep. V.	
				1.	2.	1.	2.	1.	2.	1.	2.
Cr_2O_3	77·4	63·76	66·81	66·51	66·89	67·53	66·59	73·03	73·44	72·55	73·84
$2CO_2$	44·	36·24	33·19	33·49	33·11	32·47	33·41	26·97	26·56	27·45	26·16
	121·4	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

The composition of the first three precipitations comes pretty near the formula, given above, while the other two vary largely from it. These two were made in summer, while the others were made in cold weather, and it is possible that there may have been a greater loss of carbonic acid at the higher temperature. I am inclined to think, however, that this is not the case, as, in the last preparation, the liquids were cooled, before precipitation, and the precipitate left to press in a refrigerator, containing ice. It occurred to me that one cause of the varying composition of the precipitates might be that basic compounds might at first go down, before the carbonate of soda was in excess, as is the case, for example, when ammonia, not in excess, is added to solutions of copper. To ascertain whether this was the case, an analysis was made of a precipitate, produced by pouring chrome

* Chem. News, i, 110, in J. pr. Chem., 82, 61.

alum slowly into carbonate of soda, with constant agitation, until the alkaline reaction became comparatively feeble. In this way there would be always an excess of carbonate of soda present. Two analyses were made of the same preparation.

	Calculated from Cr_2O_3, $2CO_2$.	I.	II.
Cr_2O_3.	63·76	65·03	64·96
$2CO_2$.	36·24	34·97	35·04
	100·00	100·00	100·00

This seems to prove pretty conclusively that there is a carbonate of chromium, possessing the above formula, and that the precipitate produced by the alkaline carbonates consists chiefly of it, generally mixed, however, with variable quantities of a more basic compound. This latter may very probably be a carbonate of chromium, which will be described further on.

As already mentioned, Lefort asserts that the precipitate, produced by the alkaline carbonates in solutions of the green modification of sesquioxyd of chromium, is hydrated oxyd, containing no carbonic acid. The following is the result of an analysis, made by myself, of such a precipitate. The chromium solution used was prepared by boiling the violet chrome-alum for about an hour, and cooling the solution before precipitation. The percentages obtained were 59·38 Cr_2O_3 and 40·62 CO_2. The carbonic acid is probably too high, and I regret that I did not have time to repeat the analysis. It is, however, sufficient to show that the substance contains carbonic acid, and that its composition is probably the same as that of the precipitate obtained in the violet modification.

The agreement of the results of Lefort, Wallace and Barratt, who all make the carbonate of chromium to be Cr_2O_3, CO_2 + 4HO, makes it probable that the bicarbonate, above described, loses its second atom of carbonic acid more readily than the other and is converted by washing and drying into a more stable monocarbonate. This latter is also formed, when a boiling solution of chrome alum is precipitated by carbonate of soda, as is shown by the following analysis of a precipitate thus prepared:

	Calculated.		Found.
Cr_2O_3	77·4	77·86	78·68
CO_2	22·	22·14	21·32
	99·4	100·00	100·00

3. *Carbonate of Alumina.*

Saussure* considers the precipitate, produced by alkaline carbonates in the solutions of alumina, to be a compound of alumina with a little alkaline carbonate. Muspratt† finds that the precipitate by carbonate of ammonia in alum is $3Al_2O_3$, $2CO_2$ + 16HO.

* Jour. Phys., lii, 290. † Chem. Soc., Qu. J., ii, 216.

Muspratt does not mention whether he tested the substance for ammonia, which it should contain, according to H. Rose,* who finds that the precipitate, after being washed, first with hot and then with cold water, has the composition, $Al_2O_3, 3HO+NH_4O, 2CO_2+HO$. Langlois† finds the precipitate by alkaline carbonates in the salts of alumina to be $3(Al_2O_3, CO_2)+5(Al_2O_3, 8HO)$. Wallace‡ precipitates the chlorid by carbonate of soda, in very dilute solution, and dries the precipitate over sulphuric acid. He gives the formula, $3Al_2O_3, 2CO_2, 9HO$. Bley§ obtains percentages of carbonic acid varying from 5·27 to 11·39, in the precipitate, produced by alkaline carbonates in solutions of alum, and considers it to be a mere mixture, of variable composition. Barratt‖ finds that the precipitate by carbonate of soda in chlorid of aluminum, after washing, drying, rubbing with water and again washing and drying over sulphuric acid, consists of alumina, free from carbonic acid.

The precipitates, which I have examined, were precipitated by carbonate of soda, in slight excess, from alumina-potash-alum, free from iron. The mode of analysis, used in the iron and chromium compounds, was not applicable in this case. The strongly alkaline wash-water, from the ignited alumina, contained alumina in large quantity, showing that aluminate of soda had been formed and carbonic acid, therefore, driven out of the carbonate of soda. Attempts to overcome this difficulty, by taking weighed quantities of alum and carbonate of soda, in equivalent proportions, and by exactly neutralizing the solution of alum by carbonate of soda, did not give good results. The method finally adopted was to wash the substance with water saturated with carbonic acid, until a portion of the filtrate, after being boiled to expel carbonic acid, gave no alkaline reaction. This would probably give correct results, since the water, being already saturated with carbonic acid, would hardly wash out any from the substance. The latter, moreover, would hardly absorb any more carbonic acid from the water, since, during the precipitation, free carbonic acid is given off in great quantity and the alumina must have combined with as much carbonic acid as it would be possible for it to take up. In other respects, the analyses were conducted like those of the carbonate of iron. The following are the results obtained:

	Prep. I.		Prep. II.	Prep. III.		Prep. IV.	
	1.	2.	1.	1.	2.	1.	2.
Al_2O_3	79·13	79·32	75·95	81·37	81·91	77·51	76·72
CO_2	20·87	20·68	24·05	18·63	18·09	22·49	23·28
	100·00	100·00	100·00	100·00	100·00	100·00	100·00

* Pogg. Ann., xcii, 452. † Ann. Chim. et Phys., [3] xlviii, 502.
‡ Chem. Gaz., 1858, 410, in Jahresb., 1858, 70. § J. pr. Chem., xxxix, 1.
‖ Chem. News, i, 110, in J. pr. Chem., lxxxii, 61.

Preparation I. was analyzed in April: Preps. II. and III. in summer: Prep. IV. also in summer; but, to avoid a possible loss of carbonic acid in hot weather, it was precipitated from cooled solutions of alum and carbonate of soda, washed with ice-water saturated with carbonic acid, and pressed in a refrigerator. The variable composition of the substance led me to suppose that it was a mixture of more than one substance, and, for the same reasons as in the case of the carbonate of chromium, led me to make the following analyses of precipitates, produced by pouring alum into carbonate of soda, until the alkaline reaction became weak. Both were prepared in hot weather, but with the precautions above mentioned.

	Calculated.		Prep. I. 1.	Prep. I. 2.	Prep. II. 1.	Prep. II. 2.
Al_2O_3	51·4	70·03	70·44	71·06	77·79	77·02
CO_2	22·	29·97	29·56	28·94	22·21	22·98
	73 4	100·00	100·00	100·00	100·00	100·00

The composition of the first preparation comes pretty near the formula, while that of the second is very much like that of the substances, precipitated in the other way. Possibly in this last precipitate, the alum may have been poured in too rapidly, without agitation of the liquid, and thus caused, at the point where it fell, temporary excess of alum, thus affording the same probable cause for error as in the other mode of precipitation. The above results lead to this, I think, as the most probable conclusion: viz., that the normal carbonate of alumina possesses the composition Al_2O_3, CO_2, analogous to that of the carbonates of iron and glucina and one of the carbonates of chromium; and that the precipitate, produced by the alkaline carbonates in solutions of alumina, consists chiefly of this normal carbonate, generally mixed, however, with more or less of a more basic salt or of hydrate of alumina.

4. *Carbonate of Glucina.*

G_2O_3, CO_2.

Schaffgotsch* gives an analysis of a carbonate of glucina, precipitated by boiling a solution of glucina in carbonate of ammonia. He finds the percentages, 47 53 G_2O_3, 17·57 CO_2 and 34·90 HO, corresponding most nearly to the formula, $3G_2O_3$, $2CO_2+9HO$. Weeren† gives analyses of precipitates, obtained by boiling solutions of glucina in carbonate of ammonia, under somewhat different circumstances, and obtains the formulas, $4G_2O_3+4CO_2+11HO$: $3G_2O_3+2CO_2+10HO$: $7G_2O_3+3CO_2+14HO$. For a precipitate by carbonate of ammonia, not in excess, from a neutral solution of glucina in hydrochloric acid, he obtains the formula, $11G_2O_3+6CO_2+26HO$.

* Pogg. Ann., l, 83.

† Pogg. Ann., xc, 91.

The salt of glucina, which I used, was prepared by dissolving glucina in a slight excess of sulphuric acid and washing out the excess of acid with alcohol. The glucina used had been freed from alumina and iron, by dissolving it in sesquicarbonate of ammonia and precipitating it by boiling, and by again dissolving it in caustic soda and precipitating it by boiling. From the sulphate, thus obtained, the carbonate was precipitated by carbonate of soda, in slight excess, and analyzed in the same way as the carbonate of iron. The wash-water from the ignited glucina contained no glucina, no glucinate of soda having been formed. Analyses of two preparations gave the following results:

	Calculated.		Prep. I. 1.	Prep. I. 2.	Prep. II.
G_2O_3	38·	63·34	63·31	63·57	63·52
CO_2	22·	36·66	36·69	36·43	36·48
	60	100·00	100·00	100·00	100·00

If glucina be regarded as a protoxyd, as it has been by some chemists, the above results would correspond to the formula, 3GO, CO_2 (calculated, G.=4·7, 63·40 GO and 36·60 CO_2).

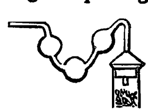
5. *Carbonate of the sesquioxyd of Uranium.*

The precipitate, produced by carbonate of potash in nitrate of uranium, after being washed with cold water and dried in the air, has, according to Ebelmen,* the following composition: 3·66 KO, 3·87 CO_2, 81·98 U_2O_3 and 10·49 HO; and is probably a mere mixture.

The precipitates, which I have examined, were precipitated, some from the sulphate, others from the nitrate of uranium, by carbonate of soda, in as small excess as possible. The general mode of analysis, described under carbonate of iron, could not be employed here. There would be a variable mixture left in the bulbed tube, after ignition, consisting partly of uranate of soda (formed when sesquioxyd of uranium is ignited with carbonate of soda) and partly of proto-sesquioxyd of uranium. The substance was, therefore, ignited in a stream of dry hydrogen, free from carbonic acid, and the carbonic acid absorbed by a weighed soda-lime tube.† In this way, the sesquioxyd is

* N. Ann. Chim. Phys., v, 189.

† This method of absorbing carbonic acid by soda-lime, seems to work very well. In one case, a tube, used for the fourth time, still absorbed the carbonic acid perfectly, as was shown by a tube, containing pieces of solid caustic potash, attached to it, not increasing in weight. The originator of the method uses, instead of a chlorid of calcium tube, a U tube, containing pumice soaked in sulphuric acid, and having a little sulphuric acid at the bottom, to show the rate at which the gas is passing through. In my analyses, I used a chlorid of calcium tube, as usual, and to show the rapidity of the stream of gas, I employed a little bulb-apparatus, of the annexed form, passing through the cork at one end of the soda-lime tube, and filled with caustic potash. This has the advantage that it absorbs a large part of the carbonic acid and thus makes the soda lime last longer.



reduced to protoxyd, which does not drive out carbonic acid from carbonate of soda. The residue in the bulb was washed somewhat, ignited, evaporated to dryness with hydrochloric acid and chlorid of ammonium, and ignited in a stream of hydrogen. After thorough washing, it was again ignited in hydrogen and weighed as UO. This process is, according to Rose,* the best method for separating uranium from the alkalies.

The three following analyses were of precipitates from the nitrate. The first two were dried: the last was not.

	Calculated.		Prep. I. 1.	Prep. I. 2.	Prep. II.
$3U_2O_3$	432	90·76	91·60	90·29	90·55
$2CO_2$	44	9·24	8·40	9·71	9·45
	476	100·00	100·00	100·00	100·00

The five next analyses were of precipitates from the sulphate. The last was precipitated by pouring the sulphate of uranium into the carbonate of soda: the others, as usual, by pouring the carbonate of soda into the uranium solution.

	Calculated.		Prep. I. 1.	Prep. I. 2.	Prep. II. 1.	Prep. II. 2.	Prep. III.
$3U_2O_3$.	432	95·16	95·52	94·60	94·13	94·68	94·54
CO_2.	22	4·84	4·48	5·40	5·87	5·32	5·46
	454	100·00	100·00	100·00	100·00	100·00	100·00

Notwithstanding the tolerably close agreement of the above results with the formulas just given, I am strongly inclined to think that these formulas do not express the true composition of the precipitates. A portion of one of the precipitates, after very protracted washing with cold water, still contained alkali, showing the presence of uranate of soda.† This result might indeed be inferred, almost with certainty, from the very strong affinity of sesquioxyd of uranium for the alkalies.‡ On account of this impurity, as well as the ease with which all these carbonates appear to lose carbonic acid, the observed percentage of carbonic acid should be less than the calculated. Instead of this, it is in nearly every case larger. I suspect, therefore, that the precipitates in question are mixtures of a less basic carbonate with uranate of soda. More of the latter appears to be formed in the precipitate from the sulphate of uranium than in that from the nitrate. Why this should be I cannot explain. What the true composition of the carbonate of uranium would be, if it could

* Analytical Chemistry, French ed., ii, 252.

† The carbonates of iron, chromium and alumina, after washing with cold water contained not a trace of soda. The carbonate of glucina contained a mere trace, which could probably have been removed by further washing.

‡ For example: the sesquioxyd of uranium cannot be separated from the alkalies by ammonia. Only the excess of alkali is separated. The rest is precipitated with the uranium, as uranate of the alkali. See Rose, Analt. Chem., Fr. ed., ii, 252.

be obtained pure, may be with probability inferred from the composition of its double salts with carbonate of potash and with carbonate of ammonia, in which it exists, according to Ebelmen,* as U_2O_3, CO_2. On the other hand, as the salts of the sesquioxyd of uranium, with the stronger acids, contain only one equivalent of acid, instead of three like those of the other sesquioxyds, analogy with the carbonates just described should make the carbonate of uranium contain less than one equivalent of acid to one of base. The first view is, however, I think, the more probable one.

Summary of the above results.

The following is a brief summary of the principal results arrived at in the foregoing pages:

1. All the carbonates in question, except, perhaps, the carbonate of uranium, lose carbonic acid readily, during the processes of washing and drying. To this may, in a great measure, be attributed the discordant results of previous observers.

2. The precipitate, produced by the alkaline carbonates in solutions of the persalts of iron, has the composition Fe_2O_3, CO_2.

3. The precipitate by the alkaline carbonates, in the violet salts of the sesquioxyd of chromium, varies somewhat in composition, but approaches the formula Cr_2O_3, $2CO_2$ and is probably a mixture of this with a little of the more basic salt next mentioned. The results of previous observers render it nearly certain that the above precipitate, by washing and drying, is converted into a more stable salt of the composition Cr_2O_3, CO_2. This latter is formed, when the precipitation takes place at the boiling point. The precipitate in the green solutions of chromium consists of carbonate, not of oxyd as stated by Lefort, and has probably the same composition as in the violet salts.

4. The precipitate by the fixed alkaline carbonates, in the salts of alumina, varies in composition, but approaches the formula Al_2O_3, CO_2 and is probably a mixture of this with a more basic salt. Both in this and in the case of the carbonate of chromium, the normal salt may be obtained nearly free from basic compounds, by pouring the alumina or chromium solution into that of the alkaline carbonate, instead of the reverse, so as to have always an excess of the alkali.

5. The precipitate by the alkaline carbonates, in the salts of glucina, has the composition G_2O_3, CO_2.

6. The precipitate by the alkaline carbonates, in solutions of the sesquioxyd of uranium, is undoubtedly a mixture of uranate of the alkali and carbonate of uranium. The latter, if it could be obtained pure, would very probably have the compo-

* Ann. Chim. et Phys., [3], v, 206–208.

sition U_2O_3, CO_2, in which state it exists, according to Ebelmen, in its double salts with the carbonates of potash and ammonia.

In conclusion, it will be observed that none of these carbonates conform to the theory of Berzelius, that the number of atoms of acid, in a neutral salt, corresponds to the number of atoms of oxygen in the base. On the contrary, their composition is generally the same as that of the salts of the protoxyds, one atom of acid to one of base.

Laboratory of the Lawrence Scientific School, Cambridge, July, 1862.

ART. XXIX.—*Supplements to the Enumeration of Plants of Dr. Parry's Collection in the Rocky Mountains*, (continued from p. 261.)

SUPPLEMENT I.—*Coniferæ*, by Drs. PARRY and ENGELMANN.

DR. PARRY collected too few specimens of the following Coniferæ for distribution, but as his notes are replete with interest they are given here (under marks of quotation) together with a few remarks of my own. G. E.

ABIES GRANDIS, Lindl. Not common in this region, resembling much the Eastern *A. balsamea*. Fendler's N. Mex. No. 828 is the same.

ABIES DOUGLASII, Lindl. "Abundant through the eastern mountain district, except on the higher elevations. A very sightly tree, of the average height of 80 feet, with a graceful oval outline; the spreading branches curving upwards at the extremities. Wood of slow growth, but very indifferent, inclined to warp and crack, turning reddish-brown in drying." This species, as well as the nearly allied *A. Canadensis*, is well distinguished from all our other Pines by the distinctly petioled leaves. Fendler's N. Mex. No. 829.

ABIES MENZIESII, Lindl. "A finely shaped tree, though of rather stiff outline, of rapid growth; wood very compact, but rather coarse grained and pitchy; the logs taper too rapidly to saw up to advantage." Cones pendulous from the end of the branches. Leaves stouter than in any other allied species, stiff and very acute, almost spinescent.

ABIES NIGRA, Poir. Probably the same as the northeastern tree (characterized by the slender and very acute leaves, ovate cones with thin and crenate margin of the scales), a pale-leaved form of which is usually named *A. alba*, but which Prof. Gray has demonstrated to belong to *A. nigra*. The true *A. alba* (leaves somewhat stouter and obtusish, cylindric cones with thickened entire margin of the scales) seems to extend from Canada to the northern Rocky Mountains, where it has been gathered by Bourgeau; but it has not fallen under Dr. Parry's or Dr. Hayden's observation, on the headwaters of the Kettle, Colorado, Missouri and Columbia Rivers, where *Abies nigra* seems to be abundant, extending down to Santa Fe (Fendler, N. Mex. No. 833). Dr. Parry found it

* Schw. xvii, 424, in Gmelin's Handb. Art. Cerium.

"composing almost the entire forest growth of the mountain slopes of Middle Park about the head of Grand River: a magnificent tree, 80 to 100 feet high, with an even, columnar trunk, below, 2–2½ feet in diameter, tapering upwards; of rapid growth; bark scaly, smooth and quite thin, of a purplish-brown color, full of tannin, and quite different from the rough brown bark of *A. nigra* of Wisconsin; wood remarkably white and soft, free of knots and scarcely resinous, preferred for inside work." Could this be *Abies rubra* Loud., and specifically distinct from *A. nigra*?

PINUS ARISTATA, Engelm., in St. Louis Transact., vol. 2, tab. 5 and 6. Dr. Parry had the good luck to discover this very peculiar and exclusively alpine species "which does not descend lower than 9000 or 10,000 feet," on the higher mountains of Clear Creek. As a full description and a figure has been given in the Transactions of the St. Louis Academy, I confine myself here to the statement that it is our only representative of Endlicher's section, *Pseudostrobus*, which comprises numerous Mexican, a few Central American, and a single West Indian species; it is characterized by quinate entire leaves and horizontal ovate cones, with thin apophyses on the long-mucronate or aristate scales, and small winged seeds. In sheltered situations it forms a tree 40 or 50 feet high and 1 or 2 feet in diameter, but on the higher bleak mountains it is a stunted bush, often thickly covered with fruit. Its growth, at least in the latter localities, is exceedingly slow, as a stick of scarcely more than one inch in diameter, brought back by Dr. Parry, shows nearly fifty annual rings, some of them $\frac{1}{30}$ of a line, and none more than $\frac{1}{8}$ of a line wide.

PINUS FLEXILIS, James. This species, discovered in the same regions by Dr. James, has to some extent remained doubtful, as his description in the account of Long's Expedition, and Torrey's diagnosis in the Annals of the New York Lyceum (vol. ii, p. 249) are based on notes only, no specimens having been collected. By later writers it has been ignored, until Mr. Fendler in 1847 collected it on the mountains above Santa Fe, (Coll. N. Mex. No. 832), when a short notice was published by the writer in the appendix to Wislizenus' Memoir of a Tour to New Mexico, etc., 1848. Endlicher, in his Synopsis Coniferarum, 1847, does not enumerate it, and Carrière in his Traité des Conifères, 1855, credits it to Wislizenus, translating only my short remarks. Nuttall, however, had already (in 1849) given a somewhat extended account of it, with a poor figure, in the continuation of Michaux's Sylva (vol. iii, p. 107, pl. 112), without clearing up the doubts, which Dr. Parry in his present expedition, 1862, is expected finally to settle. My brother, H. Engelmann, collected it on the head waters of the Platte, and Dr. Hayden on the mountains about the head waters of the Yellowstone, Missouri and Columbia rivers. Dr. Parry notes that the cones grow several together, "semipendulous" at the extremity of the horizontal branchlets; while James gave his plant "erect" cones. Near Santa Fe it grows at the elevation of 8000 or 10,000 feet, and in favorable situations becomes 60 or 80 feet high and bears "pendulous" cones, according to Fendler's note. *Pinus flexilis* is certainly intermediate between the sections *Cembra* and *Strobus* of Endlicher, and unites the two, as does *P. cembroides*, Newberry, Pacif.

R. Rep., vol. vi, Bot., p. 44, not Zucc.,* if, indeed, this is not a mere form of *P. flexilis*, approaching by its short cones close to *P. Cembra.* The large seeds of *P. flexilis* are, as Dr. James already stated and as Dr. Hayden confirmed, eaten by the Indians. They are distinguished from those of any other of our Pines by a persistent, sharp, keeled margin, representing the wing.

PINUS PONDEROSA, Dougl., is "common through all the lower valleys and less elevated districts of the mountains, associated with *A. Douglasii* and *A. Menziesii*; a most valuable timber tree." Fendler's N. Mex. No. 831. Male aments cylindrical, several inches long.

PINUS CONTORTA, Dougl., "is quite abundant on the crest and slopes of dry subalpine ridges, forming the principal part of the forest there, and extending to near the snow line; a symmetrical tree of rapid growth, 30 or 40 feet high, with slim and tapering trunk a foot in diameter, a smoothish, grayish-brown bark, detached in thin scales, and tough but coarse wood, which is liable to warp, and rarely cut into boards."

SUPPLEMENT II.—Revision of the *Œnotheræ* of the subsection *Onagra*; by Dr. ENGELMANN.

[*Prefatory Note*, by A. GRAY.—Nuttall, in his Genera, stated that Pursh had confounded two species under *Œ. albicaulis*, viz., his own *Œ. albicaulis* and *Œ. pinnatifida.* In *Plantæ Wrightianæ* I had come to the conclusion that Pursh was right, not then knowing the seeds of *Œ. pinnatifida*, Nutt. Consequently, when good fruit of the latter came to hand, in Wright's second collection, in Pl. Wright, 2, p. 56, I carelessly referred the specimens to *Œ. coronopifolia*, on account of their seeds, notwithstanding their longer capsules, overlooking the other characters, and wrongly supposing that Nuttall's description of the seeds of his *Œ. pinnatifida* or *Bradburiana* somehow belonged to *Œ. coronopifolia*, which, as I had shown in Pl. Fendlerianæ, has such seeds, while those of *Œ. albicaulis* are longer and smooth. Dr. Engelmann has recently corrected this oversight, and in the following memorandum has established the three species upon a good foundation. I greatly doubt the distinctions based upon the duration of the root, although *Œ. albicaulis* and *Œ. coronopifolia* generally, if not always, have the appearance of being perennial, while

* Zuccarini's plant of that name is one of the curious little group of American Nut-pines, including the following four species: *Pinus monophyllos*, Torrey and Fremont, with single (not connate, as Endlicher would have it) leaves; *P. edulis*, Engelm., with 2 leaves; *P. cembroides*, Zucc., (including *P. Llaveana*, Schiede. not Torr., and *P. osteosperma*, Engelm.) with 3 leaves; and *P. Parryana*, Engelm. (*P. Llaveana*, Torr. Bot. Mex. Bound., p. 208, t. 53) with 3-5, mostly 4 leaves. Other characters, taken principally from the bracts of the young shoots, strengthen the specific distinctions. This very natural little group is characterized by the small, almost globose cones, the scales bearing large pyramidal apophyses and large edible seeds, the wings of which remain attached to the scale, which, I suspect, is the case in all "wingless" seeds of pines; in *P. Pinea*, however, the wing is very distinct and detaches itself clearly from the scale and at the same time also from the seed itself, which is likewise the case in the closely allied, though 5-leaved, Californian *P. Torreyana*, Parry, where the wing, besides, is very thick, and of a corky substance. The great variability in the number of leaves in the nut-pines proves that sectional characters taken from them are without value.

Œ. pinnatifida flowers early from a slender monocarpic root; I should not rely much upon the shape and size of the petals; and the leaves are most polymorphous. But, in brief,

Œ. CORONOPIFOLIA, Torr. and Gray, is well marked by the strong villosity of the throat of the calyx, the short and thick, ovoid-oblong, or at most linear-oblong capsules, and the large, oval or oblong, strongly costate seeds, the ribs tuberculate.

The two following both have the calyx glabrous (rarely with a few hairs) in the throat, much larger petals, and larger pods.

Œ. PINNATIFIDA, Nutt., has less elongated and stouter capsules, and small, ovoid, striate-reticulated seeds (with pits between the ribs), apiculate at the hilum.

Œ. ALBICAULIS, Nutt., in all its forms, has elongated-oblong and perfectly smooth seeds, and its longer, linear, capsules are closely sessile by a broad base, and mostly porrected or divaricate from the axis which bears them, often flexuose.

Dr. Parry's No. 116 is *Œ. pinnatifida ;* his 117, probably a canescent form of *Œ. albicaulis ;* neither are in fruit.

The following communication from Dr. Engelmann was received too late for insertion in its proper place in the July No. of the Journal. A. G.]

"A large suite of specimens enables me to clear up some difficulties which have environed the following species of *Œnothera.*

"1. ŒNOTHERA CORONOPIFOLIA, Torr. & Gr. Fl. 1, p. 245; Gray, Pl. Fendl., p. 43. Perennis, saepe multicaulis, humilis, erecta seu erecto-patula, puberulo-canescens, strigosa seu hispida; foliis infimis lineari-spathulatis, caeteris pectinato-pinnatifidis; *tubo calycis ad faucem dense villoso ; petalis suborbiculatis integris* stamina aequantibus pistillo brevioribus; capsula ovato-seu lineari-oblonga *torulosa basi nunc in pedicellem brevissimum attenuata suberecta ; seminibus magnis ovatis turgidis subobtusis varie oblique truncatis tuberculatis.* My specimens were collected by Mr. Fendler (No. 222) near Santa Fe, along waterducts, and by Dr. Hayden on the sandhills of the Loupfork, on "Running Water." Stems ½–1 foot high: flower white, turning deep red, about an inch in diameter: capsule in Fendler's specimens about an inch long, in Hayden's only about 4 lines long, thicker than in the allied species: seeds yellowish-brown, about a line long, thick, beset with tubercles arranged in longitudinal rows.

"2. ŒNOTHERA PINNATIFIDA, Nutt., Gen. 1, p. 245 ; Torr. & Gr. Fl. 1, p. 494. *Œ. albicaulis*, Pursh, Fl. 2, p. 733: DC. Prodr. 3, p. 51, non Nutt. *Œ. Purshii*, Don. Syst. 2, p. 688. *Œ. Purshiana*, Steud. Nom. 2, p. 207: Annua seu biennis, humilis, diffusa, (rarissime erecta), puberula, rarius sursum hirsuta; foliis imis obovato-spatulatis acutis seu obtusis integris, caeteris pinnatifidis saepe ciliatis; *tubo calycis ad faucem nudo; petalis late obcordatis seu profunde emarginatis genitalia superantibus ;* capsula lanceolato-lineari *torulosa sessili suberecta ; seminibus ovatis turgidis utrumque apiculatis foveolatis seriatim inter costas dispositis eleganter notatis.* Sandy soil on White River, Upper Missouri, Nuttall, Geyer in Nicollet's Expedition, Dr. Hayden; Las Vegas and Santa Fe, New Mexico, Dr. Wislizenus, Mr. Fendler; the latter's specimens, few in number, bearing his private number 239, were distributed with others of the next species under No. 223; Southern New Mexico, Wright (referred to *Œ.*

coronopifolia in Pl. Wright, 1, p. 69.) All the specimens I have seen are either annual (sometimes simple and one-flowered) or, usually, biennial, with rosulate entire radical leaves; branching from the base, diffuse or even decumbent; an erect form was collected by A. Gordon on the Upper Canadian River, No. 29, similar to the last species in habit. Stems usually 4–6 inches high, but, according to Nuttall, the decumbent branches sometimes 2 feet long. Flowers 2½–3 inches in diameter, white, turning pale red: capsule 1–1¾ inches long: seeds very regularly and prettily pitted between the longitudinal ribs, 0·6–0·7 of a line long, yellow. Don and Steudel have changed Nuttall's earlier name, but his must stand and Humboldt's plant, described five years later under the same name, may receive the name of *Œ. Humboldtii.*

"3. Œnothera albicaulis, Nuttall in Fras. Cat., 1813, & Gen. 1, p. 245; Torr. & Gr. Fl. 1, 495; Gray Pl. Wright 1, p. 69, & 2, p. 56: Perennis, glabra, puberula seu hirsuta; caulis *cortice albida membranaceo nitente;* foliis maxime variis; *petalis orbiculato-ovatis* in unguem plus minus attenuatis *integris* stamina superantibus pistillum aequantibus; *sapsula e basi crassiore sessili lineari divaricata saepe flexuosa seu deflexa; ceminibus minoribus lineari-lanceolatis laevibus.* A common plant on the western plains, extending into Oregon, New Mexico and Chihuahua, as variable in habit, growth and foliage as it is common, but always easily recognized by the unvarying characters of the flower and fruit as above indicated, and also by its white glistening stems and branches, the epidermis of which is apt to peal off in the manner of many Loasaceæ. The white flowers, 1½–1¾ inches in diameter, at last turn pale-red; the very slender capsule, connected by a very thick base with the stem, is usually 1½–1¾ inches long, and spreads at right angles, or is curved or twisted in various directions. Seeds smooth, dark-brown, lance-linear and usually very acute at one end, and 0·8 line long; var. δ, has smaller (0·6 line) and obtuse seeds. According to foliage and pubescence I arrange the specimens before me under the following varieties:

a. Foliis basi in petiolum brevem attenuatis.

Var. α. Nutallii: erecta, glabriuscula seu puberula, simplex seu ramosa; foliis linearibus seu lanceolatis seu oblongis integris vel plus minus dentatis. Here belongs *Œ. pallida,* Dougl., with its variety *leptophylla,* Torr. & Gr., as already indicated by Prof. Gray. Nuttall describes this form as sometimes 3 feet high, and Geyer notes that in the sandy plains of Devil's Lake and at the sources of St. Peter's River it forms shrubby bushes of the size of Spartium scoparium, growing even 4 feet high; but it seems more usually between one and two feet high. Leaves 1–2½ inches long and 1–6 lines wide. One of the broadest leaved forms is Fendler's N. Mex. No. 224.

Var. β. runcinata: branchiato-ramosa, patula, glabra, puberula seu canescens; foliis lanceolatis grosse seu sinuato-dentatis. This is *Œ. pinnatifida,* Gray Pl. Fendl., p. 43 (description and most of the specimens No. 223, all those with the private number 243). Fendler gathered it near Santa Fe; Fremont in his 3d Expedition collected a glabrous (No. 222) and a very canescent (No. 178) form, the latter with singularly short but apparently fertile capsules, scarcely 3 lines long.

b. Foliis basi lata truncata sessilibus.

Var. γ. BREVIFOLIA: tota glaberrima, erecta, ramosissima; foliis late ovatis abbreviatis grosse dentatis. Sandhills south of El Paso, Dr. Wislizenus, No. 99. Leaves dark green, while all the other forms are pale or grayish, 4–6 lines long, acutish, or often rounded at the end.

Var. δ. TRICHOCALYX: erecta, parce ramosa, canescenti-hirsuta; foliis lanceolatis seu lanceolato-oblongis sinuato-dentatis. Las Vegas, New Mexico, Dr. Wislizenus, No. 473.—This is no doubt Nuttall's *Œ. trichocalyx*, Torr. & Gr. Fl. l. c., the specific identity of which with *Œ. albicaulis* Prof. Gray has already indicated. The long hair on the stem, ovary, and especially the calyx, consists of a single cell, remarkably broad at base, tapering to an acute point;—it is however the form of hair I find in all long-haired *Œnotheræ*. G. E.

SUPPLEMENT III.—Revision of the genus *Castilleia*; by A. GRAY.

CASTILLEIA, Linn. f.

The species of this genus are most troublesome and unsatisfactory, not only on account of the difficulty of investigating the dried specimens, but also from the variability of the characters which have been relied npon in arranging them, and especially of the calyx. Although the latter affords good characters on the whole, yet the degree of fission and the form of the lobes are far from being constant in several species; and the same remark applies in a measure to the relative length of the galea and of the lower lip. The structure of the lower lip is likely to afford some good characters; but they are not readily nor very safely to be derived from dried specimens. Bentham's four sections (in De Candolle's Prodromus) do not prove to be as distinct as they would seem. The second and the third were better combined into one, which will include all our North American species but two. The fourth section is pretty well marked, but not absolutely. Of the first, which would appear to be quite distinct, I have no specimens. Beginning with Bentham's fourth section, since this comprises the original species :—

§ 1. HEMICHROMA or EUCASTILLEIA. Calyx (sæpe incurvus) antice profunde fissus, postice leviter bifidus sæpius 4-dentatus.

C. LINARIÆFOLIA, Benth., is one of the best characterized and the most northern species. It is known by its long, narrow and glabrous cauline leaves which are not dilated at the base, the floral ones scarlet-colored, by the subulate teeth of the calyx, and by the long and narrow galea, which is more slender and falcate than in *C. tenuiflora ;* the lobes of the lower lip linear-subulate. But the flowers are not always sessile, nor the leaves only one-nerved and entire; these are often 3-cleft or 3-parted, and more or less distinctly 3-nerved at the base. To this species clearly belongs *C. fulgens*, Nutt. in herb. Philad., and *C. candens*, Durand in Pacif. R. R. Rep. 5, p. 12. (But No. 70 of the Californian (Fort Tejon) collection of Xantus, also specimens collected by Dr. Newberry in the Colorado expedition, which I had mistaken for *C. candens*, belong to *C. affinis*). This is No. 583 of Fendler's New Mexican collection, and 246 of Dr. Parry's Rocky Mountain collection.

C. TENUIFLORA, Benth., Pl. Hartw. No. 191, as Bentham intimates, should probably include *C. longiflora*, Kunze, and *C. canescens*, Benth., (which is Gregg's No. 434, 610, and Coulter's No. 1354), all from Mexico.

C. ORIZABÆ I have not seen, unless Coulter's No. 1352 and 1353 belong to it.

C. FISSIFOLIA, Linn. f. (No. 835, coll. Venezuel. Fendler). To this Weddell refers all the five other South American species of this section, including even *C. integrifolia*, Linn. f.

C. LAXA, Gray in Bot. Mex. Bound., p. 119, of Arizona (coll. C. Wright, No. 1490), has a broader calyx and corolla than any of its allies, the former very thin-membranaceous, colored, and with obtuse teeth, the galea slightly falcate; the leaves thin and not dilated at the insertion.

§ 2. EUCHROMA (incl. *Callichroma*). Calyx antice et postice fissus, segmentis integris emarginatis vel bifidis.

I have nothing to say of the six Mexican and South American species in the Prodromus. The proper North American ones I understand as follows:

* *Radice annua vel bienni.*

+ *Integrifoliæ.*

C. AFFINIS, Hook. & Arn. Folia lineari seu lanceolato-attenuata, floralia raro trifida: flores pl. m. pedicellati: calyx usque ad medium bifidus, segmentis angustis saepius bifidis vel emarginatis: galea elongata falcata; labium brevissimum.—The calyx is generally cylindrical, more or less curved, and reddish, and the wholly exserted galea 6 to 8 lines long: but the species, I believe, passes by regular gradations into the

Var. MINOR, Gray in Bot. Mex. Bound., p. 119 (*Euchroma simplex* and *E. lanceolata*, Nutt. in herb. Acad. Philad.), which has smaller flowers, less colored floral leaves, a green and herbaceous calyx, the galea of the pale corolla only three or four lines long. Hartweg's No. 1877 is a good intermediate form. The calyx in both forms (as I have elsewhere noted) varies with its segments deeply bifid, moderately bidentate, or entire.

C. INDIVISA, Engelm. Folia caulina lineari-lanceolata, floralia obovato-dilatata rarius sublobata: flores sessiles: calycis segmenta lata sæpius emarginata; galea brevis breviter exserta. I have not the means of collating this with *C. lithospermoides*.

+ + *Laciniatifoliæ.*

C. COCCINEA, Spreng. The only annual, or perhaps biennial, species with laciniately cleft leaves; confined to North America east of the Rocky Mountains, and mostly east of the great plains, ranging from Rupert's Land to Texas.

* * *Radice perenni.*

+ *Foliis floralibus superne pl. m. dilatatis et coloratis.*

++ *Villoso-pubentes, vel inferne glabræ, pube versus apicem caulis, etc., patente pilosa vel hirsuta sæpius viscosa.*

C. PARVIFLORA, Bongard. Fere undique piloso-pubescens vel hirsuta, vix hispida: folia pleraque trifida vel pinnato-laciniata, floralibus apice sæpissime rubro-colorata: calycis segmenta aut emarginato-biloba, aut profunde bifida lobis oblongis seu linearibus: corollæ labium brevissimum.

—This is apparently the commonest species and of widest range west of the Rocky Mountains, extending from Russian America to Southern California. The name given by Bongard is much the earliest, but not a good one, being founded upon what, I believe, is only a northern form of Bentham's *C. hispida* (a later and scarcely more appropriate name), with a less developed corolla. The length of the galea appears to be subject to variation in this species, as in *C. pallida*, and the calyx-segments still more so. To the present species may be referred: *C. coccinea*, Lindl. Bot. Reg. t. 1136 (non Spreng.), which, as its calyx-segments are described as being dilated and retuse, Mr. Bentham should rather have referred to his *C. Douglasii*. *Euchroma angustifolia* and *E. Bradburii*, Nutt.! in Jour. Acad. Philad. 7, p. 44, 47 (1834), both hirsute forms with deeply cleft and narrow calyx-segments. *Castilleia hispida*, Benth. in Hook. Fl. Bor. Am. & in DC. Prodr., 10, p. 532. *C. Douglasii*, Benth. in DC. l. c. p. 530; the commoner form, with oblong or more dilated and slightly lobed or cleft calyx-segments. *C. desertorum*, Geyer in Hook. Kew Jour. Bot. 5, p. 258, which is just Nuttall's *E. angustifolia*, but with partly yellow bracts. *E. macrocalyx*, *E. villosa*, *E. laciniata*, and *E. viscosa*, Nutt. in herb. Acad. Philad.

C. PALLIDA, Kunth. Inferne sæpius glabra vel glabrata, caule versus apicem calycibusque villosis: folia inferiora sæpissime integra (e forma lineari ad ovato-lanceolatam), floralia vulgo pl. m. incisa vel laciniata et albido-colorata: calycis segmenta bifida seu biloba: galea aut breviuscula aut elongata.—The most northern species, and extending round the world on the borders of the arctic zone. I am well satisfied (especially from White Mountain specimens, clearly all of one species) that the galea varies much in length or degree of development,—the lower lip remaining nearly uniform,—and that, accordingly, *C. Sibirica* and *C. septentrionalis* of Lindley are states of one species, *C. pallida*,—to which belong *C. acuminata*, Spreng. (*Bartsia acuminata*, Pursh), *C. occidentalis*, Torr. (a dwarf alpine form), *Euchroma lutescens*, Nutt. in herb. Acad. Philad., and, as a variety:—

Var. MINIATA: viridior, inferne glabra; foliis floralibus pl. m. miniatis; galea elongata magis exserta. *C. miniata*, Dougl., Benth. *Euchroma integrifolia*, Nutt. in herb. Hook. & Acad. Philad. This is pretty well marked on the whole; but in Rocky Mountain specimens it runs both into *pallida* and *septentrionalis*. As to "*C. pallida* var. *Unalaschensis*, Cham. and Schlecht.," from Sitcha, my specimens from Bongard consist of narrow-leaved ones with a short galea (true *C. pallida*) and a broader-leaved one with elongated galea, good *C. septentrionalis*, apparently, referred by Bentham to *C. miniata*. C. No. 1, Bourgeau's coll. in Palliser's Exped., is *C. miniata* with the upper cauline and floral leaves unusually cleft.

C. LATIFOLIA, Hook. & Arn. Undique viscoso-hirsuta, laxe ramosa: folia brevia, obovata, obtusissima, plerisque integra, floralia apice dilatata, 3–5-lobata, rubro-colorata: calycis segmenta lata emarginato-biloba: corolla parva. A well-marked Californian species. The comparatively short and broad calyx is sometimes equally cleft before and behind, sometimes much deeper posteriorly.

++++ *Tomentosæ, vel pube caulis molli implexa. Folia caulina linearia integra, vel trifida.*

a. Incanæ ; calycis segmentis dilatatis subintegris.

C. FOLIOLOSA, Hook. & Arn. Flocсoso-tomentosa, tomento e pilis ramosissimis! Caules suffruticosi cum foliis adultis quandoque glabrescentes: galea ultra segmenta calycis spathulato-oblonga sæpius retusa leviter exserta.—The peculiarity of the pubescence is indicated in Bot. Mex. Bound. Survey, p. 118.

C. LANATA, Gray in Bot. Mex. Bound., l. c. Herbacea, tomento arachnoideo appresso albo-lanata: flores fere *C. foliosæ*, sed majores.

b. Cinereo-puberulæ vel subtomentosæ ; calycis segmentis sæpissime bifidis ; galea exserta. Folia supra nunc glabra.

C. INTEGRA, Gray in Bot. Mex. Bound. l. c. Caulis laxe tomentosus: folia (sæpius tomentulosa) omnia integerrima, vel floralia sublobata, raro trifida: flores sesquipollicares, galea majore et labio breviore quam *C. purpureæ*.—Besides the numbers already cited, this is No. 244 of Parry's Rocky Mountain collection (a dwarf or subalpine form); and my *C. tomentosa*, from Mabibi, Arizona, Thurber, appears to be a more tomentose state of the same species, the flowers in the specimen not well developed. It is closely related to *C. purpurea*, and perhaps runs into it. To that, at least, I now refer the undistributed specimens of Wright's first collection.

C. PURPUREA, Don. Caulis tomentulosus vel cinereus: folia pubera vel glabrata, superiora vulgo cum floralibus trifida seu laciniata: flores pollicares, labio minus quam in affinibus abbreviato (2–2½ lin. longo). Floral leaves varying from cherry-red to flesh-color, or light yellow. Lower lip of the corolla by no means half the length of the galea in well developed flowers. To this species belongs *C. angustifolia*, Gray in Bot. Mex. Bound. l. c., excluding the synonymy, and excluding the plant of H. Engelmann from Bridger's Pass, the latter being *C. miniata*. It is, accordingly, Wright's No. 1491 and 1492, and Lindheimer's 488 and 669.

+– +– *Foliis (plerisque 3–5-fidis lobis linearibus) floralibus apice nec dilatatis nec coloratis. Calyx aut æqualiter aut antice profundius fissus, segmentis alte bifidis. Corollæ labium magis quam in* cæteris *trisaccato-carinatum, lobis galeæ dimidium adæquantibus. Plantæ humiles, subvillosæ vel subcinereæ.*

C. SESSILIFLORA, Pursh. Calyx et corolla tubo elongato angusto; labio tripartito, lobis lineari-lanceolatis. Corolla evoluta bipollicaris, galea 4–6 lin. longa.

C. BREVIFLORA, Gray, Pl. Parry, No. 243. (*Euchroma breviflora*, Nutt. in herb. Philad.) Spithamæa, spica densa, florescente vix pollicari; calyce ovoideo-oblongo, lobis lanceolatis; corollæ luteæ tubo fere incluso, labio inferiore triplicato-saccato breviter trifido, lobis oblongis obtusis.—Rocky Mountains, Nuttall, Parry, No. 243. A well-marked species of this genus; the lip of the corolla about as long in proportion to the galea as in *C. sessiliflora*, but more trisaccate,—therefore one of the transitions to *Orthocarpus*. The calyx in flowers of the same spike is sometimes about equally cleft behind and before, and sometimes split in front while the posterior cleft is no deeper than that between the lateral lobes.

Excludendæ. Small indeed are the absolute distinctions between some of the third section of *Orthocarpus* and *Castilleia.*

Euchroma albida, Nutt. in herb. Acad. Philad., is *Orthocarpus attenuatus*, Gray in Bot. Whippl. Exped. Pacif. R. R. Rep. 4, p. 121. This is the "O. No. 1," of Dr. Lyall's collection on the Oregon Boundary, from Lopez Island, distributed at Kew Gardens.

Euchroma pallescens, Nutt. in herb. Acad. Philad., from the Rocky Mountains, being a near relative of the preceding and of *Orthocarpus densiflorus*, and I believe not a described species, would take the name of *O. pallescens*. The lobes of the lower lip of the corolla are so conspicuous that it can hardly be *O. hispidus*, Benth., a species unknown to me. The segments of the deeply two-cleft calyx are merely bifid at their apex. Near to this, if not the same, but more hairy, with deeper-cleft calyx-segments, and yellowish corolla almost an inch long, are specimens of Geyer's Rocky Mountain collection, distributed as No. 291, therefore probably those mentioned in Hook. Kew Jour. Bot. 5, p. 259. Here also the lobes of the lower lip are quite conspicuous, and the incompletely developed specimens might very readily be taken for those of a *Castilleia*.

SUPPLEMENT IV.—Review of the genus *Mertensia*; by A. GRAY.

MERTENSIA, Roth.

The species of *Mertensia* which I have been able to examine, although not a little perplexing, may perhaps be best discriminated as follows:—

§ 1. Filamenta gracilia antheris multo longiora: corollæ tubo calyce alte 5-fido pluries longiore, limbo levissime lobato, plicis faucialibus nullis. Tota glaberrima.

1. M. VIRGINICA, DC.—The disk is annular, but on each side developed into a large lobe or glandular appendage. That of *M. Fendleri* and of some specimens of *M. paniculata* approaches it. Corolla villous inside just above the obscurely 10-glandular base of the tube.

§ 2. Filamenta antheris plus minus angustiora et longiora: corollæ limbo lobato.

2. M. MARITIMA, Don. Corollæ tubo limbo breviore calycem sub-5-partitum subæqaunte, plicis conspicuis.

3. M. PALLASSII, Don. *M. Sibirica*, DC., &c. *Pulmonaria Sibirica*, Pall., non Linn. *Lithospermum Pallassi*, Ledeb. Corollæ tubo limbo 1½–2-plo calyce 3-plo longiore, plicis tenuibus. Siberia.

§ 3. Filamenta magis dilatata, antheris æquilata seu latiora et plus minus breviora: corollæ limbo 5-fido.

* *Calyx haud ultra medium 5-fidus.*

4. M. FENDLERI (sp. nov.): foliis subtus cauleque lævibus supra cum pedicellis appresse hispidulis, caulinis oblongo-lanceolatis; racemis paucifloris; corollæ tubo lobis calycis hirsuti lato-lanceolatis limboque vix longiore intus supra basim annulato-villoso. New Mexico: foot of hills on Santa Fe Creek, Fendler No. 625. Discus pl. m. bilobus.

* * *Calyx 5-partitus, in M. oblongifolia et M. alpina quandoque alte 5-fidus.*

+– *Corolla tubo quam limbus (i. e. pars dilatata supra faucem) 2–3-plo longiore.*

5. M. DAVURICA, Don. Gracilis; foliis caulinis linearibus supra cum calyce subincano-hirtis; corolla ima basi annulato-pilosa, cæt. glabra. Siberia. The hairy ring (much less conspicuous than that of the foregoing species) is here at the very base of the corolla, occupying the position in which ten obscure glands or slight thickened spots are generally discernable: these are most evident in the following species, and in *M. alpina.*

6. M. OBLONGIFOLIA, DC., Hook. Kew Jour. Bot. 3, p. 295. *Pulmonaria oblongifolia*, Nutt.! *Lithospermum marginatum*, Lehm. in Hook. Fl. Bor. Am. Humilis; foliis caulinis oblongis vel spathulato-lanceolatis plerumque obtusis; segmentis calycis lanceolatis seu linearibus acutis corollæ tubo intus glaberrimo 2–3-plo brevioribus. Interior of Oregon, Utah, &c. Varies with the sepals very narrow and ciliate with long and rigid bristles, as in Nuttall's original specimens collected by Wyeth; or with these ciliæ minute or sparse or obsolete, as in most specimens; in Geyer's No. 316, the calyx is hardly 5-parted, and its segments broader; in Spalding's, from Clear Water, the leaves are unusually broad. The leaves resemble those of Heliotropium Curassavicum.

+– +– *Corolla tubo quam limbus ad summum sesquilongiore.*

++ *Elatæ, 1–3-pedales: folia caulina ovata seu ovato-lanceolata, acutissime acuminata vel acutata, costato-venosa; corollæ semipollicares seu paullo longiores.*

7. M. PANICULATA, Don. *M. paniculata, pilosa, pubescens, lanceolata? stylosa? & Kamtschatica?* DC. Hirsuta, hirtula, vel glabrata; segmentis calycis lanceolatis seu lanceolato-linearibus acutis hirsutis vel hispido-ciliatis tubo corollæ intus sparsim piloso paullo vel dimidio brevioribus.—A specimen of *L. denticulatum*, Hook. & Arn. from Kotzebue's Sound in Beechey's Voyage, p. 128, in herb. Torr., is certainly of this species, which probably occurs in Northeastern Asia also. H. Engelmann's specimens from Medicine-Bow Mountains and Dr. Parry's No. 286 are glabrate and dwarf mountain forms of *M. paniculata*, with barely acute leaves, and are Pursh's *Pulmonaria lanceolata.* Nuttall's *P. marginata* is much the same.

8. M. SIBIRICA, Don, non DC. *M. denticulata* (Don.) & *ciliata*, DC. (*Pulm. Sibirica*, Linn.) Glaucescens, subpubescens, vel glabra; segmentis calycis oblongis seu oblongo-linearibus obtusis ciliolatis tubo corollæ intus sparsim piloso vel fere glabro 2–4-plo brevioribus. Rocky Mountains, Eastern Siberia.

++ ++ *Pumila: folia caulina obtusa vel acutiuscula, vix venosa: corollæ $\frac{1}{4}$–$\frac{1}{3}$-pollicares.*

9. M. ALPINA, Don. *M. Drummondii*, Don. *Pulmonaria alpina*, Torr. *Lithospermum Drummondii*, Lehm., in Hook. Fl. Bor.-Am. Spithamæa ad subpedalem; foliis spathulato-oblongis lanceolatis vel supremis oblongo-ovatis parvulis; segmentis calycis nunc ovato seu oblongo-lanceolatis obtusiusculis nunc lineari-lanceolatis acutis ciliatis corollæ tubo limbum

adæquante paullo brevioribus.—Either glabrous or hirsute. Richardson's plant from the arctic coast is a large-flowered form of Torrey's *P. alpina.* Parry has an alpine form (No. 287), and a loose, evolute form with longer and narrower leaves (No. 284); in these the tube of the corolla is usually pilose inside near the middle; but it is not so in Torrey's original specimens of *M. alpina*, nor in Hooker's *M. Drummondii.* In the latter, and in Parry's specimens, as in all of the various other species I have examined, the stamens are inserted in the throat of the corolla. In the flowers of Dr. James' specimens, they are inserted pretty low down on the tube, so that the tips of the anthers barely reach to the level of the faucial plicæ or appendages. This is the case in all the various specimens I have examined (of Burke, Fremont, and Stansbury) from the western side of the Rocky Mountains, of what seems to be a narrow-leaved and hirsute variety of this species. Contrary, however, to the dimorphism in other *Borragineæ*, *Rubiaceæ*, &c., the included stamens are here accompanied by a *short* style.

§ 4. Filamenta antheris sublongiora et equilata: corollæ limbo lobato: achenia echinata!

10. M. RIVULARIS, DC. *M. elliptica*, Ledeb. ex Regel & Tiling, Fl. Ajan. N.E. Siberia and Kamtschatka. Corolla with the tube hairy within towards the base: plicæ at the throat conspicuous. I have only a specimen from Tiling's Ajan collection. In this the fruit is conspicuously *echinate* with soft prickles,—a remarkable peculiarity, which is not noticed in Regel's account of this collection.

*** Dr. Hooker, in his Arctic Essay, received long since the above was written, adopting Sir William's suggestion, refers the high arctic *M. Drummondii* (*Lithospermum Drummondii*) to our *M. Virginica.* Although Lehmann describes the corolla "*fauce notata protuberantiis quinque*, I found no appendages in an original specimen in herb. Torrey, just as Dr. Hooker notes. But I also found them obsolete in specimens of *M. alpina* and of other species in which they are sometimes evident. Wherefore I rejected the character from the diagnosis of Section 3.