although in respect to specific heat each element in a solid seems to be independent of the other elements with which it is associated, when the elementary substances are vaporized some rise in separate atoms like mercury, some in groups of atoms like iodine, sulphur, arsenic and phosphorus, and as the temperature is raised these groups are simplified with very varying degrees of readiness.

The two metals, cobalt and nickel, with which I began my inquiry, have very nearly the same atomic weight, the value, 58.24 for nickel and that for cobalt 58.49, being calculated by F. W. Clarke from the results of a great many analyses by many different chemists. They are so close together that for a long time they were regarded as identical, and Mendeléef does not hesitate even to invert the order by making Co = 58.5 and Ni = 59. These metals, nevertheless, differ from each other in several very important chemical characters. Nickel, for example, forms the well known and highly remarkable compound with carbonic oxide discovered by Dr. Mond. Cobalt, on the other hand, produces many ammino-compounds to which there is nothing corresponding among the compounds of nickel.

Having put aside the common excuses for the observed divergences from the constant of Dulong and Petit, we are compelled to look round for some other hypothesis to explain them.

The constitution of carbon compounds is now accounted for by a hypothesis concerning the configuration of the carbon atom introduced by Van't Hoff and LeBel twenty-five years ago, and which is now accepted by the whole chemical world. It seems not unreasonable to apply a similar idea to the explanation of those cases of isomerism which have been observed in certain compounds of the metals, notably chromium, cobalt and platinum. This has already been done by Professor Werner, of Zurich. If the constitution of compounds can be safely explained by such hypothesis, this implies the assumption of peculiarities in the configuration of the individual constituent metals around which the various radicles are grouped in such compounds; and hence peculiarities in the behavior of such metals in the elemental form may possibly be accounted for. For the atom of cobalt Professor Werner employs the figure of the regular octahedron. For nickel, therefore, which differs from cobalt in many ways, a different figure must be chosen. This, however, is for the present a matter of pure speculation.

PRELIMINARY NOTE ON THE GROWTH OF PLANTS IN GYPSUM.

IN the 'Handbook of Experiment Station Work' (1893), p. 176, the following passage occurs:

"The action of gypsum as a fertilizer is not well understood. It appears to act indirectly in the soil, setting free plant food, especially potash, already present, but contributing little directly to the support of plants * * * It also promotes nitrification. Gypsum is used as an absorbent in manure heaps to prevent loss of ammonia."

Nevertheless, plants will grow in nearly pure gypsum, as we propose to show.

On the east side of the San Andreas mountains, in southern New Mexico, is an immense deposit of white sand, which has the following composition, according to data kindly furnished by Mr. R. F. Hare, assistant chemist of the New Mexico Experiment Station:

$CaSO_4 + 2\ H_2O$ (Gypsum)	97.00	per cent.
$CaCO_3$ (Calcium Carbonate)	2.86	" "
$MgCO_3$ (Magnesium Carbonate)	.06	" "
$MgSO_4$ (Magnesium Sulphate)	.12	" "
K_2SO_4	.07	" "
Na_2CO_3	trace.	
NaCl	trace.	

In this deposit, locally known as the

White Sands, many plants grow and flourish. In Bulletin 22 of the New Mexico Experiment Station, Professor A. Goss gives a good plate showing the edge of the sands, with a *Rhus* and plenty of grass growing on the slope. On October 6, 1896, a few plants were obtained from the White Sands, and these formed the subject of an interesting paper by Miss Alice Eastwood in *Proceedings* of California Academy of Sciences, third series, Botany, Vol. I., No. 2.* Three of the plants were so modified by their peculiar environment as to constitute new varieties, viz., *Œnothera* or *Galpinsia tubicula* var. *filifolia*, *Œ.* or *Anogra albicaulis* (*pallida*) var. *gypsophila* and *Bigelovia* (or *Chrysothamnus*) *graveolens* var. *appendiculata*. Two others, *Thelesperma gracile* and *Muhlenbergia pungens*, were not modified.

In 1897 Professor E. O. Wooton collected plants on the White Sands, adding a number of species to the list. Of these, four have at present been published in the *Bulletin* of the Torrey Botanical Club, 1898. They are *Conanthus carnosus*, Wooton, and *Andropogon neomexicanus*, Nash, two new species as yet only known from this locality, and *Sporobolus giganteus* and *S. nealleyi*, not confined to the sands.

On February 7th of the present year we sowed seeds of Feldspar wheat and the Rural New Yorker pea in pots in five different soils in the Experiment Station greenhouse, ten seeds in each pot. The soils were as follows:

(1.) White Sands, as above.

(2.) *Larrea*-soil, *i. e.*, soil where the *Larrea* grows, on the bench behind the Agricultural College. It consists of wash from the Organ mountains principally.

(3.) Mesquite-soil, *i. e.*, soil of the Mesquite zone, the one immediately below the last, also mainly derived from the mountains.

(4.) *Pluchea*-soil, *i. e.*, sandy soil from the zone of *Pluchea borealis* and the tornillo bush; river alluvium.

(5.) Adobe soil, from the Station orchard.

The plants were watered with well water, which contains some salts in solution, but not an excessive amount. The tallest plant in each pot was measured at intervals with the following results, given in centimeters:

Wheat.

	Feb. 17.	Feb. 26	March 7.	March 14.	March 19.	April 1.	June 11.	Width of leaf blade, Apr. 1.	Diam. of Stalk Apr. 1.
White Sands,	3½	18	23¼	28½	34¼	41	81	5 mm.	2⅕ mm.
Larrea,......	8	22	30½	36	39¾	49	82	6⅔ "	2½ "
Mesquite,...	9	24	35	37	42	49	75½	6⅔ "	2⅔ "
Pluchea,....	8	24½	31	34½	40	41	75	6 "	2 "
Adobe, ...	9½	25	37	39	42½	54	78	8½ "	3 "

The data of April 1st are the best, as they include measurements of the leaf and stalk. It will be seen that on June 11th the gypsum wheat actually out-topped that from the adobe soil (which previously was the best), but it was found that during the latter part of the experiment the roots from each pot have grown downwards so as to form a mat in the soil on which the pots were placed, which was of good quality. This resulted from our thoughtlessly transferring the pots from the bench, where they had stood, to the floor of the greenhouse to make way for some other plants.

On June 11th the wheat was all ripe except one or two very small heads in all the pots except the gypsum one, which still had six or seven green heads. The ripe ears were gathered, and we got this result:

* In this paper it is stated in error that the plants were gathered in August.

(1) White Sands,	9	ears,	weighing	10.38	grams,	containing	283	grains,	weighing	7.310	grms.
(2) Larrea,	10	"	"	9.77	"	"	243	"	"	6.995	"
(3) Mesquite,	10	"	"	10.60	"	"	285	"	"	7.610	"
(4) Tornillo,	10	"	"	11.88	"	"	330	"	"	8.270	"
(5) Adobe,	10	"	"	10.24	"	"	254	"	"	7.335	"

PEAS (Measurements in cm.).

	Feb. 26.	Mar. 7.	Mar. 14.	Mar. 19.	Apr. 1.
White Sands,	12.	27.	38.	48.	57.
Larrea,	$13\frac{1}{2}$.	$25\frac{1}{2}$.	$27\frac{1}{2}$.	36.	51.
Mesquite,	$11\frac{1}{2}$.	25.	31.	38.	42.
Pluchea,	$13\frac{1}{2}$.	$29\frac{1}{2}$.	36.	47.	53.
Adobe,	$12\frac{1}{2}$.	$23\frac{1}{2}$.	26.	$35\frac{3}{4}$.	54.

No. 1 and 4 were not perfectly ripe, and may owe a very little of their weight to the extra moisture they contain. It will be seen that the gypsum wheat weighs up well with the others, and when its green heads, above mentioned, are ripe the product will outweigh considerably all of the others.

It is seen from the table that the gypsum peas are decidedly the best. We could not measure the yield (the gypsum peas were the first to bloom, on March 19th), because certain girls of the class in horticulture saw fit to remove some of the pods when unobserved by their professor.

CONCLUSIONS.—It appears, from these preliminary researches, that nearly pure gypsum will nourish plants as well as ordinary soil, or even better. It is not apparent how the wheat, etc., come by their nitrogen in such a soil, though the peas may well get it by means of their root-tubercles. The absence of other elements is also noticeable, but it is not worth while at the present time to enter into a detailed discussion of causes and effects, as further researches will, it is hoped, make such a discussion more profitable at a later date.

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FABIAN GARCIA.

N. M. AGR. EXP. STA.
MESILLA PARK, N. M., June 17, 1898.

*THE CROSS-RATIO GROUP OF 120 QUADRATIC CREMONA TRANSFORMATIONS OF THE PLANE.**

GROUPS of *linear* substitutions have long been studied with reference to (1) the geometric representation in the plane or on the sphere, (2) the rational integral functions left invariant under the operators of the group. These questions now prove to be of interest when investigated for groups of transformations of order higher than the first. The theory of birational transformations (quadratic and higher) has been given by Cremona, Cayley, Clebsch and others. Groups of such transformations have been enumerated by Autonne and S. Kantor. The cross-ratio Cremona transformation groups of order $n!$ were first given by Professor E. H. Moore in his lectures at the University of Chicago in the spring of 1895. These groups are found by determining for *each* permutation of n quantities a fundamental system of n–3 cross-ratios in terms of which the cross-ratios of *every* four out of the n quantities are expressible, and then setting up the transformation relations among these $n!$ fundamental systems.

* Abstract of a Dissertation submitted to the Faculties of the Graduate Schools of Arts, Literature and Science in the University of Chicago, April, 1898, in candidacy for the degree of Doctor of Philosophy (Department of Mathematics), by H. E. Slaught.