found by analysis at successive sampling dates vary very little from the amounts of N found experimentally. The deviation of experimental values calculated from the above equation is shown in the last column of Table 1.

TABLE 1

EXPERIMENTAL VALUES FOR P_2O_5 AND EXPERIMENTAL AND CALCULATED VALUES FOR N IN DRY FOLIAGE AT FOUR SAMPLING DATES FOR PLANTS GROWING ON THE MANURE PLOT

Dates of sampling	Experimental values		Calculated values	Relative deviation
	P_2O_5 (E_x)	N (E_y)	N (E_{y_1})	$\frac{E_y - E_{y_1}}{E_y}$
	Per cent.	Per cent.	Per cent.	Per cent.
July 7 ...	0.688	4.650	4.340	+ 0.067
July 29 ...	0.608	3.920	3.980	− 0.015
Aug. 9 ...	0.564	3.790	3.790	0
Aug. 24 ...	0.448	3.280	3.280	0

On the first sampling date (July 7), nitrogen in this manure plot is somewhat in excess in relation to the optimum value; a result which can be accounted for by an excess absorption of nitrogen caused by the intervention of nitrogen produced by nitrification in a favorable season from the cover crops used in the rotational system. On the second (July 29), third (August 9) and fourth (August 24) sampling dates equilibrium between N and P_2O_5 is attained.

The yields of tubers from the three other plots are: N (Plot No. 2) 109 pounds, PK (Plot No. 8) 148 pounds and NPK (Plot No. 10) 163 pounds per 1/100th acre plot. The deviation from the optimum (broken) line with respect to position, form and length between sampling dates shows in each case the nature of the disequilibrium between N and P_2O_5 in the plants growing on the particular plot and may be regarded as an indicator of the lack of physiological balance between nitrogen and phosphorus. Details will be published elsewhere.

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RAMAN SPECTRA OF AMINES AND METHYLATED AMMONIUM IONS

FROM the point of view of the electronic theory of valence, the ammonium ion is an exact analogue of methane, the methylammonium ion of ethane, the tetramethylammonium ion of tetramethyl methane, and so forth. Thus two systems of analogous compounds exist. Since ammonium ions can exist only in association with a suitable anion as salts, most of the physical properties of the latter are very different from those of the analogous hydrocarbons. Study of Raman spectra, however, reveals directly the intimate relation between the two series of compounds, for the spectra of the substituted ammonium halides are produced only by the vibrating cations, the isolated halide ions containing no covalent bonds and therefore giving rise to none of the observed vibrations. It should thus be expected, and has been experimentally found, that the spectra of the ammonium chlorides, from the monomethyl to the tetramethyl derivative, are completely analogous to those of the corresponding hydrocarbons from ethane to tetramethyl methane, which have been studied by other investigators.[1, 2, 3] If CH_3 and $^+NH_3$ groups be regarded approximately as single vibrating units, then these compounds possess certain well-known types of symmetry and should give rise to a few simple fundamental vibrations. The methyl ammonium ion, for instance, behaves similarly to a diatomic molecule and gives rise to a powerful valence vibration involving the C–N^+ bond. The observed fundamental vibrations (which lie in the region below 1,050 cm^{-1}) are as follows (the assumed geometrical pattern of each ion is given in parentheses, following its designation):

Methylammonium chloride (linear "diatomic" ion): 995 (6). (Compare ethane.)

Dimethylammonium chloride (symmetrical bent "triatomic" ion): 412 (2) (P); 895 (4) (P); 1029 (2) (D). (Compare propane.)

Ethylammonium chloride (unsymmetrical bent "triatomic" ion): 411 (2); 873 (5); 1047 (4). (Compare propane.)

Trimethylammonium chloride (Trigonal pyramid): 406 (1) (D); 468 (1/2) (P); 821 (5) (P); 987 (4) (D). (Compare isobutane.)

Tetramethylammonium chloride (regular tetrahedron): 372 (1) (D); 455 (2) (D); 752 (6) (P); 955 (6) (D). (Compare tetramethyl methane.)

Trimethylamine oxide hydrochloride (Trigonal pyramid): 382 (3); 500 (2); 754 (7); 947 (7). (Compare tert-butyl alcohol.)

The number in parentheses following the frequency of each line indicates its roughly estimated relative intensity. Some qualitative polarization measurements have also been made; P denotes a strongly polarized line, ($\varrho << 6/7$), D a nearly depolarized line ($\varrho = 6/7$). Analysis of the observed spectra indicates that they are in harmony with expectations from the structures assumed, and comparison with the corresponding hydrocarbons indicates that the C–N^+ bond is somewhat stronger than the C–C bond.

These compounds of course yield numerous Raman frequencies above 1,050 cm^{-1}, owing to the presence of numerous C–H and $^+$N–H bonds. The free amines

[1] K. W. F. Kohlrausch and F. Köppl, *Zeits. physik. Chem.* (*B*), 26: 209, 1934.
[2] D. H. Rank, *Jour. Chem. Physics*, 1: 572, 1933.
[3] R. Ananthakrishnan, *Proc. Indian Acad. Sci.* (Bangalore), 3(A): 527, 1936.

corresponding to most of these ammonium salts have also been studied in aqueous solution, and many new Raman lines in addition to those previously recognized[4] have been found. The detailed discussion of these spectra is necessarily somewhat complex and will be presented elsewhere, but one significant point may be reported here. Free primary and secondary amines give one (or two) powerful Raman lines between 3,300 and 3,400 cm^{-1}, presumably associated with the un-ionized N–H linkage; the corresponding ammonium salts, however, in which the amino group has acquired a proton, show no Raman frequencies above 3,050 $cm.^{-1}$ Likewise the sodium salts of glycine and alanine show strong lines near 3,330; the isoelectric amino acids show no lines above 3,030. The conclusion follows that the amino group in glycine and alanine must be electrically charged; in other words, that these amino acids exist as dipolar ions at the isoelectric point. This supplements the earlier spectroscopic proof of this structure,[5] based on studies of the ionization of the carboxyl group. Ample evidence for the theory of dipolar ions has been forthcoming from other sources, but the evidence from Raman spectra is valuable for the clarity and directness of the proof it offers for the validity of this structure. This method also should be directly applicable to the determination of structure in new compounds containing these ionizable groups.

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RECOVERY OF VIABLE ADRENAL CORTICAL TISSUE[1]

IT has been reported by Ingle[2] that autogenous transplants of the adrenal glands to the ovaries in rats consistently become established as functional grafts. On the other hand, direct homoplastic transplants of the adrenal glands of adult rats invariably have degenerated. It was suggested by one of us (Nilson) that acclimatization of transplanted glands may be a function of genetic similarity and that the survival of homoplastic transplants could be used as an index for determining homozygosity in inbreeding experiments.

The following preliminary experiments were carried out with female rats obtained from two inbred strains of pied rats segregated for differences in rate of growth and efficiency of utilization of feed.[3] Cross-strain transplants of the adrenal glands to the ovaries were made in four pairs of rats and all died of adrenal insufficiency within sixty days after operation. The adrenal glands were also exchanged between six pairs of sisters belonging to the high efficiency strain. Functional grafts were established in nine of the twelve animals. Histologic examination of the grafts sixty days after operation disclosed good regeneration of the adrenal cortical tissue. In a third experiment the adrenal glands were exchanged between four pairs of sisters belonging to the low efficiency strain. Functional grafts were established in three of these eight animals, as was demonstrated by histologic examination.

All completely adrenalectomized rats prepared in this laboratory die of adrenal insufficiency when fed a diet high in potassium and low in sodium chloride. Only animals which receive replacement therapy or which have viable adrenal cortical tissue in addition to accessory glands survive for as long as sixty days after operation. Our evidence on survival time in addition to our histologic evidence is proof that some functional grafts were established between siblings of inbred strains of rats. A detailed study of the influence of genetic relationship of the donor and the host on the success of homoplastic transplantation of adult adrenal glands in the rat is being carried out in this laboratory.

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[4] K. W. F. Kohlrausch, "Der Smekal-Raman Effekt," Berlin, 1931, pp. 311–312. New data on anhydrous liquid amines by Kohlrausch, *Monatsch. Chem.*, 68: 349, 1936.

[5] J. T. Edsall, *Jour. Chem. Physics*, 4: 1, 1936. See also M. Freymann and P. Rumpf, *Jour. Phys. Radium*, 7: 30, 1936.

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[2] D. J. Ingle and R. F. Harris, *Am. Jour. Physiol.*, 114: 657–660, February, 1936.

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