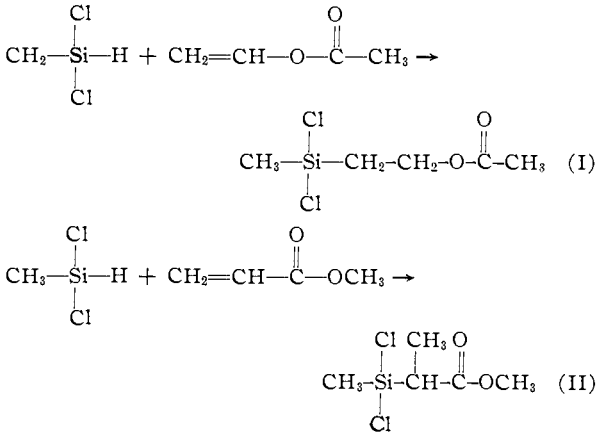
COMMUNICATIONS TO THE EDITOR

APPLICATION OF NUCLEAR MAGNETIC RESONANCE SPECTRA IN STRUCTURE DETERMINATION OF ISOMERIC SILICON HALIDES[1]

Sir:

The well-known addition of the elements of the Si–H bond to a vinyl group (or, generally, to carbon–carbon unsaturation) has been shown to be catalyzed by peroxides and ultraviolet light and, in these cases, has been regarded as a typical free-radical reaction.[2] The reaction has also been carried out thermally and with the aid of platinum and palladium catalysts,[3] but there has been no speculation regarding the mechanism involved in these reactions. The addition has been shown to involve the addition of the silicon-containing group to the terminal carbon of the unsaturated reagent in several cases[4,5] and no example of a reversed addition orientation has been noted.

We have recently added methyldichlorosilane to a number of vinyl and allyl monomers using platinum-on-carbon as catalysts and Ionol as a polymerization inhibitor. Hydrolysis studies showed marked differences between the adducts from acrylonitrile and acrylate esters, on the one hand, and adducts from vinyl esters, vinyl ethers and the allyl monomers. The determination of structure of these adducts has been neatly resolved by the use of nuclear magnetic resonance spectra which shows that the reactions are



The NMR spectrum of (I) has two triplets formed by the spin–spin interactions of the two methylene groups. The spectrum of (II) has the doublet and quadruplet which result from the interactions of the protons in the $>CHCH_3$ group. The relative positions of the peaks due to the $-CH_2-O$ and CH_3-O groups in (I) and (II) respectively, are in the proper relationship to one another as determined with reference compounds. This is true, also, of the relative positions of the CH_3CO and $-CH-CO$ peaks in (I) and (II).

Compound (II) represents the first reported example of a reversed orientation in silane additions to vinyl groups.

The results of these experiments correlate well with an ionic mechanism in which the platinum catalyst promotes a $CH_3SiCl_2\overset{S^+}{\cdots}\overset{S^-}{H}$ polarization of the silane. Electrophilic attack of the silicon moiety initiates addition to vinyl acetate and nucleophilic attack of hydride ion initiates addition to methyl acrylate in a reaction which resembles the Michael addition.

Further details of these reactions will be submitted shortly.

We wish to acknowledge the aid of Robert C. Jones in obtaining these spectra.

STANFORD RESEARCH INSTITUTE
MENLO PARK, CALIFORNIA
LEON GOODMAN
ROBERT M. SILVERSTEIN
VARIAN ASSOCIATES
PALO ALTO, CALIFORNIA
JAMES N. SHOOLERY

RECEIVED JUNE 25, 1956

(1) This work was supported by Wright Air Development Command under Contract AF 33(616)-2998.

(2) L. H. Sommer, E. W. Pietrusza and F. C. Whitmore, THIS JOURNAL, **69**, 188 (1947).

(3) G. H. Wagner and C. O. Strother (to Union Carbide and Carbon), U. S. 2,632,013, March 17, 1953.

(4) G. H. Wagner, D. L. Bailey, A. N. Pines, M. L. Dunham and D. B. McIntire, *Ind. Eng. Chem.*, **45**, 367–74 (1953).

(5) J. W. Curry, THIS JOURNAL, **78**, 1686 (1956).

HYDROLYSATES FROM SODIUM TRIMETAPHOSPHIMATE

Sir:

Contrary to the literature,[1] acid hydrolysis of trimetaphosphimate proceeds largely through intermediate ring compounds with one, two, and to some extent, three oxygens successively replacing the original imide linkages. Chain imidophosphates are never present in large amounts. While possible paths are outlined below, the main sequence of hydrolysis follows the solid arrows (see chart).

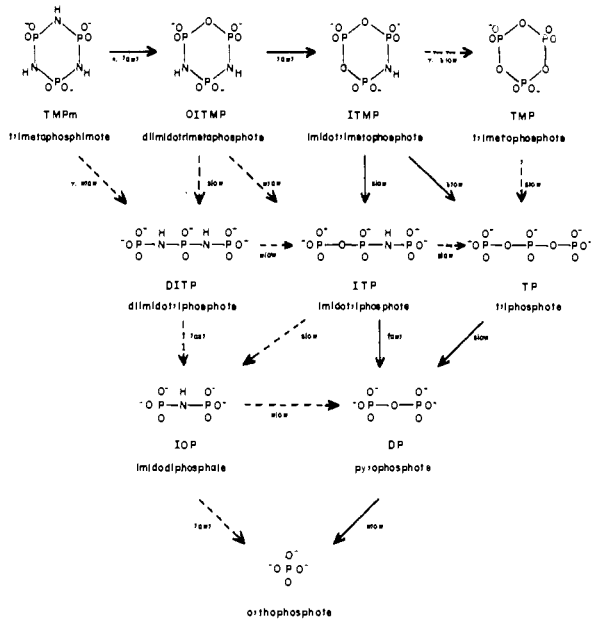
The first intermediate in this hydrolysis was isolated by Stokes[1] and prepared by a different method by de Ficquelmont,[2] both reporting it to be the chain diimidotriphosphate. However, repetition of either preparation yielded ring products, essentially DITMP with some ITMP.

The above sequence of reactions is dependent on formation of P–O–P linkages by elimination of NH_3 between P–OH and P–NH_2 groups (NH_3 detected by (1) consumption of acid and (2) odor upon rendering hydrolysate alkaline with NaOH). The yield depends on the extent of competition from the amide hydrolysis P–NH_2 + H_2O → P–OH + NH_3. The condensation reaction is quite general. For instance, ortho- and amidomonophosphate yield up to 15% pyrophosphate in acid solution (*p*H 3–4, 60°). Stokes[1] isolated 15% pyrophosphate from IDP hydrolysates (10 minutes boiling, dilute acetic acid). Chromatographic evidence for

(1) H. N. Stokes, *Am. Chem. J.*, **18**, 629–63 (1896).

(2) A. M. de Ficquelmont, *Ann. Chim.*, **12**, 169–280 (1939).

this change was reported recently.[3] Hydrolysis of DITP (*p*H 3, 60°) results in the initial formation of P-NH_2 and P-OH fragments which then condense to an extent of up to 30% of the total phosphorus present. TMPm is converted almost quantitatively into DITMP (*p*H 3).



The ring imidophosphates have been isolated from TMPm hydrolysates in good yields by ion exchange techniques. Although the chain imidophosphates occur in the acid hydrolysates of TMPm to only a small extent, DITP, ITP, and IDP have been prepared in high yields by selectively cleaving the corresponding ring imidophosphates at the oxygen bridges in 30% NaOH (75° or higher). At high NaOH concentrations P–N–P bridges appear to be inert, whereas they are cleaved more readily than P–O–P bridges in the *p*H range 2–11. Thus, P–N–P linkages differ markedly from P–O–P in dependence of hydrolysis rate on *p*H; more quantitative data will be reported soon.

The various compounds involved in this study were characterized by elemental analyses, acid–base titrations, paper chromatographic and ion-exchange separations, and X-ray diffraction (powder patterns). Products obtained by the methods of Stokes and de Ficquelmont had the elemental analyses of the monohydrate of DITMP (some ITMP·H_2O), an acid–base titration curve of a ring polyphosphate (all H's strong), an X-ray pattern nearly identical to that of TMPm·H_2O, and yielded the corresponding DITP·$6H_2O$, ITP·$6H_2O$ mixture in 30% NaOH (75°). The monohydrates of all three ring imidophosphates are isomorphous and form a continuous series of solid solutions. The hexahydrates of DITP, ITP, and TP are similarly isomorphous. A typical analysis of DITP·$6H_2O$ gave 24.3% Na, 19.8% P, 5.92% N (theoretical, 24.26% Na, 19.6% P, 5.91% N), a titration curve with pronounced endpoints at *p*H 5 and 8.6 (spread one H per mole of DITP·$6H_2O$) and a vague endpoint at *p*H 10.8.

A detailed paper on this work is in preparation.

THE PROCTER & GAMBLE COMPANY A. NARATH
RESEARCH & DEVELOPMENT DEPARTMENT F. H. LOHMAN
MIAMI VALLEY LABORATORIES O. T. QUIMBY
CINCINNATI 31, OHIO

RECEIVED JULY 16, 1956

(3) R. Klement and G. Biberacher, *Z. anorg. allgem. Chem.*, **283**, 246–256 (1956).

ISOLATION AND STRUCTURE OF MELANOCYTE-STIMULATING HORMONE FROM PORCINE PITUITARY GLANDS[1]

Sir:

We wish to report herein the isolation in pure form of the melanocyte-stimulating hormone (MSH, intermedin) from the posterior lobes of porcine pituitary glands. The structure of this hormone, a peptide consisting of 18 amino acids, will also be presented in this communication.

A crude fraction of MSH was prepared from porcine posterior pituitary powder by glacial acetic acid extraction and fractional precipitation with acetone and ether, followed by adsorption on oxycellulose (15% of the weight of the ether precipitate).[2] Following elution with 0.1 *N* HCl, a highly potent[3] concentrate was obtained. The eluate was de-acidified with methyldioctylamine[4] and brought to *p*H 6.5–7.0 with dilute ammonia. The precipitate that formed was discarded, and the supernatant fraction, after lyophilization, was submitted to zone electrophoresis on starch[5] with a pyridine-acetic acid buffer of *p*H 4.9. A peak containing the bulk of the MSH activity could be eluted from a very narrow region; this peak was then submitted to countercurrent distribution for 1100 transfers at 20°, in the system 0.5% trichloroacetic acid *vs. sec*-BuOH. One main skewed peak was observed. The peak was divided in half and each half was recovered separately. When both halves were re-run in the same system for 248 transfers, the distribution curve of each was virtually identical to the theoretical, and both possessed *K* values of 0.60. They were also shown to possess practically identical biological activities.

Quantitative amino acid analysis of the 24- and 48-hour acid hydrolysates by the paper-fluorodinitrobenzene method[6] gave the following composition, based on molar ratios of the constituent amino acids:

$Asp_{2.0}$,$Glu_{2.0}$,$Ser_{1.0}$,$Gly_{1.9}$,$Pro_{3.1}$,$Met_{0.7}$,$Phe_{1.1}$,$Tyr_{1.0}$,$Lys_{1.8}$,$His_{1.0}$,$Arg_{1.0}$, $Try_{1.0}$.

Tyrosine and tryptophan were determined by a

(1) This work is supported in part by the U. S. Public Health Service (G-2907) and the Albert and Mary Lasker Foundation. Original manuscript received July 2, 1956.

(2) (a) R. W. Payne, M. S. Raben and E. B. Astwood, *J. Biol. Chem.*, **187**, 719 (1950); (b) E. B. Astwood, M. S. Raben, R. W. Payne and A. B. Grady, THIS JOURNAL, **73**, 2969 (1951); (c) M. S. Raben, I. N. Rosenberg and E. B. Astwood, *Federation Proc.*, **11**, 126 (1952).

(3) Potency of preparations has been determined by the method described by K. Shizume, A. B. Lerner and T. B. Fitzpatrick (*Endocrinology*, **54**, 553 (1954)). Preparations purified by zone electrophoresis possess activities of 1×10^{10} MSH u./g. The unit is that described by Shizume, *et al.* Though a chemical purification occurs during the counter-current distribution procedure, some inactivation also takes place.

(4) D. E. Hughes and D. H. Williamson, *Biochem. J.*, **48**, 487 (1951).

(5) H. G. Kunkel and R. J. Slater, *Proc. Soc. Exper. Biol. Med.*, **80**, 42 (1952).

(6) A. L. Levy, *Nature*, **174**, 126 (1954).