TABLE I

DISPROPORTIONATION OF METHYLPHOSPHONIC CHLOROFLUORIDE AT 60°

Time in hr.	Fluoride Ion, %	Difluoride, %
0	0.83	4.37
3.25	1.63	8.58
20.25	1.78	9.37
48.5	1.87	9.84
70	2.11	11.11

Anal. Calcd. for CH_3PClFO: Cl, 30.44; total F, 16.31; fluoride ion, O. Found: Cl, 30.45; total F, 16.47; fluoride ion, 0.87.

Yields of 72–82% of crude distilled I, b.p. 120–144°, based on Sarin as the starting material, were obtained consistently in a large number of runs. The boiling point of the purified compound is 126.0–126.5° at atmospheric pressure.

Determination of disproportionation of I at 60°. Samples of approximately 0.40 g. of I having a fluoride ion content of 0.83% were sealed in bulbs, weighed, and kept in a thermostat at 60 ± 0.5° for various periods of time. The samples, removed from the thermostat, were cooled in ice water and immediately titrated for fluoride ion. The results are listed in Table I.

CHEMICAL CORPS, CHEMICAL RESEARCH DIVISION
CHEMICAL RESEARCH & DEVELOPMENT LABORATORIES
ARMY CHEMICAL CENTER, MD.

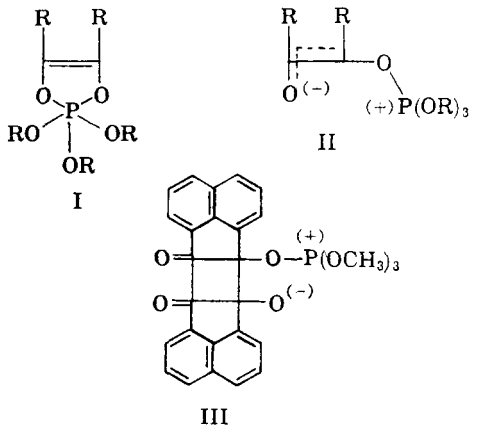
Communications TO THE EDITOR

A New Carbon-Carbon Condensation Reaction Induced by Phosphite Esters. Formation of a 2:1 Adduct in the Reduction of Acenaphthenequinone with Trimethyl Phosphite[1]

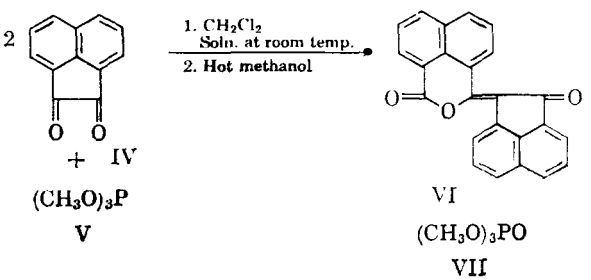
Sir:

We have described[2] crystalline *1:1 adducts* derived from the reaction of tertiary phosphite esters with 9,10 phenanthrenequinone and with α-diketones such as benzil. We favor a cyclic unsaturated oxyphosphorane structure I for these adducts, as they are remarkably soluble in alkanes and/or benzene, show no carbonyl or enolate bands in the infrared when pure, and give strong positive shifts in the phosphorus-NMR spectra relative to phosphoric acid implying considerable phosphorus shielding. An equilibrium with the open dipolar form II under certain conditions is, however, conceivable.

We should like to report now the formation of a crystalline 2:1 adduct (III) from acenaphthenequinone (IV) and trimethyl phosphite (V). The adduct (*Anal.* Calcd. for $C_{27}H_{21}O_7P$: C, 66.5; H, 4.3; P, 6.4. Found: C, 66.6; H, 4.4; P, 6.1.) was prepared as described below. It is unstable in moist air but can be handled in dry nitrogen, is practically insoluble in cold hexane, ether and benzene and has a single sharp band at 5.78 μ and a very strong set of bands in the 9.00–9.50 μ region characteristic of P—O—C vibrations. The spectra were determined in a methylene chloride solution which decomposed slowly. The 2:1 adduct could have structure III or the corresponding cyclic saturated oxyphosphorane.



When the 2:1 adduct (III) was warmed with methanol, a clean molecular rearrangement took place. The products were trimethyl phosphate (VII) and the enol lactone VI. The over-all transformation is then



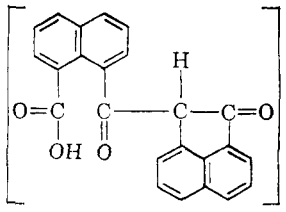
The following is a typical procedure: A mixture of acenaphthenequinone (18.2 g.; 0.1 mole), trimethyl phosphite (7 ml; *ca.* 0.05 mole), and methylene chloride (250 ml.) was stirred at 25°, under

(1) These investigations are being supported by the Cancer Institute of the National Institutes of Health (Grant CY14769) and by the National Science Foundation (Grant NSF G9917).

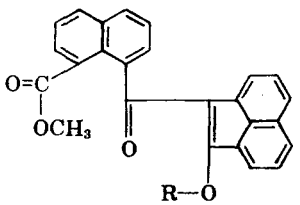
(2) F. Ramirez and N. B. Desai, *J. Am. Chem. Soc.*, 82, 2652 (1960).

nitrogen. The initial suspension became a clear, yellow solution within 15–20 min. After 1 hr., the solvent was removed *in vacuo* at temperatures below 20°. The tan crystalline residue was shown to be a *2:1 adduct* (III) derived from the "quinone" and the phosphite. Methanol (150 ml.) was added, the mixture was heated to reflux (20–30 min.) and the insoluble enol lactone VI (16.5 g., 95%; m.p. *ca.* 255°) was collected and recrystallized from toluene. The yield of VI of m.p. 275–276° was about 90%. Pure VI was colorless and had bands at 5.78, 6.33, and a somewhat stronger doublet at 5.90 and 6.00 μ (methylene chloride); $\lambda_{max}^{CH_3CN}$ 335 mμ (ϵ 26,500); *Anal.* Calcd. for $C_{24}H_{12}O_3$: C, 82.8; H, 3.5. Found: C, 83.0; H, 3.6. Trimethyl phosphate (VII) was obtained from the methanol solution. Similar results were observed when an excess of trimethyl phosphite was employed.

The enol lactone VI was cleaved into 1,8-naphthalic acid (1 mole) and acenaphthenone (1 mole) by 3 equivalents of degassed *N* aqueous sodium hydroxide (12–24 hr. at room temperature, under nitrogen.) This is consistent with a β-diketonecarboxylic acid intermediate VIII. The enol lactone VI was converted into an orange salt (bands at 5.90, 6.13, and 6.3 μ, in Nujol mull) by 1 equivalent of sodium methoxide in methanol (15 hr. at room temperature, under nitrogen) The orange salt reverted to VI on treatment with boiling acetic acid; cold acetic acid, however, gave a yellow substance, m.p. 204–205° (from benzene) which had bands at 3.26, 5.81, 6.06, and 6.18 μ (carbon tetrachloride) and gave a green color with ferric chloride. This is probably the enol tautomer IX (*Anal.* Calcd. for $C_{25}H_{16}O_4$: C, 79.0; H, 4.2. Found: C, 78.9; H, 4.4.) IX reverted to the enol lactone VI on heating with acetic anhydride and gave a yellow substance, m.p. 220–221° (from ethyl acetate) when treated with diazomethane in ether. This is presumably the enol ether X with bands at 5.81 and 5.92 μ (methylene chloride) (Calcd. for $C_{26}H_{18}O_4$: *Anal.* C, 79.3; H, 4.6. Found: C, 79.0; H, 4.7.)

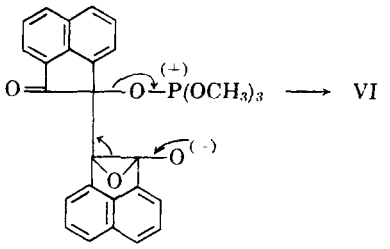


VIII



IX. R = H
X. R = CH_3

A possible mechanism for the molecular rearrangement leading to the enol lactone VI is indicated in formula XI. The ejection of a phosphate ester from a molecular complex appears to provide a strong driving force for reactions[3] The conversion of phthalic anhydride into biphthalyl by triethyl phosphite at *elevated temperatures* is another manifestation of this driving force.[4]



XI

Department of Chemistry
State University of New York
Long Island Center
Oyster Bay, N. Y.

Fausto Ramirez
N. Ramanathan

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(3) F. Ramirez, N. B. Desai, and R. B. Mitra, *J. Am. Chem. Soc.*, **83**, 492 and ref. therein.

(4) F. Ramirez, H. Yamanaka, and O. H. Basedow, *J. Am. Chem. Soc.*, **83**, 173 (1961).

Application of the Mannich Reaction with β,β-Dichlorodiethylamine to Derivatives of Uracil

Sir:

The concept of incorporating an alkylating function, *e.g.* the β,β'-dichlorodiethylamine group, into a molecule known to play an important role in biogenesis of nucleic acids has received increasing attention in recent years from those interested in chemotherapeutic control of neoplastic disease.[1] Among such molecules uracil occupies an important position inasmuch as it is a primary component of the nucleic acid moiety. Hitherto alkylating agents of the type referred to have involved incorporation of the β,β'-dichlorodiethylamine function into the uracil molecule with the amine nitrogen directly attached to the pyrimidine ring in the 5-position.[1d,e]

It has been recognized for some time that the so-called "nitrogen mustard" function varies in its alkylating properties depending on whether it is directly attached to an aromatic or pseudo-aromatic ring system or to an aliphatic system.[1c] As far as we are aware no reports have appeared in the literature concerning nitrogen mustard

(1) (a) A. Benitez, L. O. Ross, L. Goodman, and B. R. Baker, *J. Am. Chem. Soc.*, **82**, 4585 (1960); (b) R. C. Elderfield and R. N. Prasad, *J. Org. Chem., in press;* (c) H. H. Liu and C. C. Price, *J. Org. Chem.*, **26**, 264 (1961); (d) D. A. Lyttle and H. G. Petering, *J. Am. Chem. Soc.*, **80**, 6459 (1958); (e) L. F. Larianov, *Brit. J. Cancer*, 10, 26 (1956) *inter alia.*