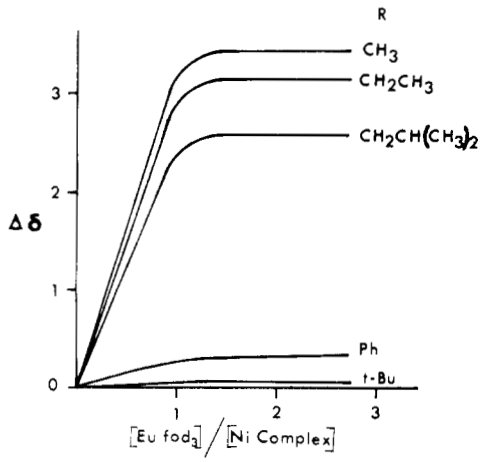

Figure 2. Comparison of the relative chemical shifts of the central proton of the O–N donor chelate rings with change of R for complexes of type I on addition of $Eu(fod)_3$.

Further studies involving complexes of type I in which R becomes successively more bulky also confirm attack of the LSR at the oxygen donors. As the size of R increases, the attachment of the LSR becomes hindered and the magnitude of the shifts of respective resonances decreases for a given LSR:complex ratio (see Figure 2).

Since the limiting shifts (under conditions of excess LSR) also decrease as R becomes more bulky (Figure 2), this implies that there is a change in the geometry of the complex-LSR adduct with change of R. Undoubtedly such a variation will involve a lengthening of the complex–LSR distance as R becomes more bulky.

Although a change of alkyl substituent will also result in concomitant electronic changes which may also influence adduct formation, it seems clear that the considerable differences observed between, for example, the isobutyl and *tert*-butyl derivatives, occur mainly because of the different steric properties of these groups. While this is very likely the case for the series of alkyl derivatives, both steric and electronic effects could well be significant in the phenyl-substituted complex.

To investigate the influence of electronic factors, the complex with R = CF_3 was prepared since this relatively small group should withdraw electron density from the conjugated chelate ring and reduce the capacity of the oxygen donors to coordinate simultaneously to the LSR. Accordingly, no evidence for adduct formation was observed on addition of $Eu(fod)_3$ or $Pr(fod)_3$ to this complex in deuteriochloroform. The disulfur analog[9] of (I, R = CH_3) is also unaffected by either of the above shift reagents and this very likely is the result of electronic effects; the sulfur atoms being softer than oxygen will tend to back-donate electron density into the π-system of the chelate ring rather than to the respective lanthanide ions which, in any case, are known to prefer hard donor atoms.[10]

A range of studies involving the use of LSR's (including chiral reagents) for conformational and other studies in related complexes will be reported soon.

Acknowledgments. We wish to thank the Australian Research Grants Committee for support and Mr V. Pickles (University of New South Wales) for assistance.

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Received December 31, 1974

Synthesis and Reactivity of α-Cyanoenamines. A Novel General Method for Preparing α-Diketones from Amides

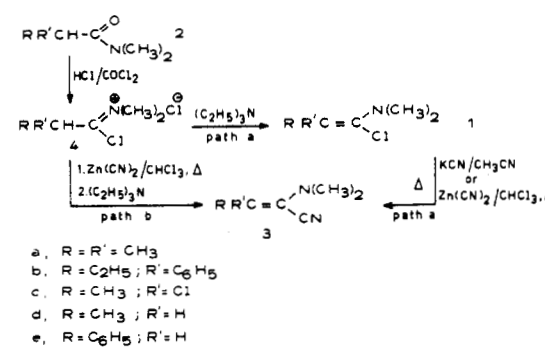
Sir:

We wish to report the utility of α-cyanoenamines as a hitherto unrecognized class of readily available and reactive synthetic intermediates which allow, inter alia, for a versatile and efficient method of synthesis of α-diketones.

The choice of a starting material for the synthesis of α-cyanoenamines has been dictated by our recent studies[1] on α-chloroenamines, a class of reagents readily available from carboxamides.

Indeed α-chloroenamines which already embody most of the structural features of α-cyanoenamines react as keteniminium chlorides and are therefore capable of undergoing nucleophilic substitution with cyanide ion. Thus 1-chloro-*N,N*-2-trimethylpropenylamine (**1a**) readily prepared[1] from *N,N*-dimethylisobutyramide (**2a**) was treated for 40 hr with 1.1 equiv of dry potassium cyanide in refluxing acetonitrile to give 1-cyano-*N,N*-2-trimethylpropenylamine (**3a**) (80% yield, bp 167°, $\nu_{C\equiv N}$ 2205 cm^{-1}). The substitution reaction worked equally well for the synthesis of **3b** from **1b** (80% yield, bp 65° (0.3 Torr), $\nu_{C\equiv N}$ 2200 cm^{-1}). However, replacement of chloride by cyanide in the less electrophilic 1,2-dichloro-*N,N*-dimethylpropenylamine (**1c**) required the presence of a Lewis acid catalyst. Zinc cyanide in refluxing chloroform worked satisfactorily and gave **3c** in 60% yield (purified by GLPC, $\nu_{C\equiv N}$ 2200 cm^{-1}). This procedure (Scheme I, path a) could not be applied to the synthesis of α-cyanoenamines derived from monosubstituted acetamides **2d,e** since the α-chloroenamines **1d,e** are more difficult to prepare and easily undergo thermal or base-catalyzed dehydrochlorination. However, when the di-

Scheme I



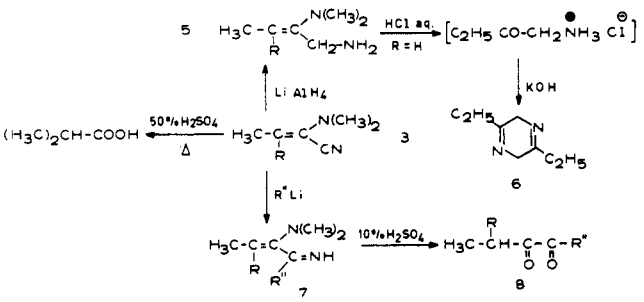
a, R = R' = CH_3
b, R = C_2H_5; R' = C_6H_5
c, R = CH_3; R' = Cl
d, R = CH_3; R' = H
e, R = C_6H_5; R' = H

Table I. Preparation of α-Diketones from α-Cyanoenamines

α-Cyanoenamine	R″Li[a]	Solvent	α-Diketones	Yields (%)[b]
3a	CH_3Li	Ether	$(H_3C)_2CHCOCOCH_3$	75[c]
3a	C_6H_5Li	Ether	$(H_3C)_2CHCOCOC_6H_5$	90
3b	C_6H_5Li	Ether	$C_2H_5(C_6H_5)CHCOCOC_6H_5$	90
3d	C_6H_5Li	Ether	$C_2H_5COCOC_6H_5$	90
3d	C_4H_9Li	Hexane	$C_2H_5COCOC_4H_9$	90

[a] The addition of the organolithium compound was performed at 0°. [b] Yields were determined by GLPC or NMR on the crude material. [c] Yields are lower due to the competing formation of a carbanion at the γ position. This latter reaction appears to be dependent on the nature of the organolithium reagent (alkyl)Li > C_6H_5Li) and the solvent (ether > hexane).

Scheme II



rect precursors of **3d,e**, the amide chlorides **4d,e**, were treated successively with zinc cyanide in refluxing chloroform and triethylamine at room temperature, the α-cyanoenamines **3d** (bp 90° (50 Torr), $\nu_{C\equiv N}$ 2220 cm^{-1}) and **3e** ($\nu_{C\equiv N}$ 2220 cm^{-1}) were obtained in 73 and 75% (crude) yields, respectively. This one-pot sequence[2] (path b) constitutes a general method of synthesis of α-cyanoenamines. It certainly competes favorably with the few presently available methods which now exist for their preparation.[3]

The α-cyanoenamines **3a–e** gave elemental analysis and spectral (mass, ir, NMR) data in agreement with their structures.[4] They are quite resistant to aqueous acids as shown by the hydrolysis of **3a** which required 2 hr of reflux in 50% H_2SO_4 to give quantitatively isobutyric acid (Scheme II). On the other hand, the nitrile group of **3** can be easily reduced with $LiAlH_4$ to the unsymmetrical diamines, **5**, which are potential sources of α-amino ketones or dihydropyrazines (Scheme II). Thus **3a** gave **5a** (R = CH_3) in 70% yields on treatment with $LiAlH_4$ in refluxing ether followed by hydrolysis with aqueous KOH whereas **3d** gave **5b** (R = H) which was immediately converted to the dihydropyrazine (**6**) on treatment with aqueous HCl at room temperature followed by neutralization with KOH.

We have also examined the reaction of α-cyanoenamines with organolithium reagents (Scheme II, Table I). These reactions occurred smoothly to yield products resulting exclusively from 1,2-additions. The adducts, **7**, were characterized by their spectral data and hydrolyzed in 10% H_2SO_4 to the α-diketones **8**.

The overall sequence 2 → 3 → 7 provides a simple, general, and versatile process (overall yields 55–80%) for the stepwise construction of the carbon skeleton of α-diketones starting from carboxylic amides. It usefully complements an earlier synthetic route[5] which started from aldehydes or enol ethers and should have a larger scope than the other classical methods for the synthesis of α-diketones.[6]

The present results already demonstrate the synthetic potential of the readily available α-cyanoenamines. A very interesting extension of this work would result from the observation that **3a** reacts with nonnucleophilic strong bases to give a carbanionic center at the γ-carbon thus allowing in principle for carbon chain lengthening at this position. This new development of α-cyanoenamine chemistry will be reported later.

Acknowledgment. We thank the "Institut pour l'Encouragement de la Recherche dans l'Industrie et l'Agriculture" for a fellowship to one of us (J.T.) and the "Fonds de la Recherche Fondamentale Collective" for partial financial support.

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(2) Typically a solution of 101 g (1 mol) of *N*-dimethylpropionamide in 400 ml of dry $CHCl_3$ saturated with HCl is treated with 80 ml of $COCl_2$. After 3 days at room temperature, the solvent is removed in vacuo and the residue is dissolved in 300 ml of $CHCl_3$. Zinc cyanide (86 g, 0.75 mol) is added cautiously at 0° and the resulting mixture is refluxed for 8 hr. The reaction mixture is further diluted with 200 ml of $CHCl_3$, then treated with 140 g of dry triethylamine and stirred for 1 hr. Addition of 200 ml of petroleum ether (bp <80°) gives two layers. After standing overnight, the upper layer is removed while the residue is washed four times with petroleum ether. The extracts are combined and, after removal of the solvents, are fractionated to give 80 g of **3d**, bp 90° (50 Torr) contaminated by ~7% starting amide.

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Strand Breaks and Sugar Release by γ-Irradiation of DNA in Aqueous Solution

Sir:

The lethal damage done to the living cell by ionizing radiation is thought to be partially due to DNA strand breaks.[1] The chemical steps of the radiation induced strand breaks are presently not well understood.

From deoxygenated N_2O-saturated aqueous solutions of DNA (500 mg/l.), we have isolated after γ-irradiation (dose, 3.5×10^{19} eV/g; dose rate 4.3×10^{18} eV/(g hr)) the three sugars 2,5-dideoxypentos-4-ulose (**1**), 2,3-dideoxypentos-4-ulose (**2**), and 2-deoxypentos-4-ulose (**3**). These products were obtained from herring sperm DNA as well as from calf thymus DNA (Serva).

For identification the isolated sugars were reduced with $NaBD_4$, trimethylsilylated, and analyzed by coupled GLC–MS. The interpretation of the mass spectra was done on the basis of typical fragmentation patterns of this class