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A NON-ALDOLIC DIMERIZATION OF N-PHENYL ACETONE D-GLYCERALDIMINE

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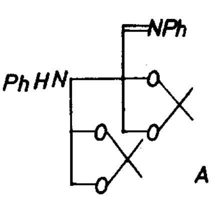
During the course of an investigation on the aldimines of acetone D-glyceraldehyde, we have found that N-phenyl acetone D-glyceraldimine dimerizes easily in the presence of a catalytic amount of acids to a new type of 1,2,3,4-tetrahydro-quinoline derivative containing a spiro bond.

We hope to report herein the structure of one of the two isomers isolated in the following manner; an equimoler amount of acetone D-glyceraldehyde and aniline was condensed in benzene at a room temperature in the presence of a small amount of acetic acid and the solution was left overnight. After removal of acetic acid from the slightly reddish-brown solution, the solution was suitably concentrated and left at a room temperature for several weeks. White needlelike crystals [I; m.p. 161-163°, $[\alpha]_D^{29} = -42.0°$ (c 1.0, $CHCl_3$), Anal. Calcd. for $C_{24}H_{30}O_4N_2$ (410) : C,70.22 ; H,7.55 ; N,6.82 . Found: C,70.18 ; H,7.49 ; N,6.98] gradually precipitated. Yield 24%. From the mother liquor, another isomer [II; m.p. 195-196°, $[\alpha]_D^{28} = +2.2°$ (c 1.2, $CHCl_3$) , Found: C,70.40 ; H,7.55 ; N,7.00] was isolated. Molecular weight of these compounds was found to be 410 by the vapour pressure and the mass spectrometric methods, which corresponds to that of dimers of N-phenyl acetone D-glyceraldimine. Acetylation of I by heating it with acetic anhydride and pyridine gave a mono acetyl derivative [III; m.p. 173°, $[\alpha]_D^{29} = -152°$ (c 1.0, $CHCl_3$), Anal. Calcd. for $C_{26}H_{32}O_5N_2$ (452): C,69.00 ; H,7.13 ; N,6.19 . Found : C,69.03 ; H,7.16 ; N,6.39]. The compound I,II and III are rather labile in chloroform solution and gradually decomposed with browning.

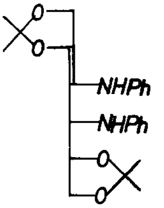
I showed the following characteristic absorption peaks in the infra-red spectrum; 3410 (NH), 2985,2935 (CH_3), 1610, 1580, 1500 (phenyl), 1485 (CH_3), 1385, 1375, 1217, 1180 (CMe_2), 750 and 690 cm^{-1}(mono and ortho-substituted benzene).

N.m.r. spectra (100 Mc, in $CDCl_3$) of I and its N-deuterated compound are given in Figs. 1 and 2. In Fig.1, the partially resolved peaks at τ 8.67, 8.60, 8.48 and 8.46 containing 12 protons can be assigned to the four methyl protons of isopropylidene groups. The number of protons appeared in the lower field (τ 5.45 -6.30) decreased from 9 to 7 on deuteration. The multiplet at τ 2.85 and 3.33 can be assigned to the phenyl protons corresponding to 9 protons.

As possible dimers of N-phenyl acetone D-glyceraldimine, The following six structural formulae can be taken into account.



A



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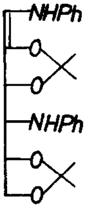

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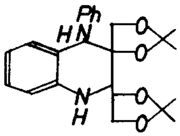
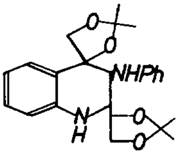
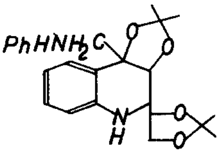


D



E



F

From the proportion of the number of phenyl protons and aliphatic protons except methyl protons of isopropylidene groups, all of the linear structures; A,B and C seem to be improbable. An aldol type condensation product corresponding to structure A has been reported by Kharash et al.(1) in the case of n-butylidene aniline. However, the facts that III showed NH absorption band at 3440 cm^{-1} and I showed no absorption band of imine (C=N) exclude the possibility of the structure A. Structure B, which is similar to the supposed intermediate in erythropyran formation from D-erythrose reported by Catala et al (2), can be neglected also from the I.r. data (absence of the absorption band of C=C) and the N.m.r. data described above. Structure C can be omitted for the similar reason.

On the other hand, structure D or F which corresponds to a cyclization product of A and C respectively, can be eliminated on the basis of the following N.m.r. evidences. It is evident that the signal of the hydrogen at the carbon linked to nitrogen should be the one proton (at C-2 in quinoline skelton) at τ6.32, which was changed from quartet to doublet (J=2.5 c.p.s.) on deuteration. Irradiation of this proton signal caused one proton sextet at τ5.42 to collapse to a triplet and reverse irradiation caused the proton signal to collapse to a narrow-

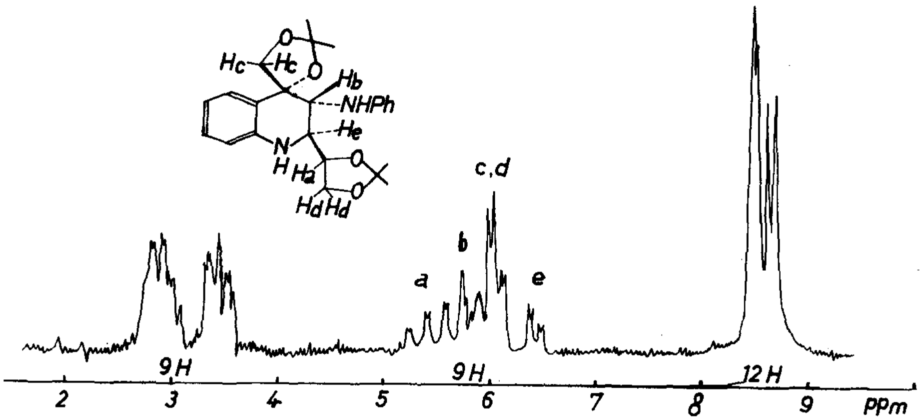


FIG. 1

N.m.r. spectrum of the compound I (100 Mc, in $CDCl_3$)

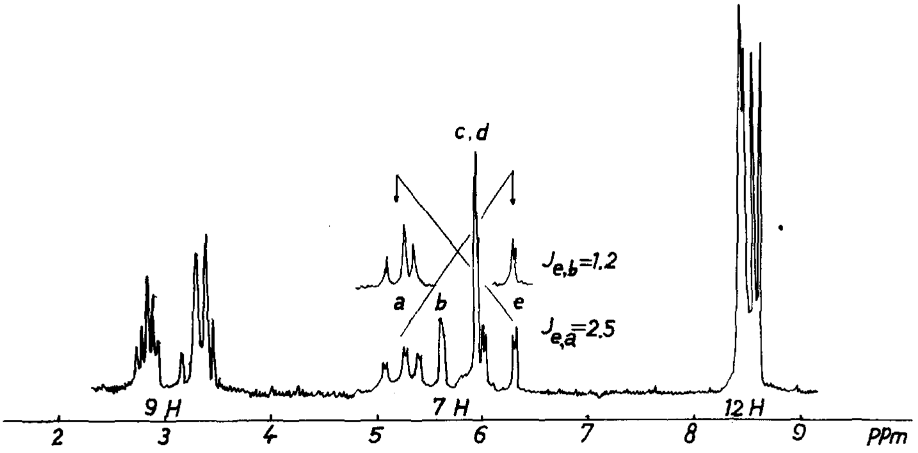


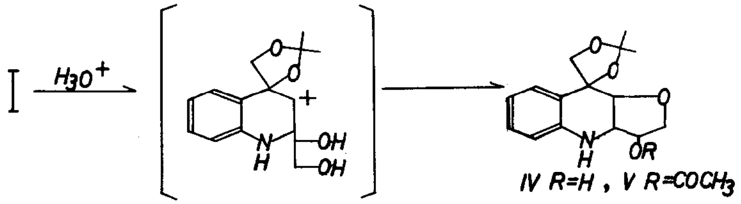
FIG. 2

N.m.r. spectrum of N-deuterated derivative of I and spin-spin decoupling (100 Mc, in $CDCl_3$)

er doublet (J=1.2 c.p.s.). The results obtained by the decoupling technique exclude the possibility of the structure D as no such a proton can be found in D. Four protons at τ 5.95-5.98 are methylene protons; two protons (Hc), which will be probably equivalent, should be a singlet at τ 5.95 and are overlapped with a part of Hd signals (maybe a quartet), while two protons (Hd) should be B_2 quartet of AB_2 sytem coupling to a Ha proton (A of AB_2, seemingly a triplet). Structure E and F are not in conflict with these considerations, however, only the former consisted with the interpretation of n.m.r. data of the following degradation product. Partial hydrolysis of I with 70 % acetic acid gave a mono isopropylidene derivative [IV; m.p. 279-280°(decomp.), $[\alpha]_D^{29}$= +13.2°(c 1.0, MeOH), Anal. Calcd. for $C_{15}H_{19}O_4N$ (277); C,64.96 ; H,6.91 ; N,5.05. Found: C,65.28 ; H,7.12 ; N,5.15] with the loss of one molecule of aniline and acetone. This unusual phenomenon may be explained in terms of steric compression due to the neighbouring groups.

Molecular ion peak (m/e 277) of IV was clearly detected in the mass spectrum in addition to M-18 ion peak. Acetylation of IV with acetic anhydride and pyridine gave an acetate [V; m.p. 215-216°, $[\alpha]_D^{28}$= +105°(c 1.0, MeOH), Anal. Calcd.for $C_{17}H_{21}O_5N$ (319) ; C,63.93 ; H,6.63 ; N,4.39. Found : C,63.93 ; H,6.82 ; N,4.76]. IV showed major absorption peaks in the I.r. spectrum at 3460 (OH, disappeared by acetylation), 3400 (NH), 2980,2880 (CH_3), 1610,1496 (phenyl), 1383,1372,1215,1188 (CMe_2), 760 cm^{-1} (ortho-disubsttuted benzene). The disappearence of the peak at 694 cm^{-1} due to the mono-substituted benzene supports quinoline skelton of I.

Unexpectedly, n.m.r. , i.r. and analytical data of V indicated the presence of only one acetoxy group and the absence of hydroxyl group. This fact should be explained by the formation of tetrahydrofuran ring during the course of the hydrolysis.



IV R=H , V R=$COCH_3$

The singlet peak of six protons at τ 8.52 in Fig.3 can be assigned to the methyl protons in spiro 1',3'-dioxolane ring, because the signals at τ 8.67 and 8.60 in Fig.1 should be assigned to the two non-equivalent methyl protons (3) in another 1,3-dioxolane ring. The assignement (in Fig.3) of other protons by the first order analysis can be made as follows ; τ 7.94 (three protons singlet of acetyl group), τ 6.87 (one proton triplet; H_2, $J_{2,2'}$= $J_{2,3}$= 11.3 c.p.s.), τ 6.46 (one proton doublet; $H_{5'}$, $J_{5',5''}$= 9.0 c.p.s.), τ 6.45 (one proton quartet ; H_4 , $J_{3,4}$= 3.0, $J_{4,11}$=1.5 c.p.s), τ 6.13 (one proton quartet ; $H_{2'}$, $J_{2',3}$= 6.3, $J_{2',2}$= 11.3 c.p.s.), τ 5.95 (one proton doublet ; $H_{5''}$, $J_{5'',5'}$= 9.0 c.p.s.), τ 5.60 (two protons doublet containing one proton of NH, which disappeared on deuteration ; H_{11}, $J_{4,11}$= 1.5 c.p.s.), τ 4.55 (one proton octet ; H_3, $J_{3,2}$= 11.3, $J_{3,2'}$= 6.3, $J_{3,4}$= 3.0 c.p.s.), τ 2.82-3.35 (four protons multiplet ; ortho-disubstituted benzene protons).

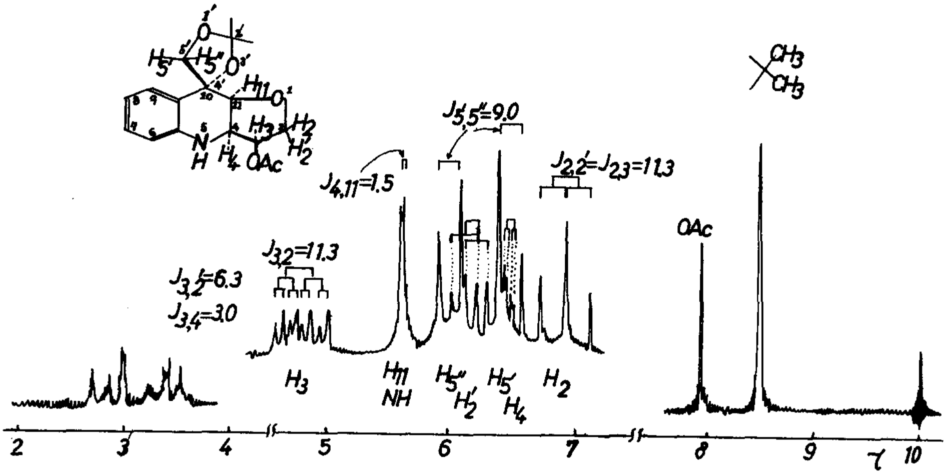


FIG. 3

N.m.r. spectrum of the compound V (60 Mc , in $CDCl_3$)

The steric structures given in Figs. 1 and 3 represent the relative configuration, on the basis of n.m.r. data.

Both the reaction mechanism and the structure of another isomer are under investigation.

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