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THE CONFORMATIONAL ANALYSIS OF HETEROCYCLES—XXIX[1]

N-ACYLINDOLINES AND N-ACYL-1,2,3,4-TETRAHYDROQUINOLINES

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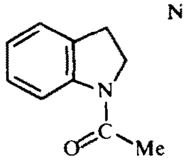
Abstract—Electric dipole moment measurements show that in benzene solution 1-acetylindoline exists almost entirely in the *endo* conformation and that 1-acetyl-1,2,3,4-tetrahydroquinoline consists of about equal quantities of the *endo* and *exo* conformers.

SIMULTANEOUSLY with the NMR re-examination of the conformation of N-acylindolines and N-acyltetrahydroquinolines undertaken by Monro and Sewell,[2] we have sought independent evidence from studies of the dipole moments of 1-acetylindoline (I $\rightleftharpoons$ II) and 1-acetyl-1,2,3,4-tetrahydroquinoline (III $\rightleftharpoons$ IV). The dipole moment work required as model compounds 1-phenyl-2-piperidone (V) and 1-methyl-3,4-dihydro-2-quinolone (VI); the first was prepared by the method of Wamhoff and Korte[3] and the second by the methylation of dihydrocarbostyril.[4]

N-Acylindolines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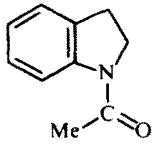
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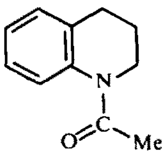
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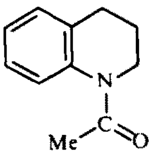
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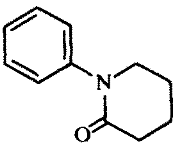
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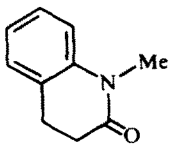
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RESULTS AND DISCUSSION

The lactams V and VI are geometrically acceptable models for the *endo* and *exo* conformations of 1-acetyltetrahydroquinoline (III and IV respectively). We may therefore write:

$$\mu^2_{obs} = N_{III}\mu^2_{V} + (1-N_{III})\mu^2_{VI}$$

in which μ_{obs} is the observed dipole moment of 1-acetyltetrahydroquinoline and N_{III} is the mole fraction of the *endo* conformer. Substituting the dipole moment values from Table 2 we have:

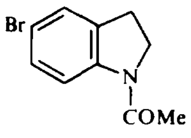
$$3{\cdot}39^2 = N_{III} \times 3{\cdot}96^2 + (1\text{-}N_{III}) \times 2{\cdot}74^2$$

$$\text{Therefore } N_{III} = 0{\cdot}49,\ N_{IV} = 0{\cdot}51.$$

That is, 1-acetyltetrahydroquinoline in benzene solution at 25° consists of approximately equal quantities of the two conformers.

We have no equally acceptable models for the two conformations of 1-acetylindoline, but the differences in geometry arising from the presence of the five-membered ring are unlikely to lead to very great changes in dipole moment. The observed moment of 1-acetylindoline (3·92D) is closely similar to that of 1-phenyl-2-piperidone (3·96D), and we conclude that 1-acetylindoline exists almost entirely in the *endo* conformation (I).

Before adopting the preceding method, we considered the use of substituted compounds and investigated the bromo derivatives VII and VIII. To solve the problem by this means we must assume (a) no interaction between the bromine and amido group, (b) no effect of bromine on the equilibrium position, and (c) that the scalar contribution of the amide function to the gross dipole moment of a pair of *exo* and *endo* isomers (e.g. III and IV) is equal.[6] The results for compounds V and VI demonstrate that (c) is quite unjustified.



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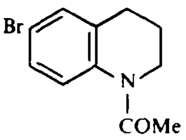
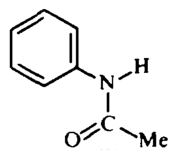


VIII



IX

The conclusions from this work are in agreement with those from concurrent NMR studies,[2b] and also with some earlier literature evidence from dipole moments[7] (the previous NMR work is discussed in ref. 2*b*). The conformation of acetanilide is generally accepted[8] to be IX; its dipole moment[7] of 3·88 D is near to that of compound V. The reported[7] dipole moment for N-methylacetanilide (3·57 D) is considerably higher than the 2·74 D of compound VI; however, whereas acetanilide is nearly planar (18° angle between ring and NHCO group in crystal[9]), in N-methylacetanilide the ring is orthogonol to the NMeCO group,[10] and hence the difference in dipole moments is not surprising.

EXPERIMENTAL

Dipole moments of the compounds were measured in benzene solutions at 25° by the method described.[5] The results are recorded in Tables 1 and 2.

Compounds used were prepared by the literature methods referred to above. Their physical properties agreed with those previously reported and all analysed satisfactorily.

TABLE 1. MEASUREMENTS* IN BENZENE AT 25°

Compound	10^6w	$10^6(\varepsilon_{12}-\varepsilon_1)$	$10^6(v_1-v_{12})$
1-Acetyl-1,2,3,4-tetrahydroquinoline	1937	14279	533
	2416	17932	703
	2659	19847	731
	6095	—	1677
1-Acetyl-6-bromo-1,2,3,4-tetrahydroquinoline	1305	5421	632
	2262	9435	1085
	2805	11729	1367
	3161	13188	1508
	3443	14440	1665
1-Acetylindoline	1265	13449	388
	1531	16212	509
	2134	22572	656
	2241	23875	683
	2616	27680	806
1-Acetyl-5-bromoindoline	1879	16733	952
	2028	18089	1026
	2699	24135	1375
	2923	26168	1494
	4405	39253	2241
1-Methyl-3,4-dihydro-2-quinolone	2380	13382	466
	2740	15297	543
	2870	16093	576
	3390	19134	632
1-Phenyl-2-piperidone	490	4855	122
	365	3603	—
	563	—	151
	681	6721	161
	969	9593	249
	1148	11349	—

* w = Weight fraction, ε_1 and ε_{12} are the dielectric constants for solvent and solution respectively, and v_1 and v_{12} are the corresponding specific volumes.

TABLE 2

Compound	$P_{2\infty}$	P_E	μ(D)
1-Acetyl-1,2,3,4-tetrahydroquinoline	287·53	52·04	3·39 ± 0·01
1-Acetyl-6-bromo-1,2,3,4-tetrahydroquinoline	249·96	60·04	3·05 ± 0·01
1-Acetylindoline	360·99	47·54	3·92 ± 0·01
1-Acetyl-5-bromoindoline	447·72	55·54	4·38 ± 0·01
1-Methyl-3,4-dihydro-2-quinoline	201·13	47·50	2·74 ± 0·005
1-Phenyl-2-piperidone	371·82	52·04	3·96 ± 0·02

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