PMR SPECTRA OF AZACINNOLINES

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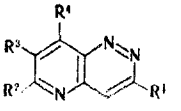
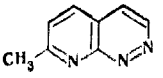
An analysis of the PMR spectra (using double resonance) of the isomeric 3-, 6-, 7-, and 8-methyl and 7-ethyl-5-azacinnolines, and also of 7-methyl-8-azacinnoline has shown the presence in these structures of a considerable localization of the C_5—C_6 and C_7—C_8 bonds, which has been confirmed by the results of a quantum-chemical calculation by the PPP method.

We have previously reported the synthesis [1-3] and chemical properties [4-6] of the new heterocyclic system of 5-azacinnoline (I) and its derivatives, the structure of which was confirmed, in particular, by their PMR spectra. However, the latter were obtained in various solvents and therefore the assignment of the signals of the protons of the heterocyclic ring was not done with sufficient strictness. In the present communication we analyze the PMR spectra (Table 1) of compound (Ia) and its alkyl derivatives (Ib-f), and also of the 7-methyl-8-azacinnoline (7-methylpyrido[2,3-c]pyridazine) (II), that we have synthesized. The assignment of the signals in the PMR spectra was made on the basis of the nature of the multiplicities and was confirmed in all cases with the aid of double resonance. It can be seen from Table 1 that the least shielded proton is that in position 3, and in order of decreasing shielding the protons formed the sequence: 3-H > 6-H > 8-H > 4-H > 7-H.



a-f



II

I a $R^1=R^2=R^3=R^4=H$; b $R^1=R^3=R^4=H$, $R^2=CH_3$; c $R^1=R^2=R^4=H$, $R^3=CH_3$; d $R^1=R^2=R^4=H$, $R^3=C_2H_5$; e $R^1=R^2=R^3=H$, $R^4=CH_3$; f $R^1=CH_3$, $R^2=R^3=R^4=H$

A similar regularity is observed in the change of the chemical shifts of the protons of the methyl groups: $3\text{-}CH_3 = 8\text{-}CH_3 < 6\text{-}CH_3 < 7\text{-}CH_3$. The position of the $8\text{-}CH_3$ signal in this sequence is probably due to the anisotropic influence of the sp^2-pair of electrons of the nitrogen atom in position 1.

The chemical shifts of the signals of the protons of the pyrido[2,3-c]pyridazine system (II) decrease in the sequence 3H > 5H > 4H > 6H.

As in cinnoline [7], the signal of the 4-H proton in the spectra of compounds (Ia-d, f) has additional splitting due to coupling with the 8-H proton with the constant J_{48} = 1 Hz.† In the PMR spectrum of compound (Ie) the signal of this proton has the form of a doublet with the characteristic constant J_{34} = 6.0 Hz. Analysis of the PMR spectra of compounds (Ib-f) has shown that the signals of the CH_3 groups of compounds (Ic and e) each consist of a doublet with J = 1.0 Hz. In the spectra of these isomers the signals of the 8-H and 7-H protons, respectively, have additional splitting with the same constant J = 1.0 Hz. Similarly to this, the signals of the protons of the CH_2 group in the PMR spectrum of compound (Id) consist of a doublet of quartets. This additional splitting disappears under double-resonance conditions with the suppression of the signals of the corresponding methyl groups or aromatic protons. The additional allyl coupling that we have observed is characteristic for systems with

*Deceased.

†A similar PMR spectrum has recently been described by Jones, who repeated the synthesis of compound (Ia) [8].

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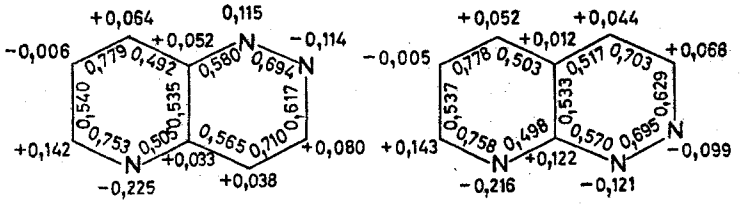
TABLE 1. PMR Spectra of Compound (Ia-f) and (II)[a]

Compound	3-H	4-H	6-H	7-H	8-H	CH_3	J_{34}	J_{67}	J_{78}	J_{68}	J_{48}	J_{H,CH_3}
Ia	9,50 d	8,05 q	9,13q	7,73 m	8,78 m	—	6,0	4,0	9,0	2,0	1,0	—
Ib	9,46 d	7,90 q	—	7,55 d	8,60 q	2,75 s	6,0	—	9,0	—	1,0	—
Ic	9,45d	8,01 q	9,00 d	—	8,50 m	2,61 d	6,0	—	—	2,0	1,0	1,0
Id	9,45 d	8,00 q	9,02d	—	8,50 m	1,37 t[b]	6,0	—	—	2,0	1,0	1,0[c]
Ie	9,50 d	7,75 d	8,95 d	7,50 m	—	3,02 d	6,0	4,0	—	—	—	1,0
If	—	7,85 m	9,08 q	7,65 q	8,76 m	3,02d	—	4,0	9,0	2,0	1,0	0,2
II	9,30d	7,80 d	7,50 d	8,05dd	—	2,85 s	5,8	8,5[e]	—	—	—	—

[a]The chemical shifts are given in ppm (δ scale) and the values of J in Hz. Multiplicities: s) singlet; d) doublet; t) triplet; q) quartet; m) multiplet. [b]δ_{CH_2} 3.0 ppm (m). [c]J_{H,CH_2}. [d]5-H signal. [e]J_{56}.

appreciable bond localization [9]. It is not found in the PMR spectra of the isomeric picolines. The absence of such additional splitting of the signals of the CH_3 groups in the PMR spectra of compounds (Ib) and (II) indicates the presence in the pyridopyridazine system of an increased localization of the bonds. Quantum-chemical calculations which we have performed by the PPP* method of the molecules of compounds (Ia) and (II) agree with this hypothesis.

As can be seen from the molecular diagrams given below, the order of the C_7—C_8 bond is 0.779 (for the C_5—C_6 bond of compound (II) it is 0.778), which is substantially greater than the orders of the C_6—C_7 bonds (0.540 and 0.537).



EXPERIMENTAL

The PMR spectra were obtained on a Tesla BS-487-C instrument with a working frequency of 80 MHz for solutions in deuterochloroform using HMDS as internal standard.

8-Methylpyrido[2,3-c]pyradazine (II). A solution of 1.9 g (10 mmole) of 2-methyl-5-vinylpyridine and 2.90 g (20 mmole) of dimethyl azodicarboxylate in 20 ml of benzene was boiled for 6 h and was then evaporated, and the residue was separated preparatively on alumina (activity grade 2) in the benzene—methanol (9 : 1) system. From the zone with R_f 0.22-0.46 we isolated a mixture of "bis-adducts" [3] with mp 36-42°C. A solution of 250 mg (0.6 mmole) of this mixture was boiled in 2 ml of hydrazine hydrate for 20 h, and then the excess of hydrazine was distilled off, the residue was extracted with hot methanol, the extract was evaporated, and the new residue was chromatographed in a thin layer of alumina. The zone with R_f 0.5-0.6 yielded 8.2 mg (10%) of compound (II). Found: mol. wt. 145 (mass-spectrometrically). $C_8H_7N_3$. Calculated: mol. wt. 145.

LITERATURE CITED

1. A. N. Kost, P. B. Terentjev, and V. G. Kartsev, Summary of the Fifth International Symposium on the Chemistry of Heterocyclic Compounds, Lubljana (1975).
2. V. G. Kartsev, P. B. Terent'ev, and A. N. Kost, Khim. Geterotsikl. Soedin., No. 7, 976 (1976).
3. P. B. Terent'ev, V. G. Kartsev, I. K. Yakushenko, L. N. Prostakova, A. N. Kost, and I. P. Gloriozov, Khim. Geterotsikl. Soedin., No. 5, 639 (1979).
4. M. F. Budyka, P. B. Terent'ev, and A. N. Kost, Khim. Geterotsikl. Soedin., No. 11, 1554 (1977).

*The calculations were performed by means of a program drawn up by A. A. Ustenko.

5. M. F. Budyka, P. B. Terent'ev, and A. N. Kost, Khim. Geterotsikl. Soedin., No. 6, 809 (1978).
6. L. N. Koikov, M. F. Budyka, P. B. Terent'ev, and A. N. Kost, Khim. Geterotsikl. Soedin., No. 9, 1272 (1978).
7. N. L. F. Armarego and T. J. Batterham, J. Chem. Soc., B, No. 8, 750 (1966).
8. G. Jones and P. Rafferty, Tetrahedron. Lett., No. 30, 2731 (1978).
9. J. Emsley, J. Feeney, and L. Sutcliffe, High Resolution NMR Spectroscopy, Pergamon, Oxford, Vol. I (1965); Vol. II (1966).