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Some Substituted 1*H*,4*H*- and 1*H*,5*H*-Pyrazolo[4,3-*c*]pyrazoles. Syntheses and Properties

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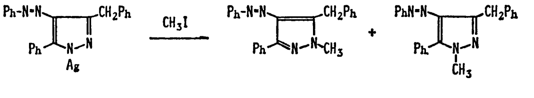
Syonpsis. 1,4-Dimethyl-3,6-diphenyl-, 1,5-dimethyl-3,3-diphenyl-, and 4-methyl-2,3,6-triphenyl-pyrazolo[4,3-*c*]-pyrazoles(IV, V, and VIII) were prepared and their structures were established on the basis of their spectral data.

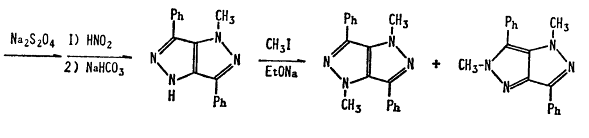
Syntheses of 2,3,5,6-tetra-aryl-1,2,4,5-tetra-azapentalenes, meso-ionic heterocycles, have recently been described.[1] These compounds contain four aryl substituents on the 2*H*,5*H*-pyrazolo[4,3-*c*]pyrazole ring. This paper presents the syntheses and properties of substituted 1*H*,4*H*- and 1*H*,5*H*-pyrazolo[4,3-*c*]pyrazoles.

Condensation of 1,4-diphenyl-2-phenylazobutane-1,3-dione[2] with methylhydrazine in ethanol gave 5-benzyl-1-methyl-3-phenyl-4-phenylazopyrazole(I), mp 151—152 °C, whereas treatment of the silver salt of 3-benzyl-5-phenyl-4-phenylazopyrazole[3] with excess of methyl iodide in boiling benzene afforded a mixture of the above-mentioned pyrazole (I) and its isomer, 3-benzyl 1-methyl-5-phenyl-4-phenylazopyrazole (II), mp 89—91 °C. The structures of these pyrazoles were deduced on the basis of their mass spectra and are consistent with the experimental results described below.



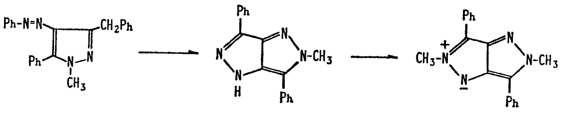
I II

Reduction of compound I with disodium dithionite and diazotization of the resulting amine by means of sodium nitrite in acetic acid followed by treatment with aqueous sodium bicarbonate yielded 3,6-diphenyl-1-methyl-4*H*-pyrazolo[4,3-*c*]pyrazole(III), mp 233—234 °C, which afforded, with excess of methyl iodide and sodium ethoxide in boiling ethanol, two mono-methylated products, 1,4-dimethyl-3,6-diphenylpyrazolo[4,3-*c*]pyrazole (IV), mp 202—204 °C, and the 1,5-dimethyl isomer (V), mp 169—171 °C, the structures being established on the basis of their mass and NMR spectra described in the experimental part.



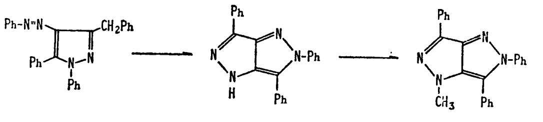
III IV V

If the structure of compound I were 3-benzyl-1-methyl-5-phenyl-4-phenylazopyrazole, the structure of compound III would be 3,6-diphenyl-2-methyl-4*H*-pyrazolo[4,3-*c*]pyrazole (III′) and, consequently, the structure of compound IV, which shows a sharp singlet proton signal from two equivalent methyl groups, would have to be 2,5-dimethyl-3,6-diphenylpyrazolo[4,3-*c*]-pyrazole (IV′); this structure, however, is ruled out, being inconsistent with the observed mass spectrum for compound IV (presence of a peak at *m/e* 82 due to $CH_3NCCNCH_3$). Thus, the structures of compounds I and II are confirmed.



II III′ IV′

3-Benzyl-1,5-diphenyl-4-phenylazopyrazole (VI) prepared by condensation of 1,4-diphenyl-2-phenylazobutane-1,3-dione with phenylhydrazine was similarly cyclized to 2,3,6-triphenyl-4*H*-pyrazolo[4,3-*c*]pyrazole (VII), mp 277—279 °C, which was converted into a mono-methylated product (VIII), mp 191—192 °C. The mass spectrum of compound VIII (presence of a peak at *m/e* 180 due to $C_6H_5CNC_6H_5$) rules out an alternative structure of 5-benzyl-1,3-diphenyl-4-phenylazopyrazole for compound VI, in which the position of the *N*-phenyl group was uncertain in the original literature.[2]



VI VII VIII

The NMR spectrum of compound VIII exhibits two multiplets centered at τ 1.75 (2H) and 2.65 (13H) due to aromatic protons, and this fact indicates that one phenyl ring (τ 1.75, *o*-2H) is coplanar with the nucleus, because Finar and Rackham showed a similar deshielding of the *ortho* protons of 1-phenyl substituted aza-aromatic compounds due to a large electric field associated with the lone pair of electrons of the nitrogen atom at position 2, this effect being operative only when both rings are coplanar.[4] Thus, to compound VIII is assigned the structure of 4-methyl-2,3,6-triphenylpyrazolo[4,3-*c*]pyrazole and not that of isomeric 5-methyl-2,3,5-triphenylpyrazolo[4,3-*c*]pyrazole, in which no coplanar phenyl is possible because of steric hindrance. This result is in contrast to the finding that the silver salt of 2-phenyl-4*H*-*v*-triazolo[4,5-*d*]-*v*-triazole affords both 4- and 5-methyl-2-phenyl-*v*-triazolo[4,5-*d*]-*v*-triazoles.[5]

Experimental

5-Benzyl-1-methyl-3-phenyl-4-phenylazopyrazole (I). This compound (Found: C, 78.55; H, 5.77; N, 15.81%; M$^+$,

352. Calcd for $C_{23}H_{20}N_4$: C, 78.38; H, 5.72; N, 15.90%; M, 352), mp 151—152 °C (from ethanol), *m/e* 352(M^+), 274($M-C_6H_5-H$), 259 ($M-PhCH_2-2H$), 103(PhCN), and 91($PhCH_2$), was prepared according to the directions given for the preparation of 3-benzyl-1,5-diphenyl-4-phenylazopyrazole[2] (VI).

3-Benzyl-1-methyl-5-phenyl-4-phenylazopyrazole (II). The silver salt (0.48 g) prepared from 3-benzyl-5-phenyl-4-phenylazopyrazole (0.36 g) and silver nitrate (1.0 g) in the usual way was heated in a mixture of benzene (15 ml) and methyl iodide (2 ml) under reflux overnight. On cooling, the precipitate was removed by filtration, and the filtrate was concentrated to yield 0.40 g of orange red solid. This crude material was subjected to purification by preparative thin layer chromatography on silica gel. Development with benzene afforded two contiguous bands with R_f lying between 0.32 and 0.47. The band with the larger R_f gave 0.10 g (26%) of compound I, and the one with the smaller R_f 0.06 g (16%) of compound II (Found: C, 78.27; H, 5.48; N, 15.92%. Calcd for $C_{23}H_{20}N_4$: C, 78.38; H, 5.72; N, 15.90%), mp 89—91 °C, *m/e* 352 (M^+), 275 ($M-C_6H_5$), 206 (PhNNCCPh), 179 (PhCHCPh), 118 ($PhCNCH_3$), and 91 ($PhCH_2$).

*3,6-Diphenyl-1-methyl-4*H*-pyrazolo[4,3-*c*]pyrazole (III).* To a suspension of compound I (4.0 g) in 80 ml of boiling 80% ethanol was added powdered disodium dithionite in small portions until the mixture became homogeneous. The mixture was then steam-distilled to remove aniline and ethanol. The remaining crystalline solid was collected and recrystallized from ethanol to yield the starting material (I; 1.08 g). The ethanolic filtrate was concentrated to dryness under reduced pressure. The residue was dissolved in 30 ml of acetic acid and diazotized with sodium nitrite (0.65 g) at 0—5 °C. The mixture was stirred for 15 min at this temperature and poured into cold dilute aqueous sodium bicarbonate. Organic materials were extracted with dichloromethane, and the extract was evaporated under reduced pressure. The residue was dissolved in a small amount of acetic acid and the solution was heated on a water bath for 15 min. On evaporation of the solvent, it gave 0.80 g (34%) of compound III (Found: C, 74.40; H, 5.01; N, 20.46%. Calcd for $C_{17}H_{14}N_4$: C, 74.43; H, 5.14; N, 20.43 %), mp 233—234 °C (white crystals from benzene).

*1,4- and 1,5-Dimethyl-3,6-diphenylpyrazolo[4,3-*c*]pyrazoles (IV and V).* Compound III (0.50 g) and methyl iodide (4 ml) were added to ethanolic sodium ethoxide solution prepared from 1 g of sodium and 45 ml of ethanol, and the mixture was heated under reflux overnight. The solvent was evaporated under reduced pressure, and the residue was washed with water and dried to yield 0.67 g of a solid. This crude product (0.50 g) was subjected to purification by preparative thin layer chromatography on silica gel using benzene-ether (10 : 1) as eluent. The band with R_f 0.45—0.53 gave 0.08 g (21%) of the 1,4-dimethyl isomer (IV) (Found: C, 75.14; H, 5.54; N, 19.54%. Calcd for $C_{18}H_{16}N_4$: C, 74.97; H, 5.59; N, 19.43%), mp 202—204 °C (from ethanol), τ 6.00 (6H, s, $2CH_3$), 2.65(6H, multiplet, aromatic), and 2.36(4H, multiplet, aromatic), *m/e* 288 (M^+), 103(PhCN), and 82($CH_3NCCNCH_3$). The band with R_f 0.38—0.44 yielded 0.09 g (23%) of the 1,5-dimethyl isomer (V) (Found: C, 75.11; H, 5.60; N, 19.64%. Calcd for $C_{18}H_{16}N_4$: C, 74.97; H, 5.59; N, 19.43%), mp 169—171 °C (from ethanol), τ 6.20(3H, s, CH_3), 5.95 (3H, s, CH_3), 2.53(8H, multiplet, aromatic), and 1.80(2H, multiplet, aromatic), *m/e* 288(M^+) and 118($PhCNCH_3$).

*2,3,6-Triphenyl-4*H*-pyrazolo[4,3-*c*]pyrazole (VII).* 3-Benzyl-1,5-diphenyl-4-phenylazopyrazole[2] (VI), treated similarly to the preparation of compound III, afforded compound VII (Found: C, 78.75; H, 4.60; N, 16.74%. Calcd for $C_{22}H_{16}N_4$: C, 78.55; H, 4.79; N, 16.66%), mp 277—279 °C (from ethanol).

*4-Methyl-2,3,6-triphenylpyrazolo[4,3-*c*]pyrazole (VIII).* Compound VII prepared above was methylated in the same way as in the preparation of compounds IV and V to yield compound VIII (Found: C, 78.56; H, 4.88; N, 16.29%. Calcd for $C_{23}H_{18}N_4$: C, 78.83; H, 5.18; N, 15.99%), mp 191—192 °C (from ethanol), *m/e* 350(M^+), 246($M-PhCNH$), and 180(PhCNPh), τ 6.15(3H, s, CH_3), 2.65(13H, multiplet, aromatic), and 1.75(2H, multiplet, aromatic).

References

1) J. H. Lee, A. Matsumoto, O. Simamura, and M. Yoshida, *Chem. Commun.*, **1969**, 1393.

2) C. Bülow and H. Grotowsky, *Ber.*, **34**, 1479 (1901).

3) D. G. Farnum and P. Yates, *J. Amer. Chem. Soc.*, **84**, 1399 (1962).

4) I. L. Finar and D. M. Rackham, *J. Chem. Soc. B*, **1968**, 211.

5) M. Yoshida, A. Matsumoto, and O. Simamura, This Bulletin, **43**, 3587 (1970).