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TRAPPING AND STRUCTURE DETERMINATION OF AN INTERMEDIATE IN THE REACTION BETWEEN 2-METHYL-5-t.BUTYLPYRROLE AND DICHLOROCARBENE

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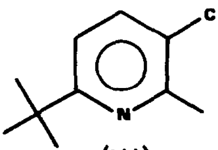
2,5-dialkyl pyrroles react in protic media with dichlorocarbene generated under basic conditions giving rise to ring expansion products (2,6-dialkyl-3-chloropyridines) and addition products (2,5-dialkyl-2-dichloromethyl-2H-pyrroles or Plancher's pyrrolenines)[1]. The latter are not intermediates for the ring expansion reaction[2].

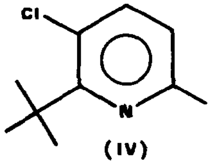
According to the mechanism[3] generally accepted[4], these two product types are formed by different routes. Pyridines arise from the cycloaddition of dichlorocarbene to the undissociated pyrrole, while 2H-pyrroles arise from an electrophilic attack of the reagent on the conjugate base of the substrate. In this way two different intermediates are supposed. The simplest hypothesis that both products were formed from a single intermediate has already been suggested[5] and recently reproposed[6].

In order to collect new data on this argument, we carried out a reaction between 2-methyl-5-t.butyl pyrrole (I) and dichlorocarbene, generated in neutral and aprotic medium (dimethoxyethane, DME) from $PhHgCCl_3/NaI$ system[7].

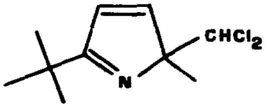
Chromatographic separation of the reaction mixture gave - together with the already-known compounds (III-V) - a crystalline product (II) containing mercury (MP: 108-109°C from CH_3CN).



(III)

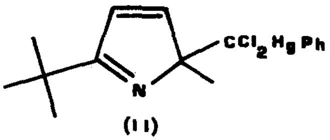


(IV)



(V)

Ir spectrum (in KBr; ν max at 3070;3050;2980;2940;1610;1525;1030;1005 and 700 cm^{-1}) and NMR spectrum (in CCl_4; 7.17δ,5H; 7.38δ and 6.49δ, 2H,AB system, J=5 Hz; 1.58δ,3H, singlet; 1.22δ,9H, singlet) suggested for the mercurial (II) the structure of [1,1-dichloro-1-(2-methyl-5-t.butyl-2H-pyrril-2-)] phenylmercury.



(II)

Well-shaped colourless crystals of (II) were obtained by slow evaporation from acetonitrile at room temperature. Crystal data are: $C_{16}H_{19}NCl_2Hg$, M=496.83, monoclinic, a=6.261(2), b=15.400(4), c=17.594(6)Å, β=96.08(2)°, V=1686.9$Å^3$, Space group $P2_1/c$, Z=4, Dc=1.79 gcm^{-3}, F(000)=944, Mokα(λ=.71069), μ=96.69 cm^{-1}.

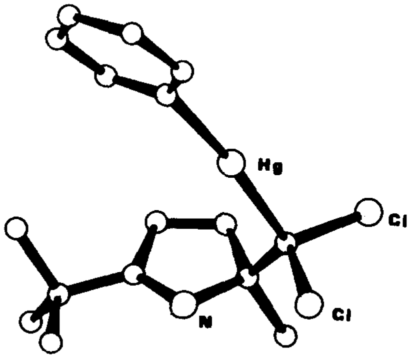
The intensity data of 2514 non-zero (I>3σ(I)) indipendent reflections were collected on an automatic four-circle diffractometer, using monochromatized Mokα radiation, θ-2θ scan mode, from a crystal of 0.25x0.30x0.30 mm, up to a θ value of 30°. No correction for absorbtion or extinction was applied.

The crystal structure was solved by Patterson and Fourier methods and refined by block-diagonal least squares.

The refinement of atomic parameters of all the non-hydrogen atoms, assuming anisotropic thermal motion only for Hg and Cl atoms, led to an R=0.062. A final difference Fourier synthesis showed no significant residual electron density maxima.

Crystallographic evidence such as the analysis of the electron population of the Fourier peaks stereochemical considerations such as valence angles and bond distances allowed us to establish unambiguously the molecular structure of the cristalline product(II).

The figure shows the stereochemical features of the molecule in the cristalline state.



It seems likely that compound (II) arises from the trapping of an intermediate in the reaction between pyrrole (I) and dichlorocarbene. The chemical properties of (II) are consistent with this hypothesis (see table).

(II) was stable when warmed (80°C) in EtOH or DME, but it was converted mainly into 2H-pyrrole (V) and chloropyridine (III) by the action of acids or bases in the same conditions.

Three other compounds were present in the reaction mixtures, and they were identified as pyrrole (I), 1-formyl-2-methyl-5-t.butyl pyrrole (VI) and 2-chloro-3-methyl-6-t.butyl pyridine (VII), on the basis of their chemical and physical properties. The presence of these compounds is attributable to an alternative evolution of (II) involving a shift of the $-CCl_2HgPh$ group from carbon to nitrogen, before the CCl_2-Hg bond cleavage. This hypothesis is now under study

Results are summarized in the following table:

TABLE

Action* of acids and bases on (II).

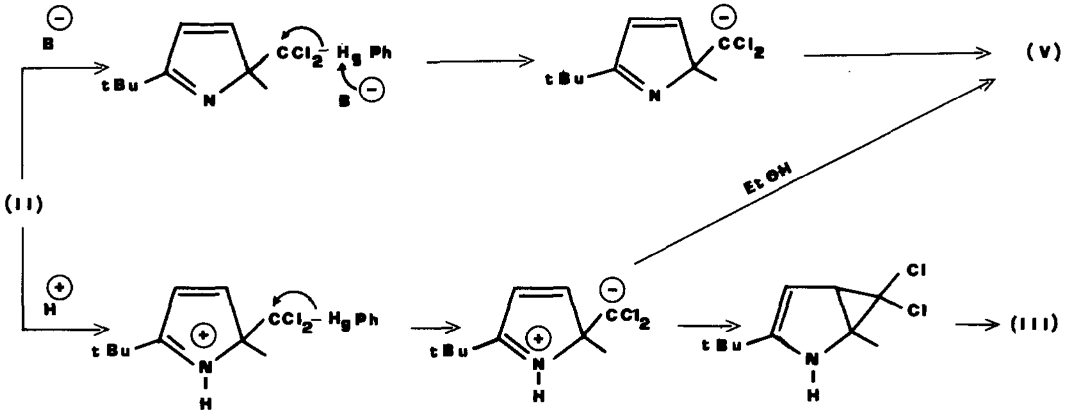
Run	Reactant	Solvent	Products (% GC area)				
			(I)	(III)	(V)	(VI)	(VII)
1	-	EtOH	unreacted substrate				
2	-	DME	unreacted substrate				
3	KOH	EtOH	5	-	95	-	-
4	MeONa	DME	-	-	100	-	-
5	TsOH	EtOH	-	40	40	-	20
6	TsOH	DME	10	70	-	20	-

*) All reactions were carried out in duplicate in a sealed tube at 80°C for 18 hrs.

The conversion 2H-pyrrole→ 3-chloropyridine, which is similar to conversion (II)→(III) reported here, is already known, but involves a carbenoid species[2]. Results of runs 1 and 2 exclude the possibility of a carbene as intermediate, which could be formed through a thermic process.

The cyclic expansion is the main process under acidic catalysis in aprotic solvents (run 6), but the formation of 2H-pyrrole(V) in addition to the chloropyridine (III) is observable in a protic solvent (run 5). This behaviour parallels previous observations on the reaction between 2,5-dialkylpyrroles and dichlorocarbene[8]. It seems reasonable to assume that protic solvents favour the formation of 2H-pyrroles, as previously observed[6].

A mechanistic pathway on the formation of 3-chloropyridine (III) and 2H-pyrrole (V) from (II) is outlined below:



The result, that an unique "open" intermediate is able to produce either 2H-pyrrole (V) or 3-chloropyridine (III), strongly suggests, that, in the reaction between 2,5-dialkylpyrroles and dichlorocarbene, both types of products (expanded and addition) are formed by the same intermediate, as above depicted in the scheme.

A more detailed work is in progress.

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