Bonding of Benzo[*a*]pyrene to Nitrogen Heterocycles by Anodic Oxidation

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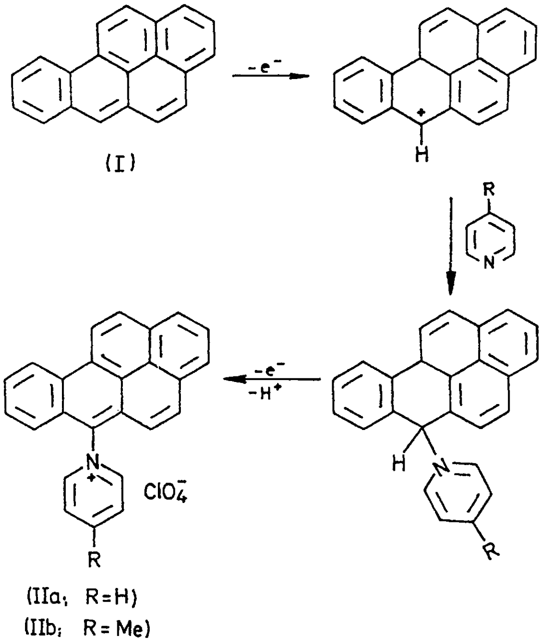
Summary Anodic oxidation of benzo[*a*]pyrene (I) in the presence of pyridine or 4-picoline results in the formation of the 6-(*N*-pyridinium) and 6-(*N*-picolinium) derivatives in high yield; the corresponding reaction using 1-methylimidazole also results in oxidative coupling but the methylimidazolium residue appears to be bonded to benzo[*a*]pyrene at C-1.

The carcinogenicity of certain polycyclic aromatic hydrocarbons has been generally ascribed[1] to their covalent interaction with deoxyribonucleic acid, DNA, and model compounds involving linkage of 1-methylcytosine[2] and thymine[3] to C-6 of (I) have been prepared by photochemical means. This is a superficial model for the unidentified *in vivo* process which results in bonding of hydrocarbons to DNA.[4] Three types of mechanism have been suggested and involve the intermediacy of K-region epoxides,[5] of carbocations,[2,6] and of aromatic radical cations[7] respectively. Johnson and Calvin have recently illustrated the second of these by a model system in which (I) interacts with iodine dipyridine nitrate to provide an *N*-(6-benzo[*a*]pyrenyl)pyridinium salt by a heterolytic process.[8] We here describe reactions which provide a model for the radical cation pathway.



SCHEME

The anodic oxidation of (I) in acetonitrile using tetraethylammonium perchlorate as electrolyte in the presence of excess of pyridine leads directly to the formation of *N*-(6-benzo[*a*]pyrenyl)pyridinium perchlorate (IIa) in high yield.† This material was identified by comparison with an authentic sample prepared by Rochlitz's method.[9] The pentadeuterio-derivative of (IIa) was made in the same way using $[^2H_5]$pyridine.

Anodic oxidation of (I) and 4-picoline provided a salt isolated as the perchlorate and further characterised as the picrate. The former was identified as *N*-(6-benzo[*a*]pyrenyl)-4-picolinium perchlorate (IIb) through the close correspondence between its u.v. and n.m.r. spectra and those of (IIa). However, similar oxidation of (I) in the presence of 1-methylimidazole led to the formation of an *N*-methylimidazolium derivative of (I) whose u.v. and n.m.r. spectra show significant differences from those of (IIa) and (IIb) and which we provisionally formulate as 1-(1-benzo[*a*]pyrenyl)-3-methylimidazolium perchlorate on the basis of its n.m.r. spectrum and alkaline hydrolysis to an iminobenzo[*a*]pyrene.‡

Radical cations of benzo[*a*]pyrene are known to be produced during the anodic oxidation of (I) in acetonitrile[10] whereas the e.m.f. employed in the above experiments is not sufficient to achieve oxidation of the heterocyclic compounds used. These facts and preliminary results from kinetic electrolysis experiments support the mechanism presented in the Scheme.

This suggests that if the radical cation of benzo[*a*]pyrene is generated by a biological one-electron oxidation in the vicinity of DNA it could result in the linkage of (I) to a pyrimidine *via* C-6, as observed in the photochemical models,[2,3] but might exhibit a different regiospecificity for bonding to the imidazole ring of a purine base.

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† All compounds described have been fully characterised by spectroscopic and microanalytical techniques.

‡ Provisionally identified as 1-aminobenzo[*a*]pyrene.

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