Aromatization of Polyfunctional Cyclic Compounds

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Summary Steroidal compounds containing three potential sites of unsaturation in rings A and B undergo aromatization into 4-methyloestra-1,3,5(10)-trienes on treatment with acetyl bromide and hydrogen bromide; under similar conditions mono- and bi-cyclic $\alpha\beta$-unsaturated ketones are also aromatized.

WE report that cyclic compounds with at least three potential sites of unsaturation readily undergo aromatization when they are treated with acetyl bromide and HBr generated *in situ* from acetyl bromide and propan-2-ol.

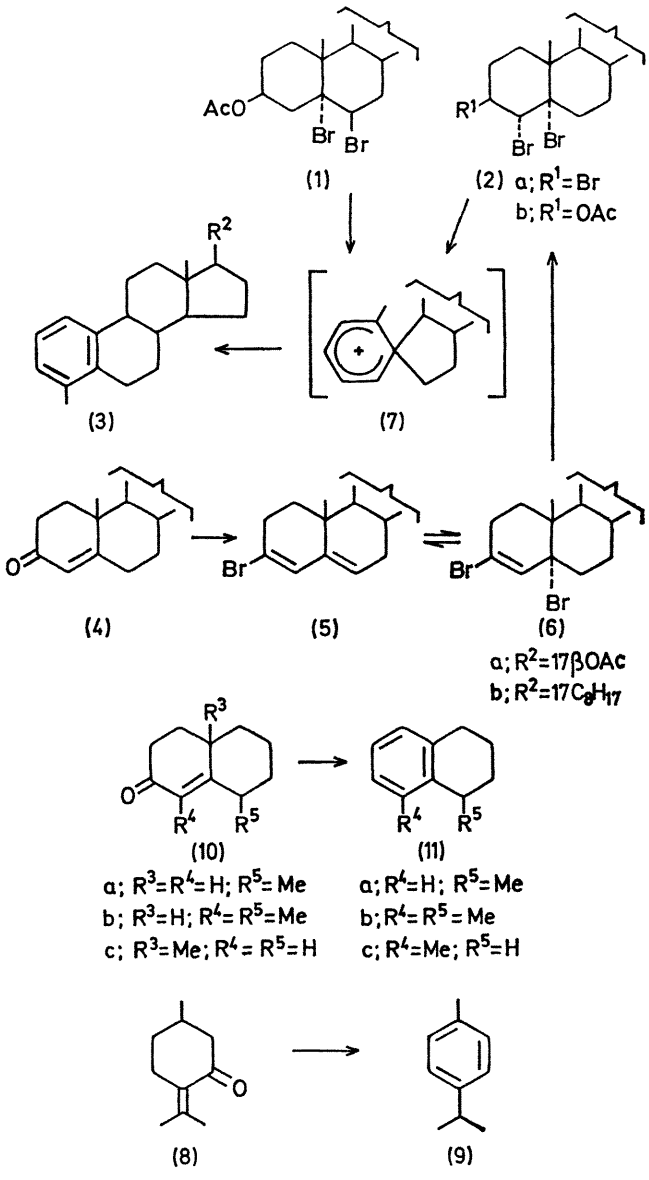
Treatment of steroids, having three substituents in rings A and B [*e.g.* the tribromide† (**2a**), or the dibromides (**2b**) and (**1**) in the 17β-acetoxy androstane series], with these reagents results in ring A aromatized derivatives (**3**), obtained as major products in *ca.* 65, 70, and 25% yield respectively.‡

Testosterone acetate (**4a**) and cholestenone (**4b**) were also converted under the same reaction conditions into the aromatic compounds (**3**) in *ca.* 60% yield.§¶ N.m.r. monitoring of the reaction with these last ketones, conducted at room temperature, revealed two intermediates: the bromodiene (**5**) which was formed almost instantaneously and the dibromide (**6**) which was formed from it. Treatment of the bromodiene (**5**), or the dibromide (**6**) with acetyl bromide and propan-2-ol as described gave the aromatic compound (**3**) in similar yield.

These aromatization reactions were carried out as follows. The ketone (1 mmol) is dissolved in 10—20 mmol of acetyl bromide in an ampoule and treated with 2 mmol of propan-2-ol at liquid air temperature. The ampoule is then sealed *in vacuo* at this temperature and subsequently heated at 85° for a few hours. When equimolar quantities of acetyl bromide and propan-2-ol are used the aromatic compounds (**3**) are also formed, but the yields are much smaller. No aromatization was observed when the reactions were carried out in open flasks instead of sealed ampoules.

These aromatizations probably take place *via* a series of additions and eliminations of HBr which lead to the benzenonium ion (**7**), the precursor of (**3**). The intermediacy of a benzenonium ion (**7**) has also been postulated in the dienol–benzene rearrangement.[3]

The reaction was also applied to mono- and bi-cyclic unsaturated ketones. Thus 3,4-dimethylcyclohex-2-enone



† Prepared by bromination of the corresponding Δ^4-derivative.

‡ In all these aromatization reactions anthrasteroids were formed as minor products (in 5—25% yield), *cf.* following communication.

§ It has been reported previously that Δ^4-3-ketones with acetyl bromide and α-bromopropionic acid are converted into (**3**) and anthrasteroids.[1,2]

¶ For other methods of aromatizations of similar systems *cf.* ref. 4,5,

gave *o*-xylene, piperitone (**8**) was converted into *p*-cymene (**9**) and the bicyclic ketones (**10a**—**c**) yielded the tetralines (**11a**—**c**) respectively. The yields of the aromatic products were quantitative, except for piperitone (**8**), which gave *p*-cymene (**9**) in 38% yield.

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