

# STEROIDS XVI<sup>1)</sup>. BROMINATION OF STEROIDAL 3-KETO-1,4,6-TRIENES

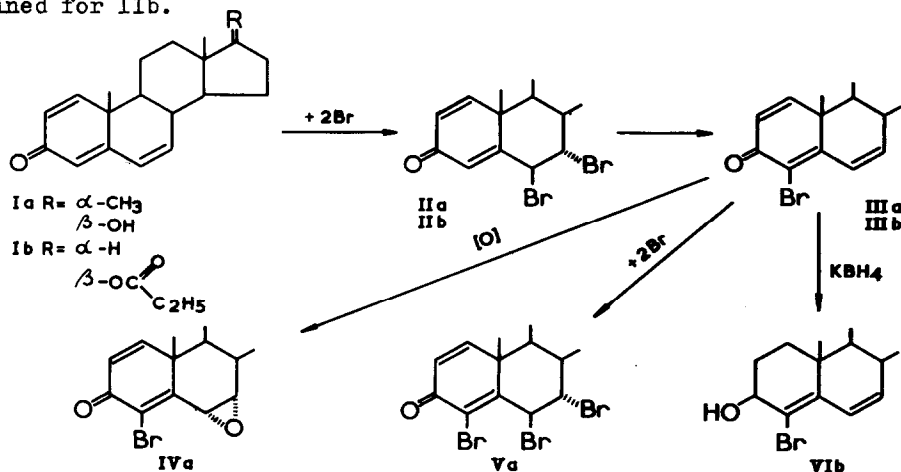
M. Kocór and M. Gumulka

Institute of Organic Chemistry of the Polish Academy of Sciences, Warsaw

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In the course of our investigations of the reactivity of steroidal 3-keto-1,4,6-trienes<sup>1)</sup> Ia and Ib we have found an interesting dehydrobromination reaction which is the subject of the present communication.

The bromination of Ia and Ib with molecular bromine or with N-bromoamides, gave only diaxial addition products, i.e. 6 $\beta$ ,7 $\alpha$ -dibromo-3-keto-1,4-dienes : IIa, m.p. 152-153,5°, and IIb, m.p. 135-137° (NMR<sup>2)</sup> of IIa : H-1 7.05, H-2 6.30, J<sub>12</sub>=J<sub>21</sub>=10 Hz, H-4 6.32, H-6 5.15, H-7 6.60). Very similar values were obtained for IIb.



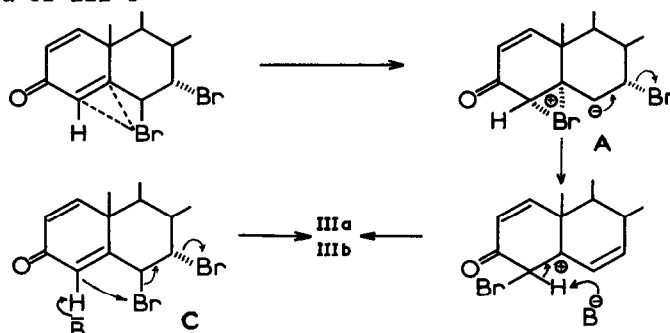
Bromination or chlorination of Ia and Ib with N-haloamides gave no trace of allylic halogenation.

Dehydrobromination of IIa and IIb with organic bases yielded 4-bromo-3-keto-1,4,6-trienes (IIIa, m.p. 97-101°, or IIIb, m.p. 102-106°) instead of the expected 6-bromo-derivatives. The structure of IIIa was supported by its spectra : UV,  $\lambda_{\text{max}}$  202,230,314 nm; IR, 1660 (C=O), 1610-1620 (C=C)  $\text{cm}^{-1}$ ; NMR : H-1 7.04, J<sub>12</sub>=9.5 Hz, H-6 6.36, J<sub>67</sub>=9.5 Hz, J<sub>68</sub>=2.8 Hz, H-2 6.78, J<sub>21</sub>=9.5 Hz, H-7 6.18, J<sub>78</sub>=2.8 Hz. Similar values were observed for IIIb.

Further evidence for the proposed 4-bromo-structure was obtained by epoxidation of IIIa to the 6 $\alpha$ ,7-epoxide IVa ( $\lambda_{\max}$  251 nm and NMR : H-1 6.90, H-2 6.30,  $J_{12}=J_{21}=10$  Hz, H-6 4.92, H-7 4.40) and by bromination of IIIa to the tribromocompound Va ( $\lambda_{\max}$  259 nm and NMR : H-1 7.10, H-2 6.40,  $J_{12}=J_{21}=10$  Hz, H-6 6.18, H-7 4.60). The bromotrienone IIIb could be also reduced by means of  $\text{NaBH}_4$  to give the unsaturated  $\beta/\beta$ -alcohol VIb, m.p. 122-124 $^\circ$  ( $\lambda_{\max}$  248, 255, 264 nm; NMR, H-6 6.36, H-7 5.80,  $J_{67}=J_{76}=10$  Hz,  $J'=3$  Hz, H-17 4.64, H-3 4.24).

We exclude classical or nonclassical carbonium ion mechanisms involving the formation of positive charge on C-4 for this unexpected dehydrobromination.

We propose that the geometry of the molecule allows overlap of the  $\pi$ -orbitals of 4,5-double bond with the valence orbitals of Br-6, giving rise to a bromine shift to the slightly negative C-4 to produce A. The latter is stabilised in the presence of bases in the normal way to give the 4-bromo compound : IIIa or III b



The possibility of an alternative concerted mechanism C is supported by the fact that we could not capture the plausible ionic transition state A by the use of an excess of the other ions ( $\text{Cl}^-$ ,  $\text{CN}^-$ ) in the reaction medium.

#### References :

- 1) Steroids XV, M. Kocór and M. Gumułka, in press
- 2) All NMR chemical shifts are given in  $\delta$  (ppm); the signals of  $\text{CH}_3$  protons have the normal values.