Base Catalysed Deacylative Dimerisation of 3-Acetylchromenone: a Facile Diels–Alder Reaction

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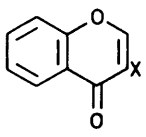
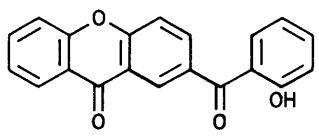
That the key step in the title reaction is the Diels–Alder addition of 3-acetylchromenone (**1**) to its acyl–acyl rearranged isomer (**9'a**) is supported by the formation of 2-salicyloylxanthone (**5**) from the reaction of (**9**) with any of the chromenones (**1**)—(**4**)

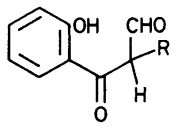
Menichi *et al.*[1] reported the deacylative dimerisation of the title chromenone (**1**) on treatment with sodium ethoxide in ethanol to give the xanthone (**5**) in 24% yield. The authors suggested that the ethoxide ion opens the pyrone ring of (**1**) to give the tricarbonyl compound (**6**), the latter undergoing base induced deacetylation to 2-hydroxyphenacylformaldehyde (**7**); the intermediates (**6**) and (**7**) then combine to form the benzophenone (**8**) that cyclises to (**5**) during acidic work-up. It is noteworthy that none of the intermediates (**6**)—(**8**) could be isolated. If this contention is correct, one should have been able to isolate at least the trihydroxy compound (**8**) since 2,2'-dihydroxybenzophenone cyclises to xanthone only when heated in the presence of mineral acid.[2] We report that the ketone (**1**), dissolved in ethanol or dioxane, on treatment with triethylamine or pyridine† at room temperature or by percolation through Brockmann 'neutral' alumina afforded, without any subsequent acid treatment, the xanthone (**5**) [m.p. 184 °C (lit.[1] m.p. 185—187 °C); λ_{max} (EtOH) 220 (log ε 4.38), 260 (4.49), and 337 (3.99) nm; ν_{max} ($CHCl_3$) 1660 (CO), 1625 (CO), and 1600 (C=C) cm^{-1}; δ_H (100 MHz; $CDCl_3$) 11.76 (1H, s, exchangeable, OH), 8.64 (1H, d, *J* 2 Hz, 1-H), 8.32 (1H, dd, *J* 8 and 1.5 Hz, 8-H), 8.12 (1H, dd, *J* 8 and 2 Hz, 3-H) and 7.84—6.80 (8H, m, other ArH); *m/z* 316 (M^+, 70%), 315 (M − H, 53), 298 (M − H_2O, 8), 287 (315 − CO, 50), 271 [298 − (CO + H), 16], 223 (315 − C_6H_4O, 24), 196 (M − $C_7H_4O_2$, 24), 149 (81), and 139 (100); acetate, m.p. 156 °C; δ_H (100 MHz; $CDCl_3$) 8.72 (1H, d, *J* 2 Hz, 1-H), 8.40—7.20 (10H, m, ArH) and 2.00 (3H, s, COMe)] in quantitative yield. This demands, according to the previous contention,[1] the base catalysed deacetylation in exclusion of deformylation of (**6**) which is most unlikely. So, we propose for the title reaction a mechanism as depicted in Scheme 1.



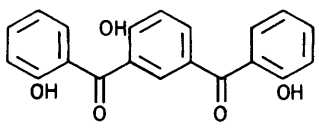
(**1**) X = COMe
(**2**) X = CHO
(**3**) X = H
(**4**) X = CO_2H



(**5**)



(**6**) R = COMe
(**7**) R = H



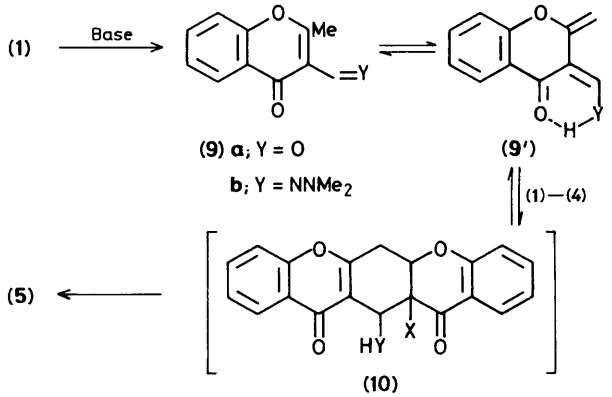
(**8**)

† The chromenone (**1**), like its lower homologue (**2**), on treatment with a secondary amine, aliphatic or aromatic, is deacylated to 1-amino-2-(2-hydroxybenzoyl)ethane: C. K. Ghosh and S. Khan, *Synthesis*, 1981, 719.

3-Acetylchromenone (**1**) acyl–acyl rearranged under base catalysis to the isomeric 3-formyl-2-methylchromenone (**9a**) that because of its active methyl group[3] remains in tautomeric equilibrium with (**9'a**) at least in basic medium. The other possible aldo–enol tautomer, if formed at all, is present in very small amounts.[4] The tautomer (**9'a**) with an *o*-quinodimethane structure[5] underwent a facile Diels–Alder reaction with the pyrano-dienophile (**1**) to give the resultant adduct (**10**) (non-isolable) which underwent base catalysed elimination and deacylative elimination to yield the xanthone (**5**). The proposed mechanism is justified by the fact that the aldehyde (**9a**)[6] [independently prepared by treating (**1**) with 1,1-dimethylhydrazine followed by hydrolytic decomposition of the resultant hydrazone (**9b**)] on treatment with any of the chromenones (**1**)—(**4**) afforded (**5**) in quantitative yield.

The mechanism in Scheme 1 requires further that any compound having the general structure (**9**) will behave like 3-formyl-2-methylchromenone towards (**1**)—(**4**) provided that the tautomeric equilibrium (**9**) ⇌ (**9'**) occurs under the reaction conditions (ethanol, pyridine catalyst, reflux, 10 h) and that YH is a good leaving group. Such is indeed the case with the hydrazone (**9b**) due to its predominant existence in the (*Z*)-ketoamine form (**9'b**)[7] and the high nucleofugality of dimethylhydrazine.[8] It has also been found that the formation of (**5**) from the reaction of (**9a**) with any of the dienophiles (**1**)—(**4**) does not require any added base.

Xanthones have previously been made from appropriately substituted diphenyl ethers or ketones[2,9] but these compounds are prepared with difficulty and often in unsatisfactory yields. The facile Diels–Alder reaction of 2-methylchromenone derivatives [*e.g.* (**9a**)] with various dienophiles may provide an



(**9**) a; Y = O
b; Y = $NNMe_2$

Scheme 1

easy and economic alternative route to xanthones or dihydroxanthones.

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