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ACID-CATALYZED PHOTOREARRANGEMENT OF THE BOND-SWITCHING ISOMER OF A PENTAMETHYLCYCLOOCTA-PYRIMIDINE-2,4-DIONE

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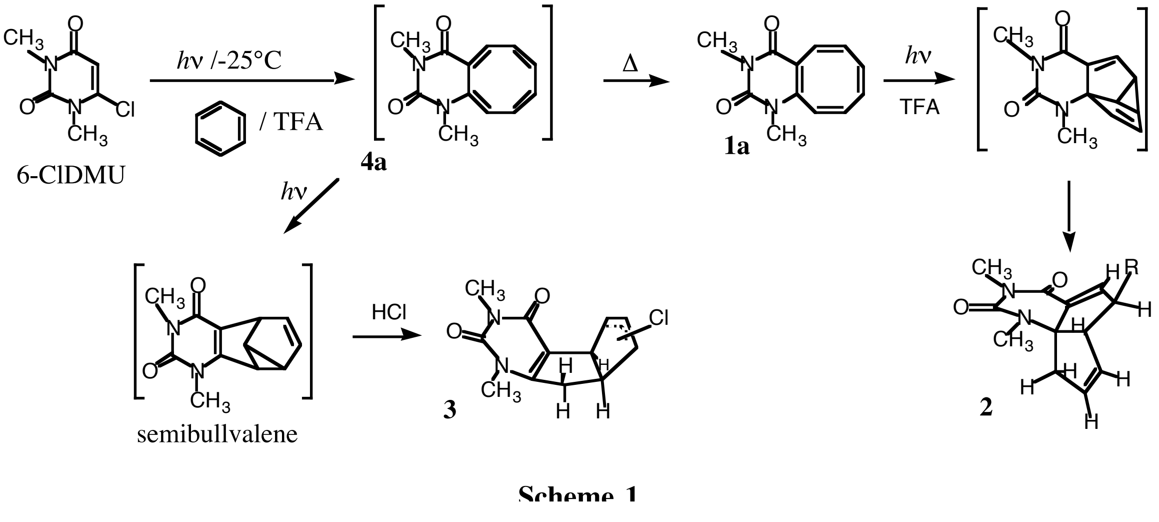
Abstract — UV-irradiation of the tautomer (**4c**) of 1,3,6,8,10-pentamethylcyclooctapyrimidine-2,4-dione (**1c**) in the presence of TFA gives 9, 11-diazapentacyclo[6.4.0.$0^{1,3}$.$0^{2,6}$.$0^{4,8}$]dodecane (**5**) and pentaleno[2,1-*d*]pyrimidine (**6**).

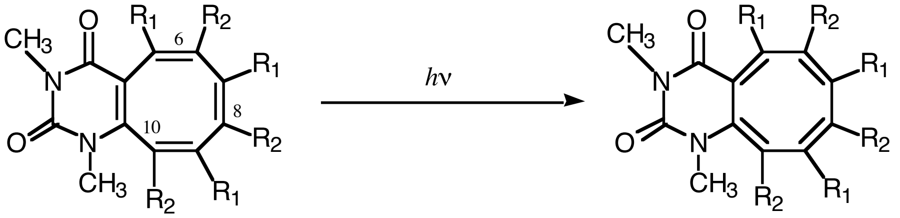
Previously we reported that UV-irradiation of 6-chloro-1,3-dimethyluracil (6-ClDMU) in benzene in the presence of trifluoroacetic acid (TFA) at room temperature effected cycloaddition reaction to give cyclooctapyrimidine (**1a**) in fair yield.[1] Photolysis of the resulting cycloadduct (**1a**) in the presence of TFA caused valence isomerization into novel tricyclic compounds, pentaleno[6a,1-*d*]pyrimidine-2,4-diones (**2**; R = OCOCF$_3$, C$_6$H$_5$) *via* a [π4s + π2a] or a [π4a + π2s] type process.[2]



Scheme 1

Furthermore, the photolysis of 6-ClDMU in frozen benzene in the presence of TFA was found to produce a different type of hydrochlorinated pentaleno[2,1-*d*]pyrimidines (**3**).

These dramatic changes in photochemical behavior depending on the reaction conditions were explained by virtue of the participation of a tentative intermediate (**4a**) that we refer to as the tautomer of **1a**.[4] However, either the isolation or the characterization of the postulated key intermediate (**4a**) or its skeletal analogue has not yet been performed until our recent findings. We reported that the photolysis of 1,3,5,7,9-pentamethylcyclooctapyrimidine-2,4-dione (**1b**) and the 1,3,6,8,10-pentamethyl isomer (**1c**) in the absence of TFA induced bond-switching[5] to give the tautomers (**4b** and **4c**) (Scheme 2).[6] These findings encouraged us to investigate the photochemical behavior of these tautomers.



1b, $R_1 = CH_3$, $R_2 = H$
1c, $R_1 = H$, $R_2 = CH_3$

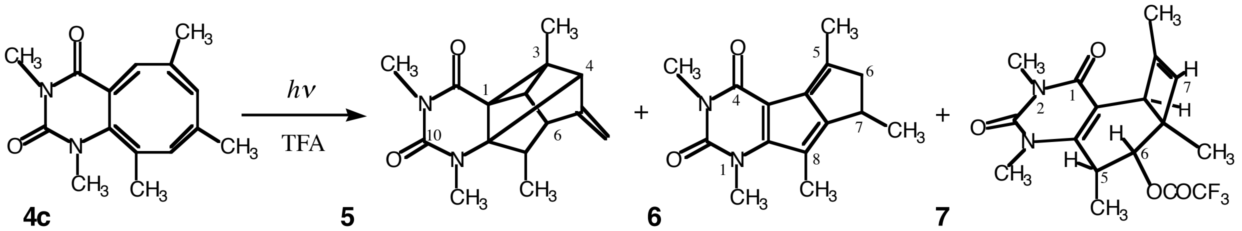
4b, $R_1 = CH_3$, $R_2 = H$
4c, $R_1 = H$, $R_2 = CH_3$

Scheme 2

In the present communication, we describe preliminary outcomes on the photolysis of the tautomeric isomer (**4c**).[7]

The 9-methyl tautomer (**4b**) is so unstable (half-life time = 30 min at room temperature) to obtain in sufficient amounts as a pure form that its UV irradiation failed to be done. On the other hand, the 8-methyl isomer (**4c**) is stable enough (half-life time of *ca.* 8 h at room temperature) to be exposed to UV-light. Hence our attention was focused on the photochemical behavior of **4c**.

UV-irradiation of a solution of **4c** in benzene in the presence of TFA gave rise to the formation of a complex mixture of new products.[8] HPLC of the resulting mixture afforded a pentacyclic and tricyclic compounds consisting of a pentaleno[2,1-*d*]pyrimidine system (**5**:[9] 20%, **6**:[9] 5.3%), together with a cyclobutaquinazoline derivative (**7**: 6%) (Scheme 3).



Scheme 3

The structure of **7**[10] was deduced on the basis of their spectroscopic studies. The ^{1}H-NMR (C_6D_6) spectrum showed three singlet signals due to N2-CH_3, N4-CH_3 and C6a-CH_3 at δ 3.28, 2.56 and 1.09 ppm, respectively. A doublet peak due to C5-CH_3 appeared at δ 0.60 ppm with coupling with H-5 (δ, 2.33 ppm, J = 7.1 Hz). A signal due to C8-CH_3 appeared at δ 1.93 ppm with long-range couplings with H-8a and H-7. A broad singlet peak due to H-8a appeared at δ 3.46 ppm and a peak ascribed to H-7 was at δ 5.82 ppm. NOE experiments confirmed the structure assigned to **7**.

The production of these pentaleno derivatives (**5** and **6**) coincides with our previous results obtained from the photoreaction in frozen benzene,[3] wherein hydro chlorinated analogues (**3**) were produced through the tentative tautomer (**4a**) by way of semibullvalene intermediate by a [π4s + π2a] type electrocyclic process (Scheme 1).

Thus, the present study may substantiate the participation of the supposed tautomer (**4a**), which is responsible for the formation of pentaleno[6a,1-*d*]pyrimidines (**2**) in the photoreaction of 6-ClDMU in frozen benzene. In addition, the present study demonstrates that a [π4s + π2a] electrocyclic process is involved in common in the present TFA-catalyzed photoisomerization of a cyclooctapyrimidine skeleton and its bond-switching isomer, resulting in the formation of a pentaleno[6a,1-*d*]pyrimidine system and a pentaleno[2,1-*d*]pyrimidine system, respectively. In addition, the presence of an acid (TFA) is found essential for the present photorearrangement, providing a novel and unique [4 + 2] electrocyclic isomerization. Further studies on the details of the reaction mechanisms are in progress.

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6. K. Ohkura, K. Nishijima, S. Uchiyama, A. Sakushima, and K. Seki, *Heterocycles*, 2001, **54**, 65-68.
7. A part of this work was presented at the 17th International Congress of Heterocyclic Chemistry, Vienna, Austria, 1999; K. Ohkura, K. Nishijima, and K. Seki, Abstracts of Papers, PO-85.
8. Reaction conditions: UV-Irradiation was carried out externally with a 500 W high-pressure mercury lamp (Eiko-sha) in a degassed Pyrex tube for 18 h.
9. K. Ohkura, K. Nishijima, and K. Seki, *Chem. Pharm. Bull.*, 2001, **49**, 384.
10. 5,6,6a,8a-Tetrahydro-1,3-dioxo-2,4,5,6a,8-pentamethylcyclobuta[*f*]quinazolin-6-yl Trifluoroacetate (**7**): Colorless oil. MS *m/z* (%); 372 (M^+, 35), 357 (10), 332 (41), 275 (9), 259 (42), 243 (11), 219 (47), 202 (8), 162 (100), 134 (22). HRMS; Calcd for $C_{17}H_{19}N_2O_4Cl\ F_3$: 372.1296. Found: 372.1326.