Tetrahedron Letters Vol. 21, pp 4615 - 4618 0040-4039/80/1122-4615$02.00/0

REACTION OF TRIS(TRIFLUOROMETHYL)CYCLOPROPENYL TRIFLUOROMETHYL KETONE WITH AZO COMPOUNDS IN THE PRESENCE OF TRIPHENYLPHOSPHINE, AND SYNTHESIS OF TETRAKIS(TRIFLUOROMETHYL)PYRIDAZINE.

Yoshiro Kobayashi*, Takaharu Nakano, Kazuharu Shirahashi, Akira Takeda, and Itsumaro Kumadaki

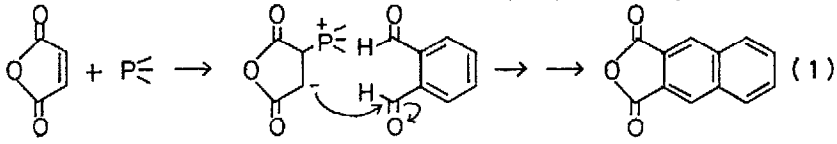
Tokyo College of Pharmacy, Horinouchi, Hachioji-shi, Tokyo 192-03, Japan

Abstract: The title cyclopropenylketone reacts with azo compounds and triphenylphosphine to give unique heterocycles; tricyclourazoles and a diazaoxacyclooctatriene. The formers were converted into a pyridazine.

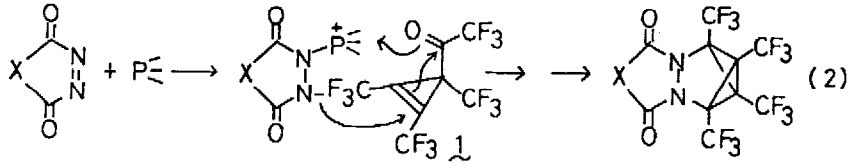
The cyclopropenylketone (1)[1] has an interesting structure: it contains a strained double bond in a three-membered ring and a carbonyl group, both of which can be converted to other functional groups.

Previously, we examined the Diels-Alder reaction of 1 with various dienes.[2] We now report the synthesis of unique heterocyclic compounds by the reaction of 1 with azo compounds in the presence of triphenylphosphine (TPP) and the transformation of the heterocyclic compound to tetrakis(trifluoromethyl)pyridazine.

Haddadin reported that o-phthalaldehyde reacts with maleic anhydride in the presence of triethyl phosphite to produce reductive adducts.[3] The first step of this reaction is an attack of lone pair electrons of the phosphorus atom to the electron-deficient double bond of maleic anhydride. The second is an attack of the carbanion formed to the carbonyl group (eq. 1).



If an azo compound is similarly activated with a trivalent phosphorus and the nitrogen anion attacks the double bond of 1, heterocyclic compounds containing the four adjacent CF_3 grouping unit can be obtained (eq. 2).



When a solution of TPP in dichloromethane was added to a solution of equimolar amounts of 1 and 4-phenyltriazoline-3,5-dione in dichloromethane at 0° under argon atmosphere, the red color of the triazolinedione disappeared at once. After the mixture was stirred for 2 hrs at room temperature, the solvent was removed on a vacuum line. The residue was purified by silicagel column chromatography to give the reductive adduct, 8-phenyl-2,3,4,5-tetrakis(trifluoromethyl)-1,6,8-triazatetracyclo[4.3.0.$0^{2,4}$.$0^{3,5}$]nonane-7,9-dione (2a) in the yield of 38%. The structure of 2a was determined based on the following data; m.p. 98°C (n-hexane); ^{19}F-nmr(Et_2O) δ[4] -0.7 (6F, sep, J_{FF}=5.2 Hz), -8.3 (6F, sep, J_{FF}=5.2 Hz); ^{1}H-nmr($CDCl_3$) δ 7.5 (bs, C_6H_5); ir(CCl_4) ν 1820, 1770, 1500, 1390, 1320, and 1280-1150 cm^{-1}; mass m/e 499 (M^+).

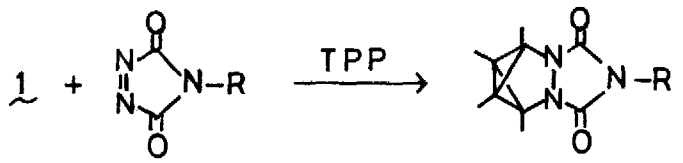
Similarly, 1 reacted with 4-methyltriazoline-3,5-dione to give a reductive adduct 2b in the yield of 37.2%. 2b; m.p. 41°C (n-hexane); ^{19}F-nmr(Et_2O) δ -2.0 (6F, sep, J_{FF}=5.2 Hz), -10.2 (6F, sep, J_{FF}=5.2 Hz); ^{1}H-nmr($CDCl_3$) δ 3.1 (s, CH_3); ir(CCl_4) ν 2920, 1820, 1770, 1440, 1400, 1320, and 1250-1150 cm^{-1}; mass m/e=437 (M^+).

In the case of 4-H-triazolinedione, the reductive adduct was not obtained, probably because the complex of TPP with 4-H-triazolinedione seemed not to be formed.

The compounds (2a, b) are new examples of tricyclourazole derivatives[5] and were expected to be transformed to the valence bond isomers of a pyridazine derivative. Therefore, we attempted the alkaline hydrolysis of 2a but failed to obtain the compound 3. The compound 2a was decomposed probably through the attack of base on the trifluoromethyl groups.

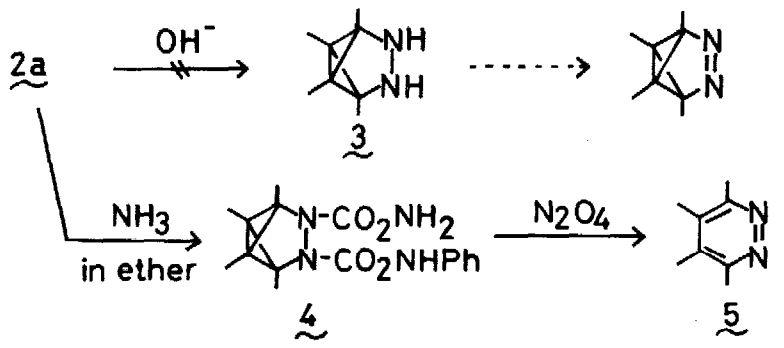
When ammonia gas was passed into a solution of 2a in ether at 0°C, the compound 4 was obtained in a quantitative yield. 4; m.p. 164°C (n-hexane and acetone); ^{19}F-nmr(CD_3COCD_3) δ 0.48 (3F, sep, J_{FF}=5.6 Hz), -1.4 (3F, sep, J_{FF}=5.6 Hz), -8.0 (6F, sep, J_{FF}=5.6 Hz); ^{1}H-nmr(CD_3COCD_3) δ 7.1-7.7 (7H, m) 9.8 (1H, bs); ir(KBr) ν 3240, 1760, 1680, 1600, 1500, 1440, and 1340-1160 cm^{-1}; mass m/e 497 (M^+-F). Nitrogen tetraoxide was introduced into the solution of 4 in dichloromethane to produce tetrakis(trifluoromethyl)pyridazine (5) in the yield of 14%. 5; m.p. 42°C (sublime at 46°/7 mmHg); ^{19}F-nmr(Et_2O) δ -0.3 (6F, m), -6.6 (6F, m); ir(CCl_4) ν 1400 and 1300-1140 cm^{-1}; mass m/e 352 (M^+). The compound 5 is a new compound having four trifluoromethyl groups. Thus, it attracted out attention concerning the perfluoroalkyl effect to stabilize the strained valence bond isomers. The photolytic and thermal reaction of the obtained pyridazine, however, did not give any isomerized product. This result is comparable to the case of tetrakis(trifluoromethyl)pyrazine.[6]

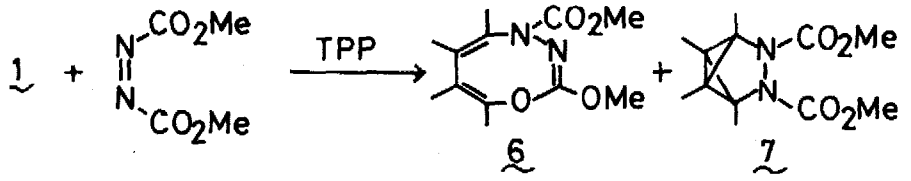
On the other hand, the reaction of 1 with dimethyl azodicarboxylate gave



2a: R = Ph

2b: R = Me





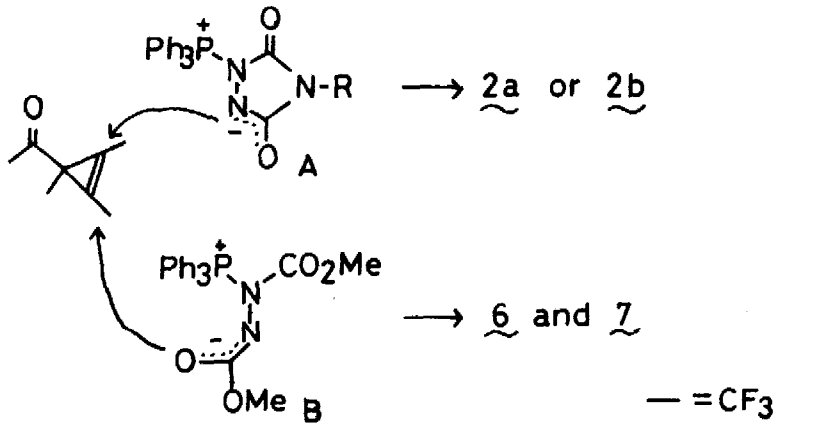


Chart 1

two reductive adducts 6 and 7 in the yield of 56% and trace by the same procedure used in the case of triazolinediones. 6; colorless oil (bulb to bulb distillation at 90°/8 mmHg); ^{19}F-nmr(Et_2O) δ -9.2 (3F, m), 1.6 (6F, m), 8.9 (3F, q, J_{FF}=15.8 Hz); ^{1}H-nmr(CCl_4) δ 3.85 (3H, s, CH_3), 4.1 (3H, s, CH_3); ir(CCl_4) ν 2940, 1760, 1660, 1450, 1440, and 1300-1100 cm^{-1}; mass m/e 470 (M^+). 7; m.p. 25-26°C (bulb to bulb distillation at 60°/10 mmHg); ^{19}F-nmr($CDCl_3$) δ 3.3 (6F, sep, J_{FF}=5.6 Hz) -9.9 (6F, sep, J_{FF}=5.6 Hz); ^{1}H-nmr($CDCl_3$) δ 3.9 (s, CH_3); ir(CCl_4) ν 2940, 1770, 1530, 1440, and 1380-1100 cm^{-1}; mass m/e 470 (M^+). Therefore, azodicarboxylate gave much less amount of the bicyclobutane compound than urazoles.

The reductive adducts (2a, b and 6) were also obtained by the following procedure. A solution of TPP in dichloromethane was first added to a solution of an azo compound in ether under argon atmosphere at -20°C and stirred for 10 min. Next, 1 was added to the reaction mixture. The reaction mixture was stirred at room temperature for 1 hr. When the mixture was purified by the procedure described above, the reductive adduct was obtained in each case. (In the case of dimethyl azodicarboxylate, only 6 was obtained.) This result suggests that the complex of TPP with an azo compound is an important intermediate in this reaction. TPP attacks the nitrogen atom of an azo compound to generate an active complex before attacking the oxygen atom of 1. The anion center of the complex attacks not the carbonyl group but the double bond of 1, probably because a homo-conjugation exists between a double bond and a carbonyl group. All the results are summarized in chart 1 with proposed mechanisms. The difference between the reactivities of the complexes (A and B) is not fully explained, but free rotation around the N-N bond may play an important role in the reaction of the latter.

References

1) C. J. Boriack, E. D. Laganis, and D. M. Lemal, Tetrahedron Lett., 1015 (1978).
2) Y. Kobayashi, T. Yoshida, Y. Hanzawa, I. Kumadaki, submitted to Tetrahedron Lett.
3) M. J. Haddadin, B. J. Agha, and R. F. Tabri, J. Org. Chem., 44, 494 (1979).
4) Benzotrifluoride signal is used as an external standard; upfield shifts are quoted as positive.
5) On the low temperature (-40°) ^{19}F-nmr, the signals of 2a changed very little. Therefore the hydrazine nitrogens in the urazole ring of 2a may be planar or very close to planar.
6) Y. Kobayashi, Y. Hanzawa, unpublished data.

(Received in Japan 8 August 1980)