A NOVEL ERYTHRINAN AND HOMOERYTHRINAN SYNTHESIS BY TETRA-n-BUTYLAMMONIUM FLUORIDE INDUCED OXY-VINYL 1,3-SHIFT. SYNTHESIS OF A 6-METHOXYCARBONYL-2,8-DIOXO-1,7-CYCLO-B-HOMO-ERYTHRINAN, A POTENTIAL INTERMEDIATE TO SCHELHAMMERA ALKALOIDS[1]

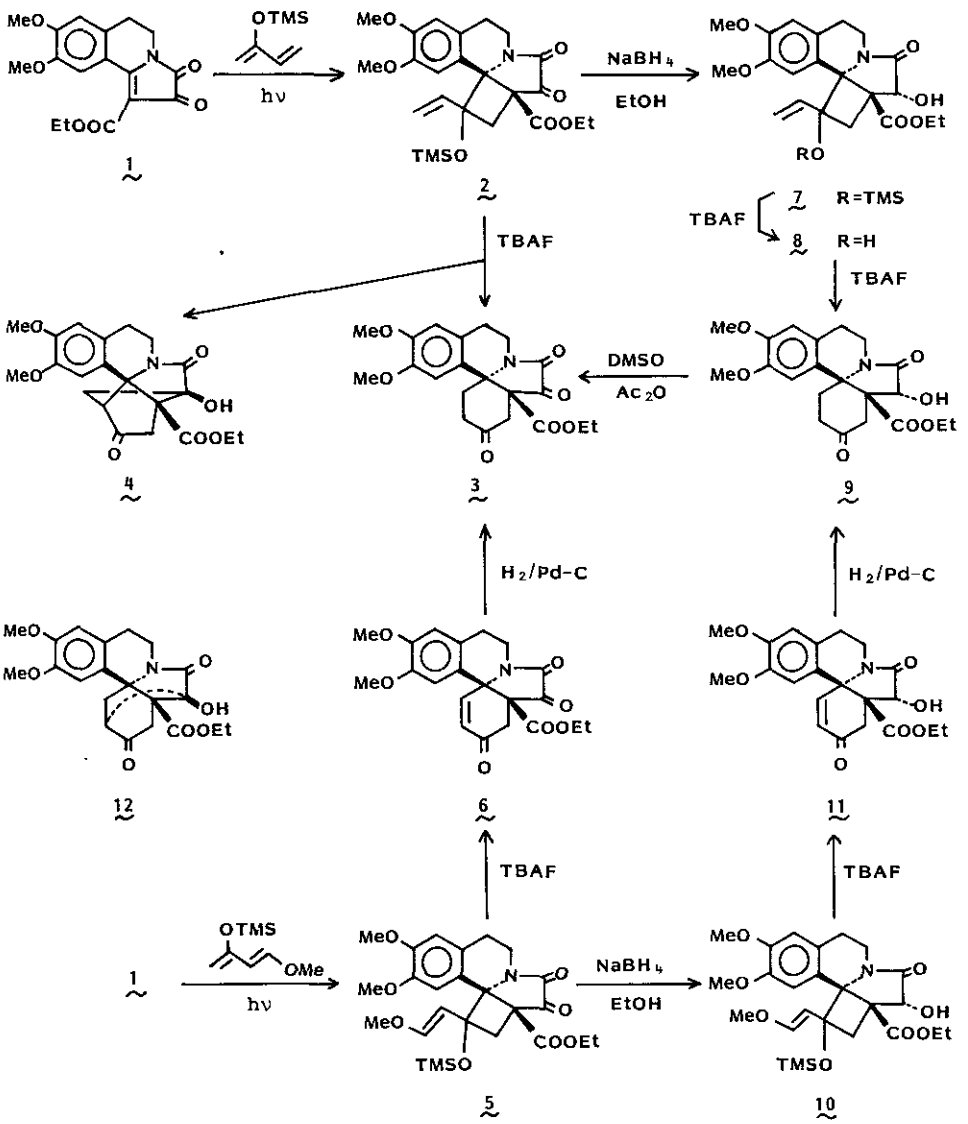
Takehiro Sano* and Jun Toda
Showa College of Pharmaceutical Sciences, 5-1-8 Tsurumaki, Setagaya-ku, Tokyo 154, Japan
Yoshisuke Tsuda* and Takeshi Ohshima
Faculty of Pharmaceutical Scienses, Kanazawa University, 13-1 Takara-machi, Kanazawa 920, Japan

Abstract——Photocycloaddition of trimethylsilyloxybutadienes to an isoquinolinopyrrolinedione followed by treatment of the [2+2]adduct with TBAF furnished erythrinan derivatives in high yields as a result of 1,3-shift. By this method, a practical synthetic route to B-homoerythrinan derivatives is now opened and a 6-methoxycarbonyl-2,8-dioxo-1,7-cyclo-B-homoerythrinan 20, a potential intermediate to Schelhammera alkaloids, was synthesized in an acceptable yield.

We have previously reported[2] a regio-controlled synthesis of ring C/D functionalized erythrinans through thermolytic 1,3-shift of trimethylsilyloxy-vinyl-cyclobutane derivatives (2 and 5) which are readily available by photocycloaddition of silyloxybutadienes to the isoquinolinopyrrolinedione 1. One of the side reaction in this method is a pyrrolytic [2+2]cycloreversion of the adducts (2 and 5), which sometimes reduces the yield of desired erythrinans. For example, thermolysis of the B-homo analog 14a afforded the B-homoerythrinan 16 (30%), mp 212-216°C(after hydrolysis of the intermediary silylenolate 15 with dil. HCl) with appreciable regeneration of the benzazepinopyrrolinedione 13 (50%). Very recently it was demonstrated[3] that tetra-n-butylammonium fluoride (TBAF) dramatically accelerates the analogous oxy-vinyl 1,3-shift by an ionic fashion, thus 1-trimethylsilyloxy-1-vinyl-cyclobutanes producing cyclohexanone derivatives under extremely mild condition usually with acceptable yields. The present communication describes availability of this method for construction of

erythrinan and B-homoerythrinan skeletons.

Treatment of the photoadduct 2 with TBAF (1.2 eq.) in THF at -30°C for 5 min yielded the diketone 3 (51%), mp 283-284°C, and the ketol 4 (11%), mp 213-215°C. The major product was proved to be the expected 1,3-shift product 3 by direct comparison with the authentic sample.[4] The minor product was elucidated as 4, the product of intramolecular Prins reaction with concomitant 1,2-shift, from the facts that it was isomeric to the known ketol 12[4] and that the same compound was produced by acid treatment of 2.[5]

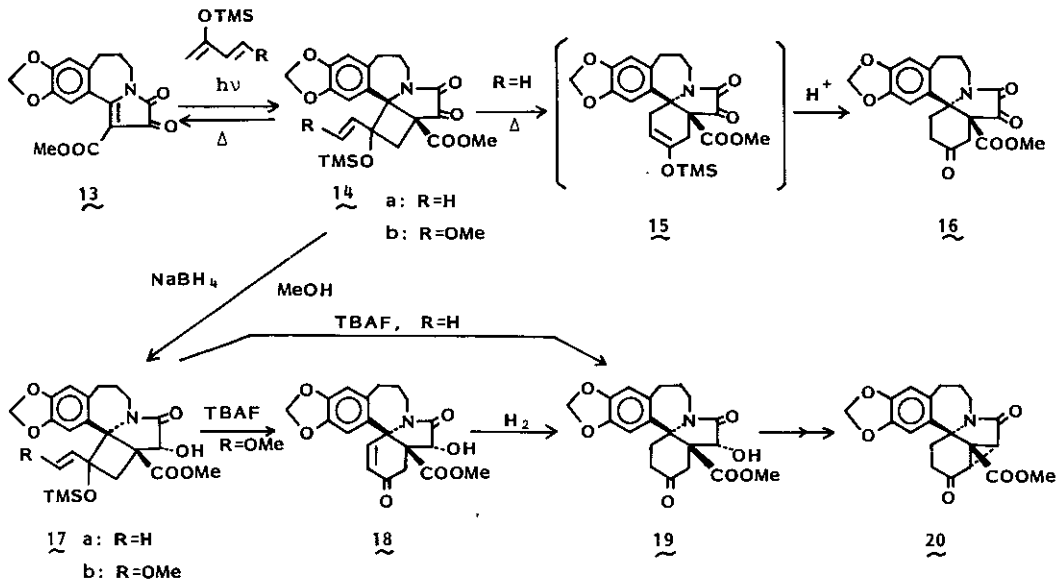


This undesired side reaction was avoided by applying the method to the alcohol 7[6,7], mp 163-165°C, which lacks the ketonic function for intramolecular Prins reaction and readily was prepared by $NaBH_4$ reduction of 2 (EtOH, 0°C, 7-10 min, 83%). However, treatment of 7 with TBAF under a similar condition (in THF, -30°C, 5 min) only caused the desilylation to yield the hydroxyvinylcyclobutane 8 (81%), mp 143-144°C, while the desired 1,3-shift occurred by elevating the reaction temperature to 10°C (80 min) giving the keto-alcohol 9, mp 235-238°C, as a single product, though the yield was not satisfactory (54%). DMSO-Ac_2O oxidation of 9 yielded 3 confirming the structure.

In contrast to 2, the methoxyvinyl analog 5, on a similar treatment with TBAF (THF, -30°C, 10 min), afforded only 1,3-shift product, the enone 6 (82%), mp 127-128°C, as a result of β-elimination of the methoxy group from the intermediary enolate. Catalytic hydrogenation of 6 (5%Pd-C, acetone, 95%) afforded the diketone 3. The alcohol 10, mp 186-188°C, prepared by $NaBH_4$ reduction of 5, similarly gave (TBAF in THF, -30°C, 60 min) the enone 11, mp 283-284°C, in high yield (81%), which on hydrogenation afforded 9 (95%).

The above method was satisfactorily applied to the synthesis of B-homoerythrinan which was hardly available by Diels-Alder reaction of silyloxybutadienes to a benzazepinopyrrolinedione.[8]

Irradiation of a mixture of the benzazepinopyrrolinedione 13[8] and 1-methoxy-3-trimethylsilyloxybutadiene (1.2 eq.) in acetonitrile (>290 nm, 0°C, 15 min) gave the photoadduct 14b (79%), mp 158-160°C. $NaBH_4$ reduction (MeOH, 100%) followed by TBAF treatment (THF, -30°C, 45 min) of the resulting alcohol 17b, mp 152-156°C, afforded the homoerythrinan 18 (85%), mp 289-292°C, in 67% overall yield from 13. Hydrogenation of 18 gave the saturated compound 19 (88%), mp 291-293°C. Starting from 13 and 2-trimethylsilyloxybutadiene, the similar sequence of reactions (13→14a→17a→19) gave the same alcohol 19 in 25% overall yield. Methanesulfonylation of 19 followed by heating of the resulting mesylate, mp 258-261°C, with DBU gave 6-methoxycarbonyl-16,17-methylenedioxy-2,8-dioxo-1,7-cyclo-B-homoerythrinan 20, mp 243-245°C, in 60% yield, which would be a potential intermediate to Schelhammera alkaloids.[9]



The above results indicate that TBAF-induced 1,3-shift when coupled with photoannulation of dioxopyrrolines by silyloxybutadienes provides an efficient method of erythrinan and homoerythrinan synthesis, particularly in the mildness of its reaction conditions.

REFERENCES AND NOTES

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4. Y. Tsuda, Y. Sakai, and T. Sano, Heterocycles, 1981, 15, 1097.
5. This rearrangement will be discussed in a separate paper (T. Sano, J. Toda, and Y. Tsuda, Heterocycles, accompanying paper).
6. The stereochemistry of OH group newly created was assigned as endo-configuration and the details will be discussed in a full paper.
7. All new compounds (7, 8, 9, 10, 11, 12, 14a, 14b, 16, 17a, 17b, 18, 19 and 20) gave correct molecular formulae and satisfactory spectral data (IR and NMR).
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