

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 ALKALOIDS¹

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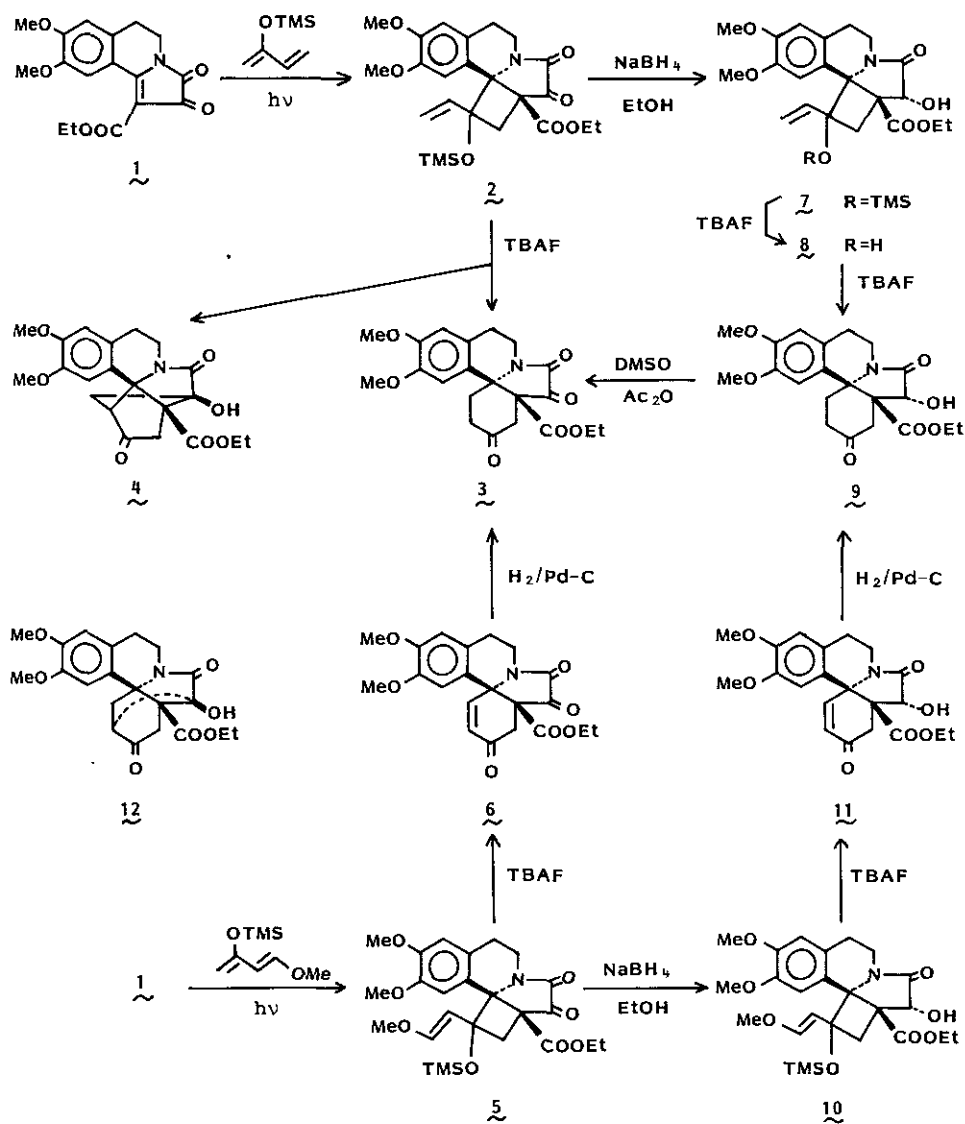
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Abstract—Photocycloaddition of trimethylsilyloxybutadienes to an isoquinolinopyrrolinedione followed by treatment of the [2+2]adduct with TBAF furnished erythrinan derivatives in high yields as a result of 1,3-shift. By this method, a practical synthetic 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 reported² 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 demonstrated³ 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 $283\text{--}284^{\circ}\text{C}$, and the ketol **4** (11%), mp $213\text{--}215^{\circ}\text{C}$. 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 NaBH₄ 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-Ac₂O oxidation of 9 yielded 3 confirming the structure.

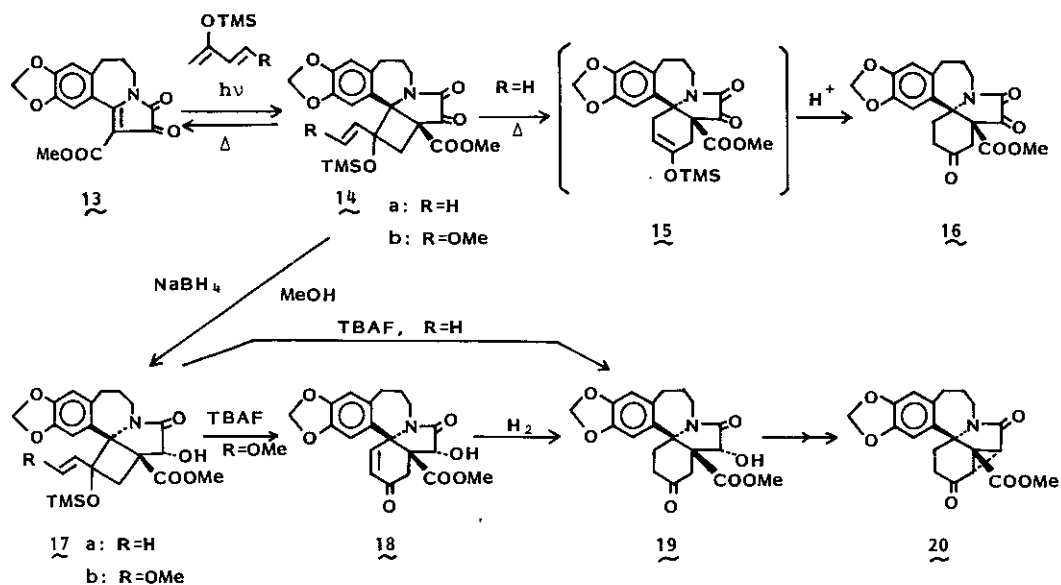
In contrast to 2, the methoxyvinyl analog 5, on a similar treatment with TBAF (THF, -30°C, 10 min), afforded only 1,3-shift product, the enone 6 (82%), mp 127-128°C, as a result of β-elimination of the methoxy group from the intermediary enolate. Catalytic hydrogenation of 6 (5%Pd-C, acetone, 95%) afforded the diketone 3. The alcohol 10, mp 186-188°C, prepared by NaBH₄ 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 13⁸ 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. NaBH₄ 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.

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- This rearrangement will be discussed in a separate paper (T. Sano, J. Toda, and Y. Tsuda, *Heterocycles*, accompanying paper).
- The stereochemistry of OH group newly created was assigned as *endo*-configuration and the details will be discussed in a full paper.
- 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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