Tetrahedron Letters,Vol.23,No.31,pp 3203-3206,1982 0040-4039/82/313203-04$03.00/0
Printed inGreat Britain

ACYLATION REACTIONS OF SILYLATED BUTADIYNES: SYNTHESIS OF SOME NATURALLY OCCURRING DIACETYLENIC KETONES

Graham E. Jones and Andrew B. Holmes*

University Chemical Laboratory, Lensfield Road,
Cambridge CB2 1EW, U.K.

Summary: *Acylation of 4-substituted 1-trimethylsilylbuta-1,3-diynes (2) with suitable acyl halides in the presence of titanium tetrachloride gave diacetylenic ketones (3) including the naturally occurring compounds (3c), (3e), and (3f).*

Many naturally occurring compounds containing a substituted 1,3-butadiyne grouping have been isolated, and their structures have been confirmed by relatively well established synthetic methods.[1-3] As a contribution to the development of a new method for the synthesis of diacetylenic ketones we wished to explore the selective acylation of 4-alkyl-1-trimethylsilylbuta-1,3-diynes (2) which we have previously shown can readily be prepared from bistrimethylsilylbutadiyne (1).[4] The selective replacement of one trimethylsilyl group in (1) by an acyl group under Friedel Crafts conditions ($AlCl_3$) was reported by Walton and Waugh,[5] but the more general reaction of compound (2) has not been investigated. We expected that the well-established ability of silicon to stabilise a β-carbonium ion[6] would lead to the selective replacement of the trimethylsilyl group of compound (2) by acyl groups under Friedel-Crafts conditions.

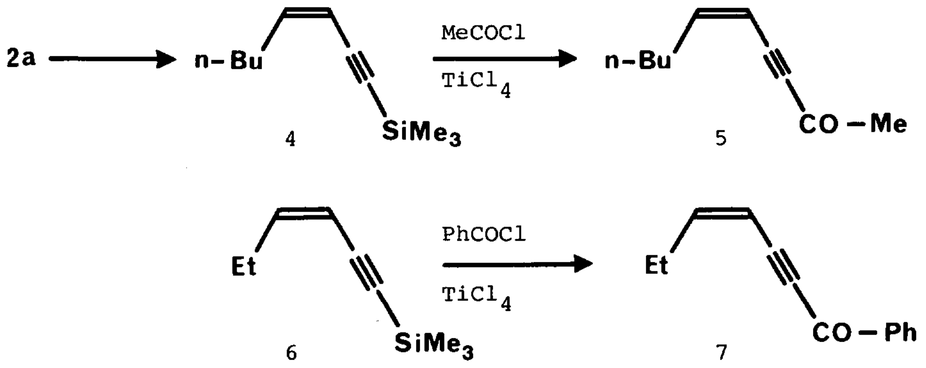
$$\underset{1}{Me_3Si{-}{\equiv}{-}{\equiv}{-}SiMe_3} \xrightarrow{\text{1. MeLi-LiBr} \atop \text{2. } R^1X} \underset{2}{R^1{-}{\equiv}{-}{\equiv}{-}SiMe_3} \xrightarrow[TiCl_4]{R^2COCl} \underset{3}{R^1{-}{\equiv}{-}{\equiv}{-}CO{-}R^2}$$

(2) a; R^1 = n-Bu
b; R^1 = $(CH_2)_3OH$
c; R^1 = $(CH_2)_3OCOC_6H_4N{=}NC_6H_5$
d; R^1 = CH_2OH
e; R^1 = $CH_2OCOCH{=}CMe_2$
f; R^1 = Me

(3) a; R^1 = n-Bu, R^2 = Me
b; R^1 = n-Bu, R^2 = 2-furyl
c; R^1 = $(CH_2)_3OH$, R^2 = Et
d; R^1 = $(CH_2)_3OCOC_6H_4N{=}NC_6H_5$, R^2 = Et
e; R^1 = $CH_2OCOCH{=}CMe_2$, R^2 = Ph
f; R^1 = Me, R^2 = Ph

Treatment of 1-trimethylsilylocta-1,3-diyne (2a)[4] with equimolar amounts of acetyl chloride and titanium tetrachloride in dichloromethane at -78°C followed by work-up with aqueous hydrochloric acid gave deca-3,5-diyn-2-one (3a) in 81% yield. Similar reaction with 2-furoyl chloride gave the 2-furyl ketone (3b) in 39% yield. However this could be improved to 80% (based on furoyl chloride) by using two equivalents of the diyne in nitromethane at 0°C.

Selective partial catalytic reduction of (2a) according to the previously reported general method[7] gave the Z-enyne (4) which was also smoothly acetylated to give (5) in 53% yield. Similarly the enyne (6) was benzoylated to give (7) in 73% yield. In all these reactions titanium tetrachloride was superior to other Lewis acids ($AlCl_3$, $SnCl_4$, and $ZnCl_2$).



The acylation reactions were then applied to novel syntheses of three naturally occurring diacetylenic ketones. Alkylation of 4-lithio-1-trimethylsilylbutadiyne with 3-iodopropan-1-ol tetrahydropyranyl ether gave, after acid hydrolysis, 1-trimethylsilylhepta-1,3-diyn-7-ol (2b) in 60% overall yield. Propanoylation of this in the presence of titanium tetrachloride gave the corresponding ketone (3c) in 56% yield.[8] This compound has been isolated from Erodiophyllum elderi by Bohlmann and his co-workers,[9] and was characterised as its phenylazobenzoate ester (3d) (m.p. 98-100°C) which we prepared directly in 77% yield by propanoylation of the ester (2c) (m.p. 117-120°C).

Coupling of 4-lithio-1-trimethylsilylbutadiyne with paraformaldehyde gave 1-trimethylsilylpenta-1,3-diyn-5-ol (2d) (71%) whose C-acylation proved more difficult than the above described example. However, after formation of the 3,3-dimethylacryloyl ester (2e) (63%) from the corresponding acid chloride in the presence of pyridine, benzoylation occurred smoothly in 47% yield to give the phenyl ketone (3e) (m.p. 35-37°C) which was identical with the compound isolated by Bohlmann from Lonas inodora (annua).[10]

Lastly, benzoylation of 1-trimethylsilylpenta-1,3-diyne (2f)[4] gave in 67% yield the antifungal ketone capillin (3f) which has been isolated from the fungicidal mugwort, *Artemisia capillaris* as well as from *A. dracunculus* and *Chrysanthemum frutescens*.[11,12]

We thank the Science and Engineering Research Council for a postgraduate studentship (to G.E.J.).

REFERENCES

1. F. Bohlmann, T. Burkhardt, and C. Zdero, 'Naturally Occurring Acetylenes', Academic Press, London and New York, 1973.

2. G. Pattenden, 'Naturally Occurring Polyolefinic and Acetylenic Compounds', Ch.3 in 'Aliphatic Chemistry', (Specialist Periodical Reports), The Chemical Society, London, 1974-1977, Vols. 2-5.

3. V. Thaller, 'Natural Acetylenic and Olefinic Compounds', Ch.1 in 'Aliphatic and Related Natural Product Chemistry', (Specialist Periodical Reports), The Chemical Society, London 1979, Vol.1; C.M. Scrimgeour, *ibid*, 1981, Vol.2.

4. A.B. Holmes and G.E. Jones, *Tetrahedron Lett*., 1980, **21**, 3111.

5. D.R.M. Walton and F. Waugh, *J. Organomet. Chem*., 1972, **37**, 45.

6. E. Colvin, 'Silicon in Organic Synthesis', Butterworths, London, 1981; L. Birkofer, A. Ritter, and H. Uhlenbrauck, *Chem. Ber*., 1963, **96**, 3280; G. Deleris, J. Dunoguès, and R. Calas, *Tetrahedron Lett*., 1976, 2449; K. Utimoto, M. Tanaka, M. Kitai, and H. Nozaki, *Tetrahedron Lett*., 1978, 2301; T. Sasaki, A. Usuki, and M. Ohno, *J. Org. Chem*., 1980, **45**, 3559.

7. A.B. Holmes, R.A. Raphael, and N.K. Wellard, *Tetrahedron Lett*., 1976, 1539.

8. This represents a 50% yield of (3c) plus a 10% yield of $\mathrm{EtCO{-}{\equiv}{-}{\equiv}{-}(CH_2)_3OCOEt}$ which was saponified in 62% yield to (3c).

9. F. Bohlmann, C. Zdero, and U. Niedballa, Chem. Ber., 1968, **101**, 2987.

10. F. Bohlmann and C. Zdero, Chem. Ber., 1966, **99**, 2413.

11. N.A. Sørensen, 'The Chemistry of Natural Products', I.U.P.A.C. Symposium on the Chemistry of Natural Products, Butterworths, London, 1961, p.569; F. Bohlmann, and K.M. Kleine, Chem. Ber., 1962, **95**, 39; K. Imai, N. Ikeda, K. Tanaka, and S. Sugawara, J. Pharm. Soc., Japan, 1956, **76**, 397, 400, 405.

12. All new compounds except (2c) were oils, and were purified by preparative layer chromatography (silica) and/or vacuum distillation. Satisfactory spectroscopic and analytical data (combustion analysis and/or high resolution mass spectra) were obtained for all compounds. The silylated diynes (2) exhibit characteristic C≡C i.r. bands at around 2210 and 2090 cm^{-1}, the enynes (4) and (6) at 2140 cm^{-1}, the diacetylenic ketones (3) at 2220 and 2140 cm^{-1}, and the enynones (5) and (7) at 2190 cm^{-1}.

(Received in UK 27 May 1982)