Tetrahedron Letters No. 15, pp 1281 - 1284, 1978. Pergamon Press. Printed in Great Britain.

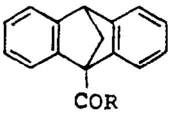
DEAMINATION OF 9-AMINO-12-HYDROXY-9,10-DIHYDRO-9,10-ETHANOANTHRACENE DERIVATIVES ; THE SYNTHESIS OF 9-SUBSTITUTED-9,10-DIHYDRO-9,10-METHANOANTHRACENES[1]

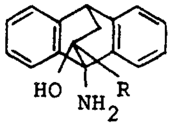
Makoto Sunagawa, Junki Katsube and Hisao Yamamoto
Research and Development Center, Pharmaceuticals Division,
Sumitomo Chemical Co., Ltd., Takatsukasa, Takarazuka, Hyogo, Japan

(Received in Japan 28 January 1978; received in UK for publication 21 February 1978)

The development of synthetic routes to 9,10-dihydro-9,10-methanoanthracene system has been the subject of continuing interest, since there have been known considerable hardships in effective construction of such ring system despite its apparent structural simplicity.

Thus, up to the present time, only a limited number of synthetic approaches have been presented. That is, the synthesis of the skeleton itself[2] and that of 11-substituted derivatives[3] have been reported and none of effective synthetic route to 9-substituted derivatives has hitherto been demonstrated. We wish to describe here the first synthesis of 9-substituted methanoanthracene derivative 1a-e by ring contraction of ethanoanthracene skeleton[4] applying deamination to amino-alcohol 2a-e. The deamination of bicyclic amines has provided a lot of molecular rearrangements[6] But the ring contraction, via bridgehead carbonium ion, of a bicyclic skeleton fused by two benzene rings has not been reported[7]



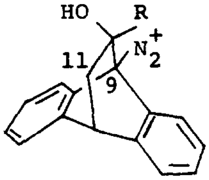


1a	2a	R = H
b	b	= CH_3
c	c	= CH_2CH_3
d	d	= $CH(CH_3)_2$
e	e	= C_6H_5

Deamination of amino-alcohol 2a in acetic acid by treatment with an aqueous solution of $NaNO_2$ yielded the product of ring contraction; 9-formyl-9,10-dihydro-9,10-methanoanthracene[8] 1a λ_{max}(log ε) in EtOH 272.2(3.29), 279(3.39) m/e 220(M^+) 191(base peak) in more than 90% yield and the product of a 1,2-hydride shift; 11-oxo-9,10-dihydro-9,10-ethanoanthracene was not detected. Similarly, in the case of 12-substituent R = alkyl group, the products 1b-d of ring contraction were respectively obtained in good yields(75-85%) from the corresponding amino-alcohol 2b-d by the same treatment.

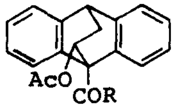
It has been reported the phenyl group on α-carbon of amine curtails the bond migration in the case of ring enlargement on monocyclic systems.[9] However, in the present case the rearrangement underwent smoothly as stated above. It is plausible in view of the fact that benzylic stabilization of the carbonium ion from amino-alcohol 2a-d is not possible because of stereoelectronic reasons.

The predominant formation of the strained methanoanthracene skeleton, that is, the specification of the bond C_{12}-C_{11} to the bridgehead carbonium ion could be expected because of an anti and coplanar relationships between the C_{12}-C_{11} and C_9-N bonds of the diazonium intermediate.



The deamination of amino-alcohol 2e(R = phenyl) was also examined under the same condition, but the complex mixture was obtained and only a trace amount of ring contracted product 1e was isolated. Compared with deamination of 1a-d and that of monocyclic amino-alcohol containing phenyl group on α-carbon of hydroxy group,[10] this result is interesting.[11]

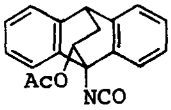
Amino-alcohol 2a could be synthesized in 5 steps starting from anthracen-9-carbaldehyde as follows;



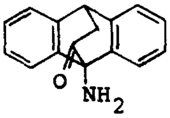
3 X = H

4 = OH

5 = N_3



6



7

The Diels-Alder reaction of anthracen-9-carbaldehyde with vinyl acetate at 170-175°C for 20 hours gave predominantly 12-acetoxy-9,10-dihydro-9,10-ethanoanthracen-9-carbaldehyde 3 m.p. 163.5-165°C, which was oxidized to the corresponding carboxylic acid 4 m.p. 260.5-262°C by treatment with CrO_3 in a quantitative yield. Treatment of 4 with thionyl chloride and then NaN_3 gave the acyl azide 5 ν(film) 2130, 1742, which was easily derived to the isocyanate 6 ν(film) 2250, 1740 by heating in benzene. Hydrolysis of the isocyanate 6 in ethanolic alkaline solution gave the objective 2a m.p. 183-183.5°C ν(nujol) 3290 δ($CDCl_3$) 3.76(dd 1H J=2.8, 9.0), 4.22(t 1H J=2.4) in about 75% yield from 4.

Other amino-alcohol 2b-e were easily derived from amino-alcohol 2a as follows; That is, oxidation of 2a by treatment with CrO_3 gave 12-oxo derivative 7 m.p. 156.5-157°C ν(nujol) 1727 δ($CDCl_3$) 2.43(d 2H J=2.5), 4.55(t 1H J=2.5), which was treated with the corresponding Grignard reagent to give amino-alcohol 2b m.p. 99.5-100.5°C, 2c m.p. 115-116.5°C, 2d m.p. 123-124°C and 2e m.p. 112.5-114°C respectively.

Table. Physical Properties[12] of Methanoanthracene Derivatives 1a-e

1a: m.p. 102.5°C ν 2750, 1718 δ 10.45(s 1H), 4.34(t 1H J=1.5), 2.75(d 2H J=1.5), 6.7-7.6(m 8H).

1b: m.p. 118-119°C ν 1704 δ 4.32(t 1H J=1.5), 2.79(d 2H J=1.5), 2.38(s 3H).

1c: m.p. 129-129.5°C ν 1708 δ 4.31(t 1H J=1.5), 2.78(d 2H J=1.5), 2.67(q 2H J=7.0), 1.18(t 1H J=7.0).

1d: m.p. 100.5-101.5°C ν 1708 δ 4.29(t 1H J=1.5), 3.05(m 1H J=7.0), 2.86(d 2H J=1.5), 1.16(d 6H J=7.0).

1e: m.p. 180.5°C ν 1674, 1598, 1581 δ 4.33(t 1H J=1.5), 2.93(d 2H J=1.5).

Acknowledgment: We wish to thank Mr. Hiromi Sato for conducting several experiments.

References and Notes

1. Dibenzotetracyclic Derivatives I.
2. a) W. R. Vaughan & M. Yoshimine, J. Org. Chem., 22, 7(1959). b) von E. Meuller & H. Kessler, Ann. Chem., 692, 58(1966).
3. a) J. Meinwald & E. G. Miller, Tetrahedron Letters, 253(1961). b) H. Tanida, T. Tsushima & T. Irie, ibid, 4331(1970). c) T. V. Domareva-Mandelshtam & I.

A. Dyakonov, Zh. Obshch. Khim., 34, 3384(1964); Zh. Org. Khim., 5, 1114 (1969), H. Nozaki, M. Yamabe & R. Noyori, Tetrahedron, 21, 1657(1965). d) J. A. Berson & M. Pomerantz, J. Am. Chem. Soc., 86, 3896(1964).

4. There have been reported several unsuccessful attempts[5] for obtaining the methanoanthracene skeleton by ring contraction of the ethanoanthracene derivatives except only one successful result by using the photochemical Wolff rearrangement.[3a]
5. W. R. Vaughan & M. Yoshimine, J. Org. Chem., 22, 528(1957).
6. a) J. A. Berson, Molecular Rearrangements, Vol. I, P. de Mayo, Ed., Jhon Wiley and Sons, Inc., New York, N.Y., 1963, p 205. b) K. Ebisu, L. B. Batty, J. M. Higaki & H. O. Larson, J. Am. Chem. Soc., 87, 1399(1965); ibid, 88, 1995(1966); J. Org. Chem., 34, 525(1969).
7. It has been reported that the deamination of 9-amino-9,10-dihydro-9,10-ethanoanthracene derivatives, in which 12-hydroxy group is absent, gave only the unrearranged products. (P. D. Bartlett & S. G. Cohen, J. Am. Chem. Soc., 62, 1183(1940), von M. Wilhelm & D. Y. Curtin, Helv. Chim. Acta, 40, 2129 (1957))
8. Structures of new products were assigned on the basis of spectral data together with elemental analysis. The data of methanoanthracene derivatives 1a-e are listed in Table at the end of text.
9. a) P. A. S. Smith & D. R. Baer, Organic Reactions, Vol. 11, John Wiley and Sons, Inc., New York, N.Y., 1960, p 165. b) I. Elphimoff-Felkin & B. Tchoubar, Compt. Rend., 231, 1314(1950).
10. It has been reported by D. Y. Curtin et al. that the deamination of cis 2-amino-1-phenylcyclohexanol gave cyclopentyl phenyl ketone in more than 99% yield. (D. Y. Curtin & S. Schmukler, J. Am. Chem. Soc., 77, 1105(1955))
11. Further investigations to understand the difference in the behaivior of 2a-d and 2e toward deamination well are still underway.
12. The spectra were measured under the following condition: IR in nujol, PMR in $CDCl_3$.