Amino-Claisen Rearrangement of *N*-Allyljulolidinium Halides

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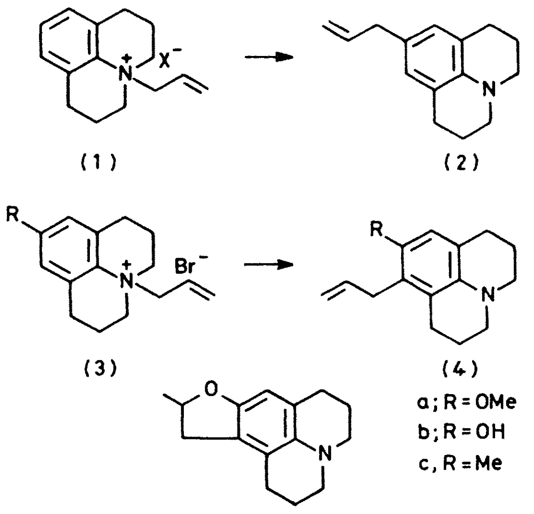
Summary Amino-Claisen rearrangement of 4-allyljulolidinium halides and 4-allyl-9-substituted-julolidinium bromides gave 9-allyljulolidines and 8-allyl-9-substituted julolidines respectively, the latter of which is the first example of *meta*-amino-Claisen rearrangement to be reported.



(1) (2)

(3) (4)

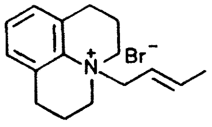
a; R = OMe
b; R = OH
c, R = Me

(5)

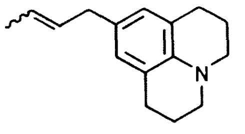
Recently we have reported that *N*-allylanilinium salts rearrange into *ortho*-allylanilines in good yield.[1] To investigate the generality of this type of quaternary amino-Claisen rearrangement[2] julolidine derivatives were selected as compounds in which both the *ortho* and *para* positions are blocked by substituents.

When 4-allyljulolidinium bromide (**1**; X = Br), m.p. 147·5—149 °C (decomp.) was heated in glycerol–water (2/1) at 140 °C for 2 h in the presence of sodium hydrogen carbonate (reaction conditions A) it rearranged to 9-allyljulolidine (**2**), *m/e* 213 (M^+), m.p. picrate 130·5—133 °C, in 85% yield. The iodide (**1**; X = I), m.p. 140·5—141 °C (decomp.) gave a somewhat lower yield (72%) of (**2**) with more julolidine contamination. The structure of (**2**) was deduced by ^{1}H n.m.r. spectroscopy, δ 6·63 (2H, s, Ar-H) and confirmed by hydrogenation and comparison with 9-propyljulolidine.[3] The allyl group on the quaternary nitrogen of the aniline framework migrated to the *para* position when the two *ortho* positions were blocked.

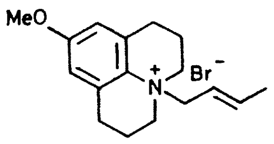
As a compound in which all the sites for Claisen rearrangement are blocked, 4-allyl-9-methoxyjulolidinium bromide (**3a**), m.p. 150·5—152 °C (decomp.) was caused to rearrange in glycerol–water (2/1) at 140 °C for 4 h under nitrogen (reaction conditions B) to give 8-allyl-9-methoxyjulolidine (**4a**), m/e 243 (M^+) [HCl m.p. 147—150 °C] in 91% yield. The presence of allyl protons and a single aromatic proton (δ 6·45) in the n.m.r. spectrum supported its structure. 4-Allyl-9-hydroxyjulolidinium bromide (**3b**), m.p. 174—175 °C (decomp.), under reaction conditions B, afforded (**4b**), m.p. 67—75 °C, in 53% yield. Products (**4a**) and (**4b**) were converted into the methyldihydrofurojulolidine (**5**), δ 1·40 (3H, d, J 6 Hz, sec-Me), 6·26 (1H, s, Ar-H) [HCl m.p. 188—200 °C (decomp.)] by refluxing in 47% HBr. Similarly, 4-allyl-9-methyljulolidinium bromide (**3c**), m.p. 166—169 °C (decomp.) under reaction conditions A gave 8-allyl-9-methyljulolidine (**4c**) in 43% yield. This rearrangement of (**3**) thus provides the first example of *meta*-amino-Claisen rearrangement.[4]



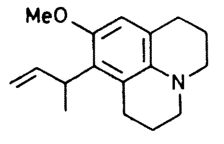
(**6**)



(**7**)

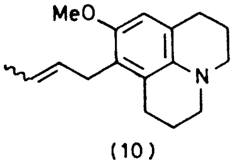


(**8**)



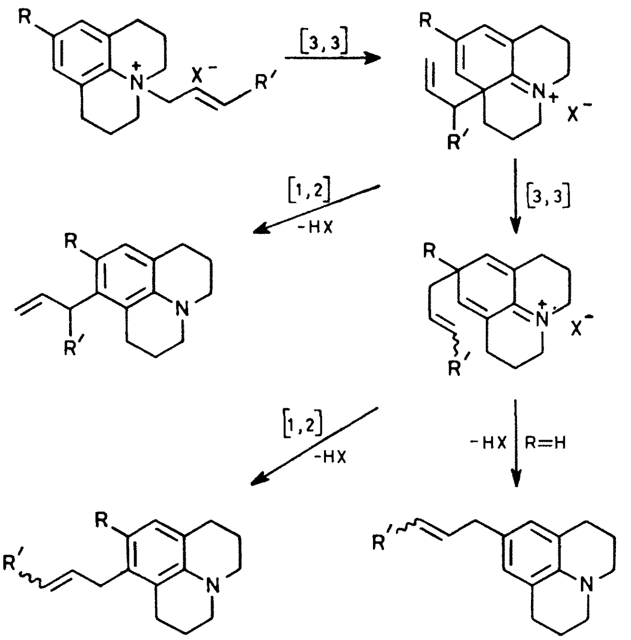
(**9**)

+



(**10**)

To investigate the rearrangement mechanism, 4-crotyljulolidinium bromide (**6**), m.p. 145—148 °C was prepared [geometrically pure by n.m.r. spectroscopy, δ 1·87 (3H, d, J 6Hz, sec-Me), 5·73 (1H, t of d with long range coupling, J 7, 15 Hz, $CH_2C\mathit{H}{=}CHCH_3$), and 6·40 (1H, q of d, J 6, 15 Hz, $CH_2CH{=}C\mathit{H}CH_3$)] and, under reaction conditions A, it rearranged to 9-crotyljulolidine (**7**), m/e 227 (M^+), δ 6·60 (2H, s, Ar-H) in 93% yield as a mixture of geometrical isomers (5/8). This mixture was catalytically hydrogenated and compared with 9-butyljulolidine which was synthesized from 9-formyljulolidine[5] by Wittig reaction and subsequent hydrogenation. The rearrangement of the crotyl group from N-4 to C-9 suggests that amino-Claisen rearrangements of (**1**) and (**6**) proceeded by two [3,3] sigmatropic rearrangements *via* chair and boat conformations. A similar rearrangement of geometrically pure 4-(*E*)-crotyl-9-methoxyjulolidinium bromide (**8**), m.p. 155—158 °C, δ 1·90 (3H, d, J 6 Hz, sec-Me), 5·70 (1H, t of d, J 8, 16 Hz, $CH_2C\mathit{H}{=}CHCH_3$), 6·40 (1H, q of d, J 6, 16 Hz, $CH_2CH{=}C\mathit{H}CH_3$), and 6·67 (2H, s, Ar-H) was carried out under reaction conditions A. The product was a mixture of 9-methoxyjulolidine (40%), 9-crotyljulolidine (**7**)(3·7%), 8-(1-methylallyl)-9-methoxyjulolidine (**9**) (14·1%), 8-(*E*)-crotyl-9-methoxyjulolidine, (*E*)-(**10**) (34%), and 8-(*Z*)-crotyl-9-methoxyjulolidine (*Z*)- (**10**) (8%) according to g.l.c. analysis (10% SE-30 at 210 °C). 9-Crotyljulolidine (**7**) was isolated by column chromatography on silica gel and compared with the specimen prepared from (**6**). The formation of (**7**) indicates that the crotyl group migrates to the *para* position where the methoxy group resides during the reaction. The products (**9**), (*E*)-(**10**), and (*Z*)-(**10**) were separated by preparative g.l.c. and characterized by mass, i.r., and n.m.r. spectroscopy: (**9**), ν_{max} (film) 907s cm^{-1}; δ 1·37 (3H, d, J 7 Hz, sec-Me), 4·8—5·2 (2H, m, $CH{=}C\mathit{H}_2$), and 6·50 (1H, s, Ar-H), (*E*)-(**10**), ν_{max} (film) 970s cm^{-1}; δ 1·63 (3H, d with long range coupling, J 4 Hz, sec-Me), 2·93 (2H, m, $C\mathit{H}_2CH{=}CHCH_3$), 5·37 (2H, m, $CH_2C\mathit{H}{=}C\mathit{H}CH_3$), and 6·40 (1H, s, Ar-H), (*Z*)-(**10**), ν_{max} (film) 707m cm^{-1}; δ 1·77 (3H, d, J 5 Hz, sec-Me), 3·36 (2H, d, J 5 Hz, $C\mathit{H}_2CH{=}CHCH_3$), 5·37 (2H, m, $CH_2C\mathit{H}{=}C\mathit{H}CH_3$), and 6·43 (1H, s, Ar-H). For *meta* migration of the allyl group of (**3**) a [3,3],[3,3],[1,2] sigmatropic rearrangement is suggested since neither addition of 4,4′-bisthio(6-t-butyl-*m*-cresol) as radical inhibitor nor the presence of an equimolar amount of julolidine in the rearrangement of (**3a**) affected the course of reaction; thus radical and dissociation–recombination mechanisms are unlikely. If the rearrangement of (**8**) is similar to that for (**3**) a [3,3],[1,2] sigmatropic rearrangement might be involved in the production of (**9**) as well as the [3,3],[3,3],[1,2] sigmatropic process for production of (**10**) (Scheme). The production of two geometrical isomers of (**10**) suggests



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that the transition states for *meta*-amino-Claisen rearrangement involve both chair and boat conformations during the second [3,3] sigmatropic rearrangement.

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[2] H. Heimgartner, H.-J. Hansen, and H. Schmid, 3,3-Rearrangement of imminium salts, *Adv. Org. Chem.*, eds. H. Böhme and H. G. Viehe, 1979, **9** (**2**), 655.

[3] 9-Propyljulolidine was prepared from 6-propyl-1,2,3,4-tetrahydroquinoline according to the procedure of julolidine synthesis by D. B. Glass and A. Weissberger, *Org. Synth.*, 1955, **3**, 504.

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[5] F. Bennington, R. D. Morin, and L. C. Clark, Jr., *J. Org. Chem.*, 1956, **21**, 1470.