

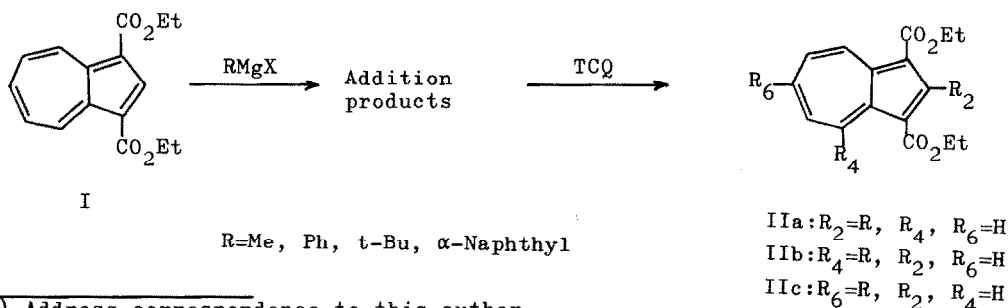
THE REACTION OF DIETHYL 2-CHLORO- AND DIETHYL 2-METHOXY-
AZULENE-1,3-DICARBOXYLATES WITH GRIGNARD REAGENTS

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Halogenoazulenes are known to react with some nucleophilic reagents, such as alkoxides or amines, giving substitution products by displacement of the halogen substituent with the reagents (1,2,3). On the other hand, as reported in our previous paper (4), it was found that the reaction of diethyl azulene-1,3-dicarboxylate (I) with Grignard reagents gave dihydroazulene-type addition products, from which were obtained the azulene derivatives (IIa, IIb and IIc), possessing the alkyl or aryl substituent at the 2-, 4- or 6-position, on dehydrogenation with tetrachloro-o-benzoquinone (TCQ); this fact shows that addition of Grignard reagents occurred on the azulene nucleus of I at the 2-, 4- or 6-position. Therefore, the reaction of azulene derivatives, possessing the substituent capable to be an anionic leaving group, such as halogen or alkoxy groups, with Grignard reagents would be of interest in connection with which type of the reaction, substitution or addition, takes place. For clarifying this point, we have studied on the reaction of diethyl 2-chloro- (III) (1) and

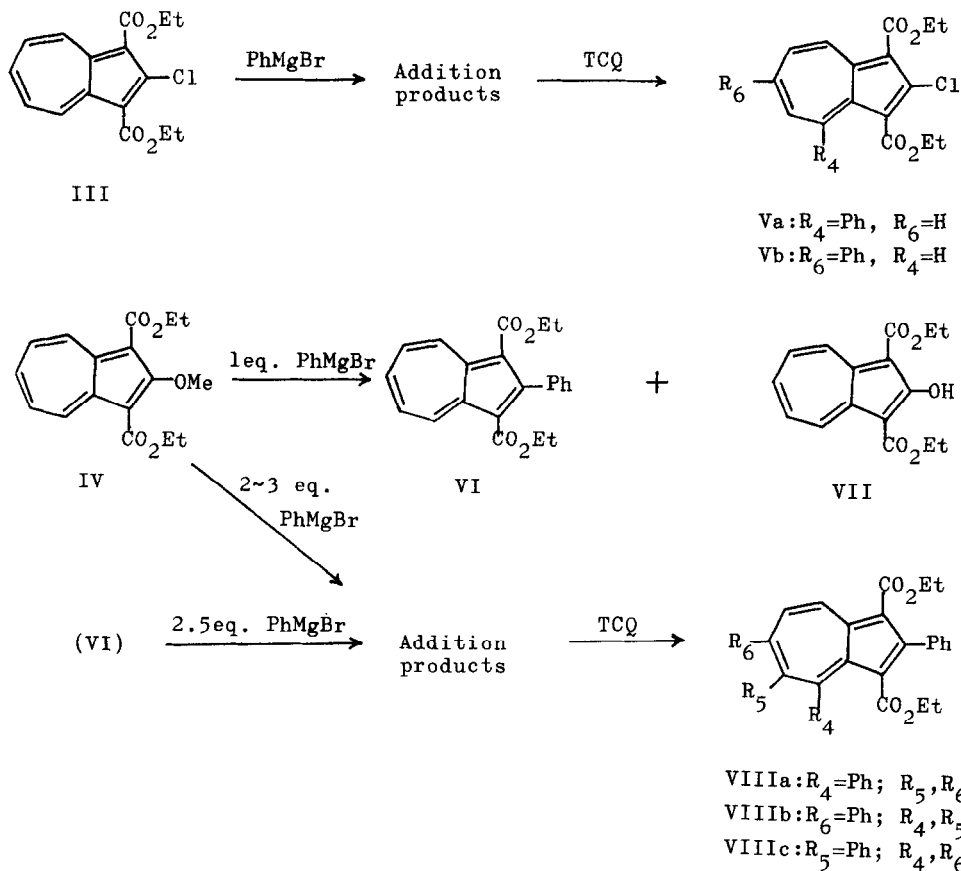


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diethyl 2-methoxyazulene-1,3-dicarboxylates (IV) (5) with phenylmagnesium bromide (PhMgBr).

The reaction of the 2-chloro derivative, III, with 2.5 molar equivalents of PhMgBr in ether proceeded easily under ice-cooling, with formation of a magnesium complex. Decomposition of this complex by addition of methanol and then diluted hydrochloric acid gave a pale yellow oily mixture of dihydroazulene-type addition products. Dehydrogenation of this mixture with TCQ afforded two kinds of phenylazulene derivatives, diethyl 2-chloro-4-phenyl- (Va); violet needles, mp. 108-109°C, and diethyl 2-chloro-6-phenylazulene-1,3-dicarboxylates (Vb); red needles, mp. 138-139°C, in 94% and 3% yields, respectively (6). In the case of using an equimolar amount of PhMgBr, a fair amount of the starting material, III, was recovered, accompanying the formation of a small amount of Va and Vb, after dehydrogenation. In this reaction no 2-phenylazulene derivative, which would be expected to be formed by displacement of the chloro substituent with the reagent, was obtained. This finding indicates that in the reaction of the 2-chloro derivative, III, with Grignard reagents, displacement of the chloro substituent at the 2-position did not occur, but addition of the reagent took place at the 4- or 6-position, with formation of the dihydroazulene-type addition products, from which were obtained, on dehydrogenation, the azulene derivatives, Va and Vb, in which the chloro substituent at the 2-position remained as it was. This is an addition-type reaction similar to that observed in the reaction of I with Grignard reagents (4).

On the other hand, the 2-methoxy derivative, IV, when treated with an equimolar amount of PhMgBr, directly gave, after decomposing the magnesium complex thereby formed, the azulene derivatives, diethyl 2-phenyl- (VI) (4) and diethyl 2-hydroxyazulene-1,3-dicarboxylates (VII) (5), in 72% and 5% yields, respectively, instead of formation of the dihydroazulene-type addition product. Further, when treated with 2-3 molar equivalents of PhMgBr, IV gave a pale yellow oily mixture of dihydroazulene-type addition products, after decomposing the magnesium complex thereby formed. Dehydrogenation of this mixture with TCQ afforded two kinds of diphenylazulene derivatives, diethyl 2,4-diphenyl- (VIIIa); violet prisms, mp. 113-114°C, and diethyl 2,6-diphenylazulene-1,3-dicarboxylates



(VIIIb), red needles, mp. 188–189°C, in 46% and 5% yields, respectively (6).

The same compounds, VIIIa and VIIIb, were also obtained from VI in 67% and 1% yields, respectively, together with a minute amount (1%) of diethyl 2,5-diphenylazulene-1,3-dicarboxylate (VIIIc), red prisms, mp. 178–180°C (6), when VI was treated with 2.5 molar equivalents of PhMgBr and then the oily mixture of addition products thereby obtained was dehydrogenated with TCQ. These findings indicate that in the reaction of the methoxy derivative, IV, with Grignard reagent, displacement of the methoxyl substituents at the 2-position by the reagent first took place with formation of the substitution product, VI, and then addition of the excess reagent to VI at the 4-, 6- or 5-position easily occurred with formation of the dihydroazulene-type addition products, from which were obtained the azulene derivatives, VIIIa, VIIIb or VIIIc, on dehydrogenation. The forma-

tion of VII is assumed to be caused by attack of Grignard reagent on the methyl carbon of the methoxyl group.

Such a difference in the reaction mode between the 2-chloro, III, and 2-methoxy derivatives, IV, toward Grignard reagents is presumed to arise from a difference in the affinity between the chlorine and methoxyl group for Grignard reagents on formation of a coordination complexes: The ethereal oxygen is much more strongly coordinated than do the chlorine atom. Therefore, in the case of IV, Grignard reagent can easily attack at the 2-position by the aid of forming the coordination complex in which the oxygen of the methoxyl group at the 2-position is coordinated on the reagent, whereas in the case of III, the reagent can not attack at the 2-position because of the difficulty of forming the coordination complex in which the chlorine is coordinated on the reagent. Further, it seems that the electronic effect of the substituents also affects on the reactivities of III and IV: The seven-membered ring of III is activated for the attack of Grignard reagents by the inductive effect due to the chloro substituent at the 2-position, whereas that of IV is deactivated by the mesomeric effect due to the methoxyl group at the 2-position.

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REFERENCES

- 1) T. Nozoe, S. Seto, and S. Matsumura, Bull. Chem. Soc. Japan, 35, 1990 (1962).
- 2) K. Hafner, H. Patzelt, and H. Kaiser, Ann., 656, 24 (1962).
- 3) T. Nozoe, K. Takase, and M. Tada, Bull. Chem. Soc. Japan, 38, 247 (1965); M. Tada, *ibid.*, 39, 1954 (1966); T. Arai, Ph.D. Thesis, Tohoku University (1966).
- 4) N. Abe, T. Morita, and K. Takase, Tetrahedron Letters, 1973, in press.
- 5) T. Nozoe, K. Takase, and N. Shimazaki, Bull. Chem. Soc. Japan, 37, 1644 (1964).
- 6) The structures of the new azulene derivatives, Va, Vb, VIIIA, VIIIB and VIIIC, obtained here were determined on the basis of the spectral data; uv and visible, ir and nmr, as well as elemental analyses. The details will be reported in a full paper.