PREPARATION OF SUBSTITUTED gem-DIMETHYLCYCLOPROPANECARBOXYLIC ACIDS

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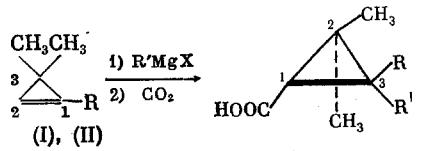
Some esters of gem-dimethylcyclopropanecarboxylic acids, for example, of chrysanthemic acid, exhibit a high insecticidal activity. In natural chrysanthemic acid (2,2-dimethyl-3-isobutenylcyclopropanecarboxylic acid) the isobutenyl group is found in the trans position. The cis position of this group does not decrease the insecticidal activity. Certain substituents on the C^3 atom can even increase the activity [1].

In the present paper, on the basis of adding Grignard reagents to cyclopropene hydrocarbons [2], a method was developed for the synthesis of gem-dimethyl-substituted cyclopropanecarboxylic acids. This method makes it easy to vary the substituent on the C^3 atom.

Cyclopropene hydrocarbons with a geminal dimethyl grouping, and specifically 3,3-dimethylcyclopropene (I) and 1,3,3-trimethylcyclopropene (II), were reacted with alkyl, vinyl, and phenyl Grignard reagents in either abs. ether or THF. The course of adding the Grignard reagent was judged by the change in the composition (GLC) of samples of the reaction mixture after their decomposition with water (disappearance of the peak of the starting cyclopropene and formation of the peak of the corresponding cyclopropane hydrocarbon). Carboxylation of the reaction mixture gave acids of the cyclopropane series with a geminal dimethyl grouping, which differed in the substituents on C^3 (yield ranged from 30 to 83%). cis-Chrysanthemic acid was obtained in 70% yield.



(I), (II) (III)-(VIII)

R = H (I), (V), (VI), (VII), (VIII); CH_3 (III), (IV);
R′ = CH_3 (III), (V); C_2H_5 (IV); Ph (VI); $CH{=}CH_2$ (VII); $CH{=}C(CH_3)_2$ (VIII)

EXPERIMENTAL

The PMR spectra were taken on RS-60 and Varian DA-60IL (60 MHz), and Tesla BS-497 (100 MHz), spectrometers using HMDS as the internal standard. The chemical signals of the

TABLE 1. Preparation Conditions and Yields of Substituted gem-Dimethylcyclopropanecarboxylic Acids

Hydrocarbon	Grignard reagent	Mole ratio of reactants	Solvent	T, °C during addition	T, °C during holding	Time of holding, h	Reaction product and its yield, %	mp., °C
(I)	CH_3MgBr	1:1	THF	0–10	30–35	1	(V), 54,7	bp 144
(I)	CH_3MgBr	1:1	Ether	0–10	20	36	(V), 51	bp 144
(I)	PhMgBr	0,9:1	»	–20	20	30	(VI), 41	130–134 cf. [7]
(I)	$CH_2{=}CHMgBr$	1:1,3	THF	40–45	20	12	(VII), 30,3	bp. 90 (40 mm)
(I)	$CH_3(CH_3)C{=}CHMgBr$	1,1:1	»	60	60	1	(VIII), 77	104 cf. [8]
(II)	CH_3MgI	1:1	Ether	0	20	28	(III), 83	117–118 cf. [6, 9]
(II)	C_2H_5MgBr	1:1	»	0	20	36	(IV), 40	80–81 cf. [2]

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protons (δ, ppm) are given relative to TMS. The GLC analyses were run on a Pye-104 instrument, and here we used a column packed with 20% PEGS, treated with H_3PO_4, to separate the acids and their esters, and a column packed with 25% 3,3'-oxydipropionitrile to separate the hydrocarbons. All of the synthesis operations were run in a dry argon atmosphere. 3,3-Dimethylcyclopropene (I) was obtained as described in [3], while 1,3,3-trimethylcyclopropene (II) was obtained as described in [4]. The Grignard reagents were obtained from equimolar amounts of Mg and the halide in either abs. ether or THF, and their concentration was determined by titration [5].

The cyclopropanecarboxylic acids were prepared by a standard procedure. Compound (I) was distilled into a solution of the Grignard reagent at 0-10°, while (II) was added in drops. The holding time and reaction temperature for each case are indicated in Table 1. The end of reaction was established by GLC analysis of samples of the reaction mixture after their decomposition with water. The carboxylation of the cyclopropyl Grignard reagent was run at −78°. The formed acid was extracted with ether and after the standard workup it was dried over anhydrous $MgSO_4$. After distilling off the solvent the liquid acids were purified by distillation, while the solid acids were purified by vacuum-sublimation. gem-Dimethylvinylcyclopropanecarboxylic acid (VII) was not isolated, and instead its ether solution was methylated at −10° using a threefold excess of CH_2N_2. The obtained ester of acid (VII) was purified by vacuum-distillation. Methyl ester (VIa) was obtained in a similar manner for acid (VI). The results of all of the experiments are summarized in Table 1.

PMR spectra (δ, ppm). Compound (III) (30% benzene solution): 0.82 s (6H, trans-CH_3 relative to COOH, 1.17 s (6H, cis-CH_3 relative to COOH), 1.50 s (1H, cyclopropane proton), 11.97 s (1H, COOH); (IV) (30% $CHCl_3$ solution): 0.91 t (3H, CH_3), 1.18 s, 1.20 s (6H, trans-CH_3 relative to COOH), 1.28 s (3H, cis-CH_3 relative to COOH), 1.50-1.85 m (2H, CH_2), 11.90 s (1H, COOH); (V) (30% CCl_4 solution): 0.60-1.65 m (2H, ring protons), 0.95 s, 1.22 s (9H, CH_3), 12.12 s (1H, COOH); (VI) (30% CCl_4 solution): two singlets of two CH_3 groups at 1.23 and 1.25 (6H, CH_3), 1.68-2.00 m, 2.32-2.48 m (2H, ring protons), 7.05 m (5H, C_6H_5), 11.84 s (1H, COOH); (VIa) (30% CCl_4 solution): 1.22 s and 1.25 s (6H, CH_3), 1.25-2.37 m (2H, cyclopropane protons), 3.47 s (3H, OCH_3), 7.18 m (5H, C_6H_5); (VII) (30% benzene solution): 1.03 s (3H, cis-CH_3 relative to COO), 1.33 s (3H, trans-CH_3 relative to COO), 1.60-1.85 m (2H, ring protons), 3.45 s (3H, OCH_3), 4.85-5.80 m (3H, CH_2=CH−); (VIII) (30% solution in C_6H_6/CCl_4): 1.00 s (3H, cis-CH_3 relative to COO), 1.23 s (3H, trans-CH_3 relative to COO), 1.52 d (1H, HC—COO, J = 5.5 Hz), 1.61 d (6H, $(CH_3)_2C$=, J = 6 Hz), 1.84 d (1H, HC—C=C<, J = 8 Hz), 5.37 d. m (1H, —HC=C<, J = 8 Hz), 11.63 broad signal (1H, COOH).

CONCLUSIONS

A method, based on the addition of Grignard reagent to cyclopropene hydrocarbons, was proposed for the synthesis of alkyl-, phenyl-, and alkenylcyclopropanecarboxylic acids that bear a geminal dimethyl grouping in the ring.

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