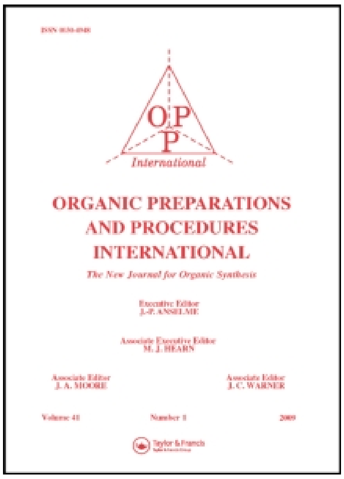

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DIETHYL CYCLOPROPANEMALONATE

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DIETHYL CYCLOPROPANEMALONATE

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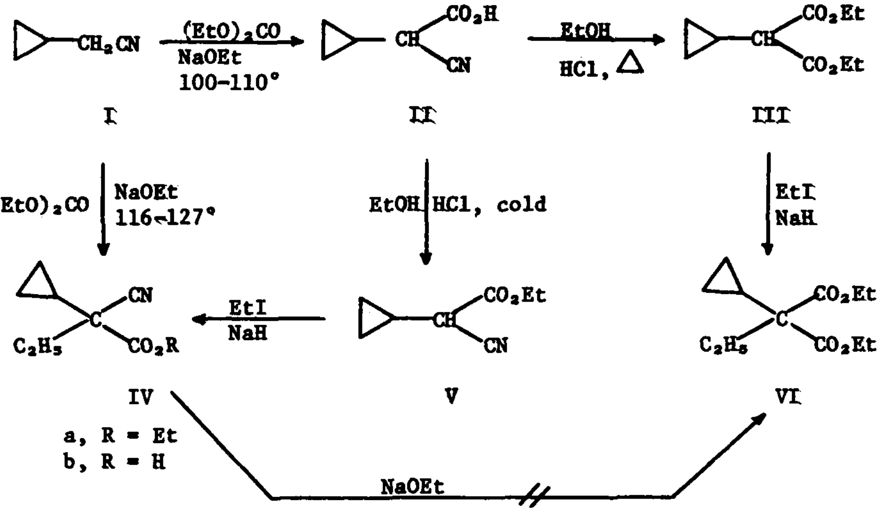
In connection with another problem preparation of diethyl cyclopropanemalonate was required.[1] A search of the literature indicated that diethyl cyclopropanemalonate was obtained by the Wolff rearrangement of the diazo compound resulting from the addition of ethyl diazoacetate to cyclopropanecarbonyl chloride.[2] We have found that the reaction of cyclopropaneacetonitrile (I)[3] with diethyl carbonate and sodium ethoxide gave α-cyanocyclopropaneacetic acid (II) in 65% yield. The reaction of II in the cold with EtOH-HCl gave V while on heating, the diester III was obtained.



The temperature of the carboxylation reaction (100-110°) was found to be critical since at 116-127°, the alkylated product IVa was obtained; authentic IVa was prepared by alkylation of V with ethyl iodide. This type of alkylation first observed by Wallingford et al.,[4] occurs only at higher reaction temperature and only with α-monosubstituted malonic esters. Monosubstituted α-cyanoacetic esters do not give this alkylation product.

Hydrolysis of IVa with NaOH gave IVb, but when ethanolysis of IVa was tried no VI was obtained. Although VI could be prepared from III, the alkylation of this material was sluggish.

EXPERIMENTAL[5]

α-Cyanocyclopropaneacetic acid (II).-To cyclopropaneacetonitrile[1] (15 g, 0.18 mole) was added sodium ethoxide (18 g, 0.27 mole) and diethyl carbonate (100 ml) and the mixture heated with stirring. The temperature gradually rose to 110° while the volatiles distilled over (4.5 hrs.). After cooling, ice was added and the mixture was extracted with ether. The ethereal extract gave diethyl carbonate on evaporation. Acidification of the aqueous phase with 6N hydrochloric acid and extraction with ether gave, after removal of solvent 14.7 g (65%) of II, bp. 80-5°/0.06 mm; IR (neat) 1728 cm^{-1} (CO); 2260 (CN); pmr (δ $CDCl_3$) 0.5-1.0 (m, 4, cyclopropane-CH_2), 1.1-1.7 (m, 1, cyclopropane CH), 3.38 (d, 1, C-H, J = 8 cps), 10.67 (s, 1, CO_2H).

Anal. Calcd for $C_6H_7NO_2$: C, 57.59; H, 5.64; N, 11.20. Found: C, 57.84; H, 5.72; N, 10.94.

Ethyl α-cyanocyclopropaneacetate (V).-An ethanol (75 ml) solution of II (3 g, 0.024 mole) was cooled to 0°. The temperature was kept between 10-15° as hydrogen chloride was bubbled in over 20 min. The solution was stirred for 1.5 hr. then concentrated to give 2 g. (55%) of V, bp. 121-4°/17 mm; IR (liq) 1735 cm^{-1} (ester), 2245 (CN); pmr 0.4-0.9 (m, 4, cyclopropane CH_2), 1.32 (t, 4, CH_2CH_3, cyclopropane C-H), 3.27 (d, 1, C-H), 4.30 q, 2, CH_2CH_3).

Anal. Calcd for $C_8H_{11}NO_2$: C, 62.72; H, 7.24; N, 9.14. Found: C, 62.75; H, 7.37; N, 9.02.

Diethyl cyclopropanemalonate (III).-Dry hydrogen chloride was bubbled through an ethanol solution (250 ml) of II (18 g., 0.14 mole) for 30 min. The solution was then heated under reflux for 1 hr. and the ethanol was removed under reduced pressure. Ether was added, the solid was filtered and the dried ($MgSO_4$) extract was concentrated to give 23 g. of crude III. Distillation gave 13.1 g. (47%) of pure III, bp. 125-130°/33 mm, lit.[2] bp. 76-80°/3 mm.

Ethyl α-cyano-α-cyclopropane butyrate (IVa).-A mixture of cyclopropaneacetonitrile (60 g., 0.74 mole), sodium ethoxide (148 g., 2.2 mole) and diethyl carbonate (800 ml, ∿4.4 mole) was heated to reflux (116°). The volatiles (ethanol and diethyl carbonate) were collected until the temperature reached 127° (∿350 ml). After an additional hour at reflux, the reaction mixture was cooled, water was added. The reaction mixture was extracted with ether to yield after evaporation, 100 g. of crude, solvent-free material. Rapid distillation gave 50 g. of 25:75% mixture of V and IVa, bp. range 112-123°/15 mm. Redistillation through a Vigreux column gave IVa (20 g., 15%), bp. 110-113°/14 mm IR (liq) 1730 cm^{-1} (ester), 2245 (CN); pmr 0.5-0.8 (m, 4, cyclopropane CH_2), 0.8-1.5 (m, 7, $OCH_2\underline{CH_3}$, CH_2CH_3, CH), 1.8-2.3 (m, 2, $C\text{-}\underline{CH_2}CH_3$), 4.27 (q, 2 $O\underline{CH_2}CH_3$); M.S. m/e (1%), 181(20), 166(24), 141(12), 136(16), 122(16), 108(91), 94(24), 81(32), 67(15), 53(20), 41(100).

Anal. Calcd for $C_{10}H_{15}NO_2$: C, 66.27; H, 8.34; N, 7.73. Found: C, 66.12; H, 8.22; N, 7.61.

Authentic IVa was also prepared by the reaction of V (2 g., 0.013 mole) in DMF-toluene (1:4, 50 ml) with NaH (0.34 g., 0.014 mole) followed by alkylation with ethyl iodide (2.2 g., 0.014 mole). After being stirred at room temperature for 1.5 hr., the reaction was quenched with water and the mixture was extracted with Et_2O. The dried ($MgSO_4$) ethereal extract was concentrated to give IVa (2.3 g., 98%), identical with the material prepared above.

α-Cyano-α-ethyl cyclopropaneacetic acid (IVb).-A solution of IVa (2 g., 0.011 mole), sodium hydroxide (5 ml of 25%) and ethanol (125 ml) was refluxed for 9 hrs. The solvent was removed under reduced pressure, water was added and the mixture extracted with ether. The aqueous phase was acidified with 6N HCl and extracted with ether. The dried ($MgSO_4$) ethereal extract was concentrated and the crude acid (1.2 g., 71%) was distilled, bp. 110°/0.75 mm; it crystallized on cooling, mp. 55-57°; IR (melt) 1720 cm^{-1}, 1750 (CO_2H), 2250 (CN), 3050-3600(OH); ($CHCl_3$) 1718, 1755 (sh) (CO_2H), 2250 (CN), 3100-3400, 3500(OH); pmr 0.5-0.80 (m, 4, cyclopropane CH_2), 0.98-150 (m, 4, CH and $CH_2C\underline{H}_3$), 1.90-2.30 (m, 2, $\underline{CH}_2CH_3$), 10.62 (s, 1, CO_2H); mass spectrum m/3 (1%) 153(85), 138(100), 124(30), 113(56), 108(100), 81(70), 53(71).

Anal. Calcd for $C_8H_{11}NO_2$: C, 62.72; H, 7.24; N, 9.14. Found: C, 62.66; H, 7.14; N, 9.01.

Ethyl α-cyclopropane-α-ethylmalonate (VI).-Alkylation of III (5.0 g., 0.025 mole) was carried out in a manner similar to the alkylation of V described above using NaH (1.8 g., 0.038 mole), ethyl iodide (5.9 g., 0.038 mole) and 100 ml of 1:4 DMF-toluene. The reaction mixture was stirred at room temperature for two days and worked up as above. Distillation of the residue gave VI in 65% yield: bp. 126-8°/18 mm; IR 1730 cm^{-1}; pmr 0.28-0.63 (m, 4, cyclopropane CH_2), 0.93 (t, 3, R-$C\underline{H}_2CH_3$), 1.25 (t, 6, $CO_2CH_2CH_3$), 1.6-2.2 (m, 3, R-$C\underline{H}_2CH_3$), cyclopropane CH), 4.18 (q, 4, $CO_2C\underline{H}_2CH_3$).

Anal. Calcd for $C_{12}H_{20}O_4$: C, 63.13; H, 8.83. Found: C, 62.95; H, 8.85.

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5. Melting points were determined on a Thomas-Hoover melting point apparatus and are uncorrected. The infrared spectra were obtained on a Perkin-Elmer 137 and the pmr spectra were determined on a Varian A-60 and a Perkin-Elmer R-12 using TMS as an internal standard. The mass spectra were determined on a AEI-MS-902.

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