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A CONVENIENT SYNTHESIS OF ARYLMETHYLENECYCLOPROPANE CARBOXYLIC ACIDS

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The copper catalyzed addition of carboethoxy carbene to alkynes followed by basic hydrolysis is the standard method to prepare cyclopropene carboxylic acids[2]. We have found, however, that if the cyclopropene resulting from the initial addition has a benzylic hydrogen adjacent to the ring, the alkaline hydrolysis condition lead instead to methylenecyclopropane acids. This phenomenon which is apparently simply a result of a combination of the greater thermodynamic stability of the methylenecyclopropane relative to the cyclopropene and the acidity of the benzylic hydrogen allowed us to conveniently synthesize methylenecyclopropanes II a-c. Yields and properties are summarized in Table I.*

The structures of the methylenecyclopropanes were established by analyses, ultraviolet spectra (all showed only a styrenyl chromophore with λ_{max} at ca. 260 mμ(log ε = 4.1-4.3) and weak shoulders at 283 and 292 mμ), absence of absorption in the 1850-1800 cm^{-1} region of the infrared (characteristic of disubstituted cyclopropenes[2]) and conversion with bromine to bromolactones (characteristic of methylenecyclopropane carboxylic acids[5]). Yields and properties of the bromolactones are given in Table I.

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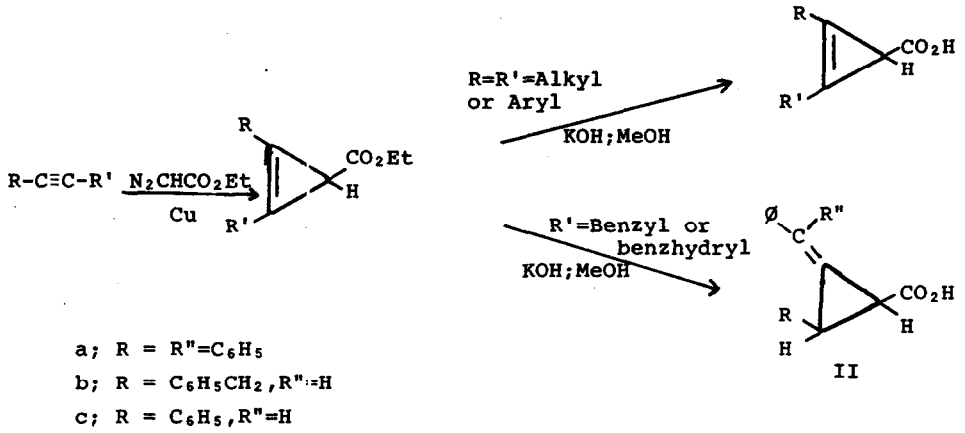
* Since completion of this work, D'yakonov et.al.[3] have reported the synthesis of II-a by a similar procedure (<3.5% yield) and demonstrated the intermediacy of the cyclopropene ester.



a; R = R"=C_6H_5

b; R = $C_6H_5CH_2$, R"=H

c; R = C_6H_5, R"=H

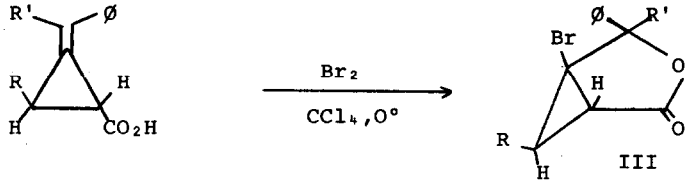
TABLE I

Methylenecyclopropane Acids and Bromolactones

Compound	Yield(%)	m.p.		Analyses %C	%H	%Br	$\nu_{C=O}$ (cm.$^{-1}$)
II-a	28[a]	163.0-164.0	calcd.	84.64	5.56		1690
			found	84.76	5.70		
II-b	32[a]	135.5-137.0	calcd.	81.79	6.10		1690
			found	81.95	6.21		
II-c	42[a,b]	153-156	calcd.	81.58	5.64		1695
			found	81.32	5.68		
III-a	70	186.3-187.0	calcd.	68.18	4.23	19.71	1775
			found	68.30	4.23	19.57	
III-b	68	116.5-118.5	calcd.	62.99	4.41	22.29	1775
			found	62.98	4.30	231.16	
III-c	47	166.0-167.5	calcd.	62.03	3.98	24.27	1765
			found	61.78	3.89	24.30	

[a] Equimolar amounts of ethyl diazoacetate were added to 1,3,3-triphenylpropyne (4a), 1,4-diphenyl-2-butyne(4b), and 1,3-diphenylpropyne(4c), respectively.

[b] Yield of cis, trans isomeric acids II-c and II-c'.



a; R = R' = Ø
b; R = ØCH$_2$-, R' = H
c; R = Ø R' = H

Additional support for the assigned structures resides in the n.m.r. spectra of both the methylenecyclopropanes and the bromolactones.

The n.m.r. spectrum* of II-a showed an acid proton at τ-1.1, an aromatic multiplet centered at τ2.7, and doublets at τ6.32 and τ7.48 (J=3.3 cps). Deuterium exchange with potassium t-butoxide on the methyl ester (m.p.=135.5 - 137.0°) established that the high field proton is more readily exchanged; this along with the splitting pattern in acid II-b suggests that the higher field proton is that alpha to the carboxyl group while the τ6.32 doublet is that of the benzylic hydrogen. The bromolactone III-a had an aromatic multiplet at τ2.7 and doublets at τ6.85 and τ7.27 (J=4.2 cps). The very small vicinal coupling constants in both the acid and lactone support the trans configuration[6].

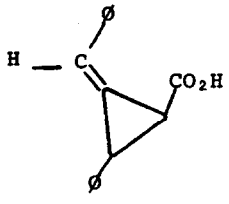
The n.m.r. of the acid II-b showed a singlet at τ-0.9, an aromatic multiplet centered at τ2.8, a triplet (J=1.6 cps) at τ3.27 (vinyl proton), a complex multiplet from τ6.7-7.3, and a quartet (AMX) at τ7.91 (J_{vic}=3.4, J_{allyl}= 1.6 cps). The high field proton must be the proton alpha to the carboxyl group because of its simple splitting pattern while the other ring proton and the magnetically non-equivalent benzyl protons give the complex multiplet.

In the bromolactone III-b, the aromatic protons are centered at τ2.9, the lactone benzylic hydrogen is a singlet at τ4.21, the benzylic hydrogens are a broadened doublet at τ7.18 (J=7.5 cps), the proton next to the carboxylate

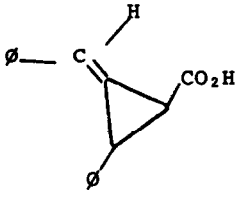
* All n.m.r. spectra were run in deuterochloroform on a Varian A-60-A and the relative areas were consistent with the assigned structures.

group is a doublet at τ7.74 (J=4.0 cps), and the remaining cyclopropyl hydrogen is a 1:1:2:2:1:1 hextet at τ8.27.

The initial product from addition to 1,3-diphenylpropyne was a 2:1 mixture of methylenecyclopropane acids from which the more abundant isomer could be separated by careful crystallization from heptane-benzene. The n.m.r. spectrum of this acid showed a singlet at τ-1.3 (acid proton), an aromatic multiplet centered at τ2.7, a vinyl triplet at τ3.00 (J_{allyl}=2.1 cps), and quartets (AMX) at τ6.57 and τ7.42 (J_{vic}=3.4 cps; J_{allyl}=2.1 cps). Comparison of this spectrum with that of the initial mixture showed that the minor isomer had, in addition to carboxylic acid, aromatic, and vinyl protons overlapping those of the major acid, quartets (AMX) at τ6.37 (J_{vic}=3.4; J_{allyl}=2.6 cps) and τ7.66 (J_{vic}=3.4 cps; J_{allyl}=1.5 cps). The n.m.r. spectrum of the bromolactone IIIc formed from the major acid showed an aromatic multiplet centered at τ2.7, a singlet at τ4.33, and an AB quartet at τ7.06 (J=3.8 cps). The small coupling constants in the isomeric acids and the lactone suggest that both acids are <u>trans</u> cyclopropanes; by comparison with the chemical shifts of II-a, the major isomer is assigned the structure II-c and the minor isomer II-c'.



II-c



II-c'

Facile formation of acids II-c and II-c' is particularly interesting since the double bond of both the cyclopropene and the methylenecyclopropane is conjugated with a phenyl ring. This observation supports previous evidence that the methylenecyclopropane is thermodynamically more stable than its endocyclic isomer[3,7].

Finally, it should be reported that a cursory attempt to isomerize one cyclopropene ester that did not have benzylic hydrogens was unsuccessful. Thus treatment of the methyl ester of 1,2-dipropylcyclopropenecarboxylic acid with potassium t-butoxide gave a crude product whose n.m.r. spectrum suggested production of traces of the exocyclic isomer but attempts to isolate a pure product failed.

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