Reaction of Activated Arenes with 2,5-Dichlorothiophenium Bismethoxycarbonylmethylide

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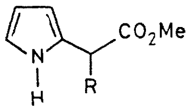
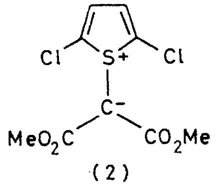
Summary π-Excessive heterocycles and arenes activated by one or more strongly electron donating substituents undergo a copper catalysed reaction with 2,5-dichlorothiophenium bismethoxycarbonylmethylide to give moderate to excellent yields of aryl malonates.

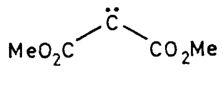
Products from the reaction of carbenoids† with aromatic substrates are notoriously variable and in most cases cyclopropanation of the aromatic rings results in the formation of norcaradiene derivatives.[1] In a few cases, however, products which are formally derived by electrophilic substitution of the ring are formed. These reactions are exceptional and are usually very specific; thus pyrrole reacts with methyl diazoacetate[2] to give moderate yields of methyl pyrrole-2-acetate (**1**, R=H) whereas under the same conditions thiophen undergoes cyclopropanation.[3]



(1)

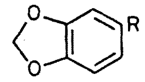


(2)

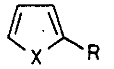


(3)

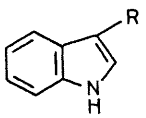
During our work on the general chemistry of 2,5-dichlorothiophenium bismethoxycarbonylmethylide (**2**) we have found that in the presence of copper or rhodium catalysts (**2**) undergoes fragmentation to produce 2,5-dichlorothiophen and bismethoxycarbonylcarbene (**3**) or the corresponding metal stabilised carbenoid. Furthermore, the carbenoid has been trapped[4] with a number of olefins, and offers a convenient high yielding route to 1,1-dialkoxycarbonyl cyclopropanes.



(4) R = H
(5) R = $CH(CO_2Me)_2$



(6) X = NH, R = H
(7) X = NH, R = $CH(CO_2Me)_2$
(8) X = S, R = H
(9) X = S, R = $CH(CO_2Me)_2$



(10) R = H
(11) R = $CH(CO_2Me)_2$

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† The term carbenoid is used in the generic sense to denote either free carbenes or metal stabilised carbene species.

The observation that pyrrole reacts with the dichloroylide (**2**) to yield dimethyl pyrrole-2-malonate (**1**, R=CO_2-Me) has prompted us to examine the possible application of this method to the synthesis of aryl malonates and our preliminary results are shown in the Table.

TABLE

Substrate	Product	Reaction time	Yield(%)[a]	Method
Toluene	No reaction	—	—	—
(**4**)	(**5**)	1 min	20	A
MeOPh	*p*-$MeOC_6H_4CH(CO_2Me)_2$	1·5 h	48	A
(**6**)	(**7**)	2·5 h	73	A
		5 min	79	B
(**8**)	(**9**)	24 h	98	A
(**10**)	(**11**)	2·5 min	85	B
PhOH	$PhOCH(CO_2Me)_2$	1 hr	40	B
$PhNH_2$	$PhNHCH(CO_2Me)_2$	10 min	94	B

Method A. The reaction was carried out using the substrate as solvent; thus the ylide (1·0 g) was dissolved in the substrate (10 ml) and bis(acetylacetonato)copper (10 mg) added. The mixture was heated under reflux and followed by t.l.c. to completion. After removal of the excess of reactant the product was purified by column chromatography. Method B. The reaction was carried out using the ylide (**2**) and the substrate in equimolar proportions dissolved in toluene in the presence of bis(acetylacetonato) copper and heated under reflux. The work up procedure is the same as described in A above. [a] Yields of isolated product. All compounds exhibited satisfactory spectral and analytical properties.

In our initial experiments the reaction of pyrrole with the dichloroylide was carried out according to method A for 2·5 h. Modifying the reaction conditions (Method B) resulted not only in shorter reaction times but also permitted a degree of reproducibility not previously observed. The failure of toluene to undergo reaction under these conditions gives an indication of the limits of the method in that only aromatic systems which are strongly activated towards electrophilic substitution give reasonable yields of products. Toluene does, however, serve as an excellent solvent for these reactions as illustrated by the conversion of indole into the 3-malonate.

A limitation of the method is seen in the reaction with substrates containing acidic hydrogen, *e.g.* phenol and aniline, which results in insertion into the OH and NH bonds.

In all cases examined to date, substitution occurs at the sites predicted on the basis of known substituent activating effects. In the case of anisole and benzo-1,3-dioxole (**4**) substitution at an available *para*-position is favoured and no products of *ortho*-substitution were observed and we believe that these results are a consequence of steric interactions between the carbenoid and the substrate.

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[1] W. Kirmse, in 'Carbene Chemistry,' 2nd edn., Academic Press, 1971.
[2] C. D. Nenitzescu and E. S. Salomonica, *Ber.*, 1931, **64**, 1924.
[3] W. Steinkopf and H. Augestad-Jensen, *Annalen*, 1922, **428**, 154.
[4] J. Cuffe, R. J. Gillespie, and A. E. A Porter, *J.C.S. Chem. Comm.*, 1978, 641.