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Metallation Reactions. XXI. Metallation of Alkyl(alkylthio)benzenes by Superbases *Versus* Organolithium Compounds

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Abstract. The metallation regiochemistry of alkyl(alkylthio)benzenes with butyllithium or with the superbasic mixture of butyllithium with potassium *tert*-butoxide is described. The reaction pattern depends on the substrate and the reagent. Butyllithium monometallates the thiomethylic carbon of methyl(methylthio)benzenes and bimetallates the thiomethylic and the annular carbon *ortho* to the thioethereal group. With superbases the metallation occurs at the thiomethylic and methylic carbon. Metallation with butyllithium of the higher homologs substitutes exclusively the hydrogen *ortho* to the thioalkylic group, while the superbases attack also the carbon atom *alpha* to the thioalkyl substituent.

Metallation reactions constitute the key step in many regiospecific syntheses of polysubstituted aromatics as well as of benzocondensed carbocyclic and heterocyclic compounds. The importance of metallation reactions lies in the easy introduction of electrophilic groups in aromatic or aliphatic compounds.[1 - 4]

The correct choice of substituents allows the regioselective introduction of electrophilic groups in various parts of the substrate.[1 - 4] Many reports on superbases[5 - 9] show that the nature of the metallating reagent can also be useful in directing the metallation/electrophilic addition reaction. The nature and the regioselective effect of various metallating reagents have also been discussed.[7 - 9] Our group has already contributed[10 - 13] to the study of the synthetic and mechanistic aspects of the regioselectivity of metallation reactions, a topic that is still open to debate.[4, 7, 9] We are studying mostly the behaviour of sulphur containing compounds in the metallation reactions with butyllithium[11, 12] and superbases.[14, 15] The metallation of alkyl(methylthio)benzenes with butyllithium[10, 11] occurs at both the benzylic and thiomethylic carbon when the two substituents are in *ortho*; when they are in *meta* or *para* the benzylic carbon cannot be metallated. We also reported that a stoichiometric mixture of butyllithium and potassium *tert*-butoxide monometallates (alkylthio)benzenes at the *alpha* position while two equivalents of the same reagent metallate both the *alpha* and the *ortho* positions.[14] Alkylarenes undergo rapid and almost quantitative hydrogen-metal exchange when treated with superbases.[7]

These results suggested the possibility of using superbases to metallate both the benzyl and thioalkyl carbons of alkyl(alkylthio)benzenes independently of their relative position (*ortho*, *meta*, or *para*).

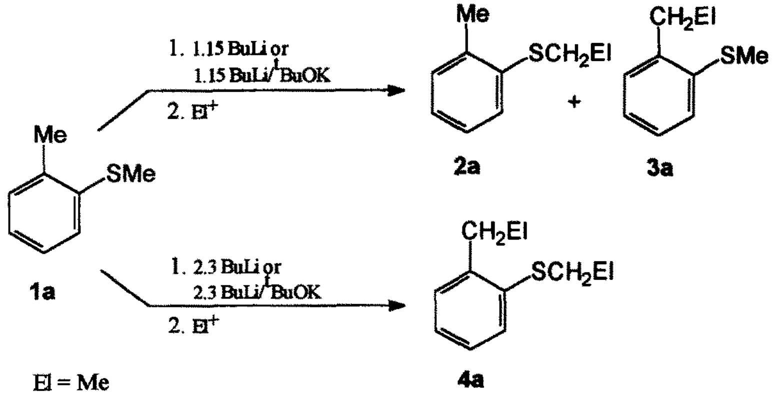
RESULTS AND DISCUSSION

The results (see Schemes and Table 1[16]) show that the monometallation with superbases of **1a** yields a mixture of two products, **2a** and **3a**, by substitution of the thiomethylic or the benzylic hydrogen respectively. Bimetallation yields product **4a** where the substitution occurs at both carbon atoms. Similar results were also obtained with butyllithium alone.[10, 11, 17]

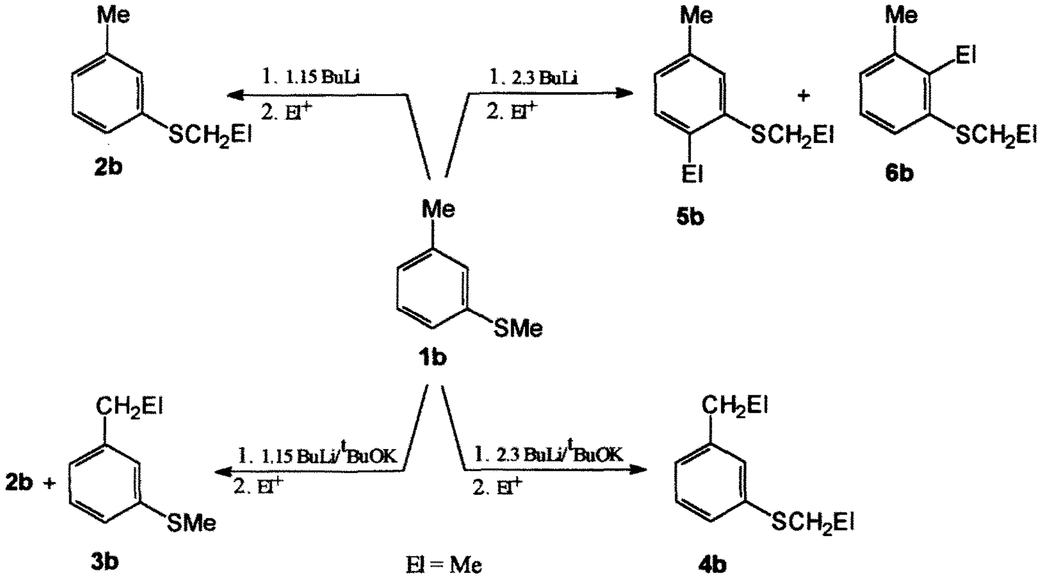
Table 1. Metallation of Alkyl(alkylthio)benzenes **1a-f** with Butyllithium.[a]

starting material	additive	reagent equiv.	% of products				
			2	3	4	5/6	7
1a	$KOC(CH_3)_3$	1.15	33 (45)	40 (55)	--	--	--
	$KOC(CH_3)_3$	2.3	--	--	78	--	--
		1.15	41	20	--	--	--
		2.3	--	--	65	--	--
1b	$KOC(CH_3)_3$	1.15	51 (69)	23 (31)	--	--	--
	$KOC(CH_3)_3$	2.3	--	--	80	--	--
		1.15	68	--	--	--	--
		2.3	--	--	--	79[b]	--
1c	$KOC(CH_3)_3$	1.15	20 (26)	56 (74)	--	--	--
	$KOC(CH_3)_3$	2.3	--	--	75	--	--
		1.15	73	--	--	--	--
		2.3	--	--	--	68	--
1d	$KOC(CH_3)_3$	1.15	81	--	--	--	--
	$KOC(CH_3)_3$	2.3	--	--	--	70	--
		1.15	73	--	--	--	--
		2.3	--	--	--	80	--
1e	$KOC(CH_3)_3$	1.15	--	65	--	--	--
	$KOC(CH_3)_3$	2.3	--	--	40	--	--
		1.15	--	--	--	--	78
		2.3	--	--	--	--	83
1f	$KOC(CH_3)_3$	1.15	70	--	--	--	--
	$KOC(CH_3)_3$	2.3	--	--	--	58	--
		1.15	--	--	--	--	74
		2.3	--	--	--	--	77

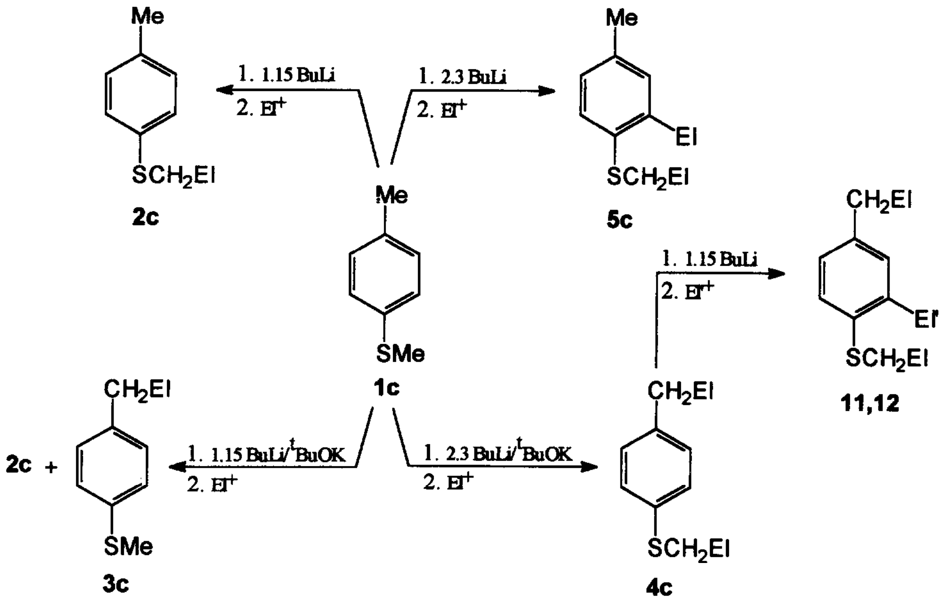
[a] Reaction mixtures were quenched with iodomethane. The relative percentages of isomers are reported in brackets. [b] Mixture of **5b** and **6b** in 80/20 ratio.



Monometallation of **1b** with butyllithium occurs on the thiomethylic carbon, yielding selectively the product **2b**; with a superbase mixture the thiomethylic and benzylic hydrogens react yielding respectively **2b** and **3b**. Bimetallation with butyllithium yields a mixture of products **5b** and **6b**,[11] coming from substitution at the *alpha* and the *ortho* positions of the thiomethylic group. Bimetallation with superbases yields only **4b** where both at the benzylic and thiomethylic hydrogens are substituted.



Monometallation with butyllithium of **1c** substitutes only the thiomethylic carbon yielding **2c**, while bimetallation yields only **5c** where both the thiomethylic and the annular *ortho* hydrogens have been substituted.[11] Monometallation with superbases yields a mixture of products (**2c** and **3c**) where either the thiomethylic or the benzylic hydrogens have been respectively substituted. Bimetallation with superbases yields **4c** upon substitution of both the benzylic and thiomethylic hydrogens.



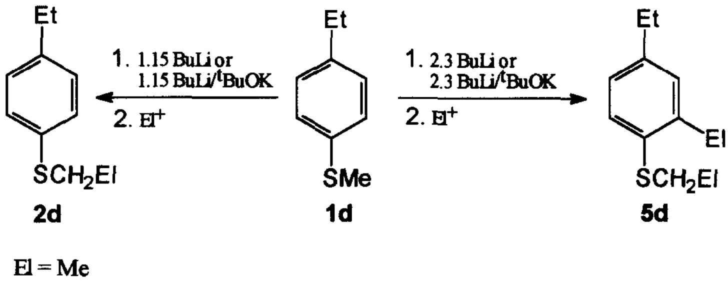
El = Me; **11**: El' = Me; **12**: El' = CO_2H

The above results show that the *ortho* derivative **1a** give the same products using either butyllithium or superbases. On the other hand, the *meta* and *para* derivatives **1b** and **1c** show different reaction patterns when treated with these two reagents. Monometallation with butyllithium of the *meta* and *para* derivatives substitutes selectively the thiomethylic hydrogen. Bimetallation of the same compounds involves the thiomethylic hydrogen and one of the two positions *ortho* to the thiomethylic group. Thus the reaction is not regioselective. However, in the *para* derivative the two *ortho* positions are equivalent. Neither monometallation with superbases is regioselective: the benzylic and thiomethylic carbons show similar reactivities yielding a mixture of products (**2a-c** and **3a-c**). However, bimetallation yields only one product since substitution occurs at both the thiomethylic and benzylic carbon, as shown by **4a-c**.

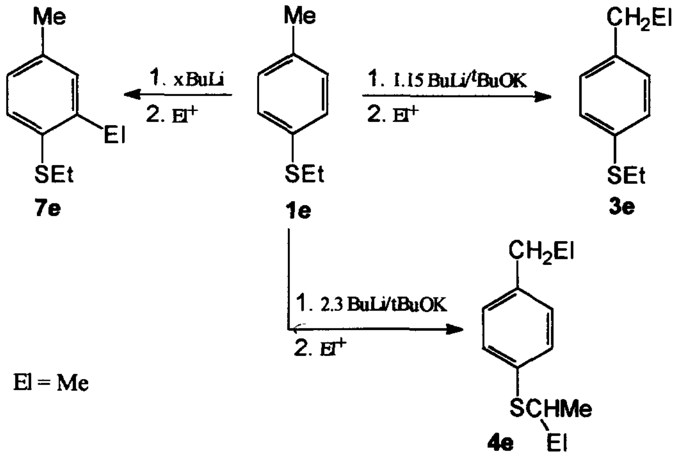
Thus, different sites of the substrate can be functionalized changing the metallating reagent. Considering also previously published data,[14] one can see that butyllithium must be used when the target is the metallation of the thiomethylic and annular carbons, leaving the benzylic carbon untouched. On the contrary superbases are useful to deprotonate the benzylic position and, for the higher (alkylthio)benzenes, the thiomethylenic carbon.[14]

This can be rationalized considering the substrate structure and the organometallic reagent. We already suggested that while the reactivity of butyllithium is related to the coordinating power of the substituents,[4] the superbase reactivity depends largely on the acidity of the various molecular sites even though coordination can still play a role.[7, 9, 18] Thus, coordination with the sulphur atom directs metallation of butyllithium in *ortho* or *alpha* to the thioalkyl substituent. In the stoichiometric mixture with potassium *tert*-butoxide, the reactivity of the various sites of the molecule depends more on their stability as carbanions.[5] However, when the stability of the various sites of the molecule is decreased by alkyl substitution (electron donors), coordination with sulphur plays again an important role.

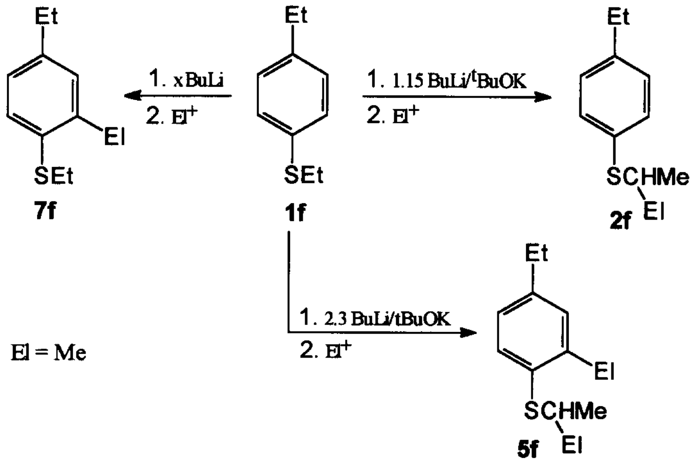
Metallation reactions of **1d-f**[16] with butyllithium or superbases support this hypothesis. In these compounds the reactivity of the benzylic and thiomethylic carbons is decreased by methyl substitution. When the acidity of the benzyl carbon is decreased as in **1d**, both butyllithium and superbase react first at the thiomethyl position and then at the *ortho* position (compare with the reactivity of **1c**).



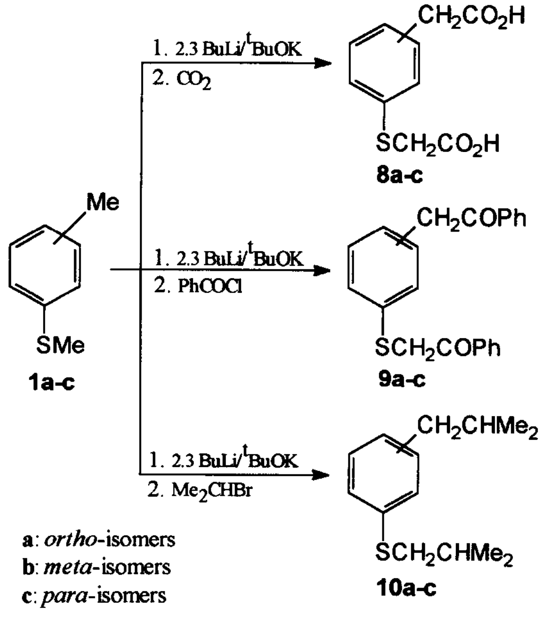
In **1e**, where the acidity of the thiomethyl carbon is lowered, butyllithium can react only in *ortho*, while the superbase reacts first at the benzylic position and then at the thiomethylenic carbon.



Finally in **1f** (Scheme 6), where the acidity of both benzylic and thiomethylic group is decreased by methyl substitution, butyllithium can only react in *ortho* to the thioethereal group while with superbases the reactivity order shows that the thiomethylenic position is more reactive than the *ortho* carbon.[19]



Examples of the synthetic utility of superbases are given by **8a-c**, **9a-c** and **10a-c** that can be prepared from **1a-c** quenching the respective dianions with carbon dioxide, benzoyl chloride, and 2-bromopropane. These and other compounds, which could be obtained otherwise with more difficult or time wasting procedures, are useful syntones. For example, products **10a-c** can be easily prepared using superbases, while the usual Friedel-Craft



alkylation of the corresponding thioethers would lead to various isomers because of rearrangements of the alkyl moiety.

Sometimes two metallating reagents (butyllithium or superbases) can prove useful. A suitable synthesis of 1-ethyl-4-(ethylthio)-3-methylbenzene (**11**) and 5-ethyl-2-(ethylthio)-benzoic acid (**12**) can be performed starting from **1c**. Bimetallation with superbases followed by treatment with iodomethane yields 1-ethyl-4-(ethylthio)benzene (**4c**). Successive one-pot metallation of the latter product with butyllithium followed by treatment with iodomethane or carbon dioxide yields **11** or **12**. Of course various combinations of electrophiles can be used.

EXPERIMENTAL

Instrumental techniques, etc., were as described in a previous paper.[15]

Starting materials

2-(Methylthio)- (**1a**),[20] 3-(methythio) (**1b**),[21] and 4-(methylthio)-1-methylbenzene (**1c**),[22] 1-ethyl-4-(methylthio)benzene (**1d**),[23] 1-methyl- (**1e**)[24] and 1-ethyl-4-(ethylthio)-benzene (**1f**)[25] were prepared as previously described from the corresponding arenethiols and dimethylsulfate or diethylsulfate.

Authentic samples

2-(Ethylthio)-1-methyl- (**2a**),[26] 1-ethyl-2-(methylthio)- (**3a**),[27] 1-ethyl-2-(ethylthio)-(**4a**),[11] 3-(ethylthio)-1-methyl- (**2b**)[28] and 4-(ethylthio)-1,3-dimethylbenzene (**5c**)[26] were prepared by published methods. The following compounds were prepared from alkylbenzenethiols and dimethyl sulphate or diethyl sulphate or 2-bromopropane, respectively.

1-Ethyl-3-(methylthio)benzene (3b). Yield 81%; bp 87 - 88°C (1 mm Hg). ^{1}H NMR ($CDCl_3$) δ: 1.17 (3 H, t, CH_3CH_2), 2.43 (3 H, s, SCH_3), 2.58 (2 H, q, CH_3CH_2), 7.04 (4 H, m, Ar-*H*). *m/z* 152 (M^+). (Found C, 70.94; H, 7.87; S, 20.91. $C_9H_{12}S$ requires C, 71.00; H, 7.94; S, 21.06).

1-Ethyl-3-(ethylthio)benzene (4b). Yield 78%; bp 70 - 73°C (0.5 mm Hg). ^{1}H NMR ($CDCl_3$) δ: 1.23 (3 H, t, CH_3CH_2S), 1.30 (3 H, t, CH_3CH_2Ar), 2.61 (2 H, q, CH_2CH_2S), 2.92 (2 H, q, CH_3CH_2Ar), 6.95 (4 H, m, Ar-*H*). *m/z* 166 (M^+). (Found C, 72.15; H, 8.44; S, 19.13. $C_{10}H_{14}S$ requires C, 72.23; H, 8.49; S, 19.28).

1-Ethyl-4-[(1-methylethyl)thio]benzene (4e). Yield 75%; bp 97 - 98°C (1 mm Hg). ^{1}H NMR ($CDCl_3$) δ: 1,12 (3 H, t, CH_3CH_2), 1.23 (6 H, d, CH_3CH), 2.55 (2 H, q, $ArCH_2$), 3.05 (1 H, m, *CH*S), 7.15 (4 H, m, Ar-*H*); *m/z* 180 (M^+). (Found C, 73.19; H, 8.88; S, 17.63. $C_{11}H_{16}S$ requires C, 73.28; H, 8.94; S, 17.78).

1-Ethyl-4-(ethylthio)-3-methylbenzene (5d). This compound was prepared as previously described[15] by consecutive treatment with butyllithium and iodomethane of **1f**. Yield 74%; bp 86 - 88°C (0.95 mm Hg). ^{1}H NMR ($CDCl_3$) δ: 1.20 (3 H, t, CH_3CH_2S), 1.29 (3 H, t, CH_3CH_2Ar), 2.35 (3 H, s, CH_3Ar), 2.42 (2 H, q, CH_2CH_2S), 2.72 (2 H, q, CH_3CH_2Ar), 7.05 (4 H, m, Ar-*H*). *m/z* 180 (M^+). (Found C, 73.15; H, 8.90; S, 17.65. $C_{11}H_{16}S$ requires C, 73.28; H, 8.94; S, 17.78).

1-Ethyl-3-methyl-4-[(1-methylethyl)thio]benzene (5f). This compound was prepared as above described by treatment with butyllithium and iodomethane of **4e**. Yield 64%; bp 102 - 103°C (2 mm Hg). ^{1}H NMR ($CDCl_3$) δ: 1,19 (3 H, t, CH_3CH_2), 1.30 (6 H, d, CH_3CH), 2.41 (3 H, s, CH_3Ar), 2.53 (2 H, q, $ArCH_2$), 3.18 (1 H, m, *CH*S), 7.11 (4 H, m, Ar-*H*); *m/z* 194 (M^+). (Found C, 74.09; H, 9.27; S, 16.31. $C_{12}H_{18}S$ requires C, 74.18; H, 9.35; S, 16.47).

Monometallation procedure with superbases

A solution of butyllithium in hexane (35 ml, 50 mmol) was cooled to -60°C under nitrogen and a solution of the starting sulfide **1a-f** (43 mmol) in hexane (20 ml) was added. Finely powdered potassium *tert*-butoxide (5.6 g, 50 mmol) was added and the temperature allowed to rise to -20°C. The mixture was kept for 1 h at -20°C, after which the temperature was allowed to rise to -10°C. After 3 h, an excess of iodomethane (12.8 g, 90 mmol) was slowly added, the cooling bath removed and the reaction completed by stirring overnight at room temperature. The reaction mixture was poured into water, the organic layer separated and the aqueous layer extracted with ether. The combined organic extracts were dried (Na_2SO_4), filtered and evaporated. The products were distilled and identified by GC/MS comparison with authentic samples.

In this manner, the following compounds were obtained:

a) from **1a**, a mixture of **2a** and **3a** in 45/55 ratio (GC); total yield 73%.
b) From **1b**, a mixture of **2b** and **3b** in 69/31 ratio (GC); total yield 74%.
c) From **1c**, a mixture of **2c**[16] and **3c**[16] in 26/74 ratio (GC); total yield 76%.
d) From **1d**, **2d**[16] in 81% yield.
e) From **1e**, **3e**[16] in 65% yield.
f) From **1f**, **2f**[16] in 70% yield.

Bimetallation procedure with superbases

These reactions were carried out as above described, using two moles of superbasic reagent per mole of thioether and iodomethane as electrophile.

In this manner, the following compounds were obtained:

a) from **1a**, **4a** in 78% yield.
b) From **1b**, **4b** in 80% yield.
c) From **1c**, **4c**[16] in 75% yield.
d) From **1d**, **5d**[16] in 70% yield.
e) From **1e**, **4e**[16] in 40% yield.
f) From **1f**, **5f** in 38% yield.

The following compounds were similarly obtained from **1a**, **1b** and **1c**, respectively, using carbon dioxide or benzoyl chloride or 2-bromopropane as electrophiles.

*2-[(Carboxymethyl)thio]benzeneacetic acid (**8a**).* The metallated mixture of **1a** was poured onto ca. 100 g of crushed solid carbon dioxide and worked as previously described.[15] The crude product was crystallized from toluene. Yield 67%; m.p. 184 - 185°C; (lit.[10] m.p. 186°C).

*2-[2-[(Benzoylmethyl)thio]phenyl]-1-phenylethanone (**9a**).* Yield 51%; yellow viscous oil, b.p. 92 - 93°C (3 mm Hg).The product was identified by comparison with an authentic sample.[10]

*1-(2-Methylpropyl)-2-[(2-methylpropyl)thio]benzene (**10a**).* Yield 57%; pale yellow oil, b.p. 148 - 150°C (10 mm Hg). ^{1}H NMR ($CDCl_3$) δ: 0.89 (12 H, d, CH_3), 1.89 (2 H, m, C*H*), 2.28 (4 H, d, SCH_2), 2.54 (4 H, d, ArCH_2), 7.01 (4 H, m, Ar-*H*). *m/z* 222 (M^+). (Found C, 75.52; H, 9.92; S, 14.25. $C_{14}H_{22}S$ requires C, 75.61; H, 9.97; S, 14.42).

*3-[(Carboxymethyl)thio]benzeneacetic acid (**8b**).* Yield 58%; the crude product was crystallized from water, m.p. 128 - 130°C (dec.). IR (nujol, cm^{-1}): 3116 (OH), 1696 (C=O). ^{1}H NMR (DMSO-d_6) δ: 3.54 (2 H, s, SCH_2), 3.79 (2 H, s, CH_2Ar), 7.19 (4 H, m, Ar-*H*), 12.44 (2 H, s, br, COO*H*, D_2O exchanged). *m/z* 226 (M^+). (Found C, 53.01; H, 4.41; S, 14.04. $C_{10}H_{10}O_4S$ requires C, 53.09; H, 4.46; S, 14.17).

*2-[3-[(Benzoylmethyl)thio]phenyl]-1-phenylethanone (**9b**).* Yield 57%; flash-chromatography (1/1 benzene/light petroleum); yellow viscous oil, b.p.134 - 135°C (7 mm Hg). IR (neat, cm^{-1}): 1690, 1740 (C=O). ^{1}H NMR ($CDCl_3$) δ: 4.23 (2 H, s, SC*H*2), 4.51 (2 H, s, ArC*H*2), 7.64 (14 H, m, Ar-*H*). *m/z* 346 (M^+). (Found C, 76.20; H, 5.18; S, 9.13. $C_{22}H_{18}O_2S$ requires C, 76.28; H, 5.24; S, 9.24).

*1-(2-Methylpropyl)-3-[(2-methylpropyl)thio]benzene (**10b**).* Yield 63%; pale yellow oil, b.p.108 - 110°C (4 mm Hg). ^{1}H NMR ($CDCl_3$) δ: 0.89 (12 H, d, CH_3), 1.73 (2 H, m, C*H*), 2.30 (4 H, d, SCH_2), 2.69 (4 H, d, ArCH_2), 6.95 (4 H, m, Ar-*H*). *m/z* 222 (*M*+). (Found C, 75.49; H, 9.93; S, 14.29. $C_{14}H_{22}S$ requires C, 75.61; H, 9.97; S, 14.42).

*4-[(Carboxymethyl)thio]benzeneacetic acid (**8c**).* Yield 55%; the crude product was crystallized from water, m.p. 212 - 213°C (dec.). IR (nujol, cm^{-1}): 3100 (OH), 1698 (C=O). ^{1}H NMR (DMSO-d_6) δ: 2.30 (2 H, s, SCH_2), 3.74 (2 H, s, CH_2Ar), 7.28 (4 H, m, Ar-*H*), 12.86 (2 H, s, br, COO*H*, D_2O exchanged). *m/z* 226 (M^+). (Found C, 52.98; H, 4.39; S, 14.01. $C_{10}H_{10}O_4S$ requires C, 53.09; H, 4.46; S, 14.17).

*2-[4-[(Benzoylmethyl)thio]phenyl]-1-phenylethanone (**9c**).* Yield 61%; flash-chromatography (1/1 benzene/light petroleum), yellow viscous oil, b.p.134 - 135°C (2 mm Hg). IR (neat, cm^{-1}): 1785, 1725 (C=O). ^{1}H NMR ($CDCl_3$) δ: 4.20 (2 H, s, SC*H*2), 4.33 (2 H, s, ArC*H*2), 7.64 (14 H, m, Ar-*H*). *m/z* 346 (M^+). (Found C, 76.18; H, 5.20; S, 9.15. $C_{22}H_{18}O_2S$ requires C, 76.28; H, 5.24; S, 9.24).

*1-(2-Methylpropyl)-4-[(2-methylpropyl)thio]benzene (**10c**).* Yield 65%; pale yellow oil, b.p. 95 - 97°C (4mm Hg). ^{1}H NMR ($CDCl_3$) δ: 1.02 (12 H, d, CH_3), 1.88 (2 H, m, C*H*), 2.35 (4 H, d, SCH_2), 2.78 (4 H, d, ArCH_2), 7.15 (4 H, m, Ar-*H*). *m/z* 222 (M^+). (Found C, 75.54; H, 9.91; S, 14.27. $C_{14}H_{22}S$ requires C, 75.61; H, 9.97; S, 14.42).

Metallation procedure with butyllithium alone

These reactions were carried out as previously described,[11] using iodomethane as electrophile. In this manner, using one mole of organolithium reagent per mole of thioether, the following compounds, identified by GC/MS comparison with authentic samples, were obtained:

a) from **1a**, a mixture of **2a** and **3a** in 67/33 ratio (GC), total yield 61%.
b) From **1b**: **2b** in 68% yield.
c) From **1c**: **2c**[16] in 73% yield.
d) From **1d**: **2d**[16] in 73% yield.
e) From **1e**: **7e**[16] in 78% yield.
f) From **1f**: **7f**[16] in 74% yield.

Using two or more moles of organolithium compound per mole of thioether the following compounds were obtained:

a) from **1a**: **4a** in yield 65%.
b) From **1b**: a mixture of **5b** and **6b** in 80/20 ratio (GC); total yield 79% (this mixture, after desulphurisation with Raney nickel, showed two peaks, with retention times identical with those of 1,2- and 1,4-dimethylbenzene).
c) From **1c**: **5c**[16] in 68% yield.
d) From **1d**: **5d**[16] in 80% yield.
e) From **1e**: **7e**[16] in 83% yield.
f) From **1f**: **7f**[16] in 77% yield.

Sequential, one-pot introduction of electrophiles on 1c

The procedure above described[15] was followed in the preparation of **11** and **12** metallating first with the superbasic mixture and then with butyllithium. In this manner using iodomethane as first and second electrophile *1-ethyl-4-(ethylthio)-3-methylbenzene (11)* was obtained in 54% yield; yellow oil, b.p.86 - 88°C (0.95 mm Hg). ^{1}H NMR (CDCl$_3$) δ: 1.20 (3 H, t, CH_3CH_2S), 1.26 (3 H, t, CH_3CH_2Ar), 2.35 (3 H, s, CH_3Ar), 2.57 (2 H, q, CH_3CH_2S), 2.85 (3 H, q, CH_3CH_2Ar), 7.1 (3 H, m, Ar-*H*). *m/z* 180 (M^+). (Found: C, 73.20; H, 8.88; S, 17.63. $C_{11}H_{16}S$ requires C, 73.28; H, 8.94; S, 17.78). This compound, after desulphurisation with Raney nickel, gave 1-ethyl-3-methylbenzene in almost quantitative yield.

Similarly, using carbon dioxide as second electrophile, *5-ethyl-2-(ethylthio)benzoic acid (12)* was obtained in 60% yield; crystallized from aqueous ethanol, m.p.84 - 86°C. IR (nujol, cm^{-1}): 3130 (OH), 1685 (C=O). ^{1}H NMR (DMSO-d_6) δ: 1.16 (3 H, t, CH_3CH_2S), 1.25 (3 H, t, CH_3CH_2Ar), 2.59 (2 H, q, CH_3CH_2S), 2.90 (2 H, q, CH_3CH_2Ar), 7.33 (3 H, m, Ar-*H*), 12.96 (1 H, s, br, COO*H*, D$_2$O exchanged). *m/z* 210 (M^+). (Found: C, 68.71; H, 6.65; S, 15.14. $C_{11}H_{14}O_2S$ requires C, 68.83; H, 6.71; S, 15.25). This compound, after desulphurisation with Raney nickel, gave 3-ethylbenzoic acid in almost quantitative yield.

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REFERENCES

1. Gschwend, H.W.; Rodriguez, H.R. *Org React.* (N.Y.) **1979**, *26*, 1.
2. Wakefield, B.J. in "*The Chemistry of Organolithium Compounds*", Pergamon Press, Oxford, **1974**.
3. Narasimhan, N.S.; Mali, R.S. *Synthesis* **1983**, 957.
4. Snieckus, V. *Chem. Rev.* **1990**, *90*, 879.
5. Schlosser, M. *Pure & Appl. Chem.* **1988**, *60*, 1627.
6. Schlosser, M.; Choi, J.H.; Takagishi, S. *Tetrahedron* **1990**, *46*, 5633.
7. Mordini, A. in: *Advances in Carbanion Chemistry* (V. Snieckus, ed.), Chapter 1, Jai Press, Greenwich CT, 1992,.
8. Barry, C.E.; Bates, R.B.; Beavers, W.A.; Camou, F.A.; Gordon, B.; Hsu, H.-J.; Mills, N.S.; Ogle, C.A.; Siahaan, T.J.; Suvannachut, K.; Taylor, S.R.; White, J.J.; Yager, K.M. *Synlett* **1991**, 207.
9. Schlosser, M. in: *Modern Synthetic Methods* (R. Scheffold, ed.), Verlage HCA, Basel, and VCH, Weinheim, Vol. **6**, (1992), 227.
10. Cabiddu, S.; Melis S.; Piras, P.P.; Sotgiu, F. *J. Organometal. Chem.* **1979**, *178*, 291.
11. Cabiddu, S.; Fattuoni, C.; Floris, C.; Gelli, G.; Melis, S.; Sotgiu F. *Tetrahedron* **1990**, *46*, 861.
12. Cabiddu, S.; Fattuoni, C.; Floris, C.; Gelli, G.; Melis, S. *J. Organomet. Chem.* **1991**, *419*, 1.
13. Cabiddu, S.; Contini, L.; Fattuoni, C.; Floris, C.; Gelli, G. *Tetrahedron.* **1991**, *47*, 9279.
14. Cabiddu, S.; Fattuoni, C.; Floris, C.; Gelli, G.; Melis, S. *J. Organomet. Chem.* **1992**, *441*, 197.
15. Cabiddu, S.; Fattuoni, C.; Floris, C.; Gelli, G.; Melis, S. *Tetrahedron* **1993**, *49*, 4965.
16. Sometimes using certain electrophiles the products of a reaction are identical to the reagents or products of other reactions: **1d** = **3c**, **1e** = **2c**, **1f** = **4c** = **2d** = **3e**, **5d** = **7f**, **7e** = **5c**, **4e** = **2f**.
17. Cabiddu, S.; Floris, C.; Gelli, G.; Melis, S. *J. Organometal. Chem.* **1989**, *366*, 1.
18. Knipe, A.C. In *Organic Reaction Mechanism*, John Wiley and Sons, New York, **1992**, pp. 337-365.
19. With superbases the total yield of the products reported in the Table is usually lowered by the presence of several trimetallation products, detected by GC/MS. The formation of these compounds cannot be evoided even using a stoichiometric amount of superbase. Trimetallation reaction is under study and we will report the results as soon as possible.
20. Leandri, G.; Mangini, A.; Passerini, R. *Gazz. Chim. Ital.* **1954**, *84*, 3; *Chem. Abstr.*

1956, *50*, 222d.
21. Gilman, H.; Webb, F.J. *J. Am. Chem. Soc.* **1949**, *71*, 4062.
22. Wedekind, E.; Schenk, D. *Chem. Ber.* **1921**, *541*, 608.
23. Hess, R.E.; Haas, C.K.; Kaduk, B.A.; Schaeffer, C.D.; Yoder, C.H. *Inorg. Chim. Acta* **1971**, *5*, 161.
24. Gilman, H.; Beaber, N.J. *J. Am. Chem. Soc.* **1925**, *47*, 1450.
25. Kuliev, A.M.; Gasanov, F.I. *Uch. Zap. Azerb. Gos. Univ. Ser. Khim.* **1967**, *5*, 58; *Chem. Abstr.* **1969**, *71*, 12727w.
26 Cabiddu, S.; Floris, C.; Melis, S. *Tetrahedron Lett.* **1986**, *27*, 4625.
27 Fricke, R.; Spilker, G. *Chem. Ber.* **1925**, *58*, 25.
28 Illuminati, G.; Gilman, H. *J. Am. Chem. Soc.* **1949**, *71*, 3349.

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