Synthesis and Nmr Data of Some Variously Substituted Diphenylmethanes and Dibenzylbenzenes

GIORGIO MONTAUDO[1], PAOLO FINOCCHIARO, SALVATORE CACCAMESE, and FRANCESCO BOTTINO
Institutes of Industrial and Organic Chemistry, University of Catania, Viale A. Doria, Catania, Italy

Fifty-four new compounds—methyl and halo derivatives of diphenylmethane and *o,m,p*-dibenzylbenzene—were prepared under mild conditions. The identity of compounds prepared was established by nmr, and spectral assignments are reported.

In connection with a study on the conformational properties of molecules containing substituted diarylmethane units (*11*), a number of such compounds were prepared. Compounds in Tables I–VII, hitherto unreported by other authors, were prepared through Friedel and Crafts reactions starting from appropriate aromatic hydrocarbon and chloromethyl derivatives.

The choice of mild conditions (low temperature and reaction time, catalyst, solvent, excess of hydrocarbon, and nitrogen steam) was crucial to avoid or minimize isomerization and disproportionation. This was pointed out also by Olah (*14, 15*). Nmr spectra were used to provide unequivocal structure proof for our compounds—i.e., to test for eventual rearrangements of methyl groups which occurred during the alkylation reaction.

To build up reliable assignment maps from the analysis of the spectra, a number of diphenylmethane and dibenzylbenzene derivatives already known (prepared by other authors by different synthetic procedures) were used as references. These compounds, reported in Table VIII, were prepared and their nmr spectra were recorded and analyzed, together with the other compounds which were synthesized.

In our opinion, the Friedel and Crafts reaction represents a satisfactory route to the synthesis of diphenylmethane and dibenzylbenzene derivatives, and is somewhat simpler with respect to alternative methods (ketone reduction, Grignard synthesis).

EXPERIMENTAL

Nitroethane and aromatic hydrocarbons—commercial products of high purity—were dried, distilled, or crystallized before use. Chloromethyl derivatives, where not available commercially, were prepared according to the literature (*13*).

Aluminum chloride was sublimed, stannic chloride was vacuum distilled, and zinc chloride was fused before use.

Melting points (uncorrected) were obtained in glass capillary tubes sealed under vacuum, and checked with a Kofler hot stage microscope.

The following instruments were used in the present work: Varian A-60, X-100 and Jeol C-60HL nmr spectrometers, Mechrolab V.P.O. 302, and Perkin-Elmer 237 infrared spectrometer.

Elemental analyses were obtained commercially (Institute of Organic Chemistry of the University, Milan). Infrared data, although omitted here, are available on request.

Method. A mixture of chloromethyl derivative and hydrocarbon, dissolved in nitroethane, was added to the catalyst under stirring, and a nitrogen stream was maintained through the reaction, at constant temperature. Workup consisted of pouring the reaction mixture into an excess of methanol or water, filtering the solvent, washing the residue with diluted HCl and water, and vacuum drying. Liquid products were purified by chloroform extraction, drying-off the solution, evaporation of the solvent, and vacuum distillation.

Criteria of Purity. The characteristics and specific reaction conditions used in the preparation of all compounds reported are listed in Tables I–VII.

All compounds described analyzed correctly for elemental analysis. It has to be realized, however, that in many cases the presence of sizable impurities (hydrocarbons of higher or lower molecular weight) could be masked by small deviations in the analytical data. Under these circumstances, in judging the purity of a product, we have relied more upon the molecular weight determinations.

NMR SPECTRA

The identity of the compounds prepared was established by their nmr spectra. The spectra consist of three types of signals corresponding to methyl, methylene, and nuclear aromatic protons. Methyl and methylene peaks appear as sharp singlets. Aromatic protons have various appearances according to the nuclear substitution pattern. In many cases, peak assignments follow in a straightforward manner from the relative intensities and positions of signals. This is the case of polysubstituted rings (1,2,4,5; 1,2,3,4,5; 1,2,3,5) where nuclear protons appear as singlets. In less substituted rings, aromatic protons may show up as multispin systems.

For nuclear protons, in 1,2,4- and 1,2,5-trisubstituted rings (strictly AA′B), no sensible $J_{AA'}$ was detected, and the analysis was carried out as for a pure AB system. Aromatic protons in 1,4-disubstituted rings (strictly A_2B_2) were also analyzed as AB systems, a particularly good approximation due to the absence of extra lines. Aromatic protons in 1,2,6-trisubstituted rings (halo-derivatives) showed the characteristic pattern of AB_2 systems. $\Delta\nu/J$ values were estimated according to standard procedures (*8*).

Aromatic protons in 1,2-disubstituted and monosubstituted rings appear, in general, as complex multiplets and, in these cases, no complete analysis was attempted.

Sometimes, however, the analysis of this type of spectra becomes, for reasons discussed elsewhere (*11*), simpler

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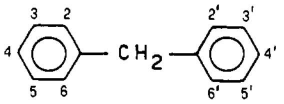
[1] To whom correspondence should be addressed.

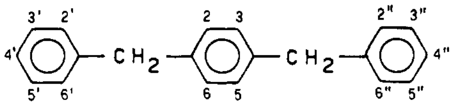
Table I. Derivatives of Diphenylmethane[a]



N	Position of methyl groups	Mp, °C or K_p/mm Hg	Mol wt[b] (calcd) found	H_2	H_3	H_4	H_5	H_6	$H_{2'}$	$H_{3'}$	$H_{4'}$	$H_{5'}$	$H_{6'}$	CH_2
				Nmr[c, d]										
1	2,3,5,6	54–55	(224.3)	*135*	*143*		*143*	*135*						261
			225.1	*124*	*131*	408[e]	*131*	*124*	425[f]	425[f]	425[f]	425[f]	425[f]	242
2	2,4,6,2′,5′	102–103	(238.4)	*137*		*147*		*137*	*152*			*135*		247
			240.0	*126*	409[e]	*135*	*409*[e]	*126*	*139*	406[g]	418[g]	*126*	377[e]	227
3	2,3,5,6,2′,5′	115–116	(252.4)	*133*	*146*		*146*	*133*	*154*			*137*		252
			260.0	*121*	*134*	417[e]	*134*	*121*	*142*	406[g]	417[g]	*128*	374[e]	232
4	2,4,6,2′	55–56	(224.3)	*138*		*148*		*138*	*155*					247
			227.0	*126*	410[e]	*135*	410[e]	*126*	*142*	420[f]	420[f]	420[f]	388[f]	229
5	2,3,5,6,2′,4′,6′	133–135	(266.4)	*133*	*142*		*142*	*133*	*133*		*133*		*133*	254
			264.0	*122*	*131*	401[e]	*131*	*122*	*122*	401[e]	*122*	401[e]	*122*	235
6	2,3,5,6,3′	72–73	(238.4)	*137*	*144*		*144*	*137*		*144*				260
			240.0	*124*	*131*	411[f]	*131*	*124*	411[f]	*131*	411[f]	411[f]	411[f]	240
7	2,3,5,6,4′	102–103	(238.4)											
			242.0	*124*	*132*	408[e]	*132*	*124*	408[h]	414[h]	*135*	414[h]	408[h]	240
8	2-Cl,2′,5′	140/0.3	(230.7)											
			235.0	. . .	434[f]	420[f]	420[f]	403[e]	*134*	412[f]	412[f]	*126*	403[f]	234
9	2′-Cl,4-Br,2,3,5,6	160–163	(337.7)											
			341.7	*126*	*145*	. . .	*145*	*126*	. . .	435[f]	418[f]	418[f]	390[f]	240
10	2′-F,4-Br,2,3,5,6	139–141	(321.2)											
			320.3	*130*	*146*	. . .	*146*	*130*	[i]	426[f]	416[f]	416[f]	393[f]	243
11	2,6-Cl_2,2′,5′	89–91	(265.2)											
			273.0	. . .	437[j]	423[j]	437[j]	. . .	*140*	405[k]	415[k]	*127*	372[e]	247

[a] Experimental details have been submitted for review and have been deposited with the ASIS Service. Data include: molar amounts of reagents, catalyst, and solvent; temperature and time of reaction; yield and crystallization; elemental analyses for carbon, hydrogen, and halogens. [b] Measured by V.P.O. in *o*-dichlorobenzene at 130° C. [c] ^1H chemical shifts measured in cps downfield from TMS as internal standard, at 60 MHz; values in the first row refer to spectra in $CHCl_3$ at 38° C; values in the second row refer to spectra in CCl_4 at 38° C (compound 10: spectrum in $CDCl_3$). [d] Values in italics denote methyl singlets. [e] Singlet. [f] Complex multiplet. [g] AB system: $J_{3'4'}$, 8 cps; $\Delta\nu/J \sim 1.4$. [h] AB system: $J_{2'3'}$ = 8 cps; $\Delta\nu/J \sim 0.75$. [i] ^{19}F spectrum: 63.9 ppm from $CFCl_3$ as internal standard, measured at 94 MHz, in $CDCl_3$ at 30° C. [j] AB_2 system: $J_{34'}$ = 8 cps; $\Delta\nu/J \sim 1.7$. [k] AB system: $J_{3'4'}$ = 7.5 cps; $\Delta\nu/J \sim 1.3$.

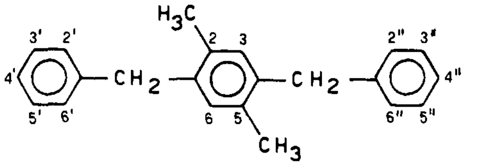
Table II. Derivatives of Dibenzylbenzene of General Formula[a]



N	Position of methyl groups in the side rings	Mp, °C	Mol wt[b] (calcd) found	H_2	H_3	H_5	H_6	$H_{2',2''}$	$H_{3',3''}$	$H_{4',4''}$	$H_{5',5''}$	$H_{6',6''}$	CH_2
				Nmr[c, d]									
1	2′,4′,2″,4″[e]	101–102	(314.5) 314.0	420[f]	420[f]	420[f]	420[f]	*137*	417[g]	*144*	417[g]	417[g]	246
2	2′,5′,2″,5″[e]	95–96	(314.5) 314.0	420[f]	420[f]	420[f]	420[f]	*140*	414[g]	414[g]	*145*	414[g]	248
3	2′,4′,6′,2″,4″,6″	165–166	(342.5) 342.3	416[f]	416[f]	416[f]	416[f]	*138*	407[f]	*143*	407[f]	*138*	252
4	2′,3′,5′,6′,2″,3″,5″,6″	210–211	(370.6) 368.2	416[f]	416[f]	416[f]	416[f]	*135*	*142*	408[f]	*142*	*135*	258
5	2′,3′,4′,5′,6′,2″,3″, 4″,5″,6″	278–279	(398.6) 396.0	416[f]	416[f]	416[f]	416[f]	*137*	*142*	*142*	*142*	*137*	256
6	2′,2″-Cl_2	87.5–88.5	(327.2) 322.7	421[f]	421[f]	421[f]	421[f]	. . .	430[g]	418[f]	418[f]	418	238
7	2′,6′-Cl_2,2″,6″-Cl_2	182–183	(396.1) 396.0	420[f]	420[f]	420[f]	420[f]	. . .	442[h]	428[h]	442[h]	. . .	255
8	4′,4″-Br_2,2′,3′,5′, 6′,2″,3″,5″,6″	250–251	(528.4) 526.1	418[f]	418[f]	418[f]	418[f]	*140*	*156*	. . .	*156*	*140*	256

[a] Experimental details have been submitted for review and have been deposited with the ASIS service. Data include: molar amounts of reagents, catalyst, and solvent; temperature and time of reaction; yield and crystallization; elemental analyses for carbon, hydrogen and halogens. [b] Measured by V.P.O. in *o*-dichlorobenzene at 130° C. [c] ^1H chemical shifts measured in cps downfield from TMS as internal standard at 60 MHz, in $CDCl_3$ at 38° C (compound 6 and 7 at 60° C). [d] Values in italics denote methyl singlets. [e] Reported recently also by Moshchinskaya and Karateev (*12*). [f] Singlet. [g] Complex multiplet. [h] AB_2 system: $J_{3',4'}$, 8 cps; $\Delta\nu/J \sim 1.7$.

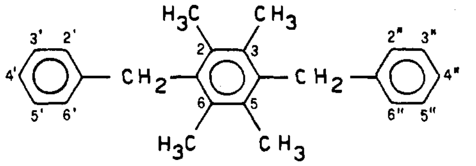
Table III. Derivatives of Dibenzylbenzene of General Formula^{a}



N	Position of methyl groups in the side rings	Mp, °C	Mol wt^{b} (calcd) found	Nmr^{c,d} H_2	H_3	H_5	H_6	$H_{2',2''}$	$H_{3',3''}$	$H_{4',4''}$	$H_{5',5''}$	$H_{6',6''}$	CH_2
1	2′,2″	110–111	(314.5) 312.0	*134*	404^{e}	*134*	404^{e}	*143*	423^{f}	423^{f}	423^{f}	423^{f}	245
2	2′,4′,2″,4″	157–158	(342.5) 343.7	*136*	396^{e}	*136*	396^{e}	*143*	410^{f}	*146*	410^{f}	410^{f}	244
3	2′,5′,2″,5″	152.5–153.5	(342.5) 341.0	*140*	397^{e}	*140*	397^{e}	*145*	410^{g}	418^{g}	*145*	397^{e}	247
4	2′,4′,6′,2″,4″,6″	292–294	(370.5) 371.6	*137*	378^{e}	*137*	378^{e}	*139*	414^{e}	*147*	414^{e}	*139*	242
5	2′,3′,5′,6′,2″3″,5″,6″	322–323	(398.6) 397.2	*140*	375^{e}	*140*	375^{e}	*132*	*145*	410^{e}	*145*	*132*	247
6	2′,3′,4′,5′,6′,2″,3″, 4″,5″,6″	370–372	(426.7) 425.5	^{h}									
7	2′-Cl,2″-Cl	131–133	(355.3) 357.0	*126*	406^{f}	*126*	406^{f}	. . .	436^{f}	423^{f}	423^{f}	406^{f}	238
8	2′,6′-Cl_2,2″,6″-Cl_2	282–284	(424.2) 418.4	*132*	374^{e}	*132*	374^{e}	. . .	442^{i}	428^{i}	442^{i}	. . .	247
9	4′-Br,4″-Br,2′,3′,5′, 6′,2″,3″,5″,6″	369–371	(556.4) 561.6	^{h}									

[a] Experimental details have been submitted for review and have been deposited with the ASIS Service. Data include: molar amounts of reagents, catalyst, and solvent; temperature and time of reaction; yield and crystallization; elemental analyses for carbon, hydrogen, and halogens. [b] Measured by V.P.O. in o-dichlorobenzene at 130° C. [c] ^{1}H chemical shifts measured in cps downfield from TMS as internal standard, at 60 MHz in $CDCl_3$ at 38° C (compound 7: spectrum in CCl_4 at room temperature; compound 8: in CCl_4 at 60° C; compound 5: in $CDCl_3$ at 60° C). [d] Values in italics denote methyl singlets. [e] Singlet. [f] Complex multiplet. [g] AB system: $J_{3'4'}$, 8 cps; $\Delta\nu/J \sim 1.7$. [h] Insoluble. [i] AB_2 system: $J_{3'4'}$, 8 cps; $\Delta\nu/J \sim 1.7$.

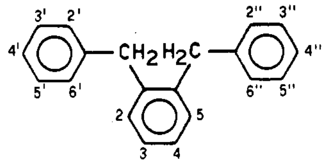
Table IV. Derivatives of Dibenzylbenzene of General Formula^{a}



N	Position of methyl groups in the side rings	Mp, °C	Mol wt^{b} (calcd) found	Nmr^{c,d} H_2	H_3	H_5	H_6	$H_{2',2''}$	$H_{3',3''}$	$H_{4',4''}$	$H_{5',5''}$	$H_{6',6''}$	CH_2
1	2′,2″	234–236	(342.5) 347.0	*136*	*136*	*136*	*136*	*156*	426^{e}	426^{e}	426^{e}	394^{e}	255
2	2′,4′,2″,4″	223–224	(370.6) 370.0	*136*	*136*	*136*	*136*	*153*	420^{f}	*136*	404^{g}	386^{g}	251
3	2′,5′,2″,5″	268–270	(370.6) 372.1	*138*	*138*	*138*	*138*	*154*	409^{h}	425^{h}	*136*	381^{f}	255
4	2′,4′,6′,2″,4″,6″	178–179	(398.6) 397.6	*130*	*130*	*130*	*130*	*133*	401^{f}	*142*	401^{f}	*133*	263
5	2′,3′,4′,5′,6′,2″,3″, 4″,5″,6″	293–295	(454.7) 449.1	^{i}									
6	4′-Br,4″-Br	216–217	(472.3) 463.6	*127*	*127*	*127*	*127*	411^{j}	438^{j}	. . .	438^{j}	411^{j}	243
7	4′-Cl,4″-Cl	212–213	(383.4) 388.6	*129*	*129*	*129*	*129*	411^{j}	429^{j}	. . .	429^{j}	411^{j}	246
8	2′,6′-Cl_2,2″,6″-Cl_2	233–235	(452.2) 450.3	*123*	*123*	*123*	*123*	. . .	433^{k}	419^{k}	433^{k}	. . .	260
9	2′-Cl,2″-Cl	194–196	(383.4) 383.3	*126*	*126*	*126*	*126*	. . .	440^{e}	423^{e}	423^{e}	395^{e}	246
10	4′,4″-Br_2-2′,3′,5′, 6′,2″,3″,5″,6″	303–305	(584.5) 586.0	*128*	*128*	*128*	*128*	*131*	*148*	. . .	*148*	*131*	269

[a] Experimental details have been submitted for review and have been deposited with the ASIS service. Data include: molar amounts of reagents, catalyst, and solvent; temperature and time of reaction, yield and crystallization; elemental analyses for carbon, hydrogen, and halogens. [b] Measured by V.P.O. in o-dichlorobenzene at 130° C. [c] ^{1}H chemical shifts measured in cps downfield from TMS as internal standard at 60 MHz, in $CDCl_3$ (compound 8: spectrum in CCl_4 at 60° C; compound 9: in CCl_4 at room temperature; compound 10: in $CDCl_3$ at 80° C). [d] Values in italics denote methyl singlets. [e] Complex multiplet. [f] Singlet. [g] AB system: $J_{5'6'}$, 4 cps; $\Delta\nu/J \sim 4.4$. [h] AB system: $J_{3'4'}$ = 7.5 cps; $\Delta\nu/J \sim 2.3$. [i] Insoluble. [j] AB system. [k] AB_2 system: $J_{3'4'}$, 8 cps; $\Delta\nu/J \sim 1.7$.

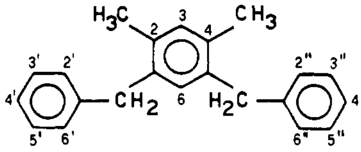
Table V. Derivatives of Dibenzylbenzene of General Formula[a]



N	Position of methyl groups in the side rings	Mp, °C	Mol wt[b] (calcd) found	Nmr[c, d]									
				H_2	H_3	H_4	H_5	$H_{2',2''}$	$H_{3',3''}$	$H_{4',4''}$	$H_{5',5''}$	$H_{6',6''}$	CH_2
1	2',4',2'',4''	79–81	(314.5) 311.0	420[e]	420[e]	420[e]	420[e]	*132*	420[e]	*140*	420[e]	420[e]	236
2	2',5',2'',5''	77–79	(314.5) 317.0	414[e]	414[e]	414[e]	414[e]	*126*	414[e]	414[e]	*130*	414[e]	228
3	2',3',5',6',2'',3'',5'',6''	226–228	(370.6) 370.1	389[f]	410[f]	410[f]	389[f]	*132*	*143*	408[g]	*143*	*132*	245
4	2',3',4',5',6',2'',3'', 4'',5'',6''	264–266	(398.6) 398.2	391[f]	412[f]	412[f]	389[f]	*131*	*143*	*150*	*143*	*131*	246
5	4',4''-Br$_2$-2',3',5', 6',2'',3'',5'',6''	316–318	(528.4) 520.1	390[f]	411[f]	411[f]	390[f]	*132*	*149*	. . .	*149*	*132*	245

[a] Experimental details have been submitted for review and have been deposited with the ASIS Service. Data include: molar amounts of reagents, catalyst, and solvent; temperature and reaction time; yield and crystallization; elemental analyses for carbon, hydrogen, and halogens. [b] Measured by V.P.O. in *o*-dichlorobenzene at 130° C. [c] ^1H chemical shifts measured in cps downfield from TMS as internal standard at 60 MHz, in $CDCl_3$ at 38° C (compound 5: spectrum at 60° C). [d] Values in italics denote methyl singlets. [e] Complex multiplet. [f] A_2B_2 system: estimated $\Delta\nu/J \sim 5$. [g] Singlet.

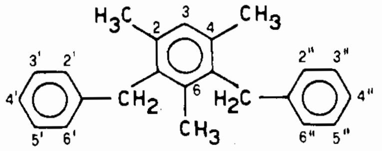
Table VI. Derivatives of Dibenzylbenzene of General Formula[a]



N	Position of methyl groups in the side rings	Mp, °C	Mol wt[b] (calcd) found	Nmr[c, d]									
				H_2	H_3	H_4	H_6	$H_{2',2''}$	$H_{3',3''}$	$H_{4',4''}$	$H_{5',5''}$	$H_{6',6''}$	CH_2
1		70–71	(286.4) 286.2	*137*	414[e]	*137*	430[f]	430[f]	430[f]	430[f]	430[f]	430[f]	250
2	2',2''	106–108	(314.5) 315.0	*139*	420[f]	*139*	389[e]	*139*	420[f]	420[f]	420[f]	420[f]	242
3	2',4',2'',4''	96–97	(342.5) 342.3	*138*	413[f]	*138*	387[e]	*135*	413[f]	*143*	413[f]	413[f]	239
4	2',5',2'',5''	98–99	(342.5) 343.0										
5	2',4',6',2'',4'',6''	201–202	(370.6) 371.5	*145*	408[e]	*145*	328[e]	*119*	394[e]	*145*	394[e]	*119*	233
6	2',3',5',6',2'',3'',5'',6''	181–182	(398.6) 389.6	*148*	418[e]	*148*	327[e]	*112*	*135*	403[e]	*135*	*112*	237
7	2',3',4',5',6',2'',3'', 4'',5'',6''	251–252	(426.7) 425.0	*150*	412[e]	*150*	328[e]	*115*	*132*	*142*	*132*	*115*	240
8	4',4''-Br$_2$,2',3',5', 6',2'',3'',5'',6''	328–330	(556.4) 559.0	*134*	412[e]	*134*	326[e]	*106*	*134*	. . .	*134*	*106*	217

[a] Experimental details have been submitted for review and have been deposited with the ASIS Service. Data include: molar amounts of reagents, catalyst, and solvent; temperature and reaction time; yield and crystallization; elemental analyses for carbon, hydrogen, and halogens. [b] Measured by V.P.O. in *o*-dichlorobenzene at 130° C. [c] ^1H chemical shifts measured in cps downfield from TMS as internal standard at 60 MHz, in $CDCl_3$ at 38° C (compound 8: spectrum at 60° C). [d] Values in italics denote methyl singlets. [e] Singlet. [f] Complex multiplet.

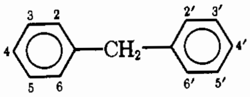
Table VII. Derivatives of Dibenzylbenzene of General Formula[a]



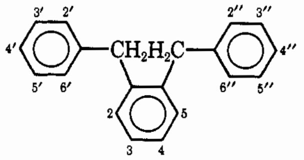
N	Position of methyl groups in the side rings	Mp, °C	Mol wt[b] (calcd) found	Nmr[c, d] H$_2$	H$_3$	H$_4$	H$_6$	H$_{2',2''}$	H$_{3',3''}$	H$_{4',4''}$	H$_{5',5''}$	H$_{6',6''}$	CH$_2$
1	2′,2″	137–139	(328.5) 327.0	*140*	412[e]	*140*	*125*	*153*	425[f]	425[f]	425[f]	391[f]	252
2	2′,4′,2″,4″	155–156	(356.6) 354.5	*140*	412[e]	*140*	*126*	*152*	420[e]	*144*	404[g]	386[g]	249
3	2′,5′,2″,5″	157–158	(356.6) 356.0	*141*	412[e]	*141*	*126*	*151*	406[h]	418[h]	*137*	378[e]	251
4	2′,4′,6′,2″,4″,6″	150–152	(384.6) 380.0	*135*	412[e]	*135*	*120*	*131*	412[e]	*140*	412[e]	*131*	255

[a] Experimental details have been submitted for review and have been deposited with the ASIS Service. Data include: molar amounts of reagents, catalyst, and solvent; temperature and reaction time; yield and crystallization; elemental analyses for carbon, hydrogen, and halogens. [b] Measured by V.P.O. in *o*-dichlorobenzene at 130° C. [c] ^{1}H chemical shifts measured in cps downfield from TMS as internal standard at 60 MHz, in CDCl$_3$ at 38° C. [d] Values in italics denote methyl singlets. [e] Singlet. [f] Complex multiplet. [g] AB system: $J_{5'6'}$ = 4 cps; $\Delta\nu/J \sim 4.5$. [h] AB system: $J_{3'4'}$, 8 cps; $\Delta\nu/J \sim 1.4$.

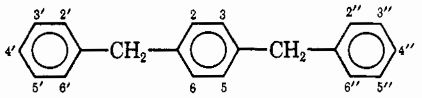
Table VIII. Nmr Data of Some Diphenylmethane and Dibenzylbenzene Derivatives[a]



N	Position of methyl groups	H$_2$	H$_3$	H$_4$	H$_5$	H$_6$	H$_{2'}$	H$_{3'}$	H$_{4'}$	H$_{5'}$	H$_{6'}$	CH$_2$	Ref.
1	2[b]	*144*										250	(*15*)
		124	427[c]	427[c]	427[c]	427[c]	427[c]	427[c]	427[c]	427[c]	427[c]	229	
2	4[b]			*144*								247	(*15*)
		422[d]	422[d]	*130*	422[d]	422[d]	430[c]	430[c]	430[c]	430[c]	430[c]	230	
3	2,4,6[b]	*140*		*145*		*140*						255	(*6*)
		125	407[d]	*129*	407[d]	*125*	423[c]	423[c]	423[c]	423[c]	423[c]	236	
4	2,4,6,4′[b]	*141*		*145*		*141*			*145*			254	(*10*)
		128	407[d]	*134*	407[d]	*128*	410[e]	416[e]	*134*	416[e]	410[e]	239	
5	2,4,6,2′,4′,6′[b]	*133*		*142*		*133*	*133*		*142*		*133*	255	(*17*)
		121	401[d]	*130*	401[d]	*121*	*121*	401[d]	*130*	401[d]	*121*	236	
6	2,5,2′,5′[b]	*143*			*143*		*143*			*143*		245	(*7*)
		132	411[f]	419[f]	*132*	399[d]	*132*	411[f]	419[f]	*132*	399[d]	226	
7	2,3,5,6,2′[b]	*132*	*145*		*145*	*132*	*156*					252	(*4*)
		121	*133*	410[d]	*133*	*121*	*144*	420[c]	420[c]	420[c]	386[c]	233	
8	2,3,5,6,2′,3′,5′,6′[b]	*129*	*142*		*142*	*129*	*129*	*142*		*142*	*129*	268	(*17*)
		117	*129*	404[d]	*129*	*117*	*117*	*129*	404[d]	*129*	*117*	245	
9	2-Cl[g]	. . .	427[c]	427[c]	427[c]	427[c]	427[c]	427[c]	427[c]	427[c]	427[c]	245	(*1*)
10	2-F[g]	[h]	428[c]	428[c]	428[c]	428[c]	428[c]	428[c]	428[c]	428[c]	428[e]	240	(*1*)



N	Position of methyl groups	H$_2$	H$_3$	H$_4$	H$_5$	H$_{2',2''}$	H$_{3',3''}$	H$_{4',4''}$	H$_{5',5''}$	H$_{6',6''}$	CH$_2$	Ref.
11	[g]	427[c]	427[c]	427[c]	427[c]	427[c]	427[c]	427[c]	427[c]	427[c]	235	(*16*)
12	2′,4′,6′,2″,4″,6″[g]	396[i]	414[i]	414[i]	396[i]	*130*	412[d]	*138*	412[d]	*130*	240	(5)



N	Position of methyl groups	H$_2$	H$_3$	H$_5$	H$_6$	H$_{2',2''}$	H$_{3',3''}$	H$_{4',4''}$	H$_{5',5''}$	H$_{6',6''}$	CH$_2$	Ref.
13	2,5[g]	*137*	425[c]	*137*	425[c]	425[c]	425[c]	425[c]	425[c]	425[c]	250	(2)
14	2,3,5,6[g]	*139*	*139*	*139*	*139*	420[c]	420[c]	420[c]	420[c]	420[c]	266	(3)
15	2,3,5,6,2′,3′,5′,6′,2″,3″,5″,6″[g]	*130*	*130*	*130*	*130*	*128*	*142*	404[d]	*142*	*128*	267	(9)

[a] ^{1}H chemical shifts measured in cps downfield from TMS as internal standard at 60 MHz. [b] First row: spectrum in CHCl$_3$ at 38° C; second row: spectrum in CCl$_4$ at 38° C. [c] Complex multiplet. [d] Singlet. [e] AB system: $J_{2'3'}$, 8 cps; $\Delta\nu/J \sim 0.75$. [f] AB system: J_{34}, 8 cps; $\Delta\nu/J \sim 10$. [g] Spectrum in CDCl$_3$ at 38° C. [h] ^{19}F spectrum: 64.5 ppm from CFCl$_3$ as internal standard, measured at 94 MHz, in CDCl$_3$ at 30° C. [i] A$_2$B$_2$ system: estimated $\Delta\nu/J \sim 5$.

because the *ortho* aromatic protons of some compounds are found several cps (15–40) upfield with respect to the other (*meta* and *para*) protons.

In fact, when the shielded *ortho* protons belong to 1,2-disubstituted central ring—i.e., Table V: compounds 3–5—the four central nuclear protons show the characteristic pattern of the A_2B_2 system and $\Delta\nu/J$ values were then estimated according to standard procedures (*8*).

In another case, when the shielded *ortho* protons belong to a 1,2-disubstituted side ring—i.e., Table I: compounds 4, 8–10—they appear shifted upfield in the spectrum.

As far as the assignments of methyl signals are concerned, they were usually assigned on the basis of the relative peak intensities. Where this criterion proved insufficient because of the presence of peaks of equal intensity, opportune correlation maps were built up using, as references, compounds in which methyl peaks were unequivocally assigned.

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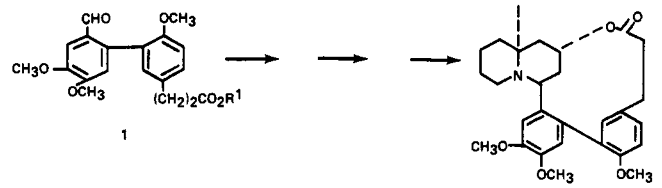
Synthesis of Biphenyl Portion of Decinine

BENJAMIN BLANK[1] and PRAFUL D. VAIDYA
Research and Development Division, Smith Kline & French Laboratories, Philadelphia, Pa. 19101

The syntheses and characterization of intermediates leading to 3-[3-(2-formyl-4,5-dimethoxyphenyl)-4-methoxyphenyl] propionic acid (1a), a possible precursor in the total synthesis of decinine methyl ether, are described.

The Lythraceae alkaloids have been of continuing interest to our laboratories—first, as problems in structure determination (*10, 11, 14, 37*) and, more recently, as structures with possible medicinal utility as anti-inflammatory (*25*) and diuretic agents (*36*).

In recent years (*3, 10, 14, 16, 17, 21, 37*), not only have the structures of several of these quinolizidine alkaloids been elucidated, but Ferris et al. (*15*) have proposed a possible biogenetic route for their syntheses. Subsequently, Matsunaga et al. (*26*) demonstrated the chemical feasibility of forming 2-oxo-4-quinolizidines from benzaldehyde and isopelletierine. Recently, Rosazza et al. (*31*) described a synthesis of Lythraceae alkaloids which required only a convenient method for forming the biphenyl linkage found in several members of this family of alkaloids—e.g., decinine, 2—in order to be considered a total synthesis. Therefore, the preparation of biphenyls—e.g., 1—containing substituents which could be used in the preparation of decinine, 2 is described.



1

The synthesis of 1 was undertaken as shown in Chart I. The intermediates used in this synthesis are new, and are listed in Table I, together with appropriate physical constants.

3,4-Dimethoxyphenylacetone was prepared from 3,4-dimethoxyphenylacetic acid and acetic anhydride. In our hands, attempts to prepare the acetone from 3,4-dimethoxyphenylacetonitrile via the acetoacetonitrile (*33*) led chiefly to the recovery of unchanged dimethoxyphenylacetoacetonitrile. Ring closure of the acetone with nitromalondialdehyde (*13*), to give 3, was effected in aqueous base (*4, 6, 22–24*). Etherification to give the methyl ether,

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[1] To whom correspondence should be addressed.