

Electronic Supplementary Information

Bis(ammonium) ionic liquids with herbicidal anions

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Figure S1. ^1H NMR spectrum of **1a** (dodecamethylene-1,12-bis(dimethyldecylammonium) di[2-(4-chloro-2-methylphenoxy)propionate]).

```

expt std1h
SAMPLE           DEC. & VT
date   Jan 19 2013 dfrq 300.070
solvent    dmso    dn   H1
file     exp      dpwr 30
ACQUISITION      dof  0
sfrq   300.071    dm   nnn
tn      H1        dmm  c
at      3.500     dmf  200
np      32542     wfile
sw      4649.0    proc
tb      2600      fn   ft
ts      1          not used
tpwr   56
pw      7.0       werr
d1      1.000    wexp
tof     526.0    wbs
nt      64        wnt
ct      64
alock   n
gain    not used
FLAGS
i1      n
in      n
dp      y
DISPLAY
sp      -20.7
wp      2678.5
vs      181
sc      0
wc      250
hzmm   10.71
is      722.01
rf1    300.2
rfp    0
th      1
ins    100.000
nm no ph

```

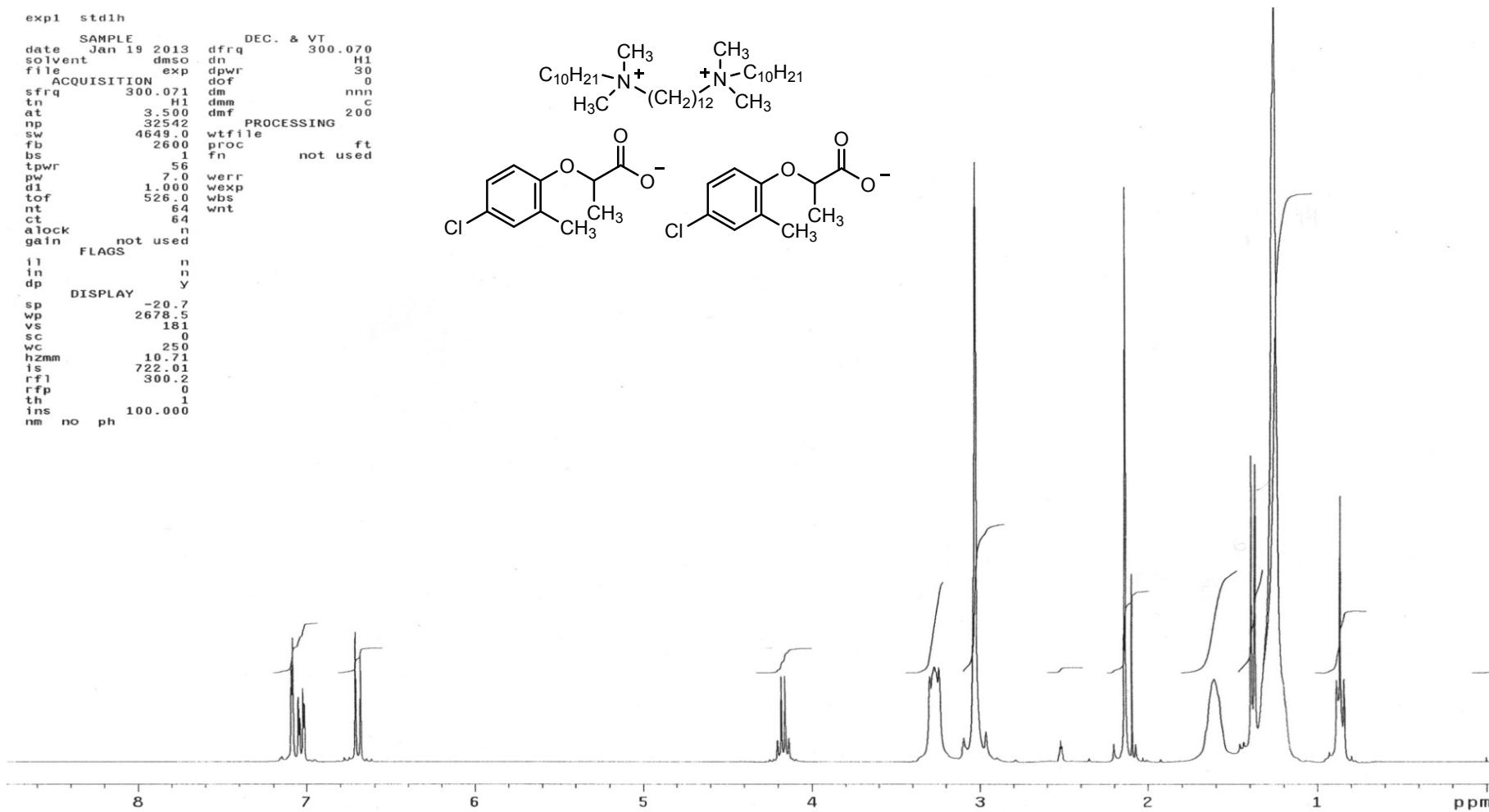
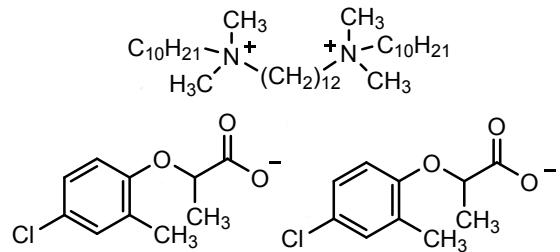


Figure S2. ^{13}C NMR spectrum of **1a** (dodecamethylene-1,12-bis(dimethyldecylammonium) di[2-(4-chloro-2-methylphenoxy)propionate]).

```

exp2 s2pul
SAMPLE Jan 19 2013 dfrq DEC. & VT 300.070
solvent dmso dn H1
file exp dpwr 40
ACQUISITION dof 0
sfrq 75.461 dm vyy
tn C13 dmm w
at 0.640 dmf 12000
np 24432 PROCESSING
sw 19084.0 lb 1.00
fb 10600 wfile ft
bs 4 proc
tpwr 61 fn 65536
pw 7.0
d1 0.500 werr
tof 1452.2 wexp
nt 16384 wbs
ct 924 wnt
alock n
gain not used
FLAGS
i1 n
in n
dp y
DISPLAY
sp -231.6
wp 15551.0
vs 182
sc 0
wc 250
hzmm 62.20
fs 178.34
rf1 3957.5
rfp 2980.4
th 10
ins 100.000
ai ph

```

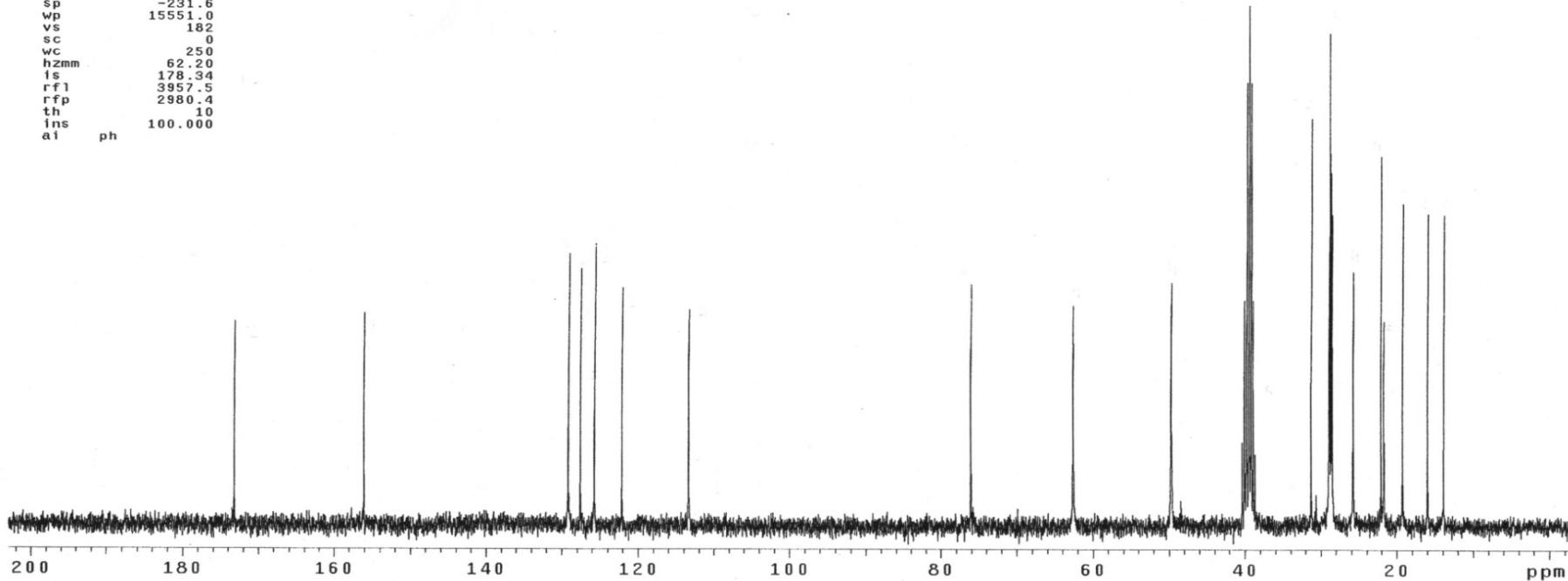
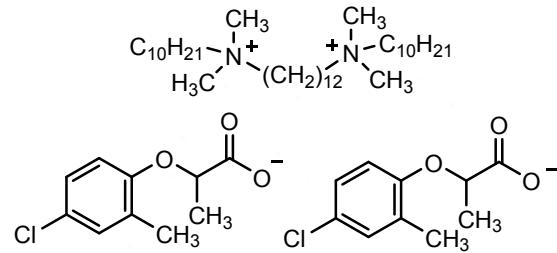


Figure S3. ^1H NMR spectrum of **1b** (dodecamethylene-1,12-bis(dimethyldecylammonium) di[3,6-dichloro-2-methoxybenzoate]).

```

expt  std1h
date  Jan 18 2013  DEC. & VT  300.070
solvent dmso    dfrq   H1
file    exp     dn      30
        ACQUISITION  dof    0
sfrq   300.071  dm      nnn
tn     H1       dmm    c
at     3.500   dmf    200
np     32542   PROCESSING
sw     4649.0  wfile   ft
fb     2600    proc    not used
bs     1        fn
tpwr   56      werr
pw     7.0     wexp
d1     1.000   wbs
tof    526.0   wnt
nt     64
ct     64
alock  n
gain   not used
FLAGS
i1     n
in     n
dp     y
DISPLAY
sp     -71.5
wp     3096.2
vs     195
sc     0
wc     250
hzmm  12.38
is     720.58
rf1    300.5
rfp    0
th    1
ins   no
nm   ph 100.000

```

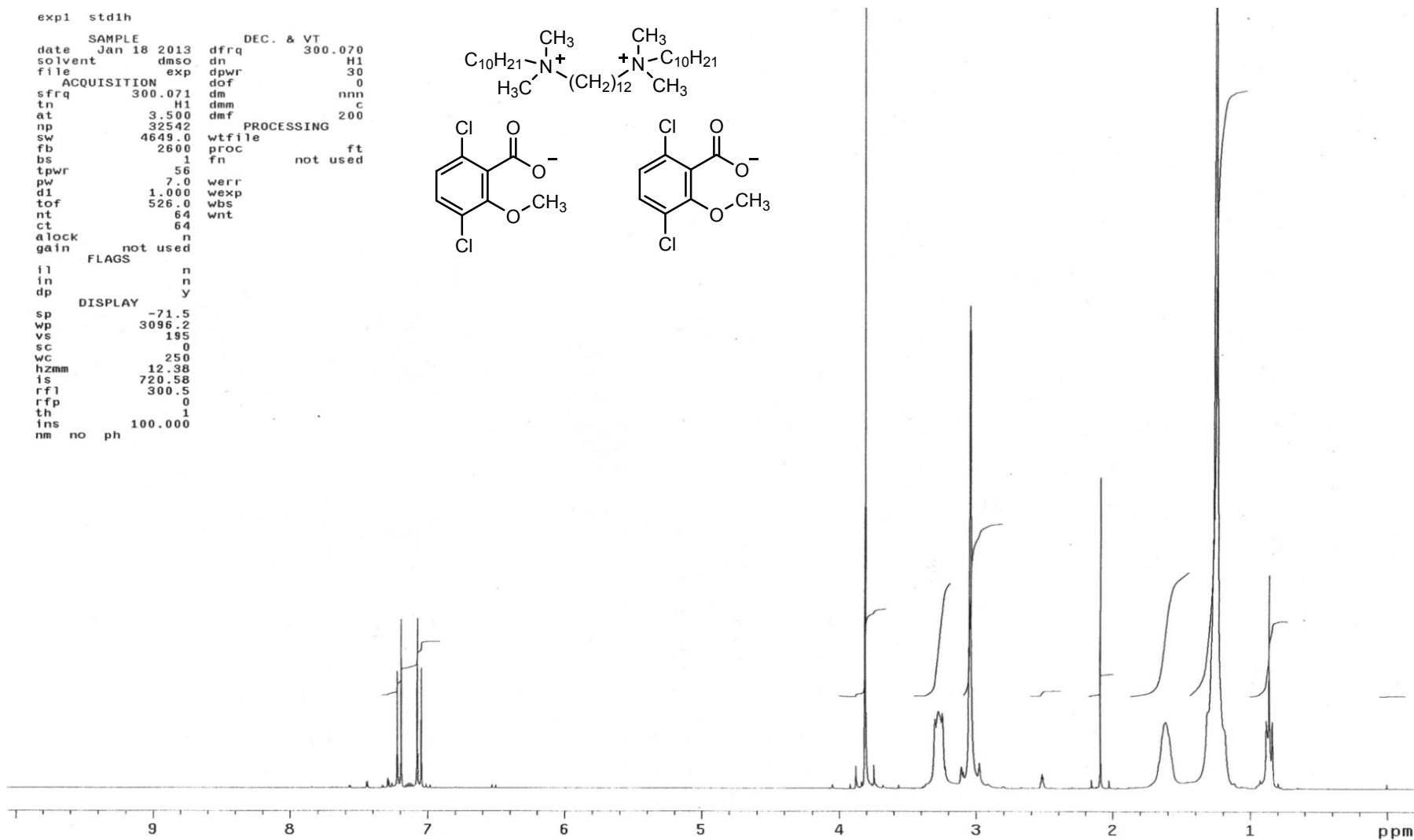
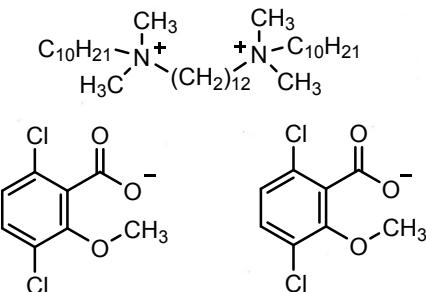


Figure S4. ^{13}C NMR spectrum of **1b** (dodecamethylene-1,12-bis(dimethyldecylammonium) di[3,6-dichloro-2-methoxybenzoate]).

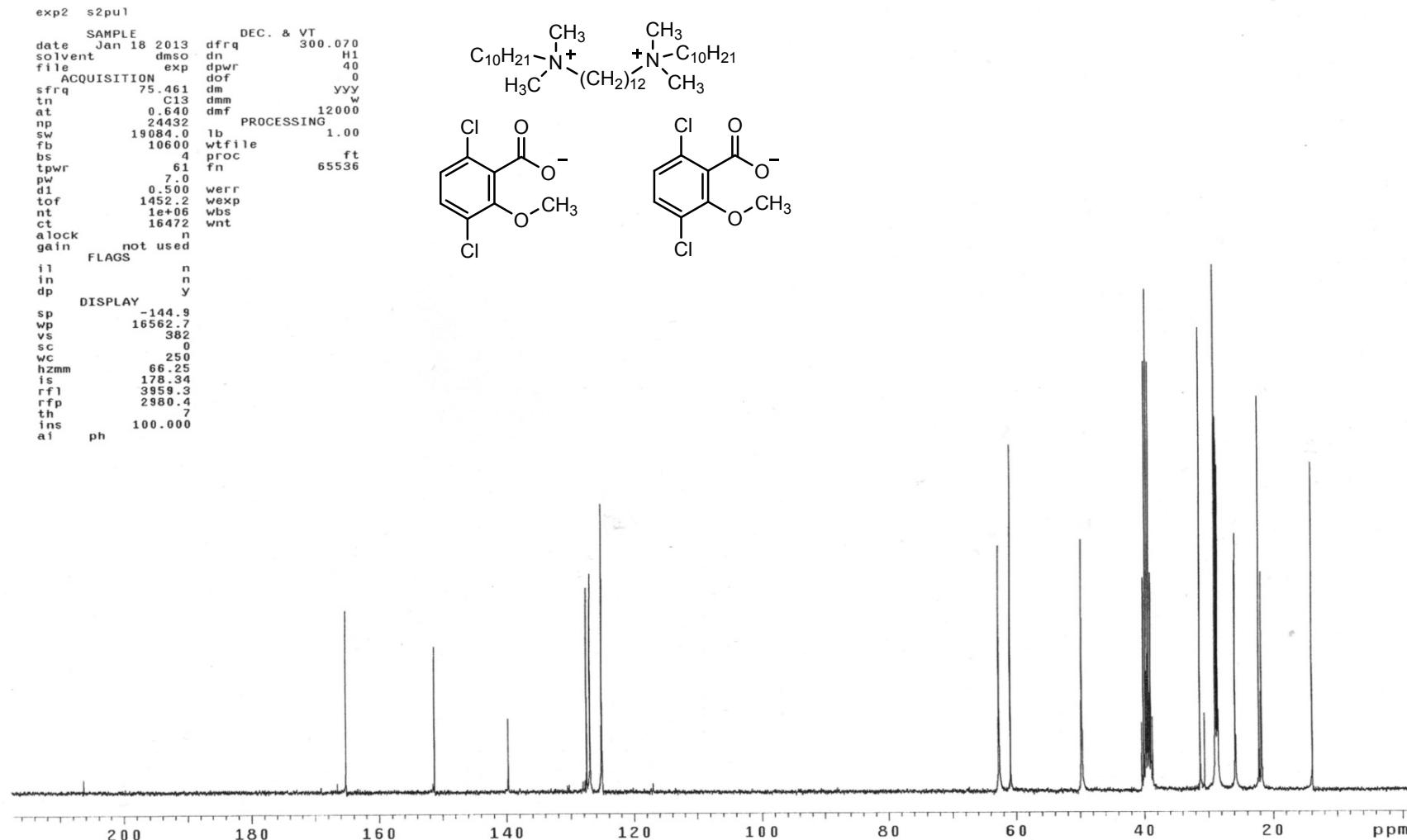


Figure S5. ^1H NMR spectrum of **2a** (oxybis(ethylene)bis(dimethyldecylammonium) di[2-(4-chloro-2-methylphenoxy)propionate]).

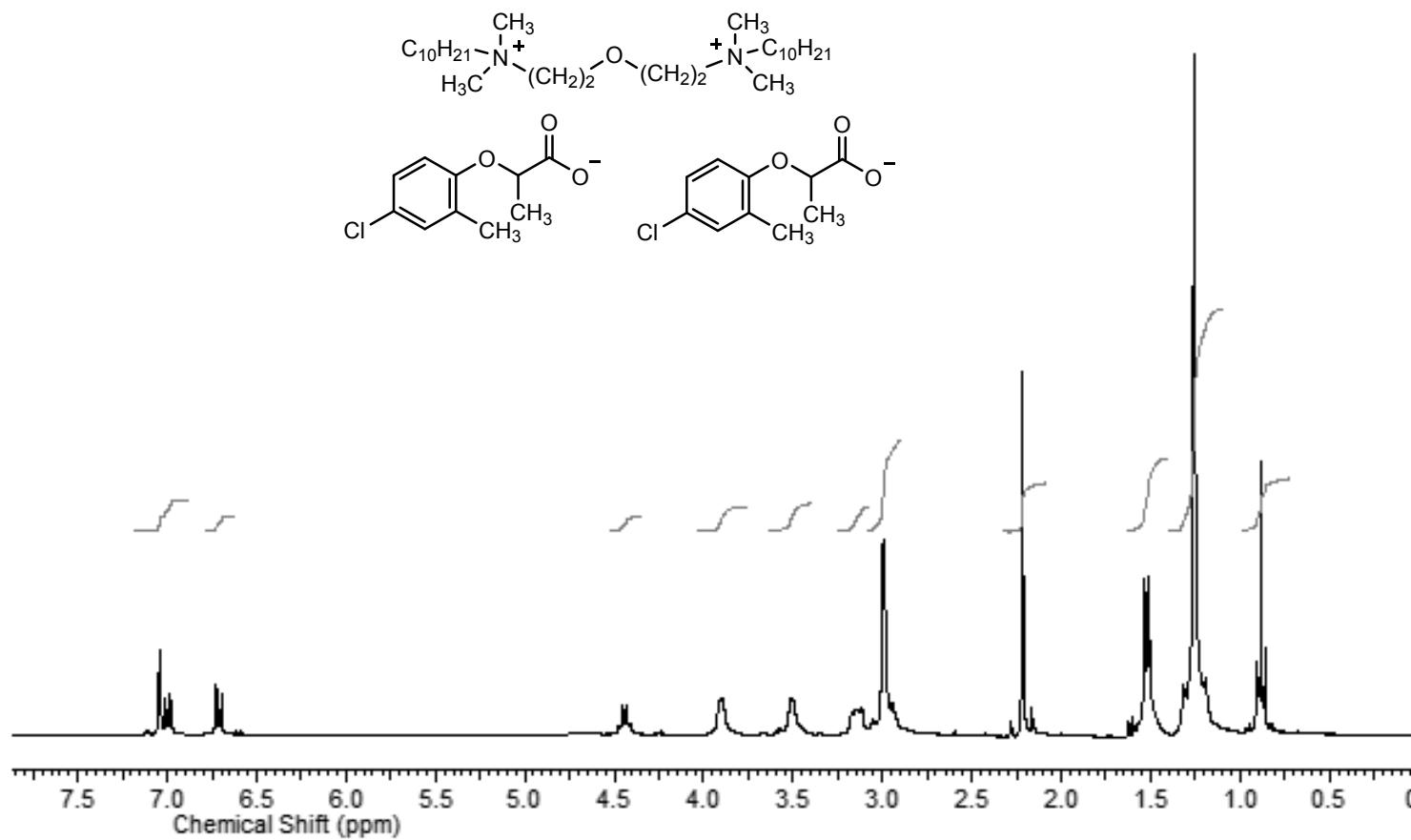


Figure S6. ^{13}C NMR spectrum of **2a** (oxybis(ethylene)bis(dimethyldecylammonium) di[2-(4-chloro-2-methylphenoxy)propionate]).

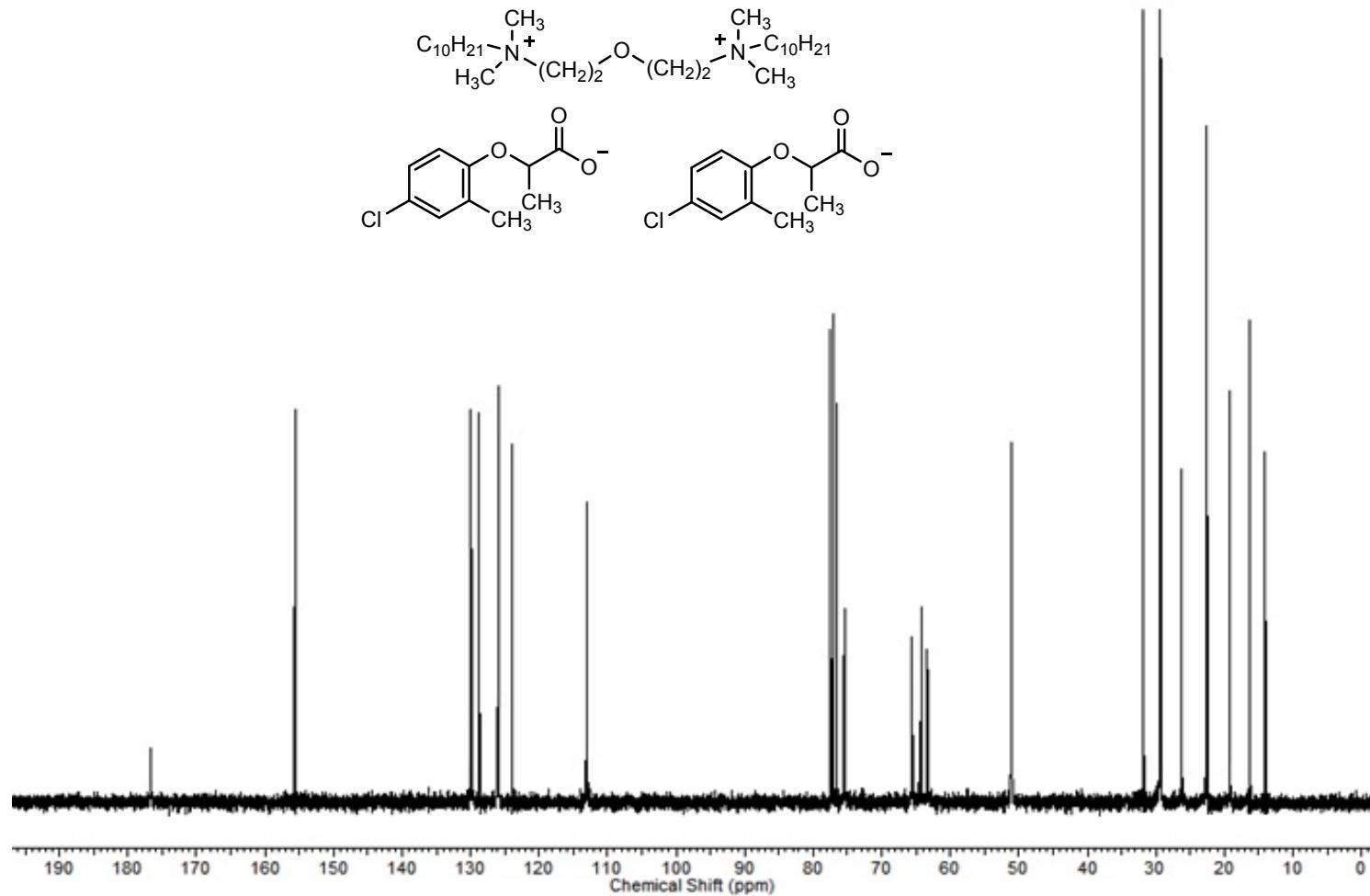


Figure S7. ^1H NMR spectrum of **2b** (oxybis(ethylene)bis(dimethyldecylammonium) di[3,6-dichloro-2-methoxybenzoate]).

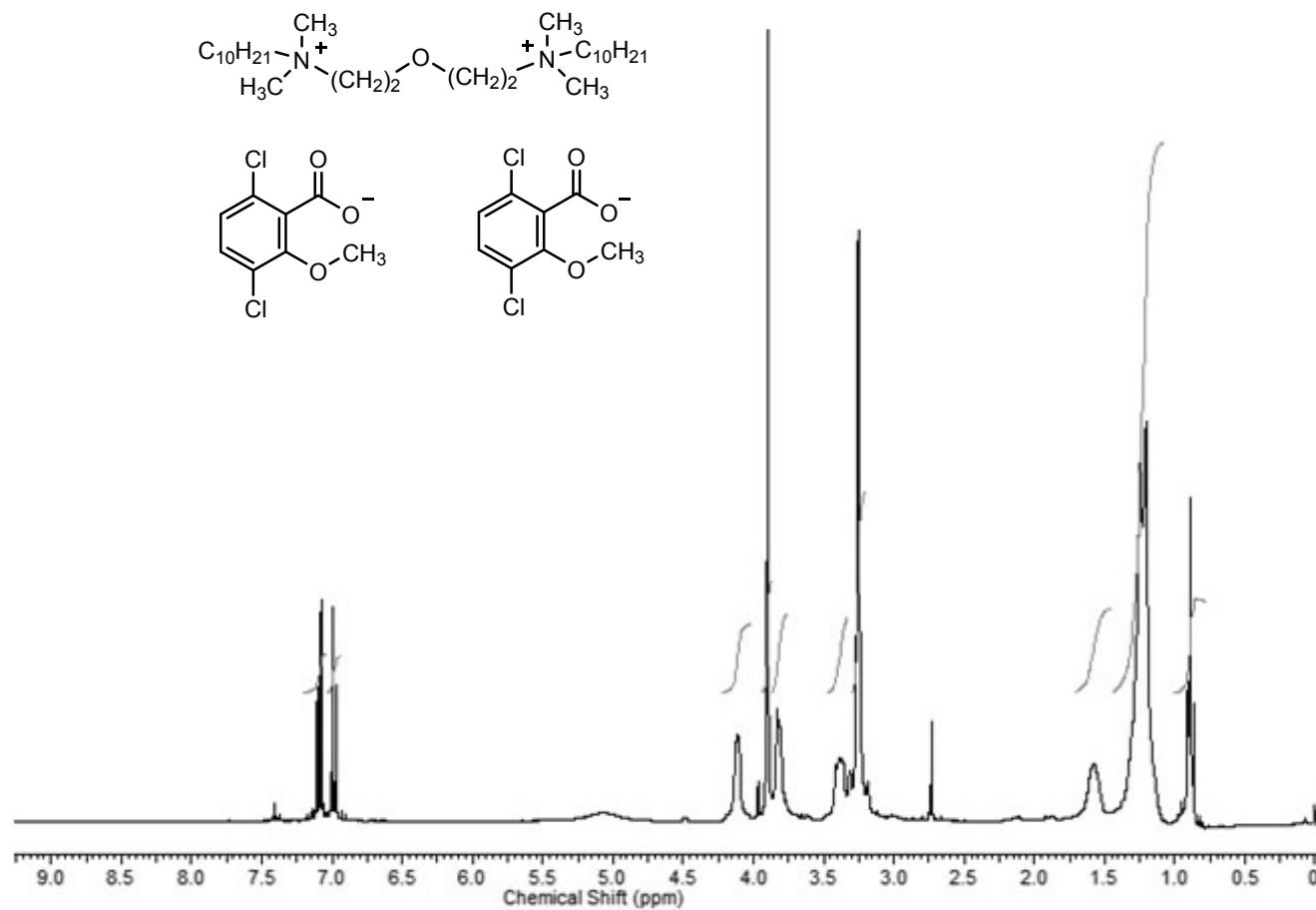


Figure S8. ^{13}C NMR spectrum of **2b** (oxybis(ethylene)bis(dimethyldecylammonium) di[3,6-dichloro-2-methoxybenzoate]).

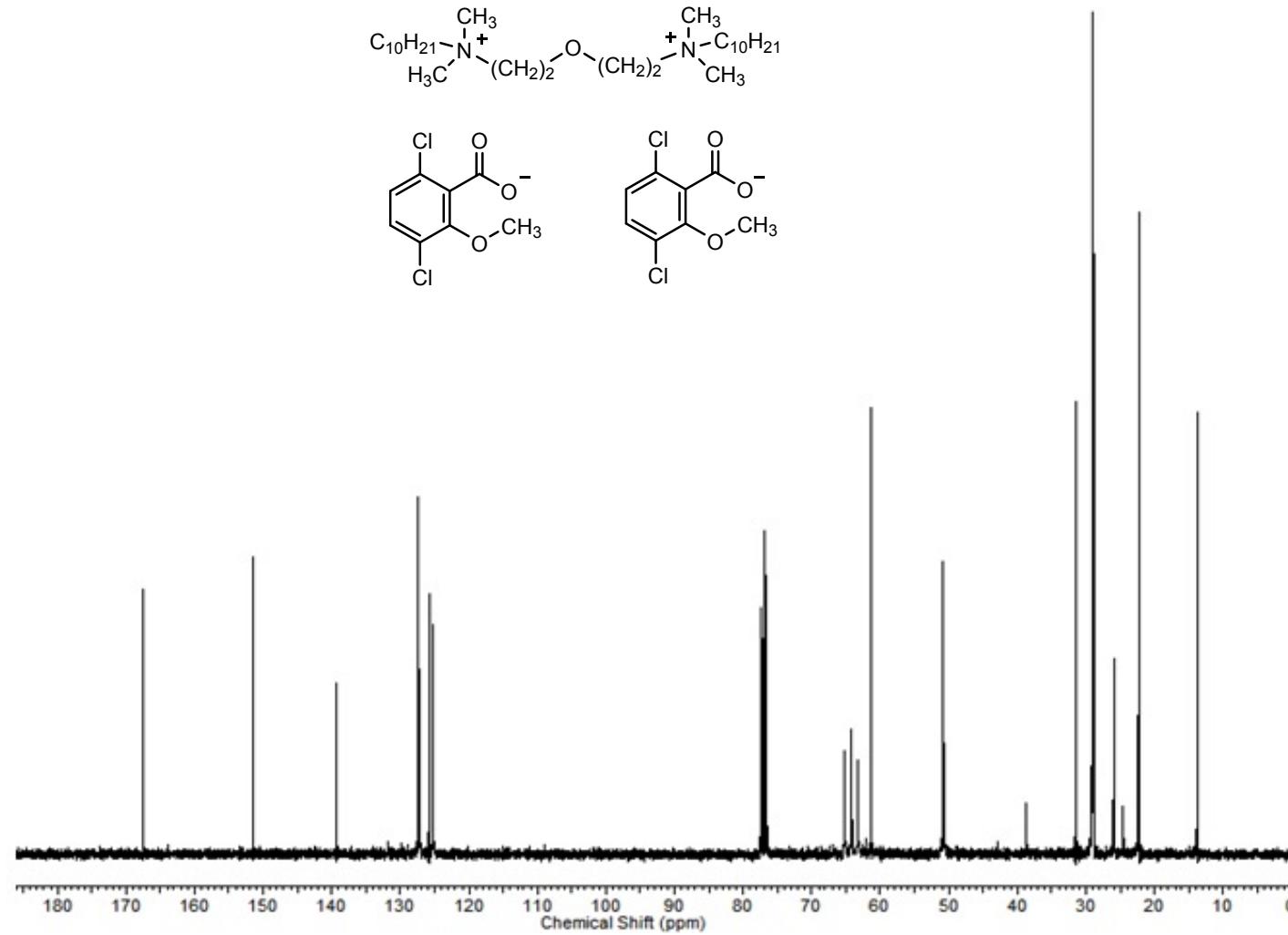


Figure S9. ^1H NMR spectrum of **2c** (oxybis(ethylene)bis(dimethyldecylammonium) di[(4-chloro-2-methylphenoxy)acetate]).

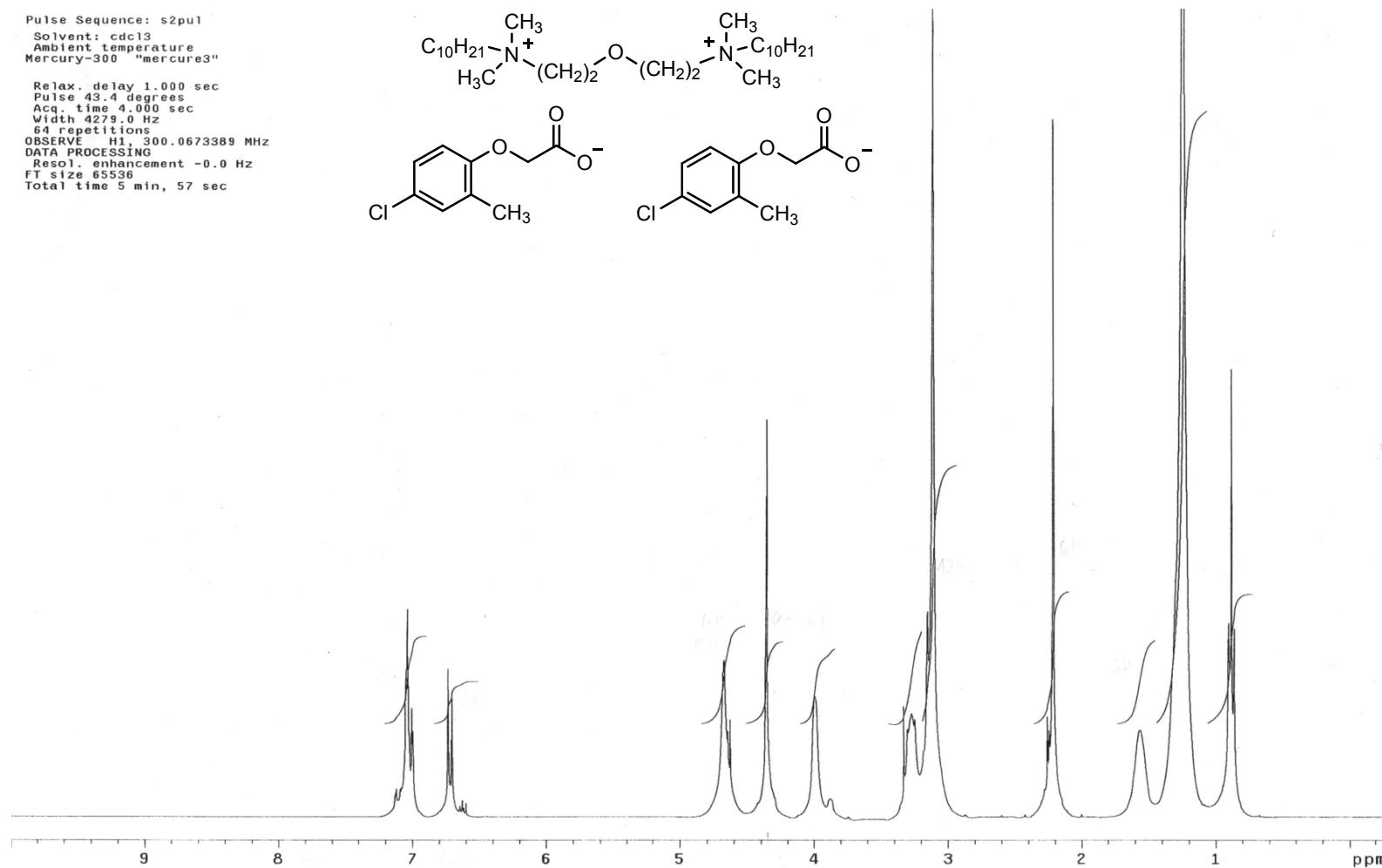


Figure S10. ^{13}C NMR spectrum of **2c** (oxybis(ethylene)bis(dimethyldecylammonium) di[(4-chloro-2-methylphenoxy)acetate]).

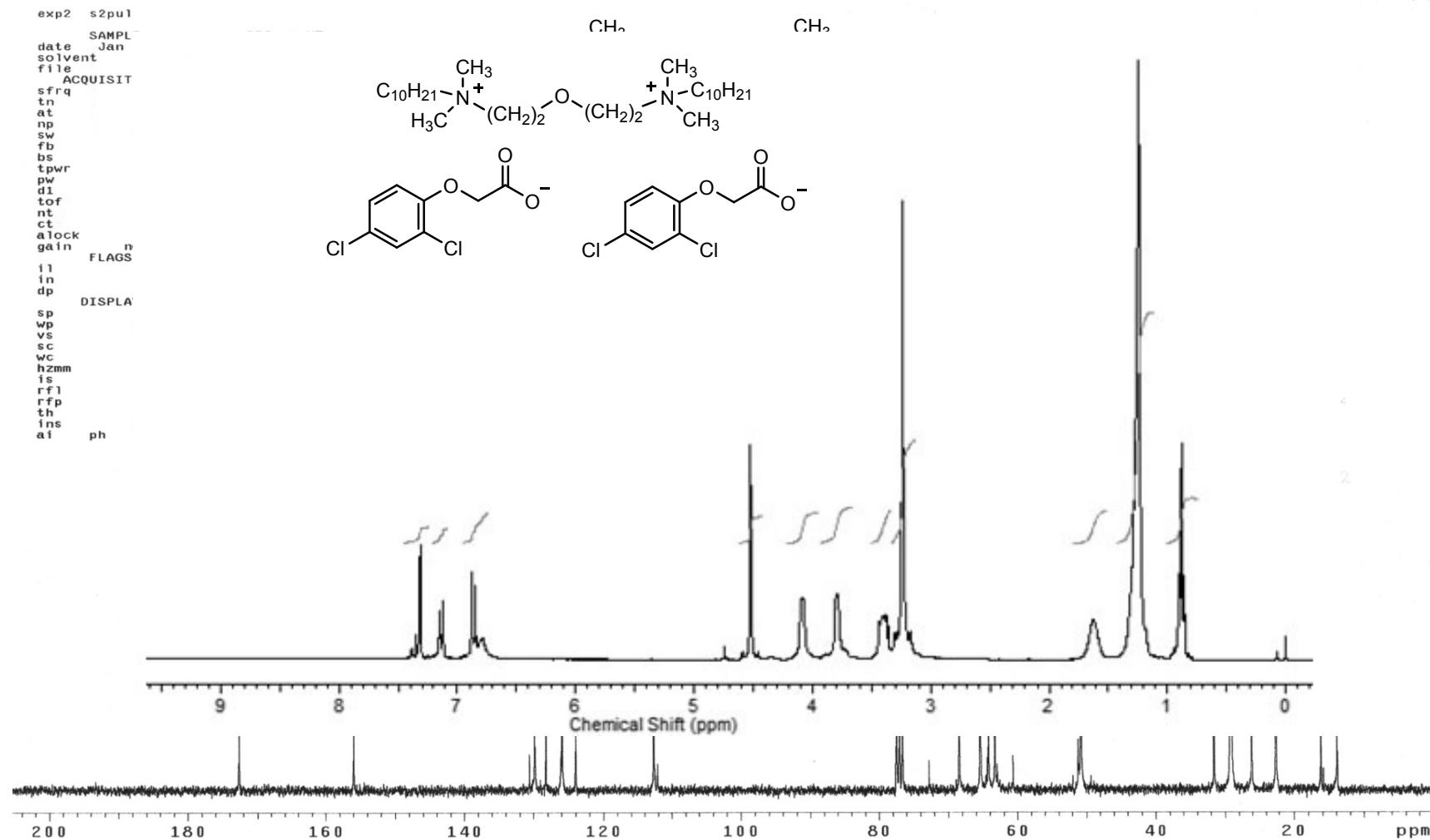


Figure S11. ^1H NMR spectrum of **2d** (oxybis(ethylene)bis(dimethyldecylammonium) di[(2,4-dichlorophenoxy)acetate]).

Figure S12. ^{13}C NMR spectrum of **2d** (oxybis(ethylene)bis(dimethyldecylammonium) di[(2,4-dichlorophenoxy)acetate]).

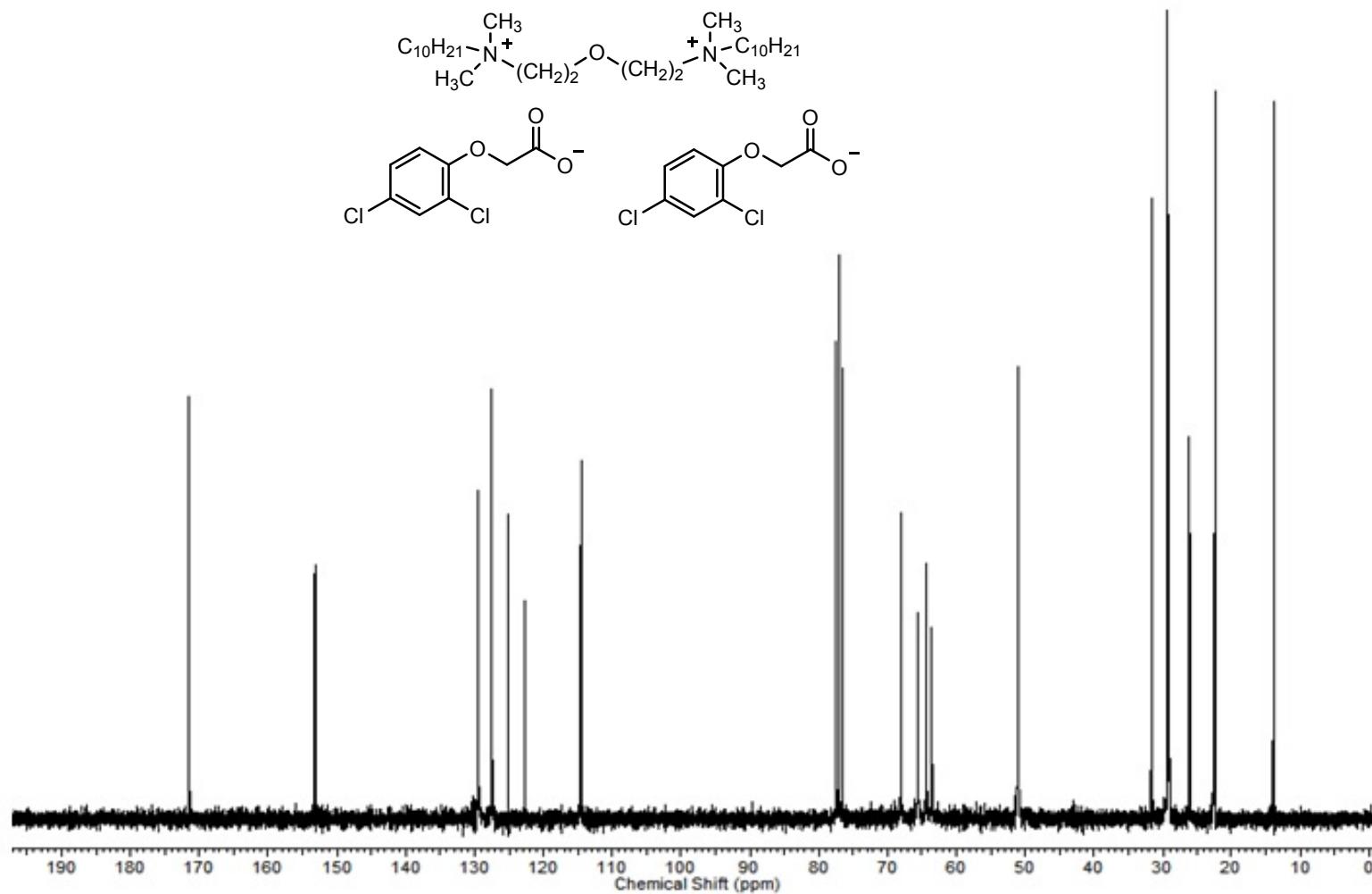


Figure S13. ^1H NMR spectrum of **3a** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[2-(4-chloro-2-methylphenoxy)propionate]).

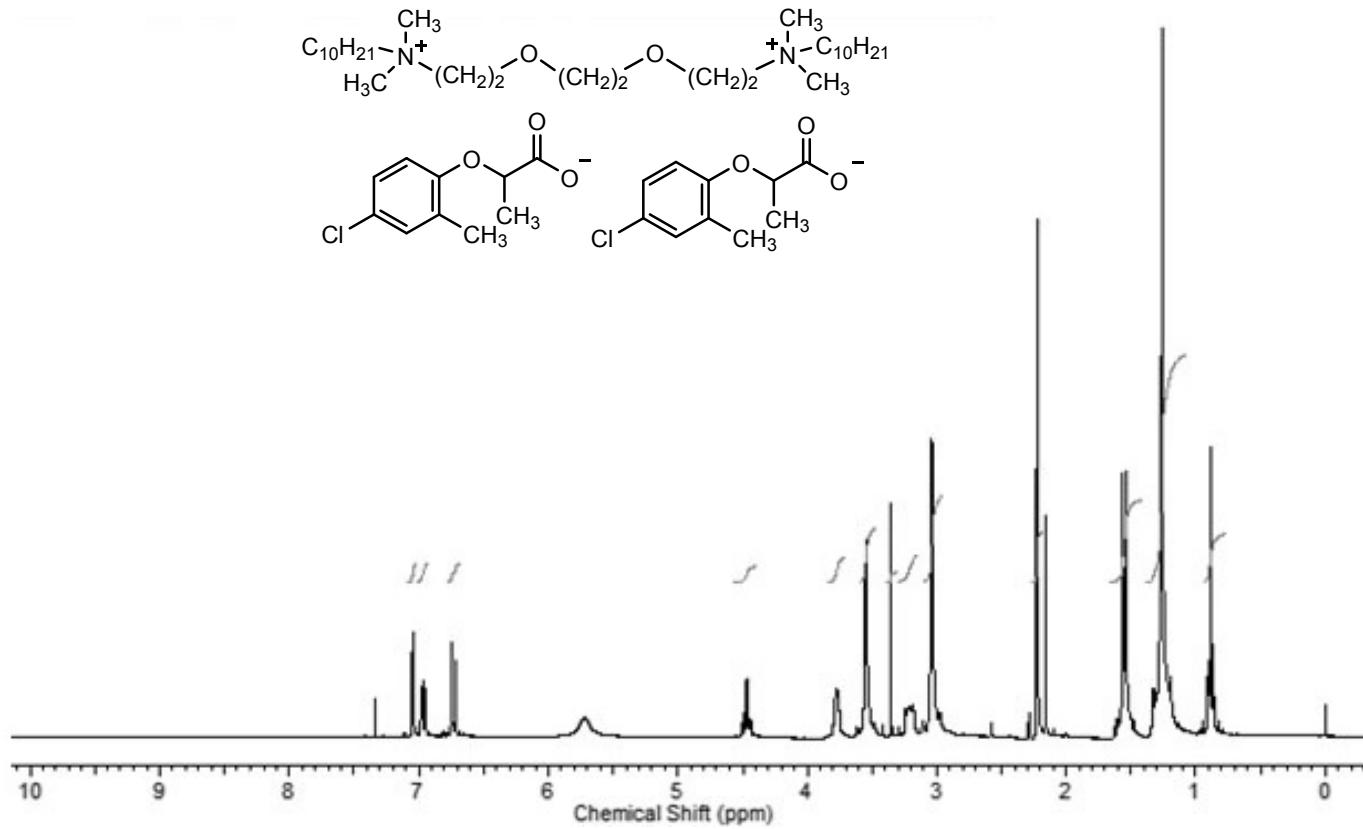


Figure S14. ^{13}C NMR spectrum of **3a** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[2-(4-chloro-2-methylphenoxy)propionate]).

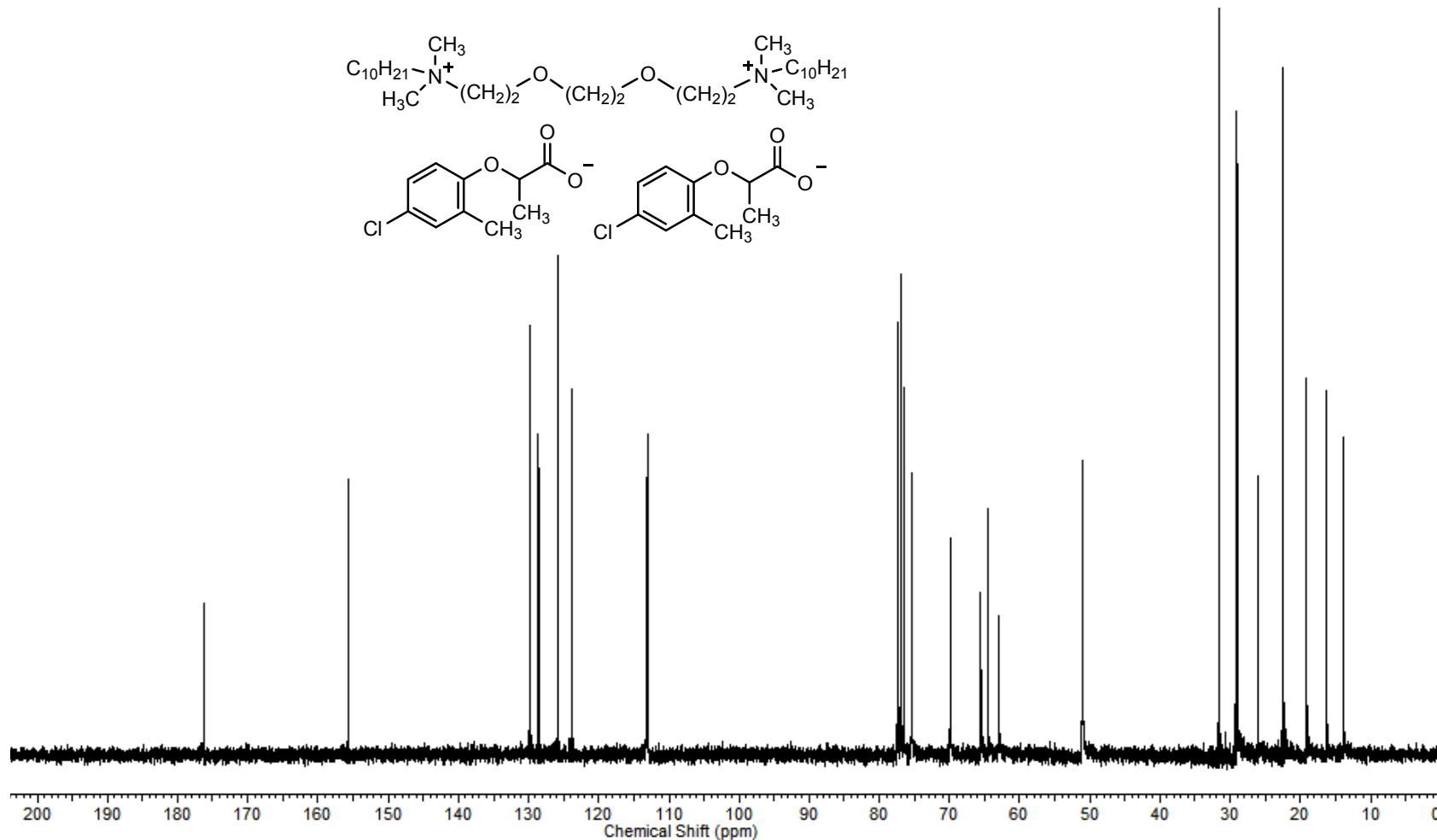


Figure S15. ^1H NMR spectrum of **3b** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[3,6-dichloro-2-methoxybenzoate]).

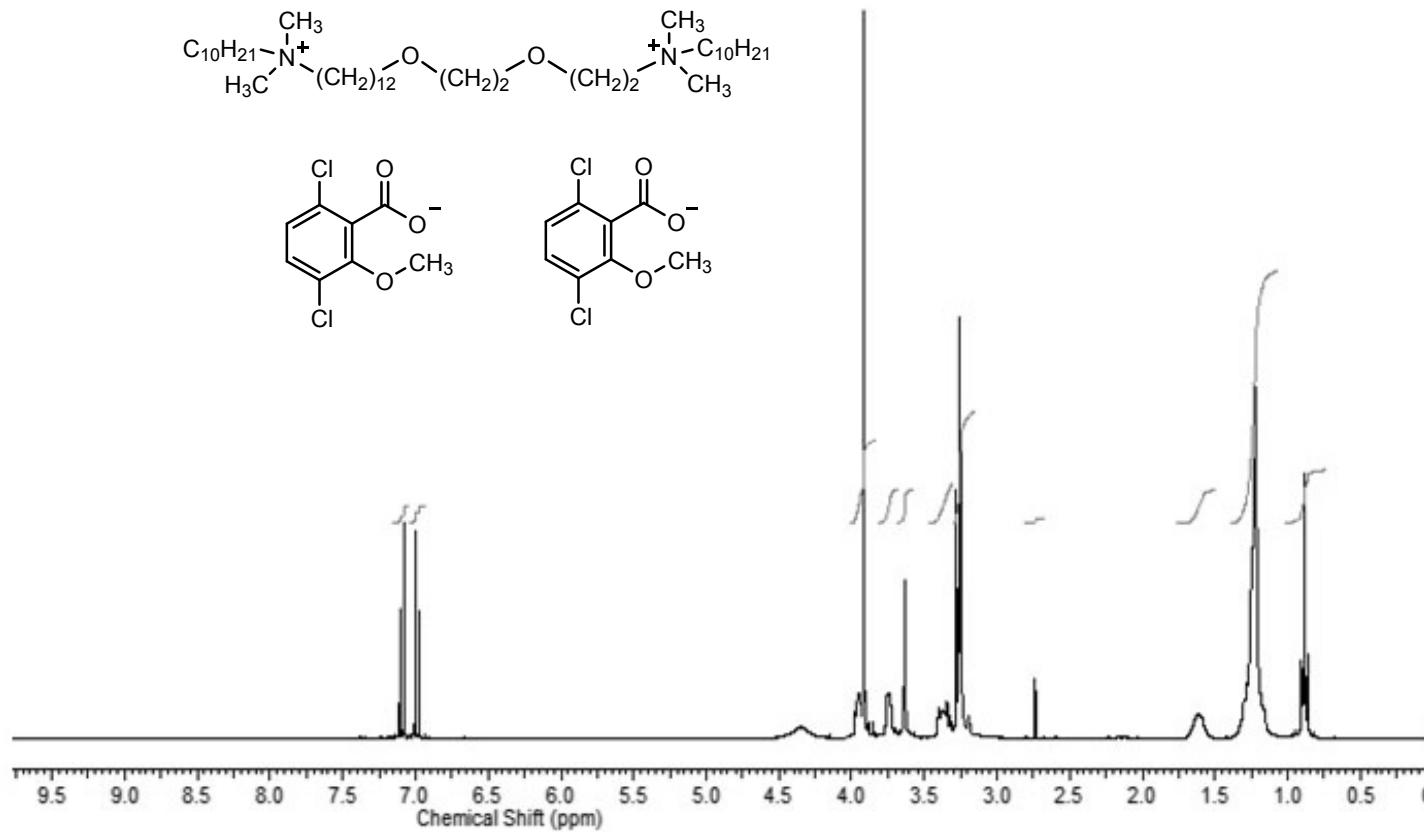


Figure S16. ^{13}C NMR spectrum of **3b** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[3,6-dichloro-2-methoxybenzoate]).

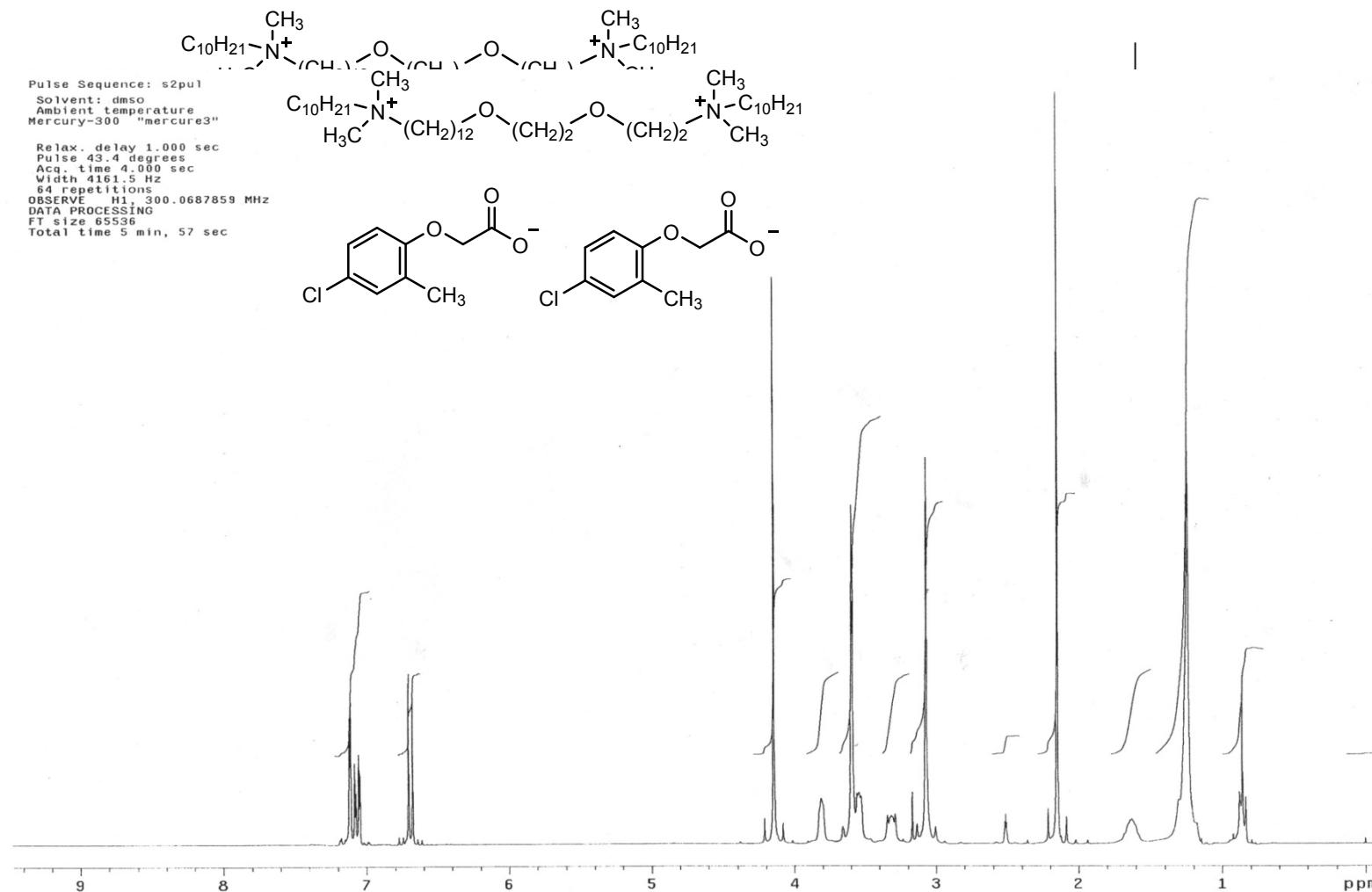


Figure S17. ^1H NMR spectrum of **3c** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[(4-chloro-2-methylphenoxy)acetate]).

Figure S18. ^{13}C NMR spectrum of **3c** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[(4-chloro-2-methylphenoxy)acetate]).

```

Pulse Sequence: s2pul
Solvent: dmso
Ambient temperature
Mercury-300 "mercure3"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 8.000 sec
Width 15898.3 Hz
1324 repetitions
OBSERVE C13, 75.4523920 MHz
DECOUPLE H1, 300.0702830 MHz
Power 40 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 65536
Total time 712 hr, 3 min, 14 sec

```

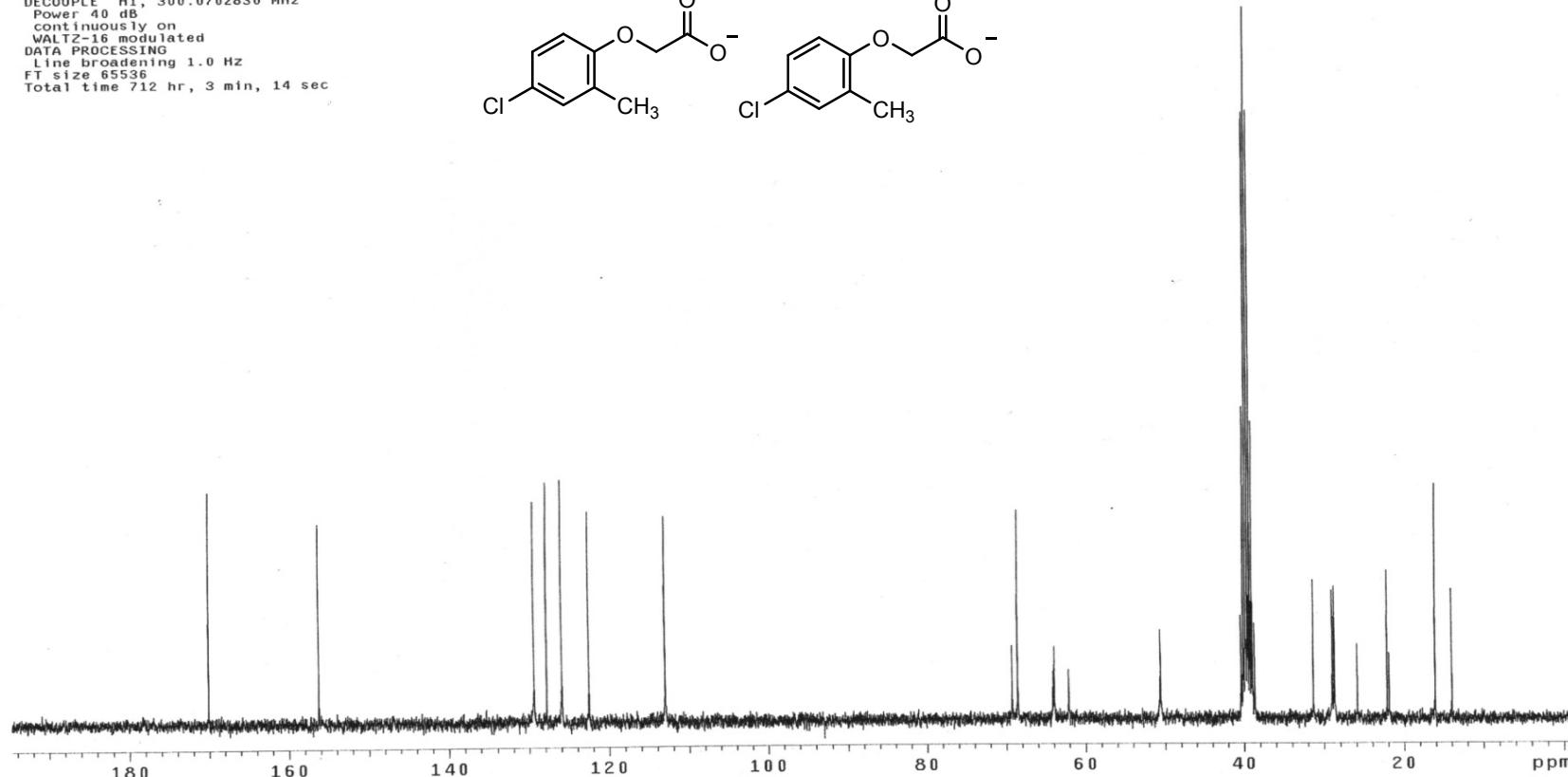
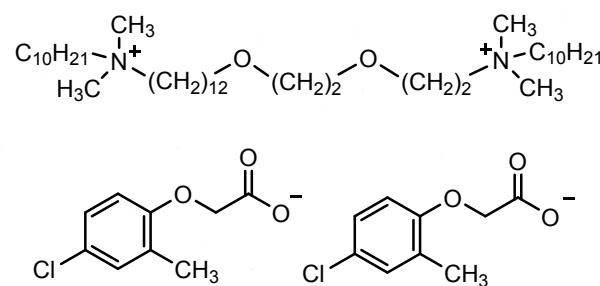


Figure S19. ^1H NMR spectrum of **3d** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[(2,4-dichlorophenoxy)acetate]).

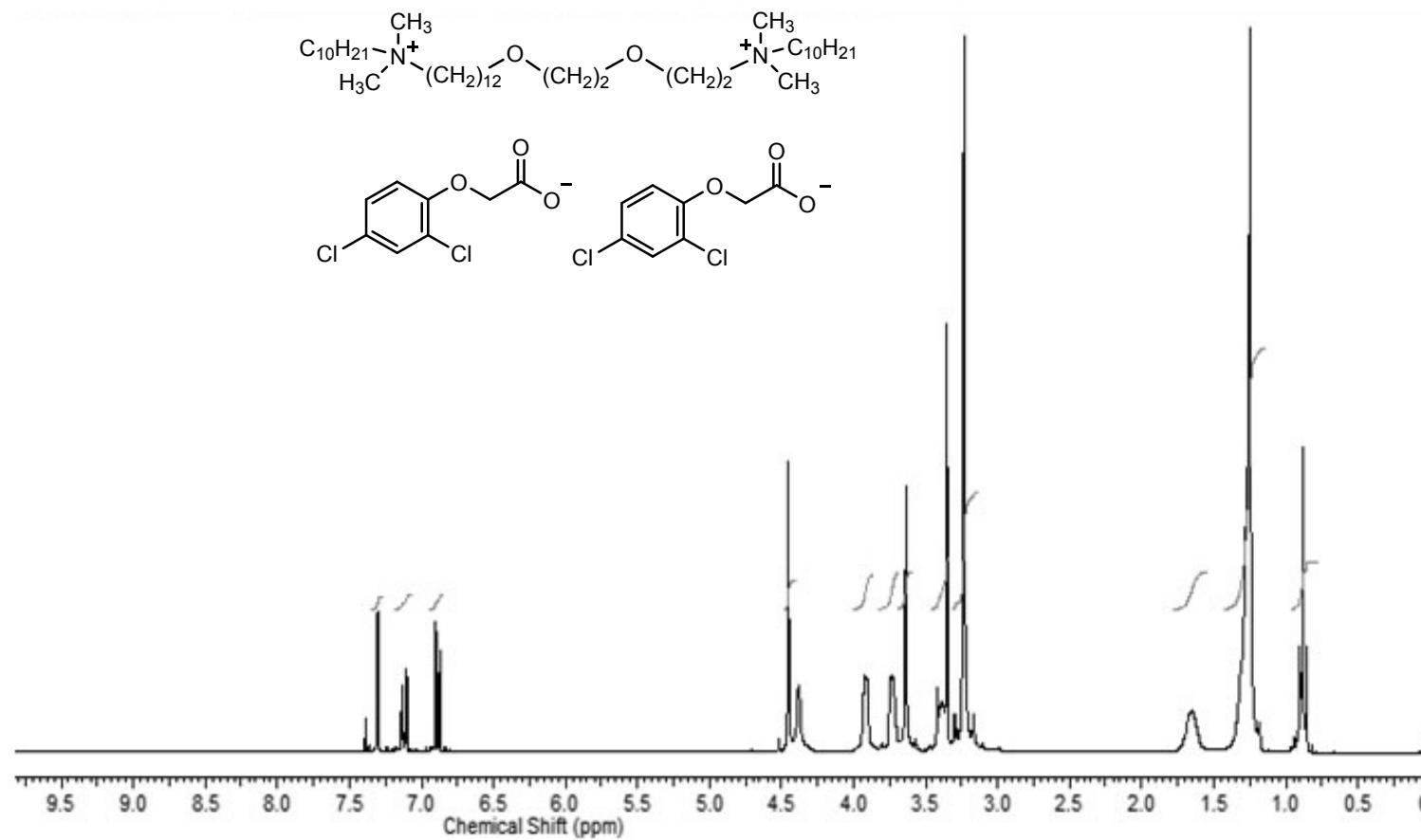


Figure S20. ^{13}C NMR spectrum of **3d** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[(2,4-dichlorophenoxy)acetate]).

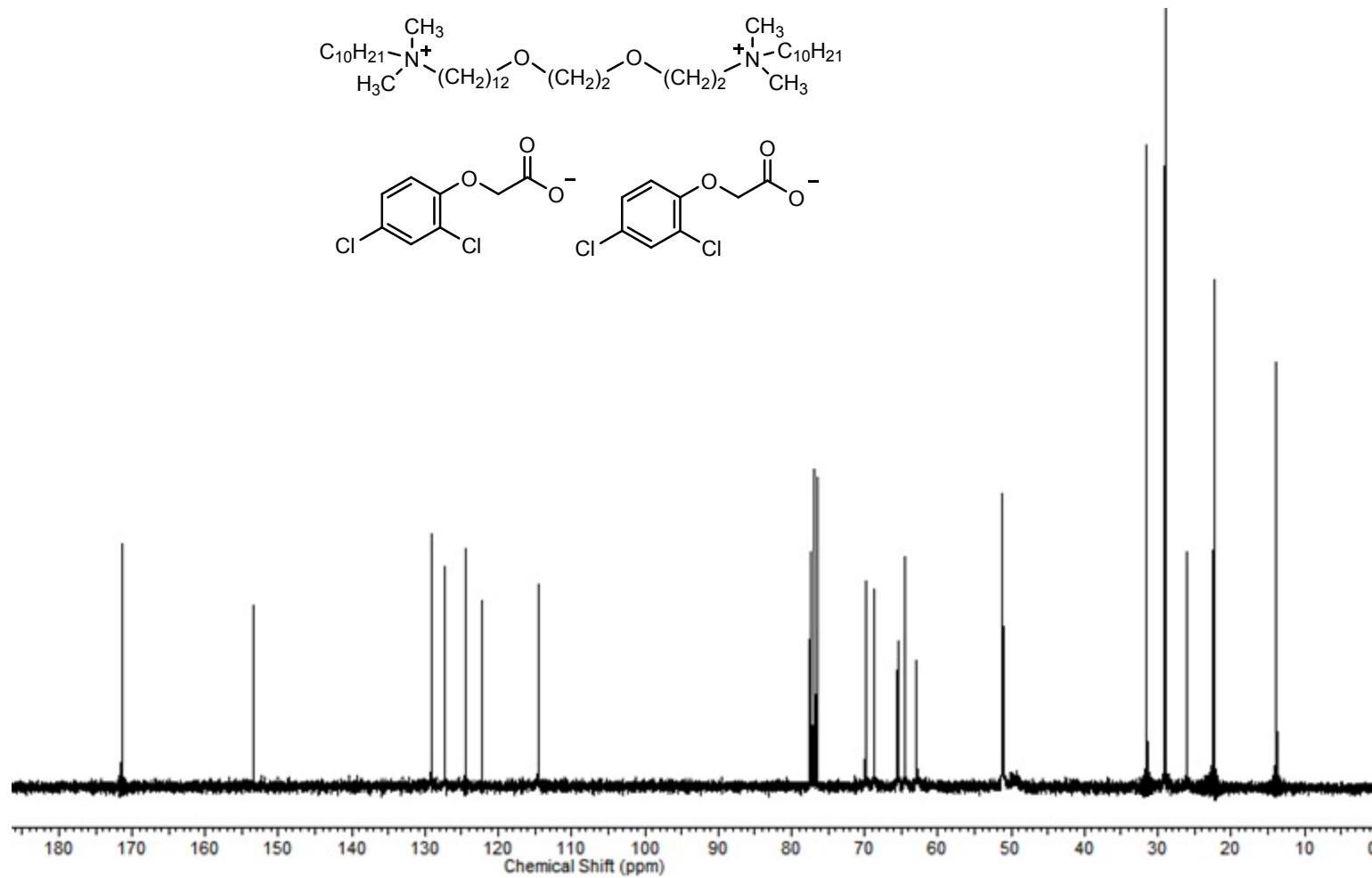


Figure S21. DSC thermogram of **1a**

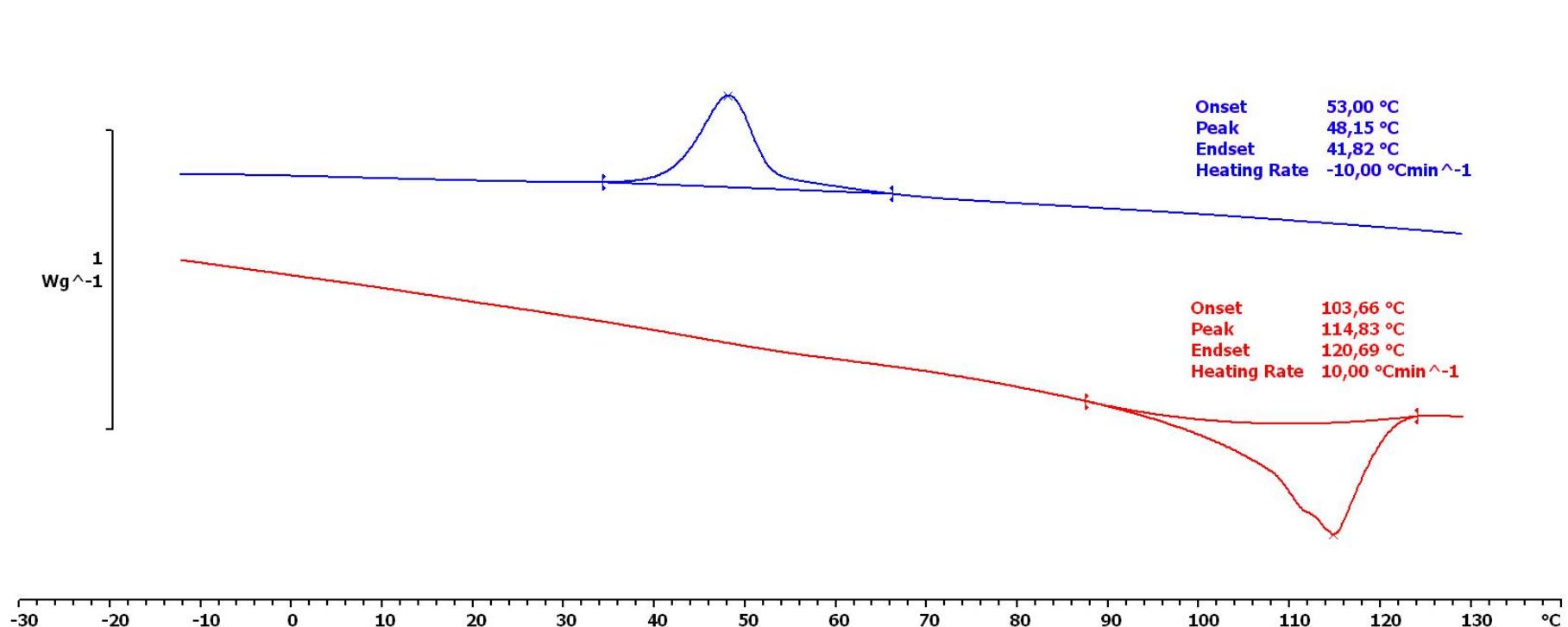


Figure S22. DSC thermogram of **1b**

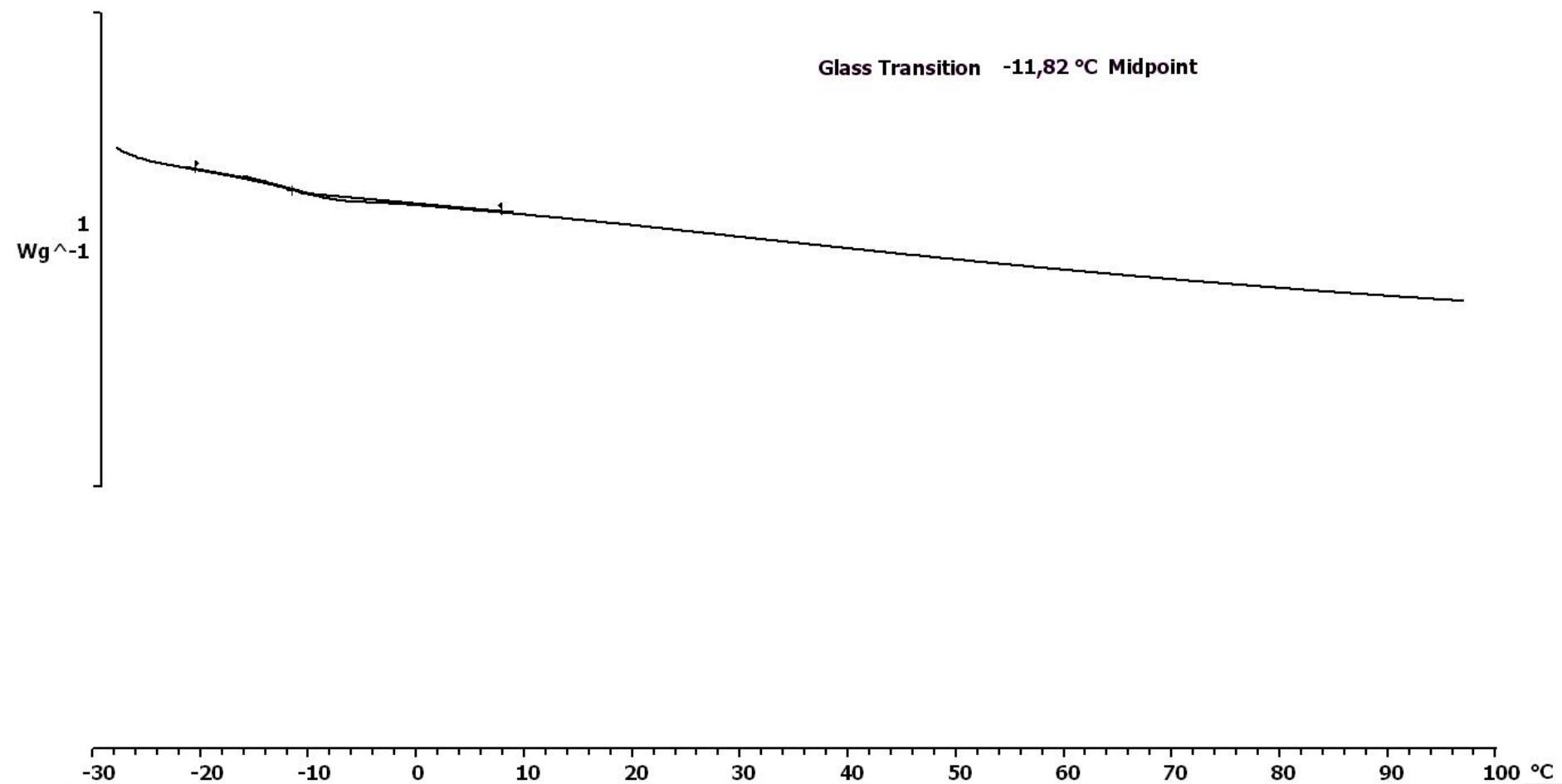


Figure S23. DSC thermogram of **2a-2d**

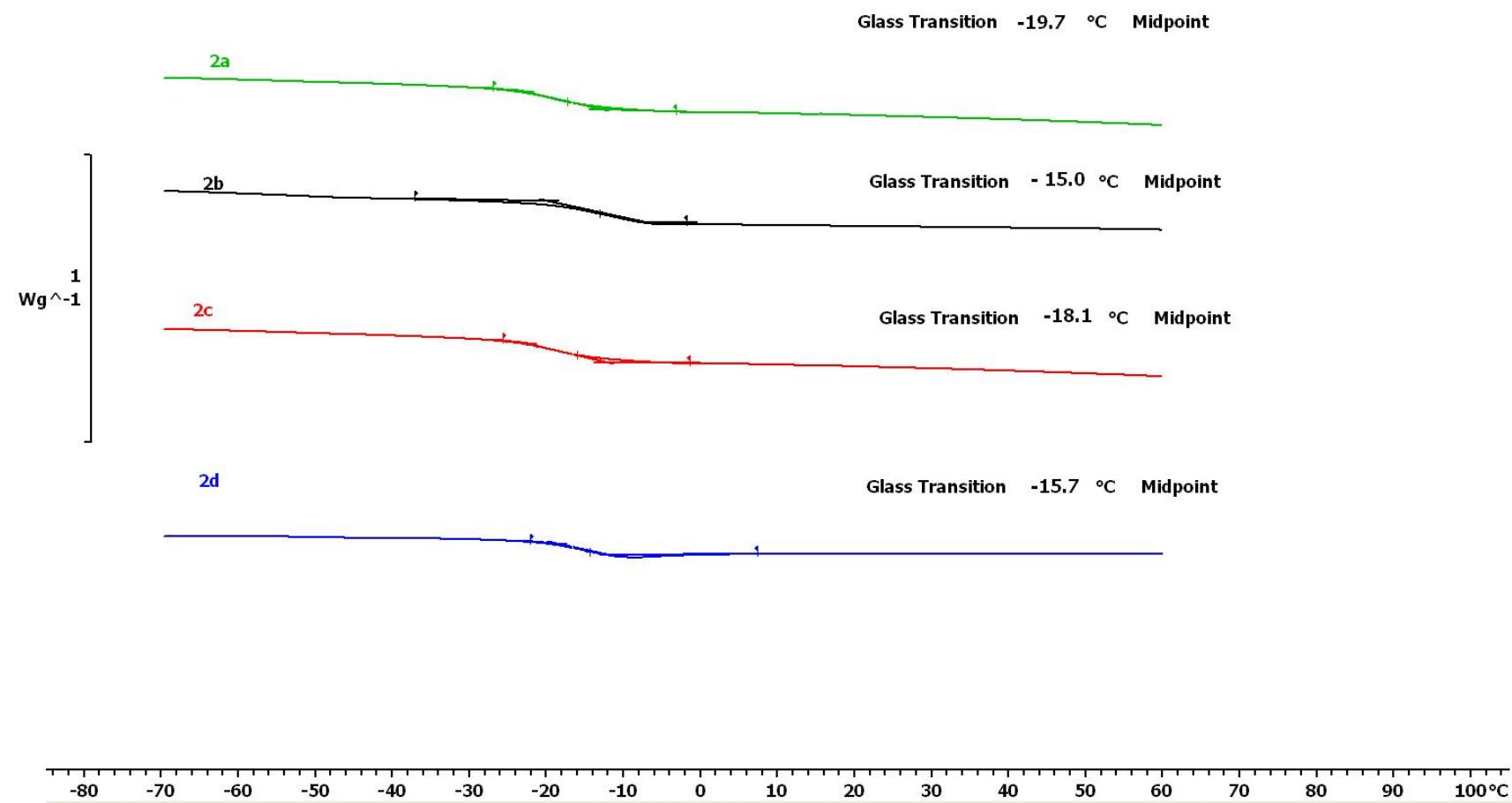


Figure S24. DSC thermogram of **3a-3d**

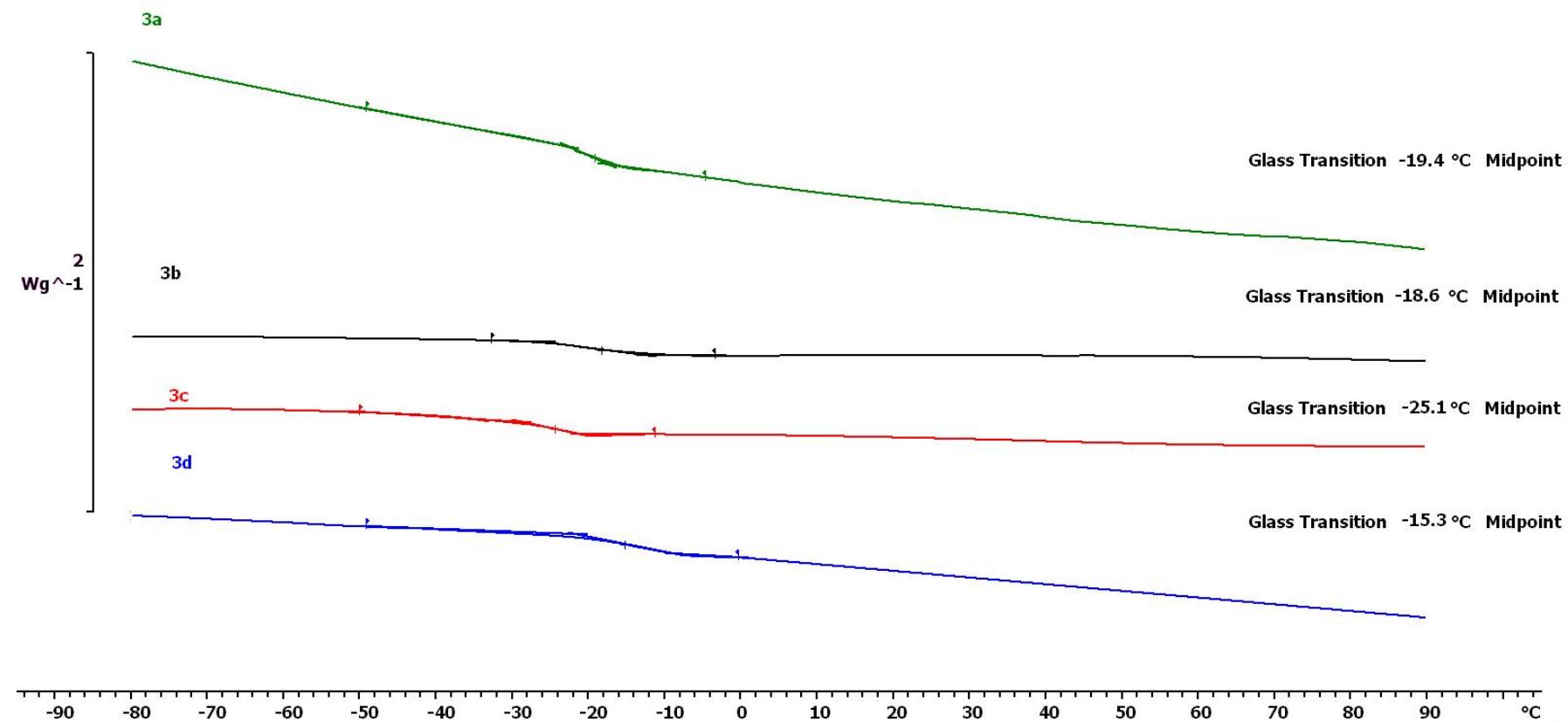


Figure S25. TGA thermogram of **1a** and **1b**

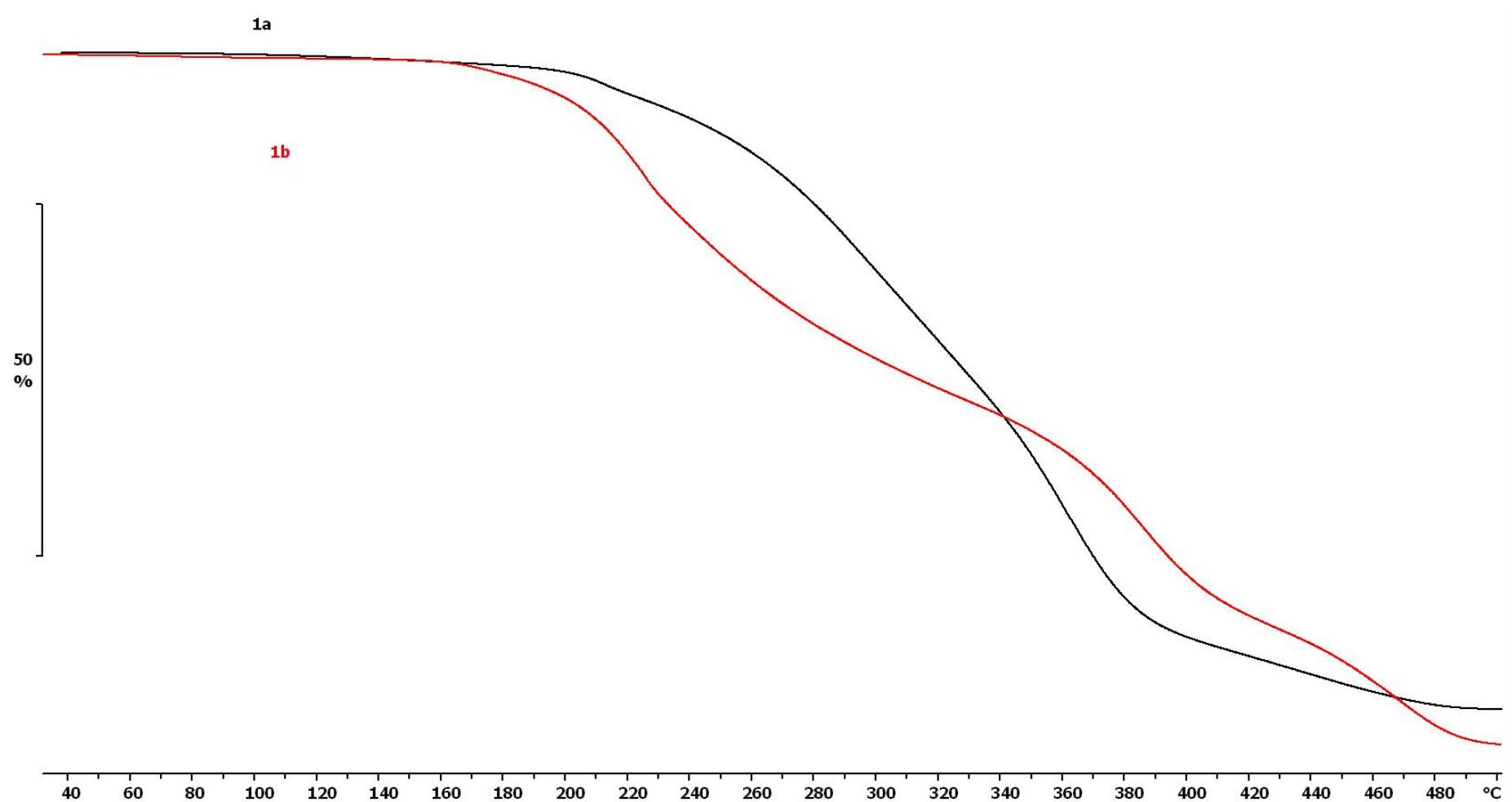


Figure S26. TGA thermogram of **2a-2d**

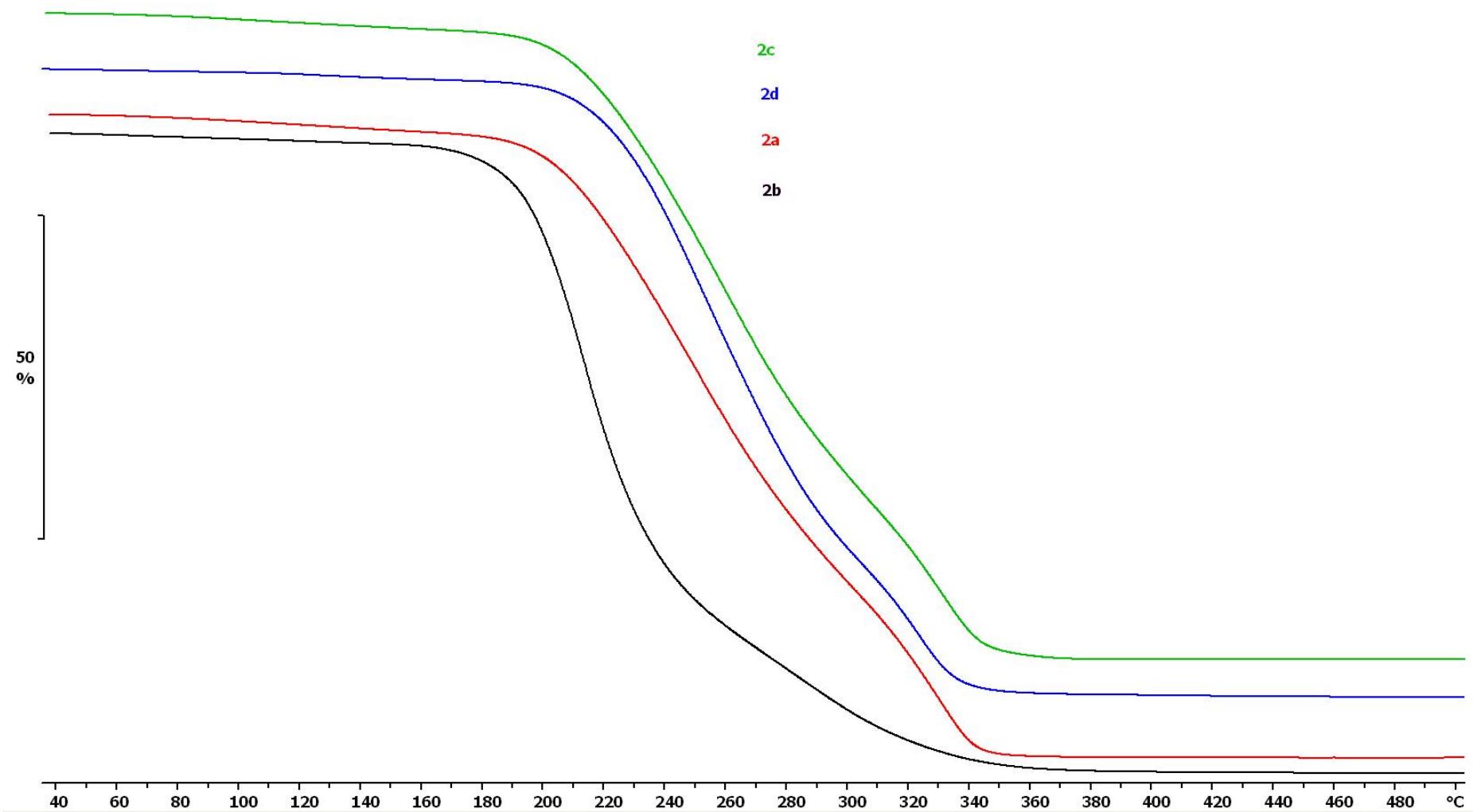


Figure S27. TGA thermogram of 3a-3d

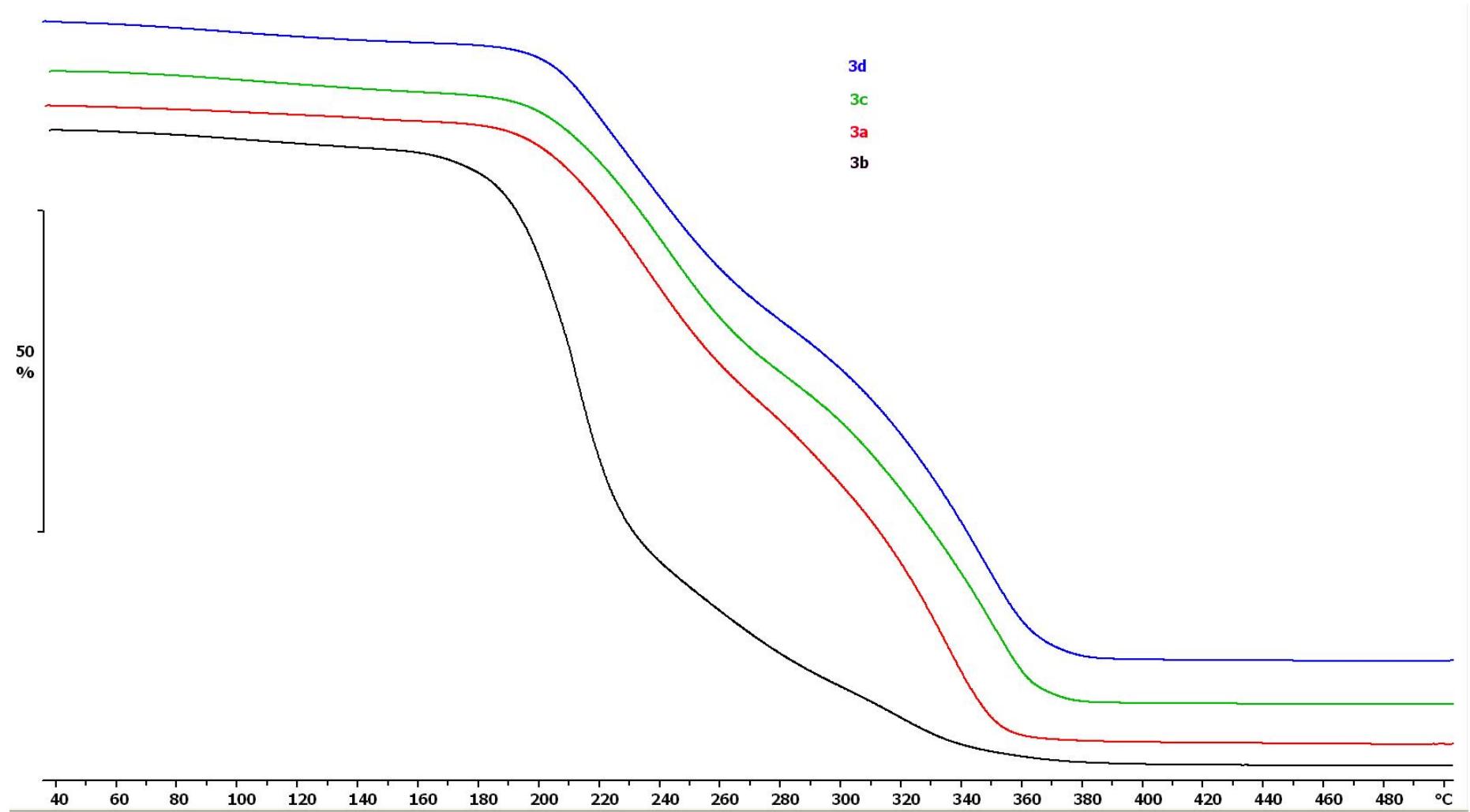


Table S1. Efficacy tests for bis(ammonium) HILs in the greenhouse experiments.

Salt	CHEAL - Lambsquarters (<i>Chenopodium album L.</i>)	SINAL - White mustard (<i>Sinapis alba L.</i>)
	Fresh weight reduction (%)	
2a	37	8
2b	32	9
2c	60	55
2d	47	52
3a	51	22
3b	58	33
3c	32	33
3d	27	47
MCPA ^a	20	25
Dicamba ^a	26	13
2,4-D ^a	10	40

^athe commercial herbicides