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The characterization of some 3,4-methylenedioxycathinone (MDCATH) homologs

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Abstract

In the past 35 years, a wide variety of illicit drugs have appeared in the clandestine market. Many of these compounds are based on the structure of amphetamine (1-phenyl-2-aminopropane) to which various functional or structural groups have been added. Previous modifications to the amphetamine molecule include addition of a methylenedioxy bridge to give 3,4-methylenedioxyamphetamine, and attachment of a β-keto oxygen to yield cathinone. A chemical synthesis integrating the salient functional/structural groups of these two classes of amphetamine analogs results in manufacture of methylenedioxycathinone (MDCATH). In each instance, N-alkylation of these analogs provides a series of homologs. Furthermore, many of these analogs/homologs meet several criteria which typically support the clandestine laboratory synthesis of novel illicit drugs ('designer drugs'). The MDCATH analogs represent a potentially new series of 'designer drugs' whose chemical characteristics have not previously been reported. Appropriate selection of analytical, chemical and physical tests will enable rapid identification of these analogs by a comparative analysis using the data provided. Copyright © 1997 Elsevier Science Ireland Ltd.

Keywords: Methylenedioxycathinone; Designer drugs; Methylenedioxyamphetamine analogs; Amphetamine analogs; Cathinone analogs

1. Introduction

Substitutions to the amphetamine molecule (1-phenyl-2-aminopropane) provide a large number of compounds with the ability to elicit physiological responses in humans. These responses cover a wide range of activity varying from analeptic (*N*-methyl

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amphetamine, 'methamphetamine') to hallucinogenic (2,5-dimethoxy-4-bromo-amphetamine, 'DOB') to anoretic (*N,N*-diethylaminopropiophenone, 'amfepramone') through entactogenic (3′,4′-methylenedioxyphenyl-2-methyl-aminobutane, 'MBDB') [1–6]. Occasionally, and usually unexpectedly, these substituted amphetamine 'analogs/homologs' [7] appear on the clandestine drug scene as 'designer drugs'. One of the first of the substituted amphetamine structures to be identified in the illicit drug trade, circa October 1967, [8] was 3,4-methylenedioxyamphetamine ('MDA'), a substance with both stimulant and hallucinogenic properties [9,10]. This was followed by the identification in 1972 of *N*-methyl-MDA ('MDMA', 'Ecstasy') [11]. In the 1980s, a number of additional *N*-substituted homologs of MDA were clandestinely synthesized and subsequently identified [12] and then controlled by Federal statute[1]. More recently, MBDB, the butane homolog of MDMA, was identified in the illicit drug market [13–15]. In September of 1988, methcathinone (α-methyl-aminopropiophenone, *N*-methylcathinone, 'CAT'), the β-keto analog of methamphetamine, was surreptitiously produced in the United States (U.S.) for the first time[2]. By 1990, CAT manufacture had become an acute law enforcement problem in the Upper Peninsula of Michigan [16]. Furthermore, between 1990 and 1996 inclusive, at least 120 CAT manufacturing laboratories were seized throughout the U.S.[3] Interestingly, cathinone (α-amino-propiophenone, β-keto-amphetamine), the parent compound of CAT, has not been reported in any clandestine laboratory in the U.S. This may be due to the tendency of cathinone to quickly dimerize during the synthesis purification procedure producing an inactive product (3,6-dimethyl-2,5-diphenylpyrazine) [17,18]. (S)-(−) Cathinone is biosynthesized in the leaves of the khat plant, *Catha edulis* Forsk. (Celastraceae) [19,20]. Unlike cocaine, extraction of cathinone from the plant leaves is probably impractical due to the natural degradation and dimerization which occur rapidly after harvest.

One series of substituted amphetamine analogs with a potential for surreptitious manufacture incorporates the chemical functions of MDA and cathinone. These are the 3,4-methylenedioxycathinone (MDCATH) homologs (Fig. 1, Table 1). In a recent study using rats [21], administration of the first two members of the series, MDCATH (I) and *N*-methyl-MDCATH (II), gave evidence that the experimental animals interpreted the

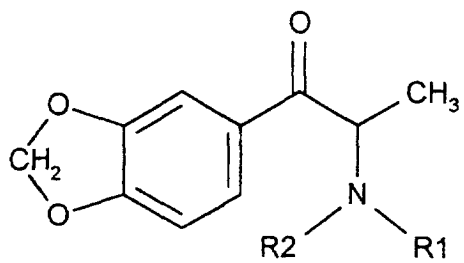


Fig. 1. Structure of 3,4-methylenedioxycathinone and some N-substituted homologs.

[1] 'The Controlled Substance Analogue Enforcement Act of 1986', Public Law 99-570, Title 1, Subtitle E, 27 October 1986.

[2] DEA interview of Mark McPhee, 26 October 1994.

[3] Dr James Tolliver, Drug Enforcement Administration, Office of Diversion Control, Washington, DC, personal communication, November 1996.

Table 1
Melting points and R_1, R_2 substitutions for Fig. 1 compounds

No.	Compound[a]	MW	MP°C	R_1	R_2
1	MDCATH	193.2	208–209	H	H
2	*N*-Methyl MDCATH	207.2	226–228	CH_3	H
3	*N*-Ethyl MDCATH	221.2	225–228	C_2H_5	H
4	*N,N*-Dimethyl MDCATH	221.2	242–244	CH_3	CH_3
5	*N,N*-Diethyl MDCATH	249.2	164–166	C_2H_5	C_2H_5
6	MDP-1-P	178.2	40–41[b]	—	—
7	MD-2-Br-P-1-P	257.1	51–53	—	—
8	MDP-1-P-2-Oxime	207.2	149–151[c]	—	—

[a]MD=3,4-Methylenedioxy; CATH=Cathinone; P-1-P=Phenyl-1-Propanone (propiophenone).
[b]Frinton Laboratories Catalog 11, 1986–1987, lists 38–39°C.
[c]U.S. Patent 1,964,973 lists 153–154°C.

compounds as MDMA-like. This activity, and the relative ease of synthesis, suggest a possibility of future clandestine laboratory production [22].

Compounds I and II, along with the potentially active *N*-ethyl (III), *N,N*-dimethyl (IV), and *N,N*-diethyl (V) homologs, and their synthesis precursors, were analyzed by a variety of analytical and instrumental techniques. Should these compounds appear in the underground drug market, the data presented below will enable their rapid identification.

2. Experimental

Presumptive tests (i.e. color, field or functional group tests) were performed on the five β-keto amines I–V. For comparative purposes, a number of related phenethylamines were also analyzed. Testing used porcelain spot plates containing approximately 2–5 mg of each drug as the hydrochloride salt. For the single step reagents (Marquis[4] and Mecke[5]), 2–3 drops were added to each drug and the color change, if any, immediately noted. Approximately 20 s later, the tests were reevaluated to determine if a progression of colors had occurred. In the multi-component tests (secondary amine[6] and Chen's[7]) an equal number of drops (2–3) of each reagent was sequentially added to the drug. The color was observed immediately after the addition of the last component, except for the cathinone analogs where a time in seconds for color formation is noted in Table 2.

Solid phase infrared (IR) spectra were acquired using an ATI-Mattson Genesis Series Fourier Transform Infrared Spectrophotometer interfaced with a Dell Dimensions model XPS P90 computer. Gas phase IR spectra were recorded using a Hewlett-Packard (HP) model 5890 Series II gas chromatograph (GC) (Table 3) interfaced with both an HP model 5970 mass selective detector (MSD) and an HP model 5965 infrared detector (IRD). An HP Vectra XP/60 computer controlled the instrument. Solid phase IR spectra

[4]1 ml 37% formaldehyde in 10 ml of concentrated sulfuric acid.
[5]0.5 g selenious acid in 100 ml of concentrated sulfuric acid.
[6]Reagent 1: 1% sodium nitroprusside in water to which 10% by volume of acetaldehyde has been added. Reagent 2: 2% aqueous sodium carbonate.
[7]Reagent 1: 1% aqueous acetic acid. Reagent 2: 1% aqueous copper sulfate. Reagent 3: 2 N aqueous sodium hydroxide.

Table 2
Presumptive tests

	Marquis[a]	Mecke[b]	2° amine[c]	Chen[d]
Amphetamine	O(I)→Bn	N.C.	N.R.	N.R.
Methamphetamine	O(I)→Bn	N.C.	Bu(I)	N.R.
Dimethylamphetamine	O(I)→Bn	N.C.	N.R.	N.R.
Nor-ephedrine	N.C.	N.C.	N.R.	Pr
Ephedrine	N.C.	N.C.	N.R.	Pr
Dimethylephedrine	N.C.	N.C.	N.R.	Pr
MDA	Pr→Bk	G(I)→Bu(I)	N.R.	N.R.
Methyl MDA	Pr→Bk	G(I)→Bu(I)	Bu	N.R.
Dimethyl MDA	Pr→Bk	G(I)→Bu(I)	N.R.	N.R.
Cathinone	N.C.	N.C.	N.R.	O (20 s)
Methylcathinone	N.C.	N.C.	Bu/flecks	O (30 s)
Dimethylcathinone	N.C.	N.C.	N.R.	O (150 s)
MDCATH	Y(I)	Y(I)	N.R.	O (≥180 s)
Methyl MDCATH	Y(I)	Y(I)	Bu(W)	O (≥180 s)
Ethyl MDCATH	Y(I)	Y(I)	N.R.	N.R. (240 s)
Dimethyl MDCATH	Y(I)	Y(I)	N.R.	N.R. (240 s)
Diethyl MDCATH	Y(I)	Y(I)	N.R.	N.R. (240 s)
MD nor-ephedrine	O→O/Bn→Bk	O→Bn	N.R.	Pr
MD ephedrine	O→O/Bn→Bk	O→Bn	N.R.	Pr

MD=3,4-methylenedioxy; CATH=cathinone; (I)=intense; (W)=weak; O=orange; Bu=blue; Br=brown; Bk=black; Pr=purple; Pk=pink; Y=yellow; G=green; N.C.=no change in reagent color; N.R.=no reaction, color due to reagent mix, i.e. pink or rust for the secondary amine test and 'robin's egg' blue for the Chen's test.

[a]Feigl, F. and Anger, V., Spot Tests in Organic Analysis, Elsevier, New York, 1966, pp. 138–140.

[b]Gonzales, T.A., Vance, M., Helpern, M. and Umberger, C.J., Legal Medicine Pathology and Toxicology, 2nd edn., Appleton-Century-Crofts, Inc., New York, 1954, pp. 1211–1213.

[c]Op. cit., Feigl, G. and Anger, W., pp. 250–251.

[d]Clark, E.G.C. and Berle, J., eds., Isolation and Identification of Drugs, The Pharmaceutical Press, London, 1969, p. 131.

of the amines were acquired as the hydrochloride (HCl) salts in a potassium bromide matrix (Fig. 2).

Chloroform solutions of the amines as free bases were injected into the GC-MSD-IRD to obtain vapor phase IR spectra (Fig. 3) and, concurrently, electron impact (EI) mass spectra. Mass spectra were also acquired from an HP model 5989A mass spectrometer (MS) interfaced with an HP 5890 Series II GC. Programing was controlled with a UNIX based Apollo Series 400 computer. EI (Fig. 4) and CI (chemical ionization) (Fig. 5; Table 4) mass spectra were both obtained from this instrument. Acquisition of the CI mass spectra used methane as the reagent gas at a source pressure gauge reading of one torr. In addition to the above interfaced GCs, an HP 5890 GC with dual flame ionization detectors (FID) and dual 'mega-bore' columns was used to obtain retention time (RT) data (Table 3). An HP Vectra 486/66 XM computer controlled program execution. Isothermal and programed acquisitions are both reported in Table 3. Proton nuclear magnetic resonance (pNMR) spectra (Fig. 6) were recorded using a Varian Gemini 300 Fourier transform nuclear magnetic resonance (FTNMR) spectrometer. Compounds I–V

Table 3
GC retention times (min) for 3,4-methylenedioxycathinone and related compounds

No.	Compound[a]	HP-1[b]	HP-17[c]	DB-17[d]	HP-1[e]
0	Ephedrine	0.85	0.73	5.55	2.57
1	MDCATH	3.04	3.15	10.09	5.34
2	*N*-Methyl MDCATH	3.52	3.2	10.07	5.70
3	*N*-Ethyl MDCATH	4.60	3.53	10.46	6.29
4	*N,N*-Dimethyl MDCATH	4.26	3.31	5.81	6.11
5	*N,N*-Diethyl MDCATH	7.65	4.78	11.21	7.42
6	MDP-1-P	1.65	1.54	8.07	3.91
7	2-Bromo-MDP-1-P	4.59	4.47	10.93	6.24
8	MDP-1-P-2-Oxime	9.16	7.21	12.00	7.63
9	*N*-Acetyl-MDCATH	—	—	10.10	8.56
10	*N*-Acetyl-*N*-Methyl MDCATH	—	—	10.39	8.95
11	*N*-Acetyl-*N*-Ethyl MDCATH	—	—	10.56	9.53

[a]MD=3′,4′-Methylenedioxy; CATH=Cathinone; P-1-P=Phenyl-1-propanone.
[b]HP-1, 5 M×0.53 mM×2.65 micron, HP 5890 GC, FID detector, 140°C isothermal, Helium carrier flow 13.4 ml/min, linear velocity 102 cm/s, split ratio 5.4:1.
[c]HP-17, 10 M×0.53 mM×2.65 micron, HP 5890 GC, FID detector, 180°C isothermal, Helium carrier flow 15.75 ml/min; linear velocity 119 cm/s; split ratio 5.7:1.
[d]DB-17, 15 M×0.32 mM×0.25 micron, HP 5890 GC, MSD-IRD detectors, programed 100°C for 2 min; rate 10°C/min; 230°C; final time=0.0; Helium carrier flow 3.12 ml/min, linear velocity 96.2 ml/min, split ratio 13:1.
[e]HP-1, 12 M×0.20 mM×0.33 micron, HP 5890 GC, MS detector, programed 100°C for 1 min; rate 10°C/min; 240°C for 0.1 min; Helium carrier flow 0.79 ml/min, linear velocity 42 cm/s, split ratio 32:1.

were extracted from basic aqueous solutions into deuterochloroform ($CDCl_3$). The free base solutions were then passed through a bed of anhydrous sodium sulfate directly into 5-mm NMR sample tubes. Tetramethylsilane served as an internal chemical shift standard (δ+0.00 ppm) at 20°C (ambient) with a 300 MHz observation frequency. Melting points were determined using capillary tubes (1.6–1.8 mm×90 mm) in a Hoover Unimelt apparatus (Table 1). The syntheses of Compounds I, II, VII (3′,4′-methylenedioxy-2-bromopropiophenone), and VIII (3,4-methylenedioxypropiophenone-2-oxime), has already been described [20]. Compounds III, IV, and V were prepared in a manner exactly analogous to compound II by substituting *N*-ethylamine, *N,N*-dimethylamine, and *N,N*-diethylamine respectively for *N*-methylamine. Compound VI,

Table 4
Mass fragments (CI) of some 3,4-methylenedioxycathinone homologs

No.	Compound[a]	Base	M(MW)	M+1	M+29	M+41
1	MDCATH	(44)[b]	193.2	194	222	234
2	*N*-Methyl MDCATH	(58)[b]	207.2	208	236	248
3	*N*-Ethyl MDCATH	72	221.2	222	250	262
4	*N,N*-Dimethyl MDCATH	72	221.2	222	250	262
5	*N,N*-Diethyl MDCATH	100	249.2	250	278	290

[a]MDCATH=3,4-methylenedioxycathinone.
[b]Spectrum acquisition from 60–295 Da precluded observation of these fragments.

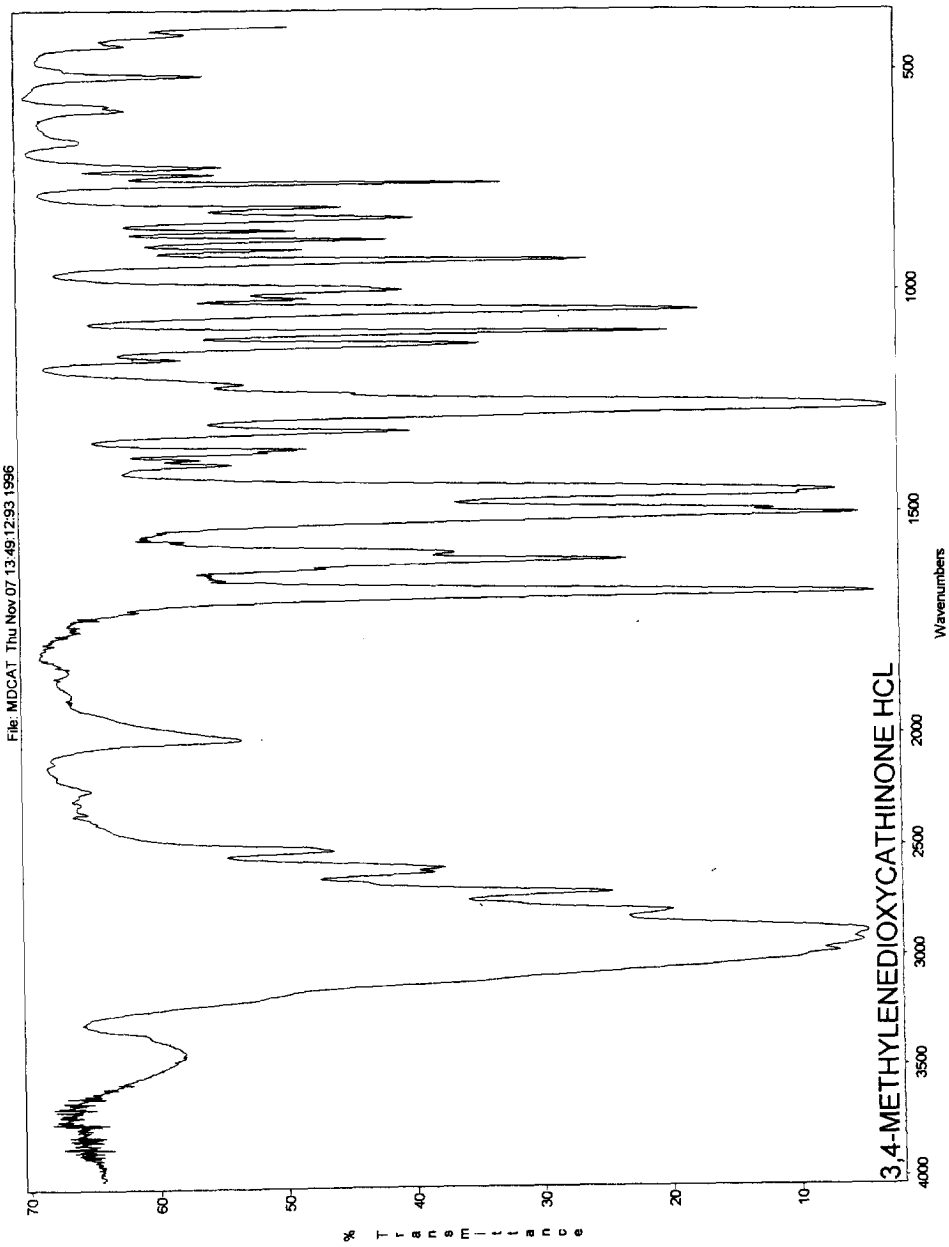
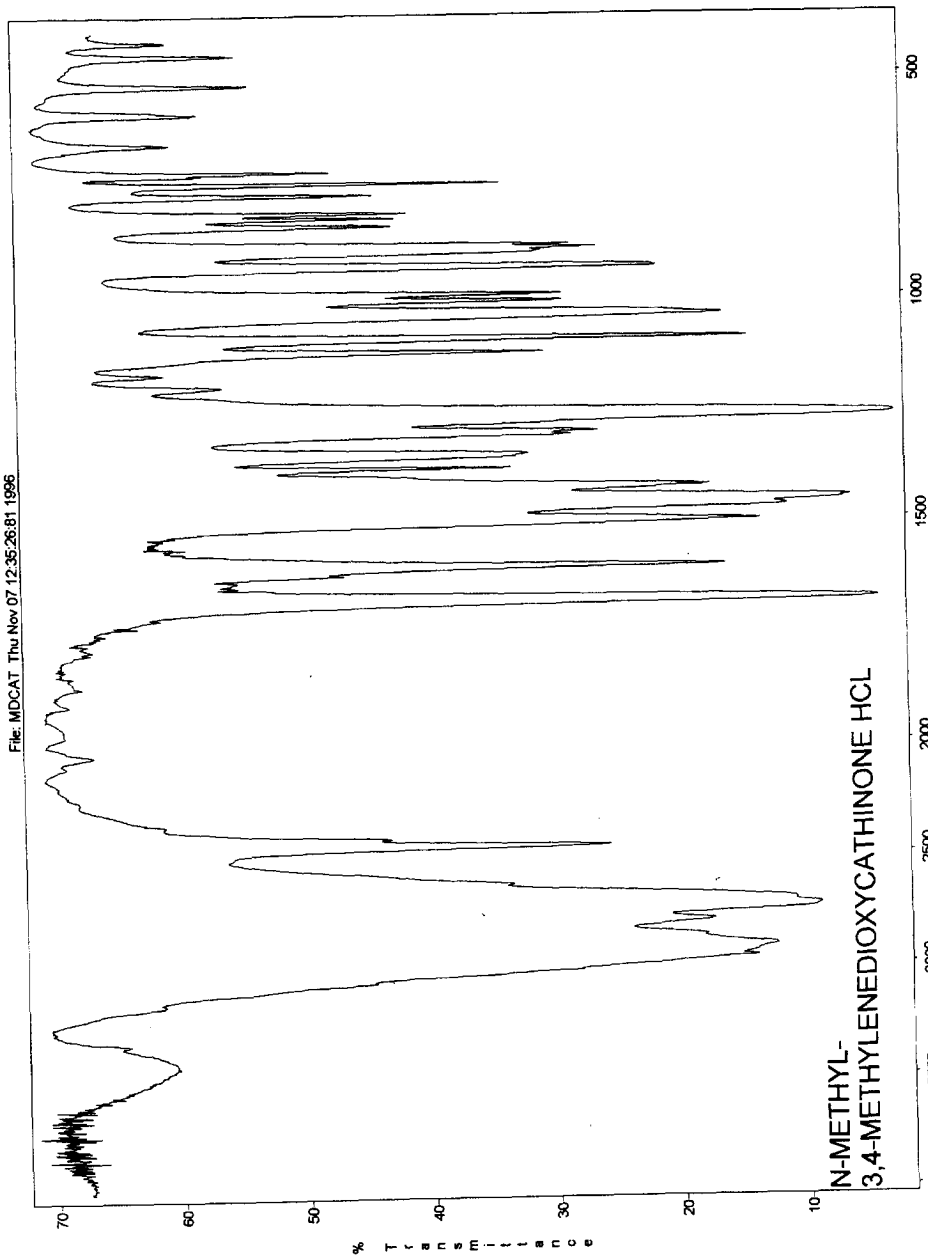


Fig. 2. IR spectra (solid phase) of some 3,4-methylenedioxycathinone homologs and precursors.



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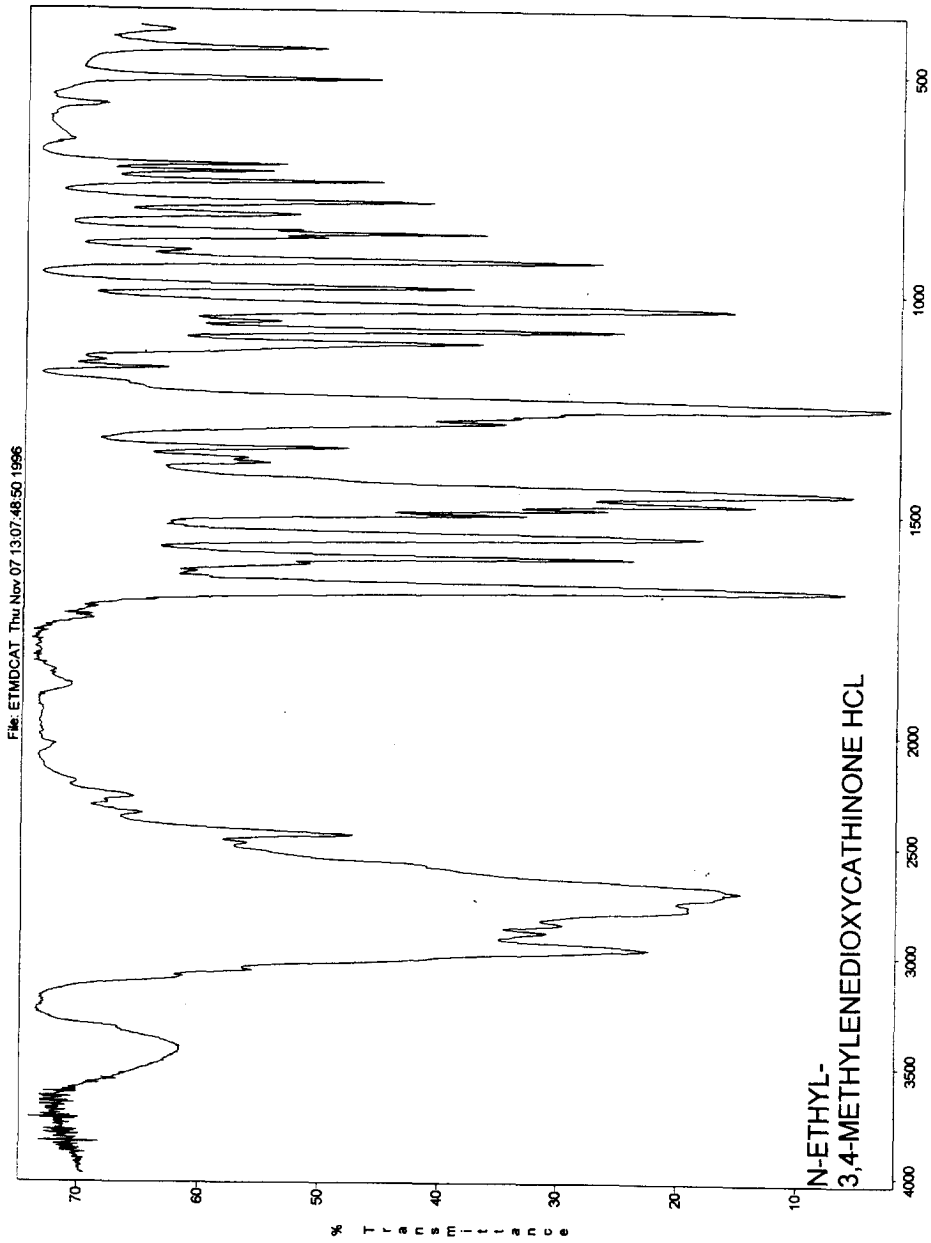

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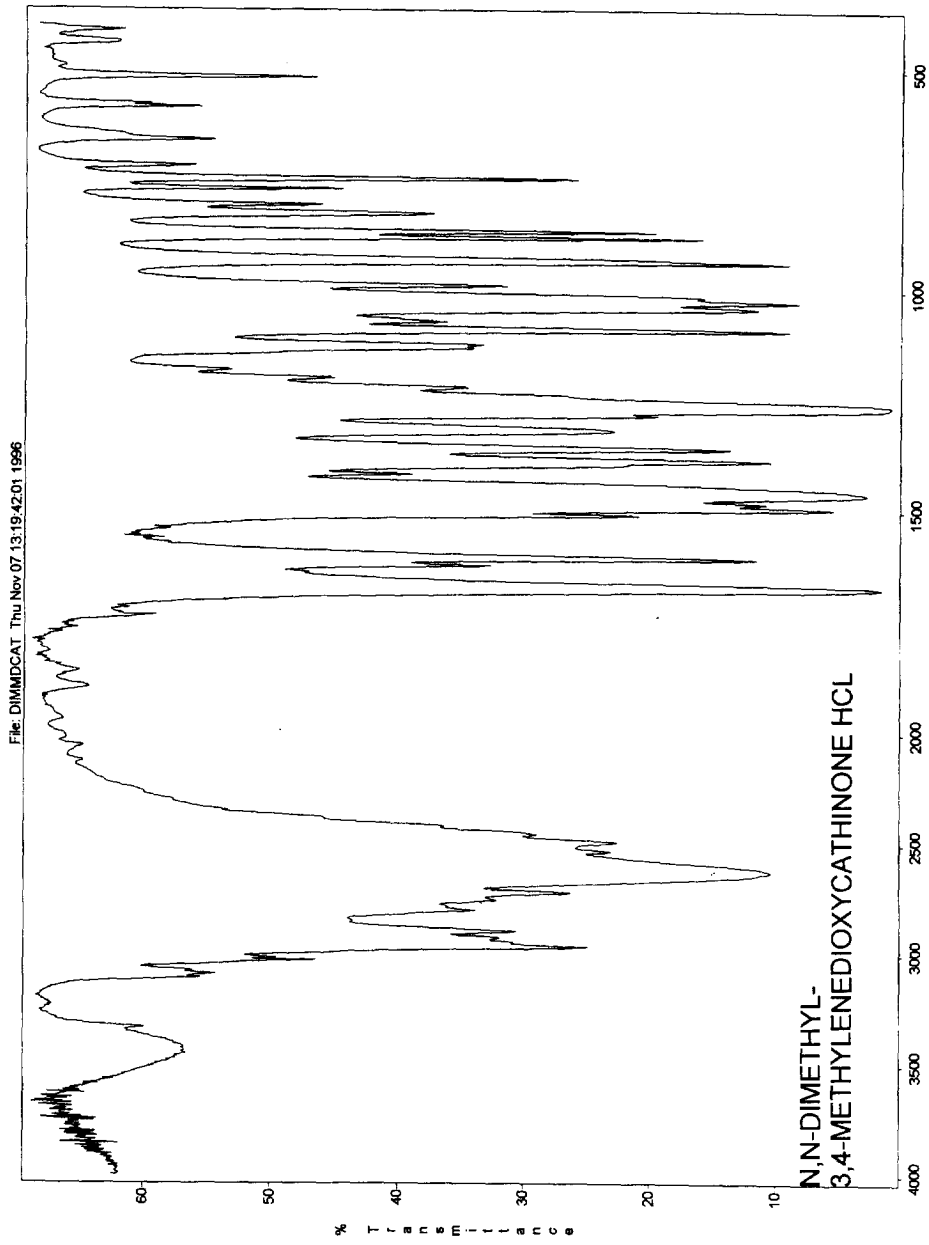

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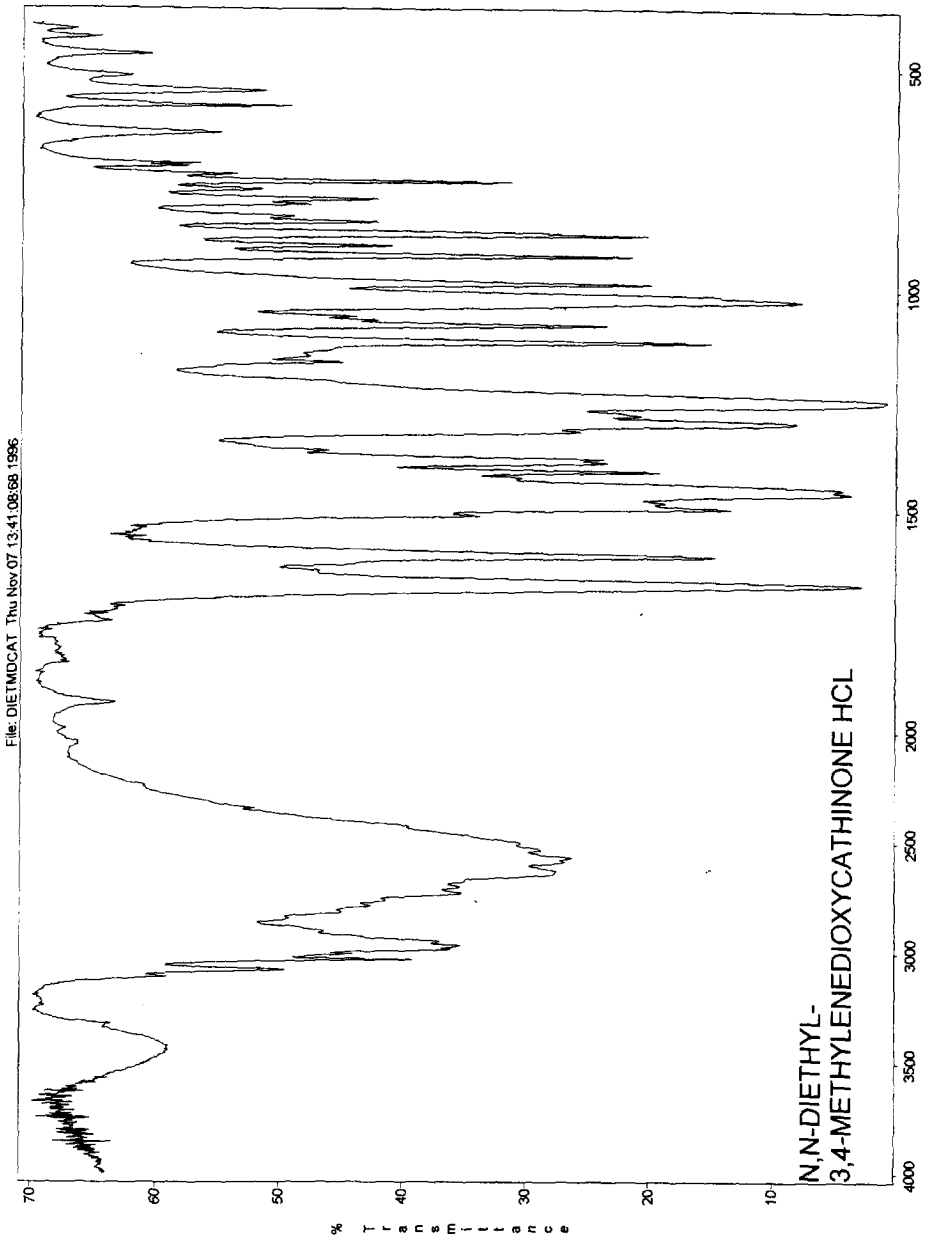

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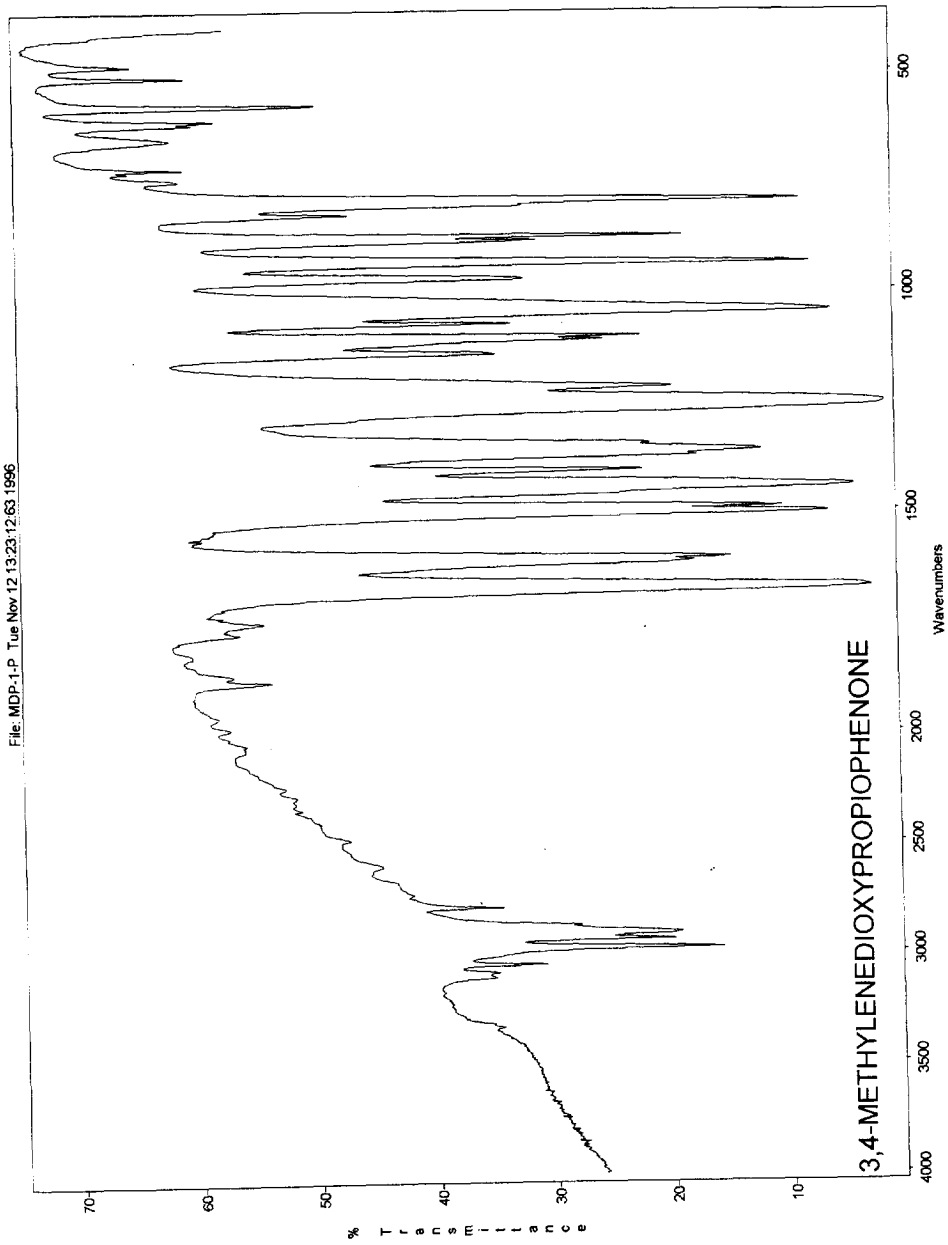

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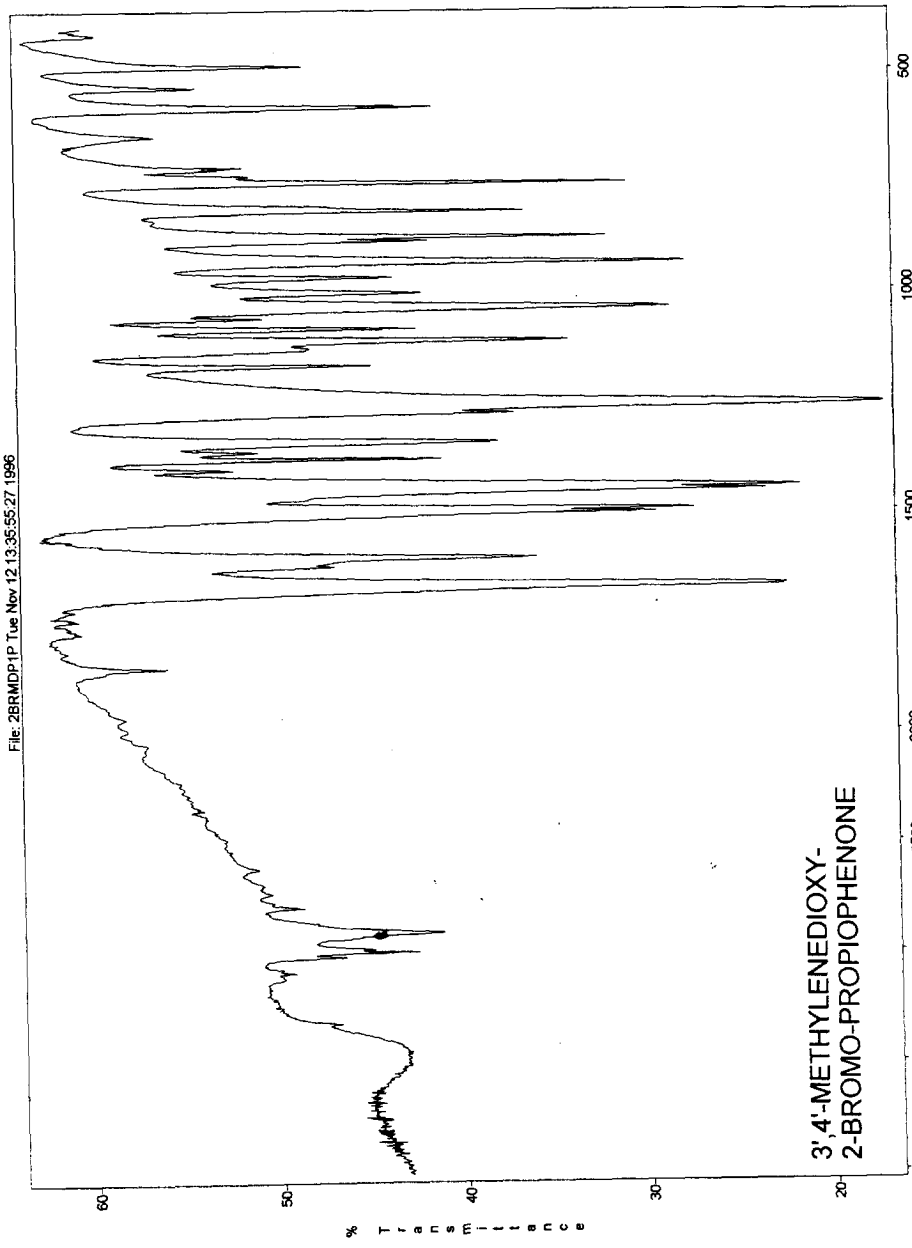

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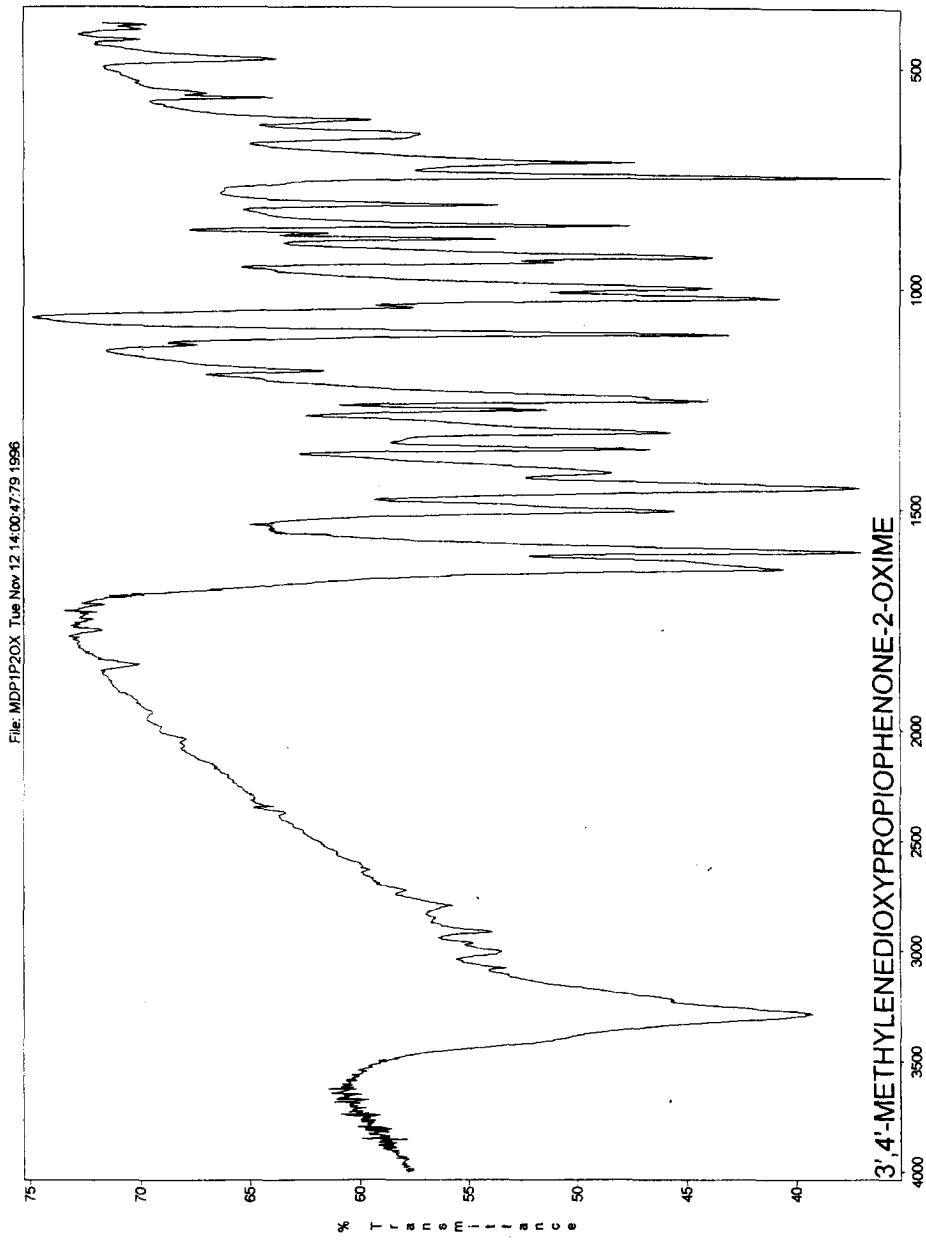

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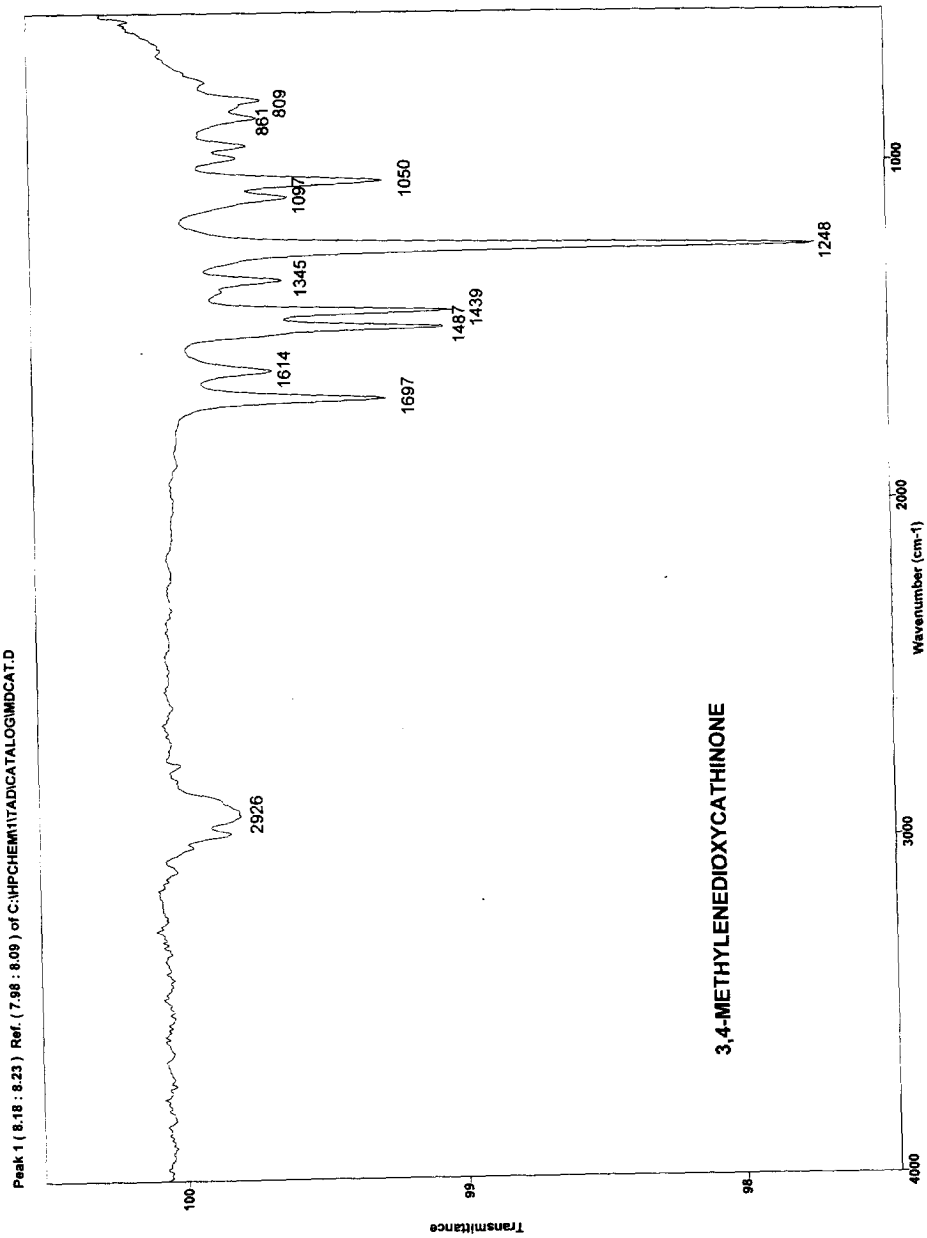
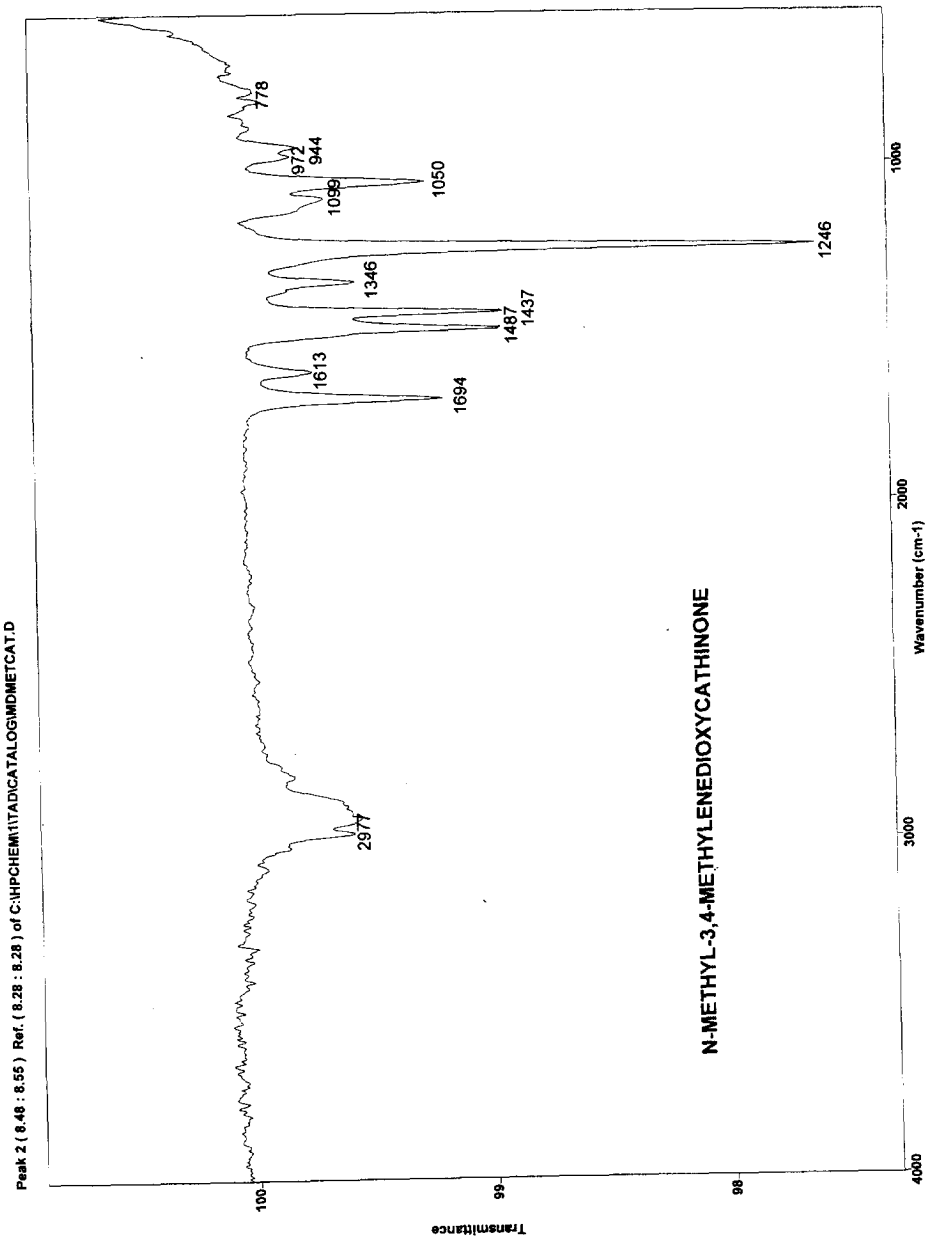


Fig. 3. IR spectra (vapor phase) of some 3,4-methylenedioxycathinone homologs.



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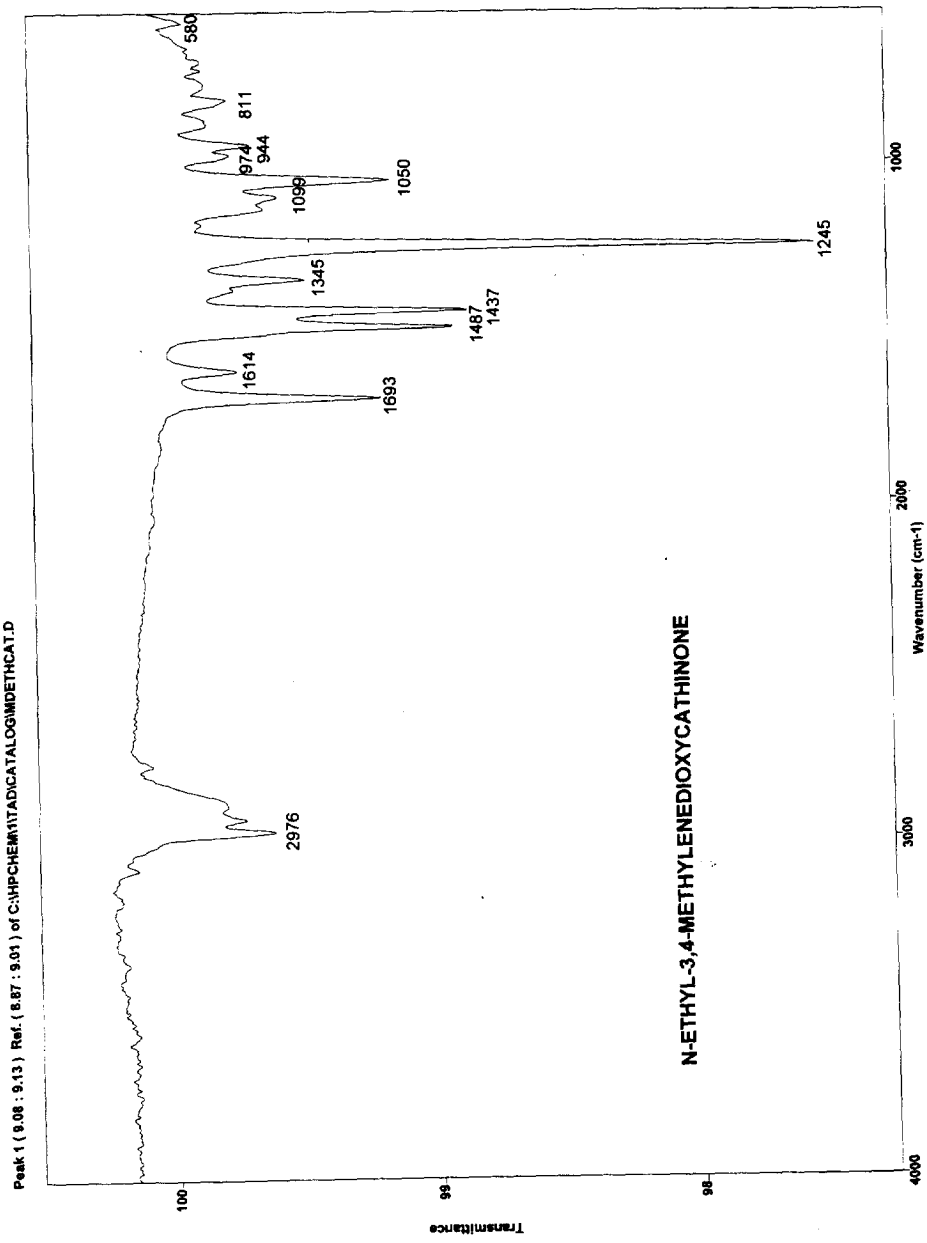

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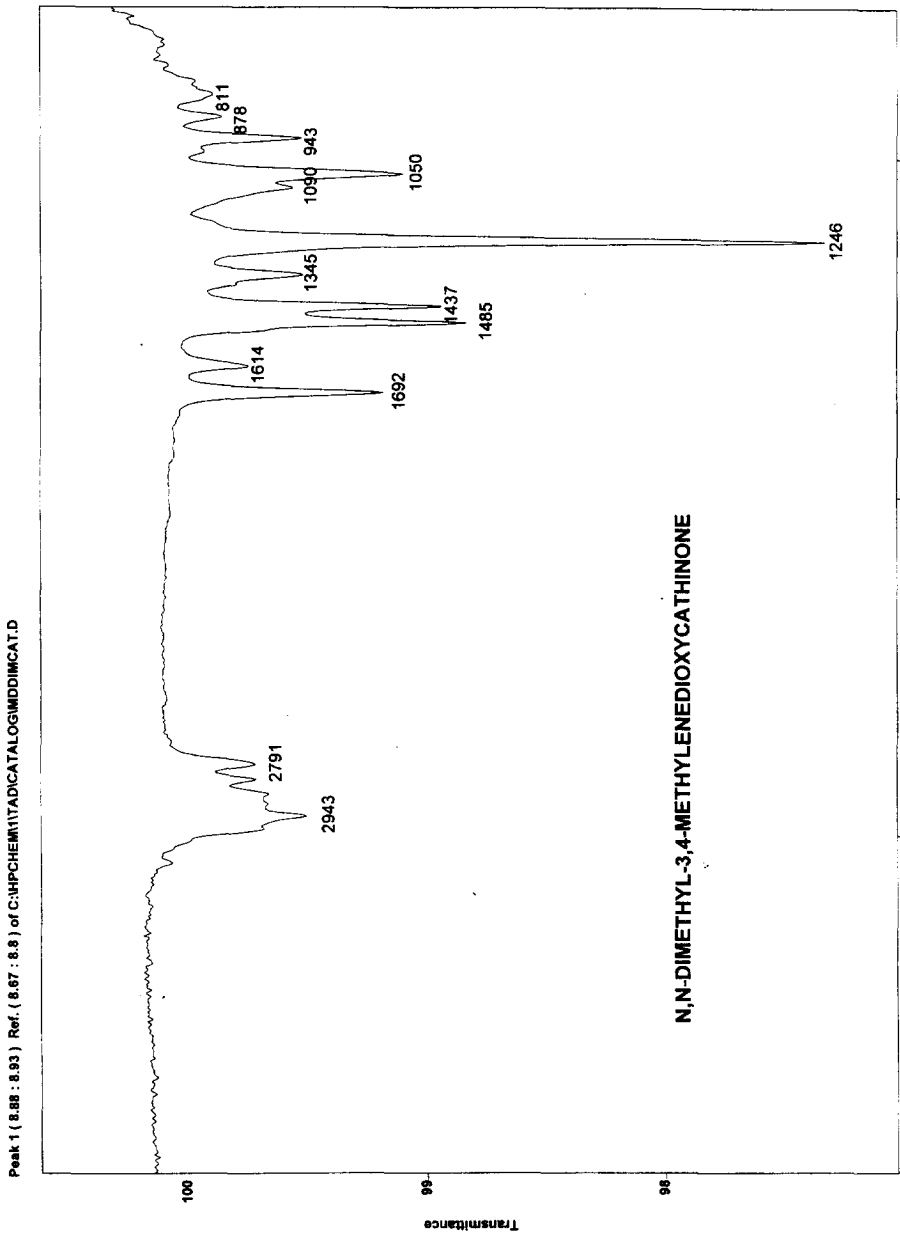

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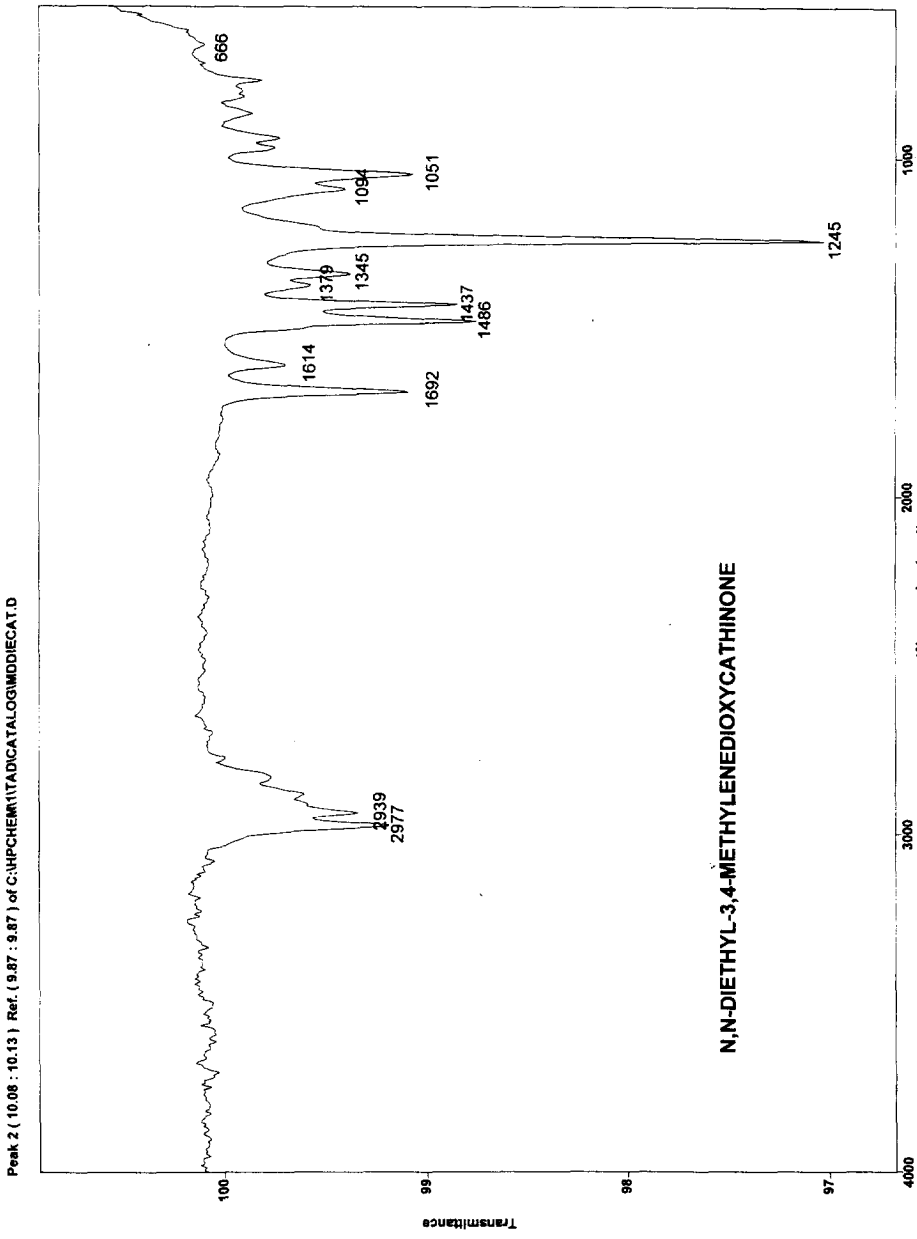

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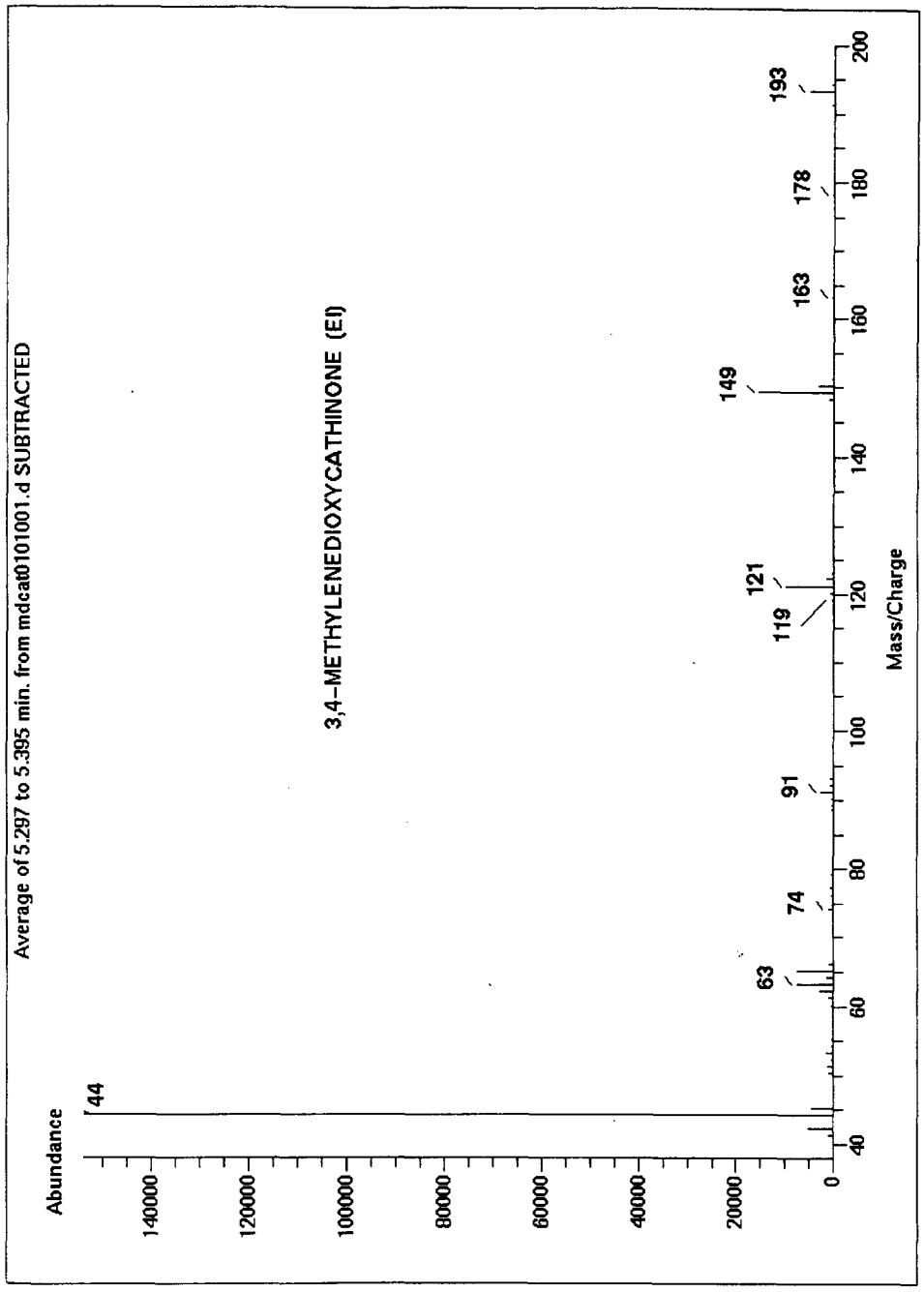
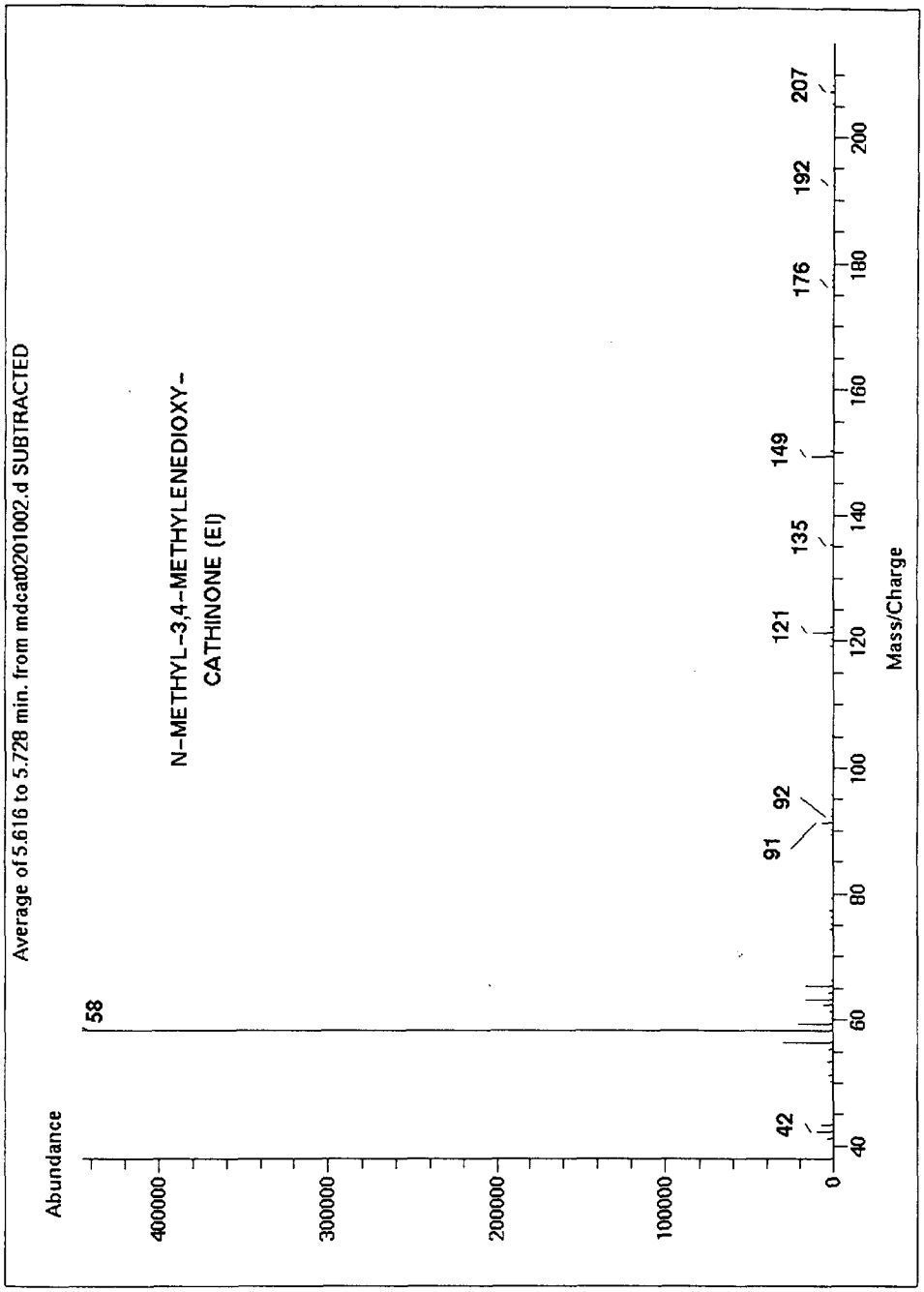


Fig. 4. Electron impact mass spectra for MDCATH homologs and precursors.



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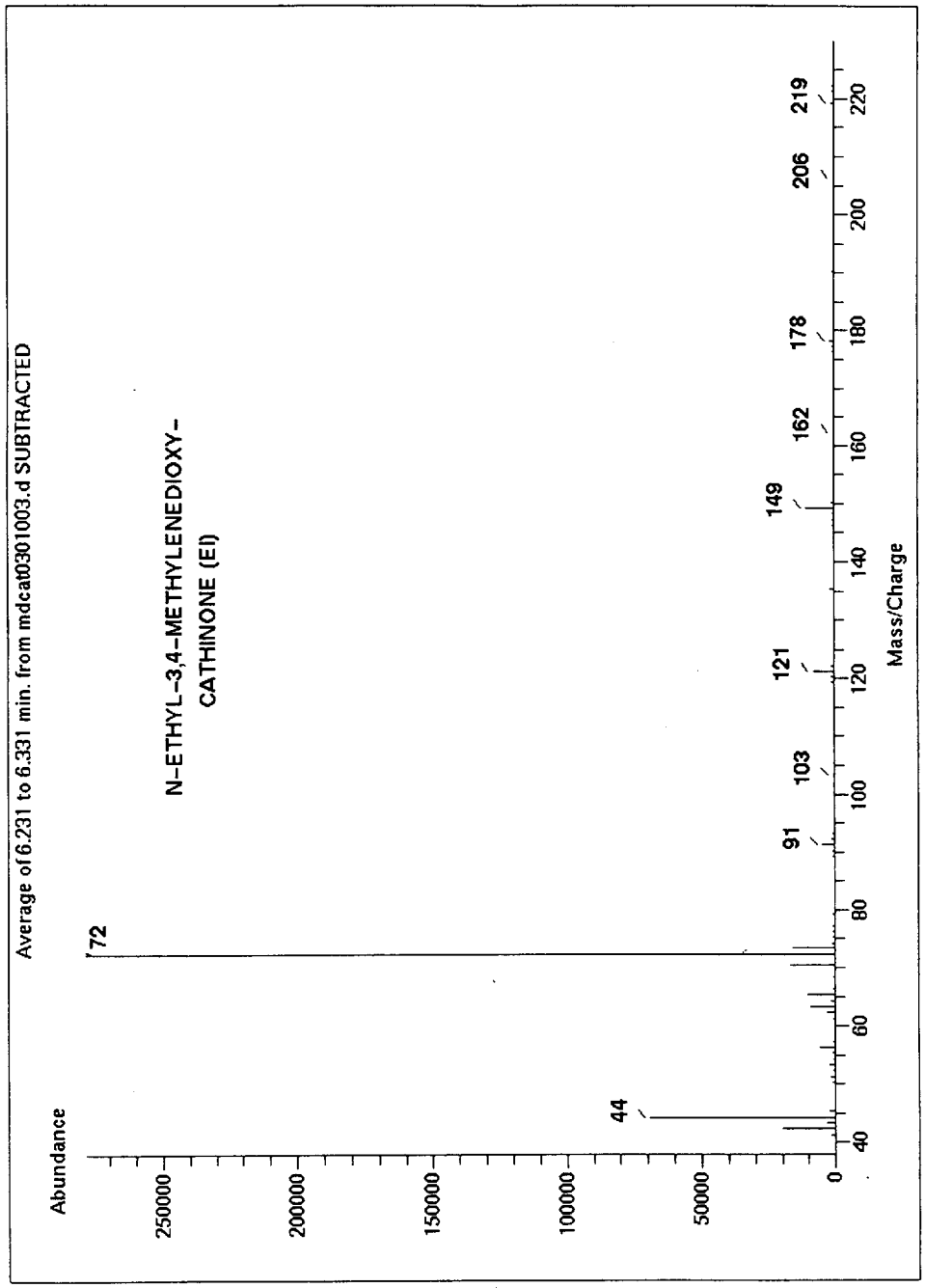

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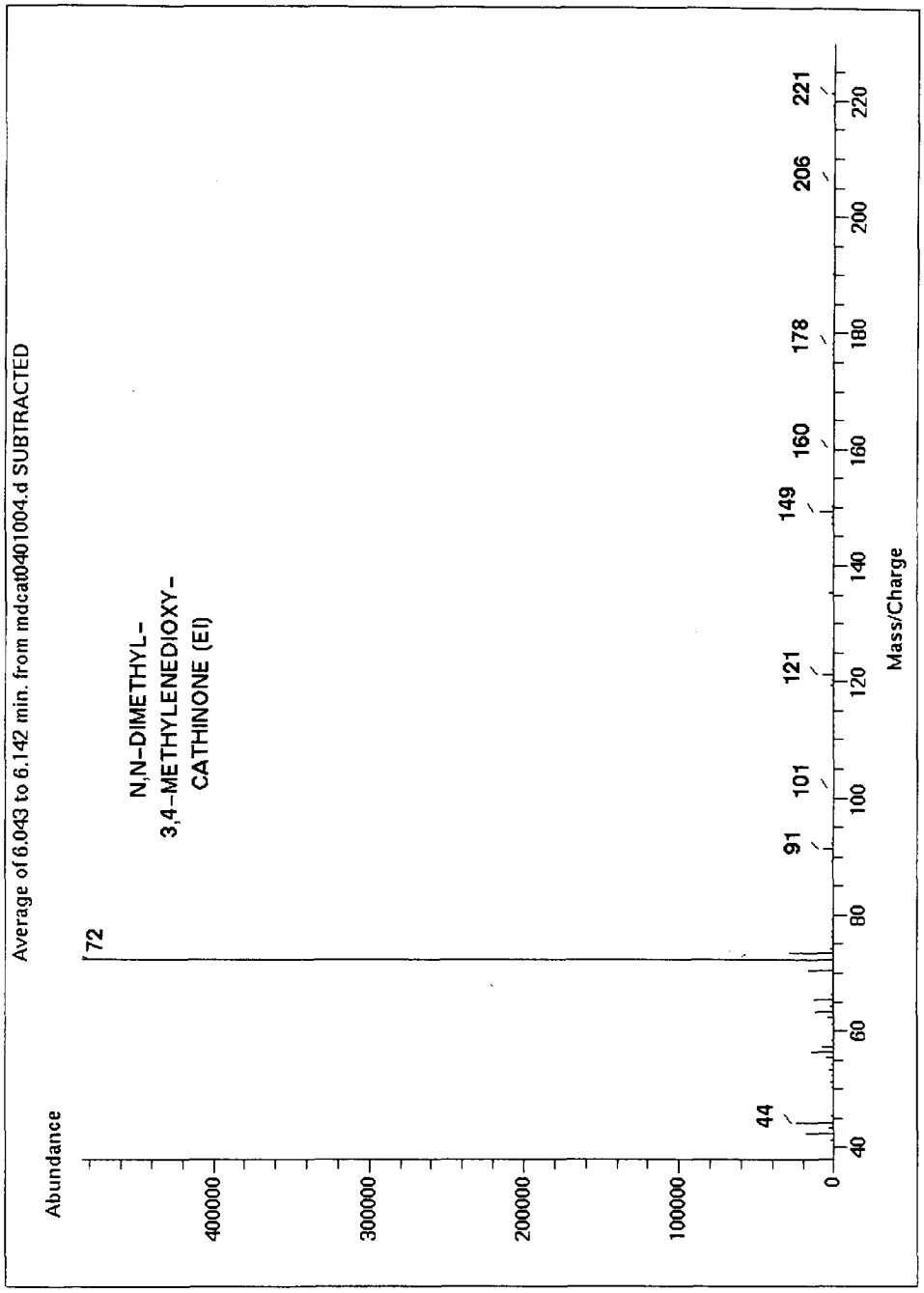

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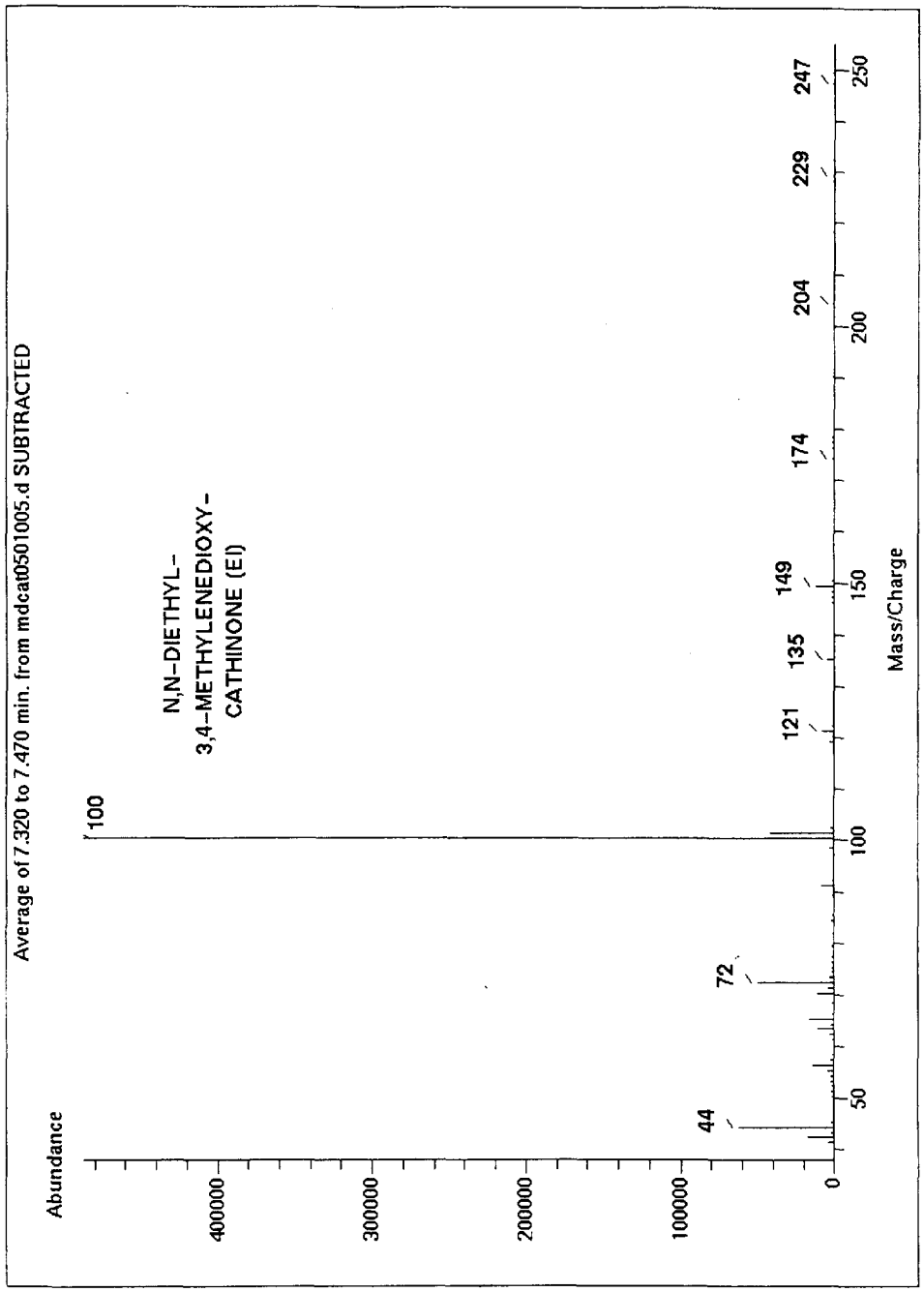

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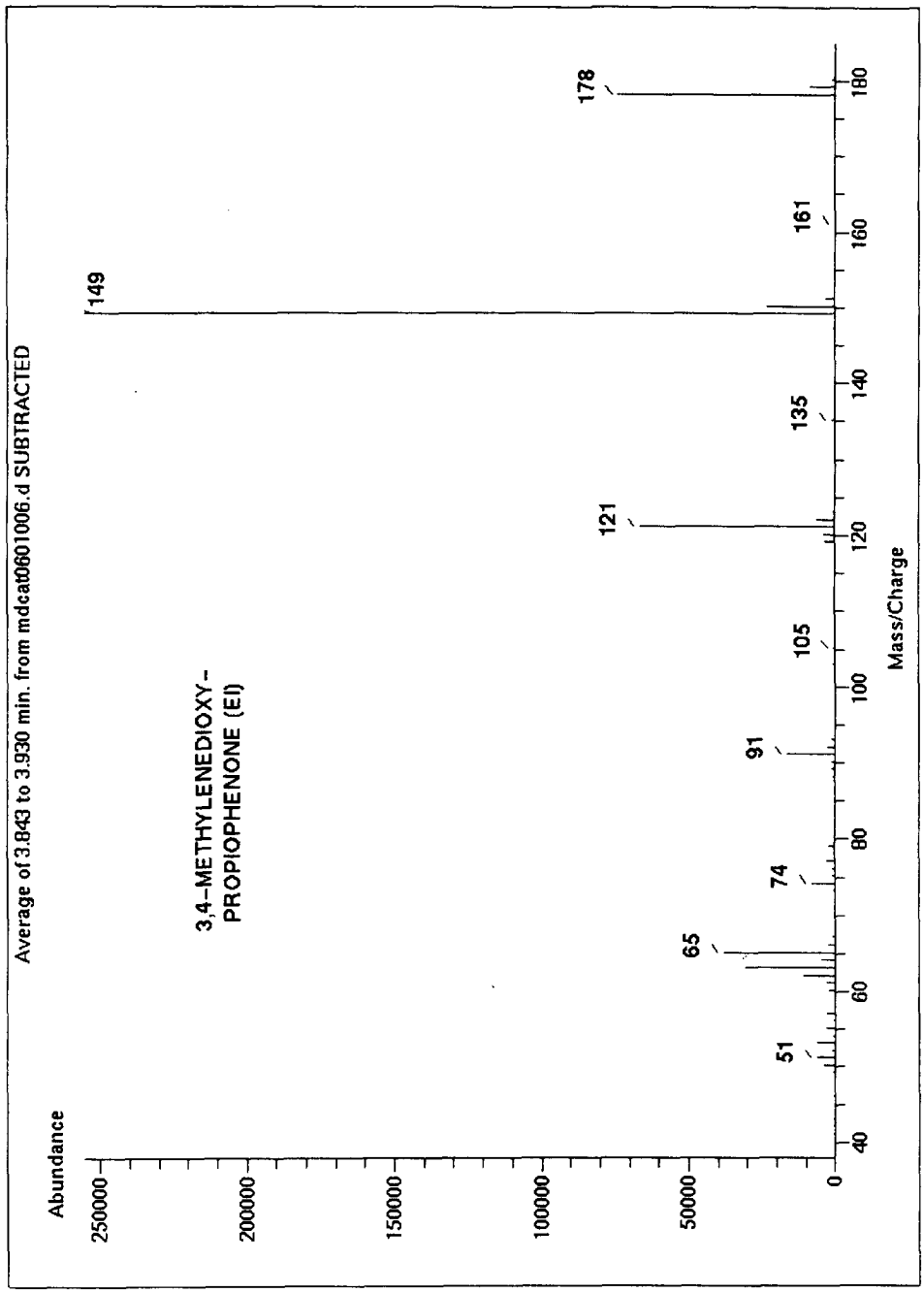

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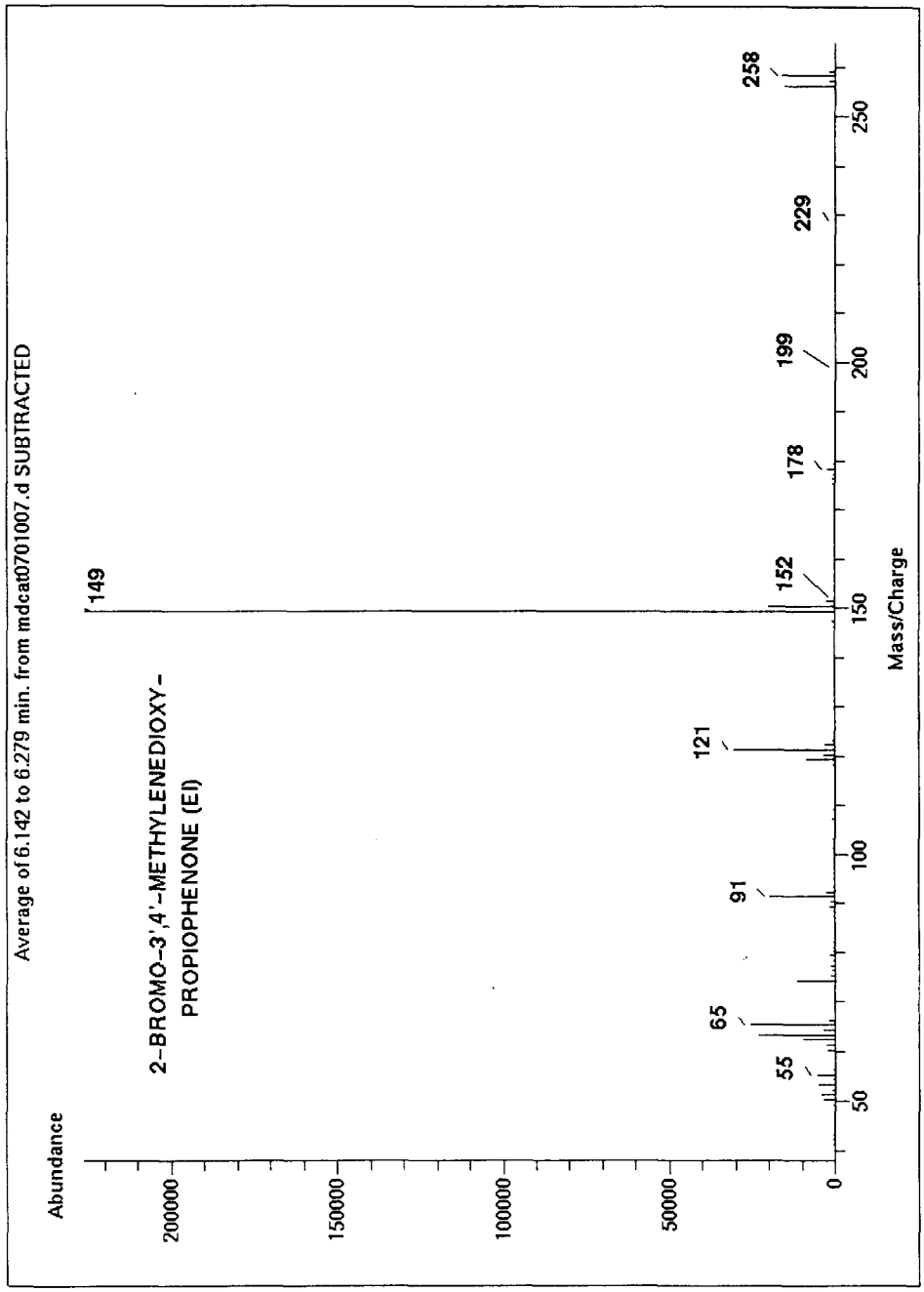

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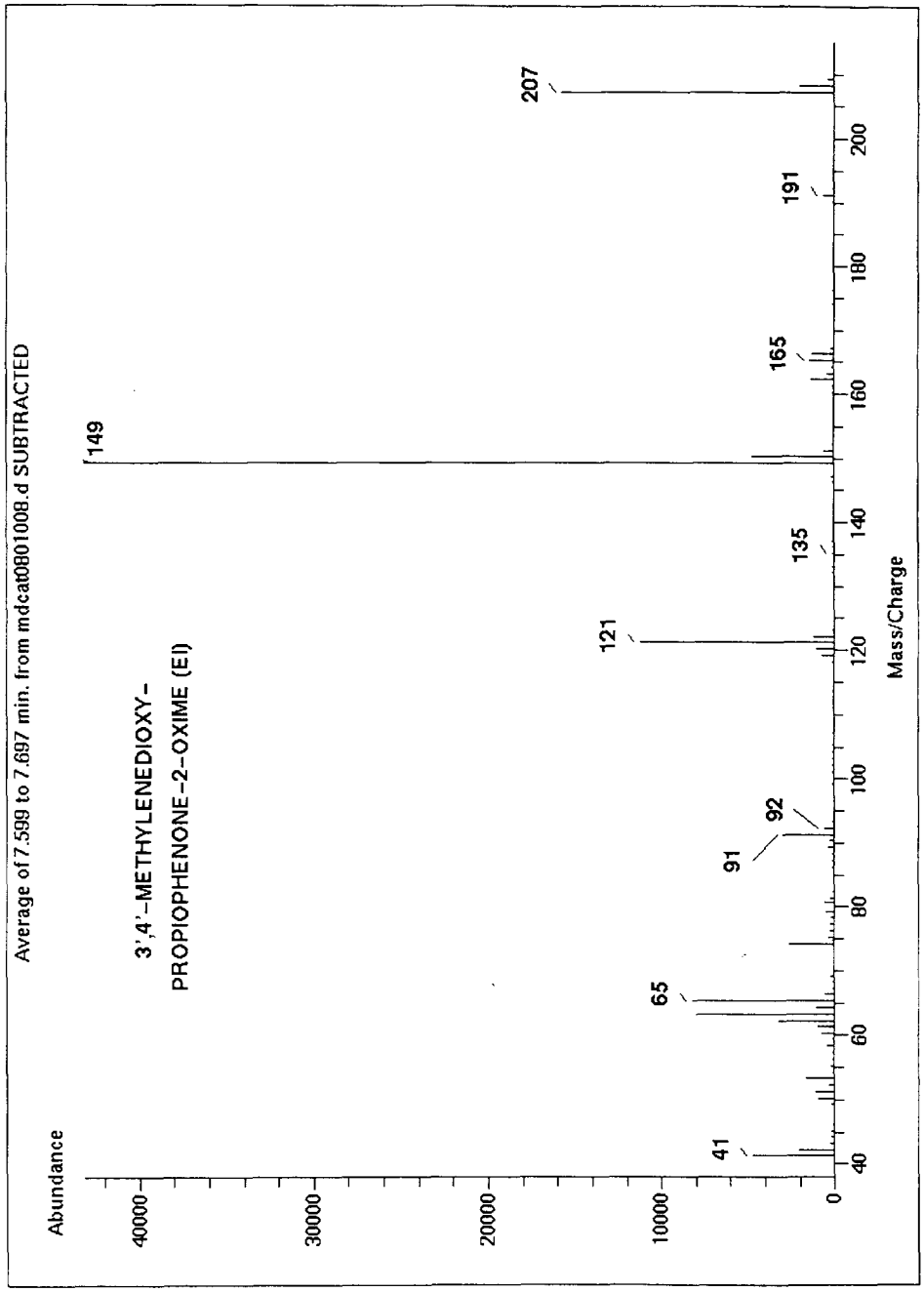

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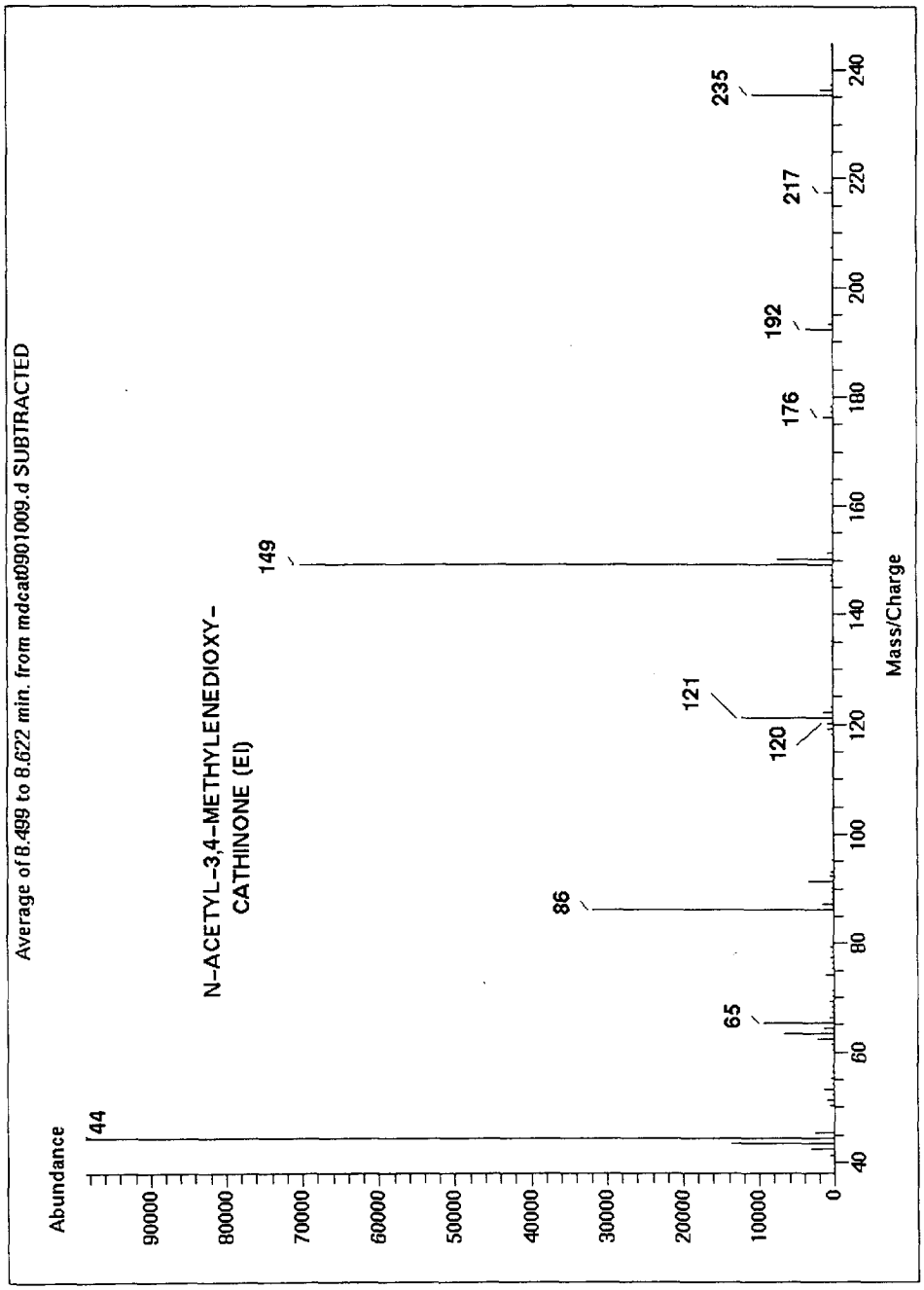

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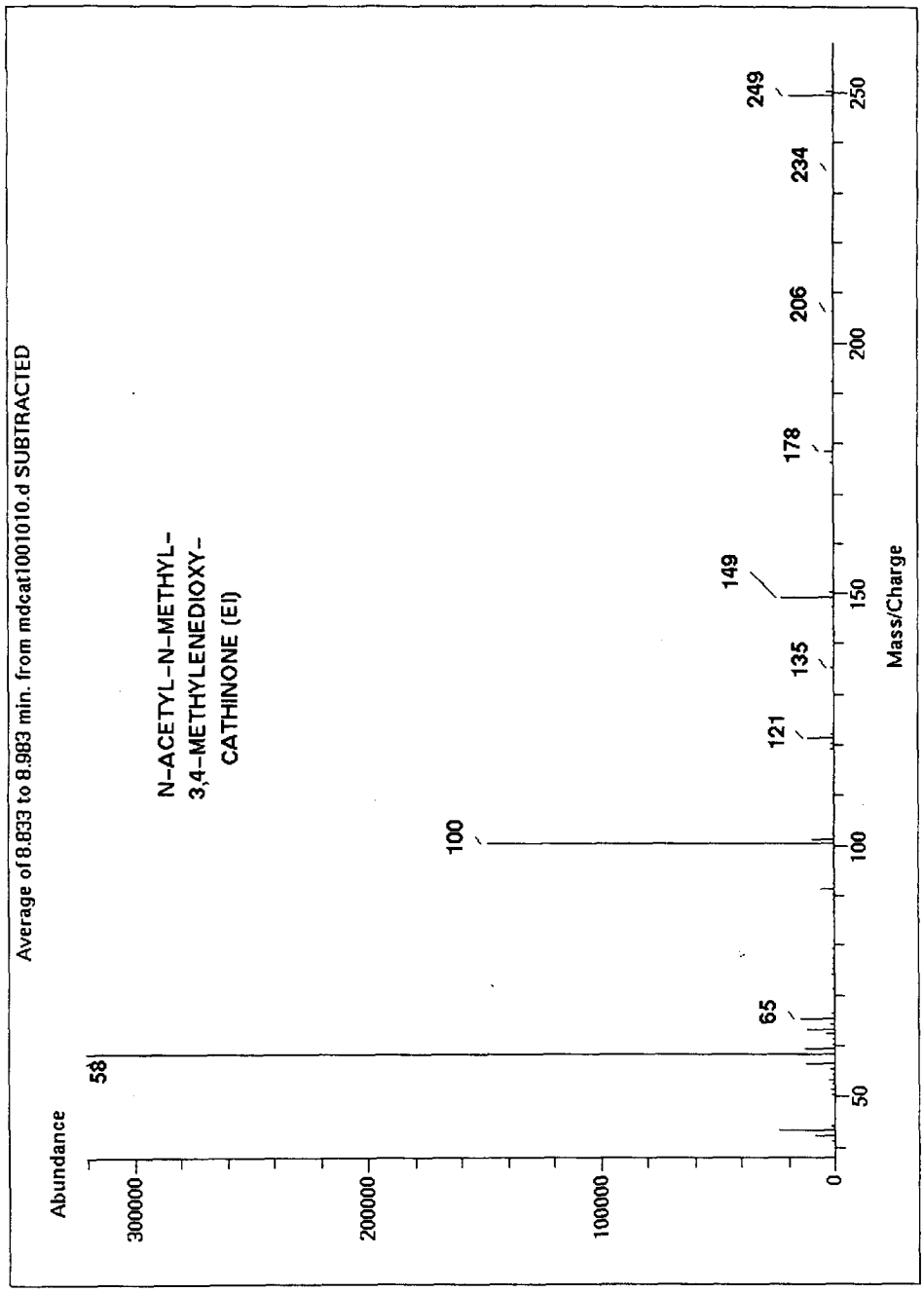

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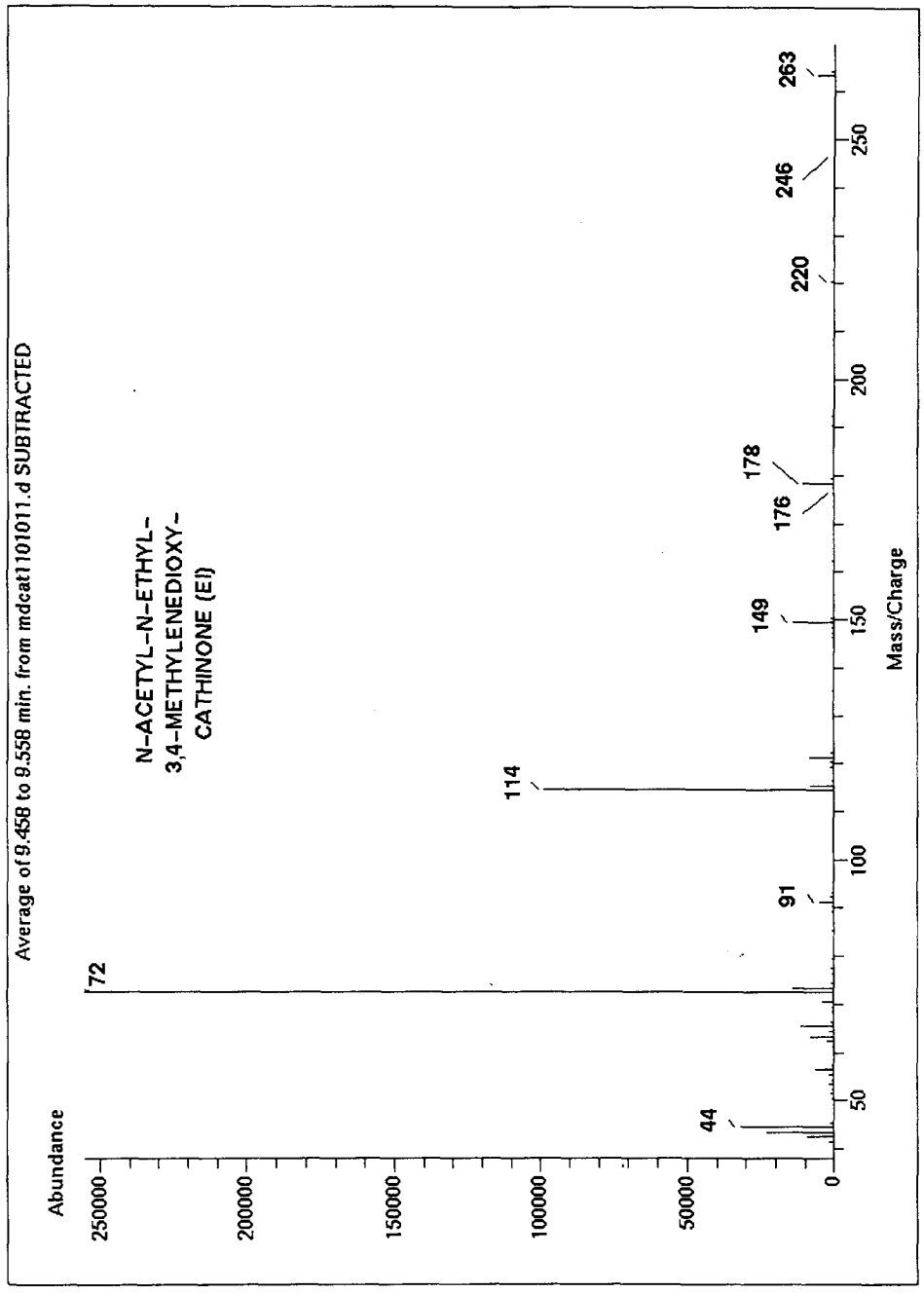

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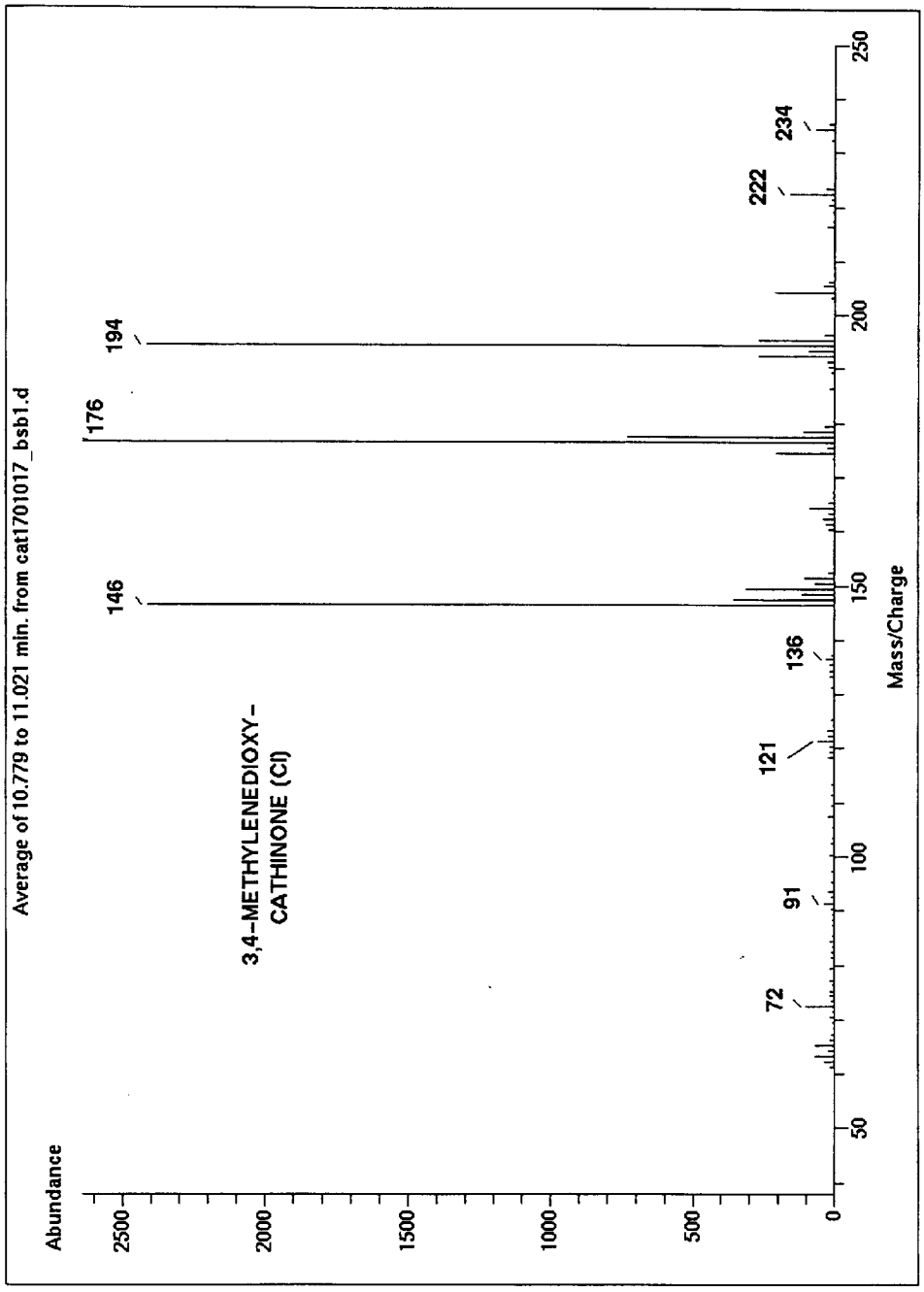

Fig. 5. Chemical ionization mass spectra for MDCATH homologs.

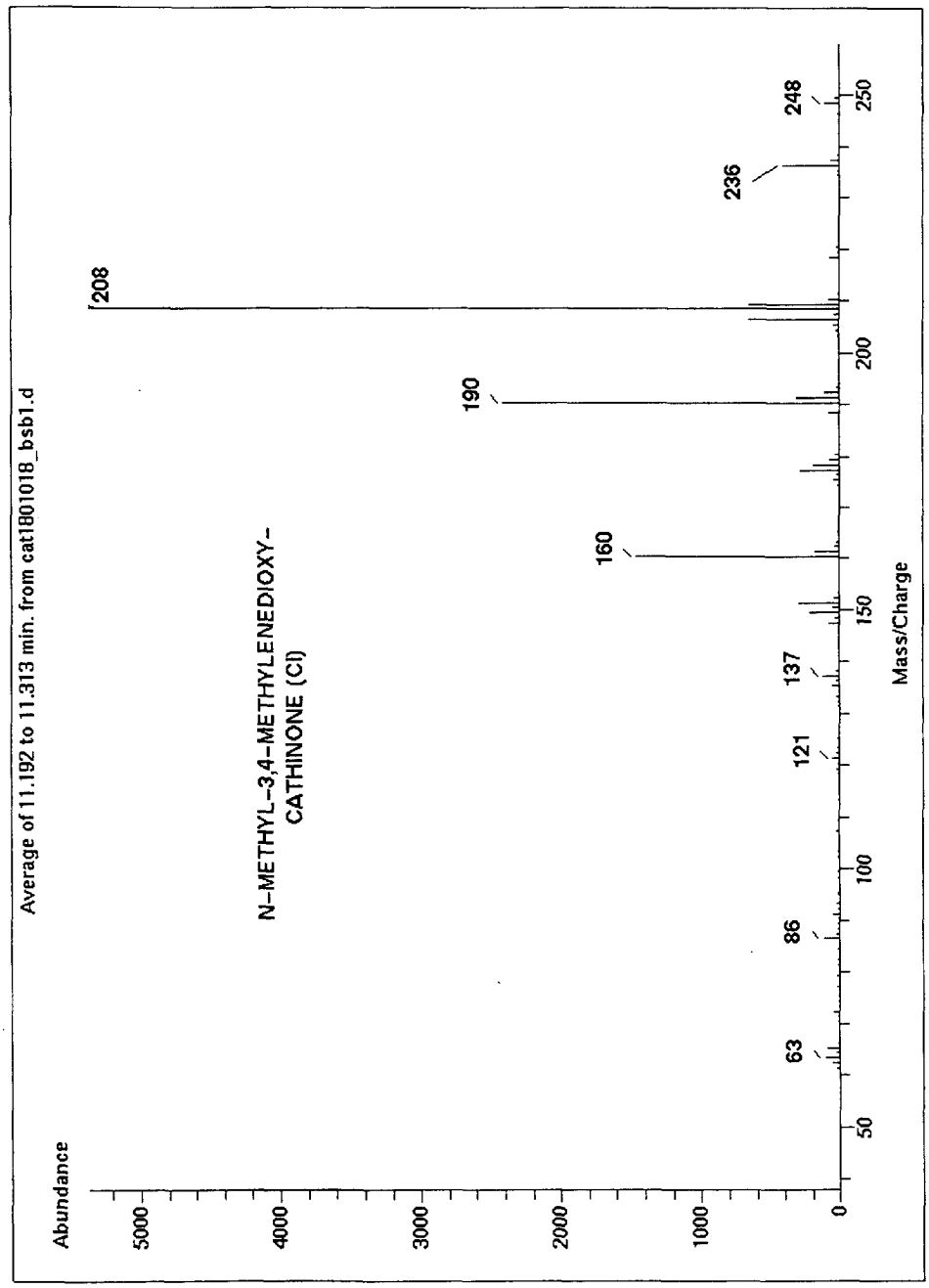

Fig. 5. (*continued*)

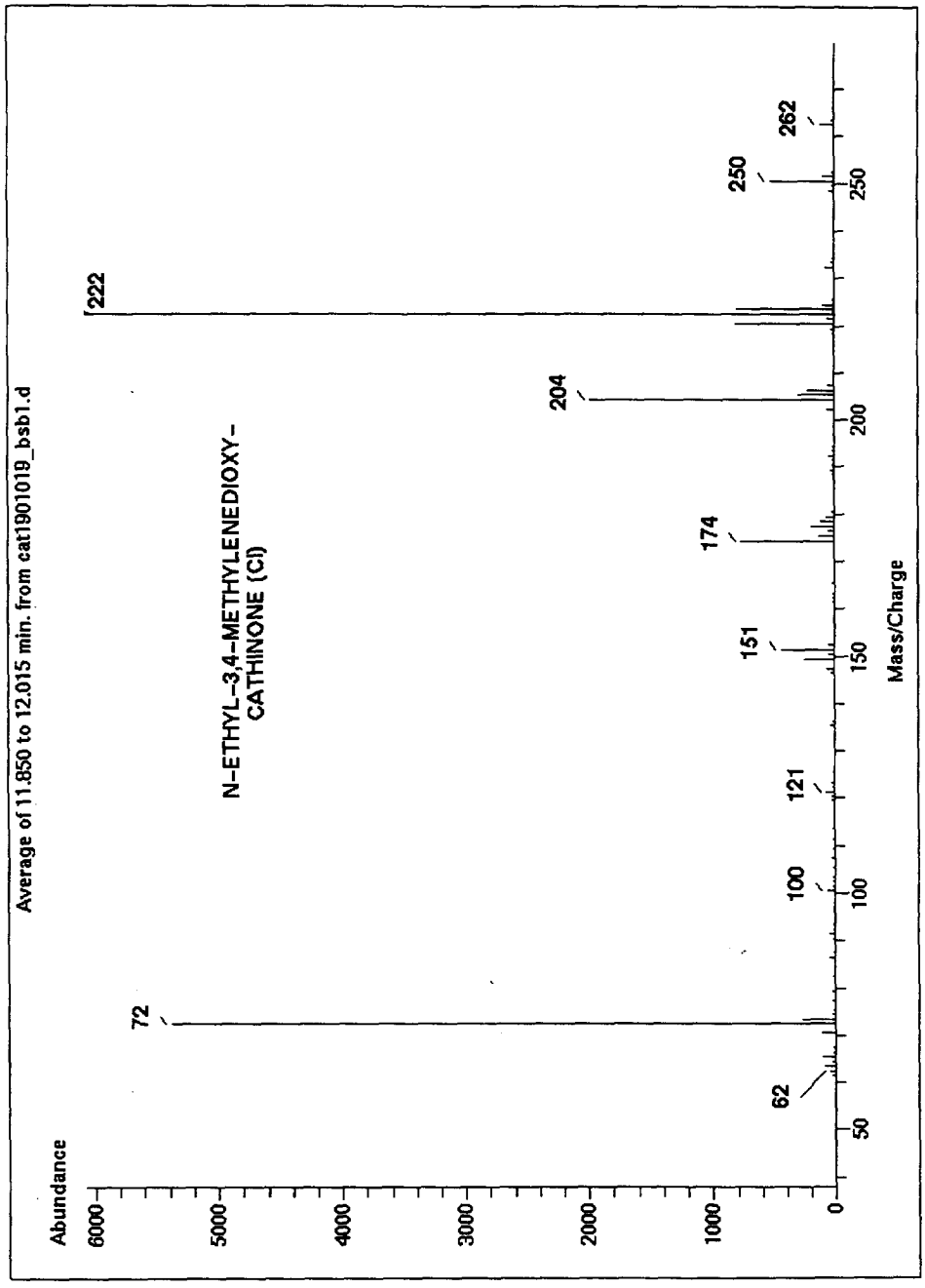

Fig. 5. (*continued*)

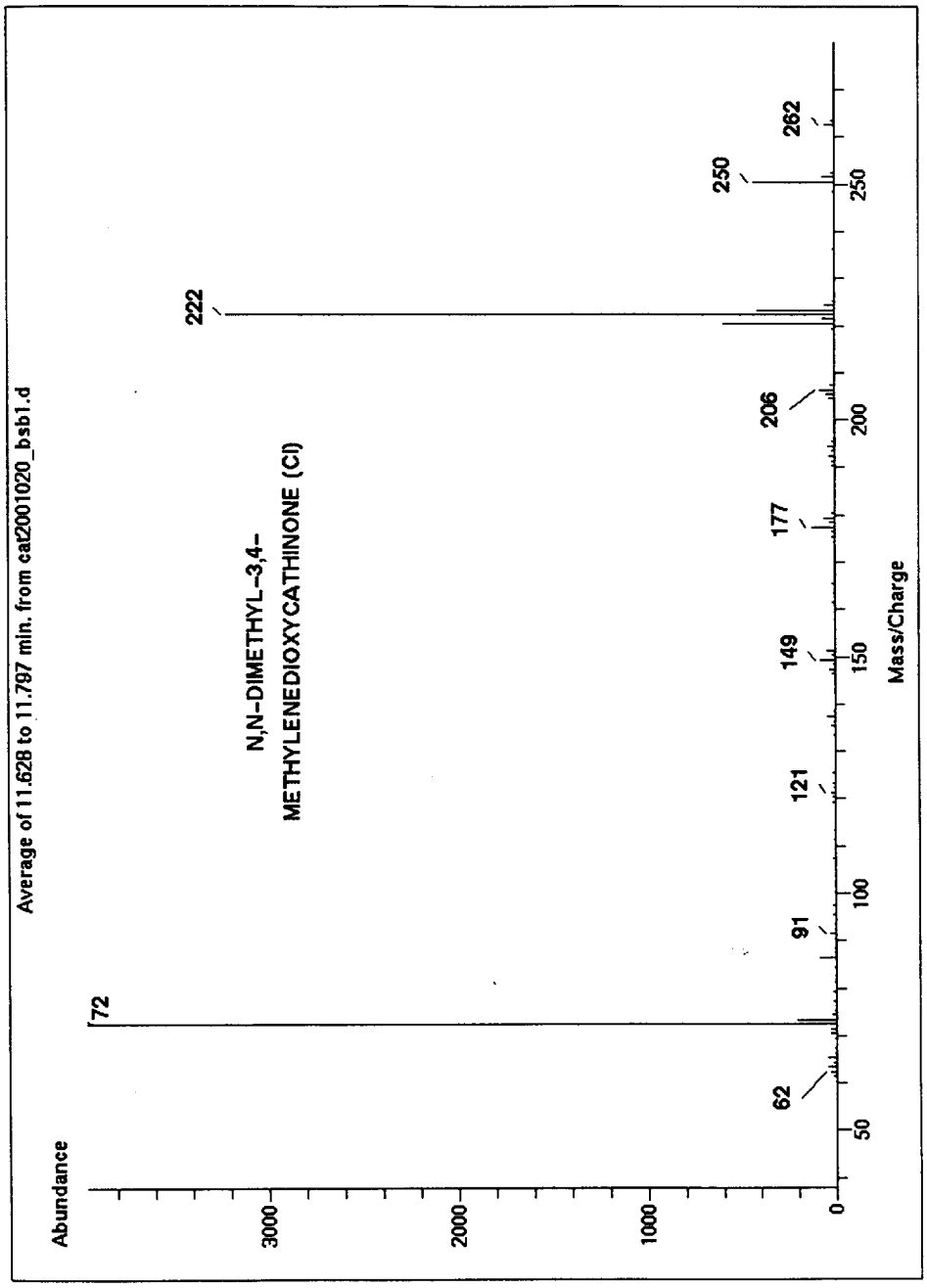

Fig. 5. (*continued*)

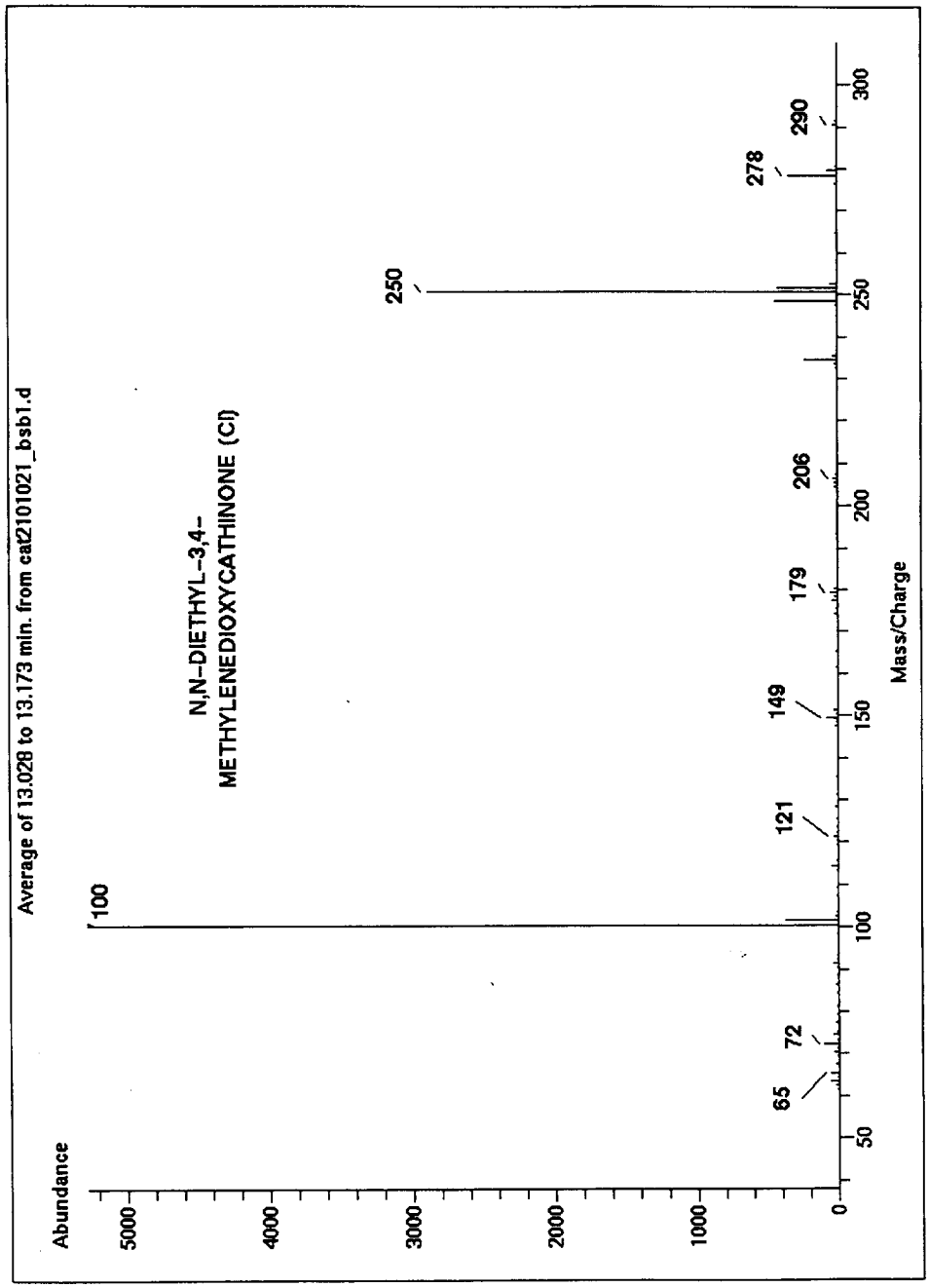

Fig. 5. (*continued*)

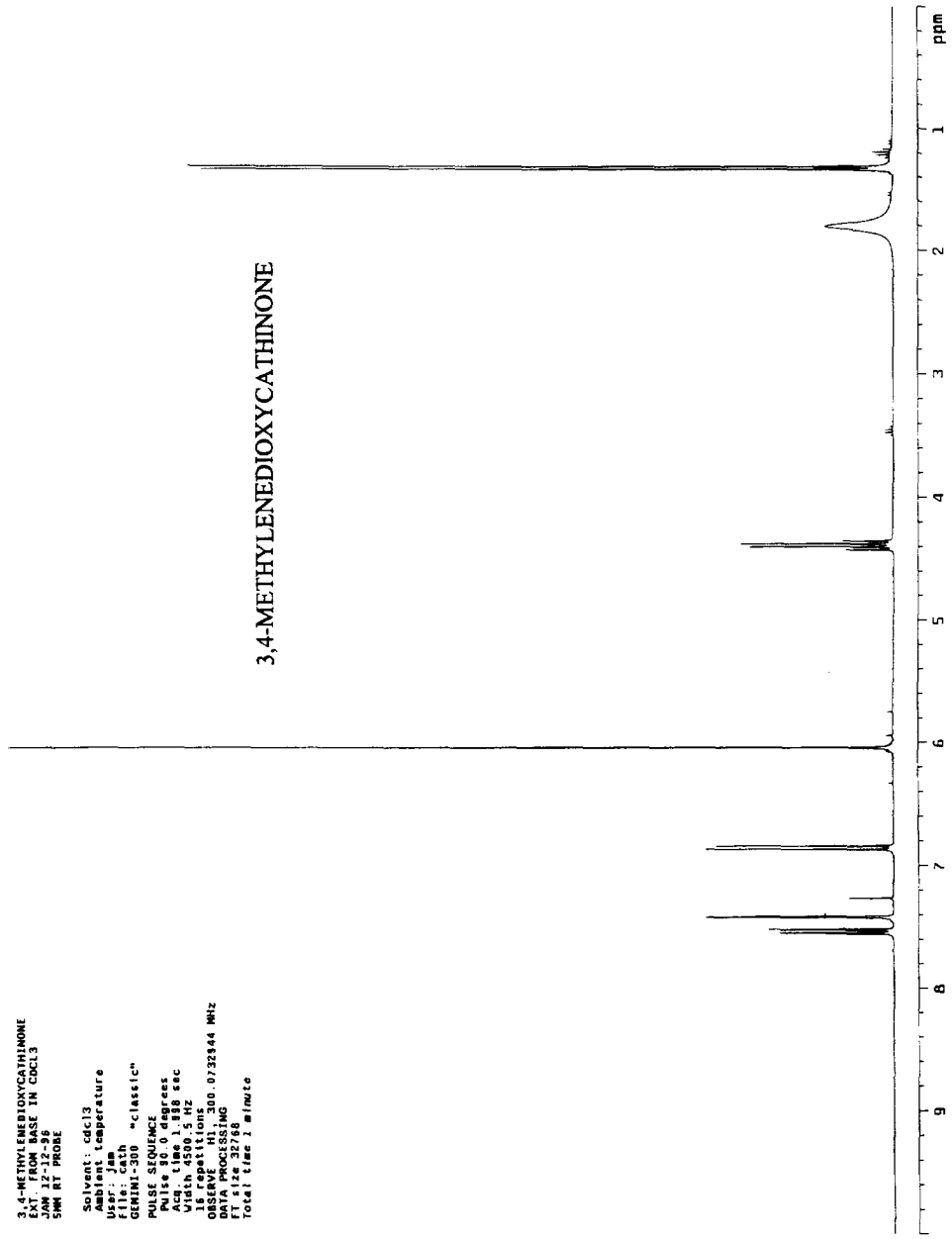

Fig. 6. Proton nuclear magnetic resonance spectra for MDCATH homologs.

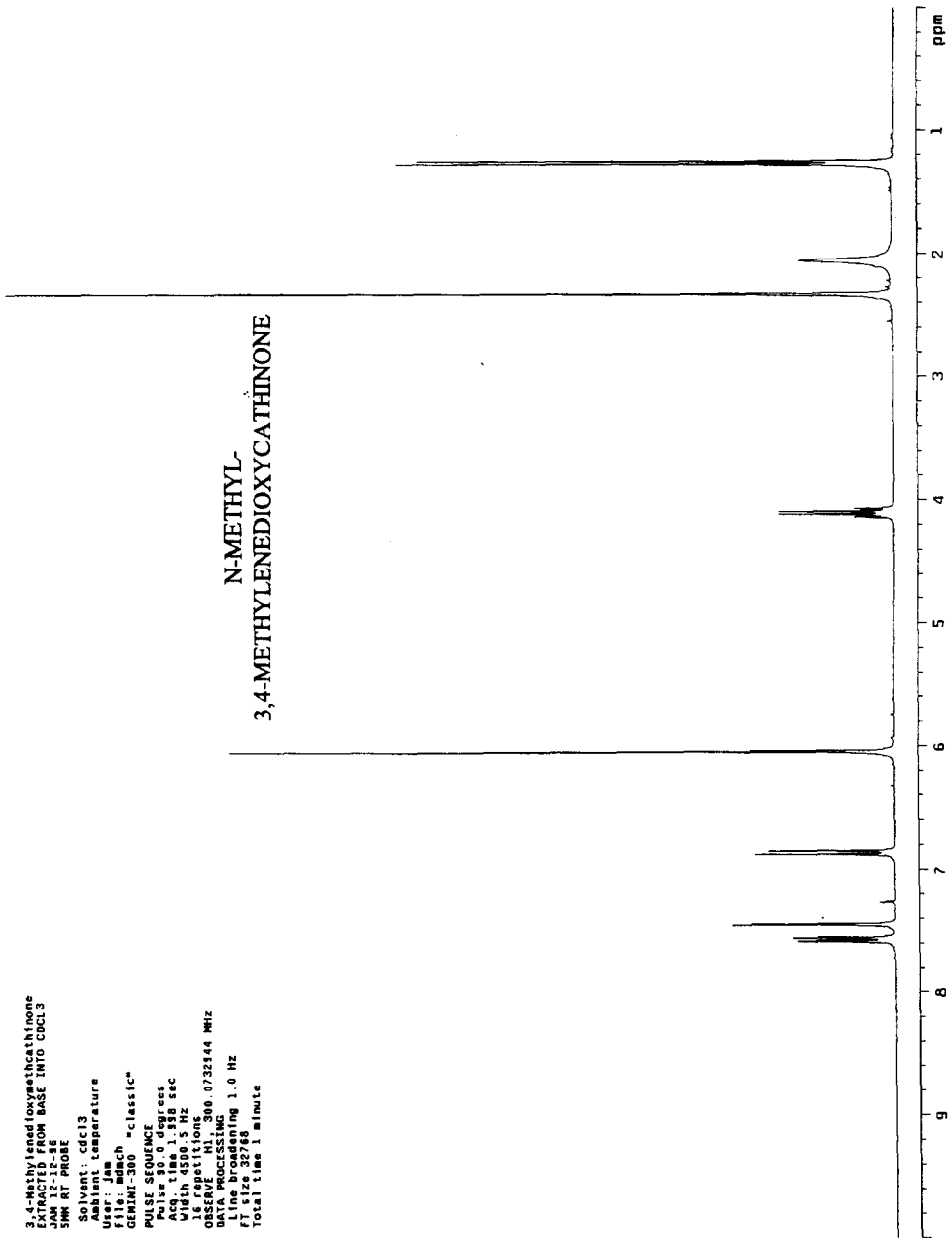

Fig. 6. (*continued*)

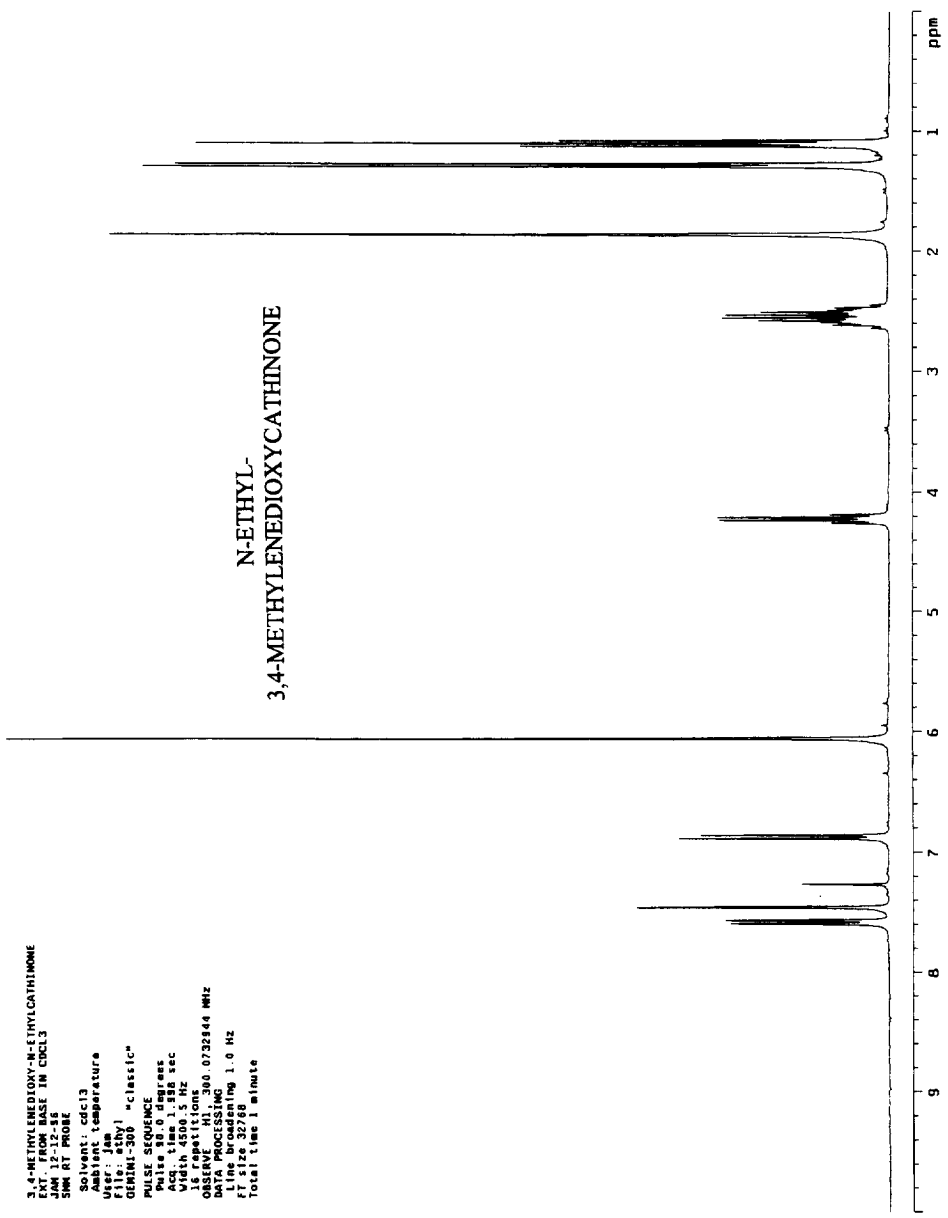

Fig. 6. (*continued*)

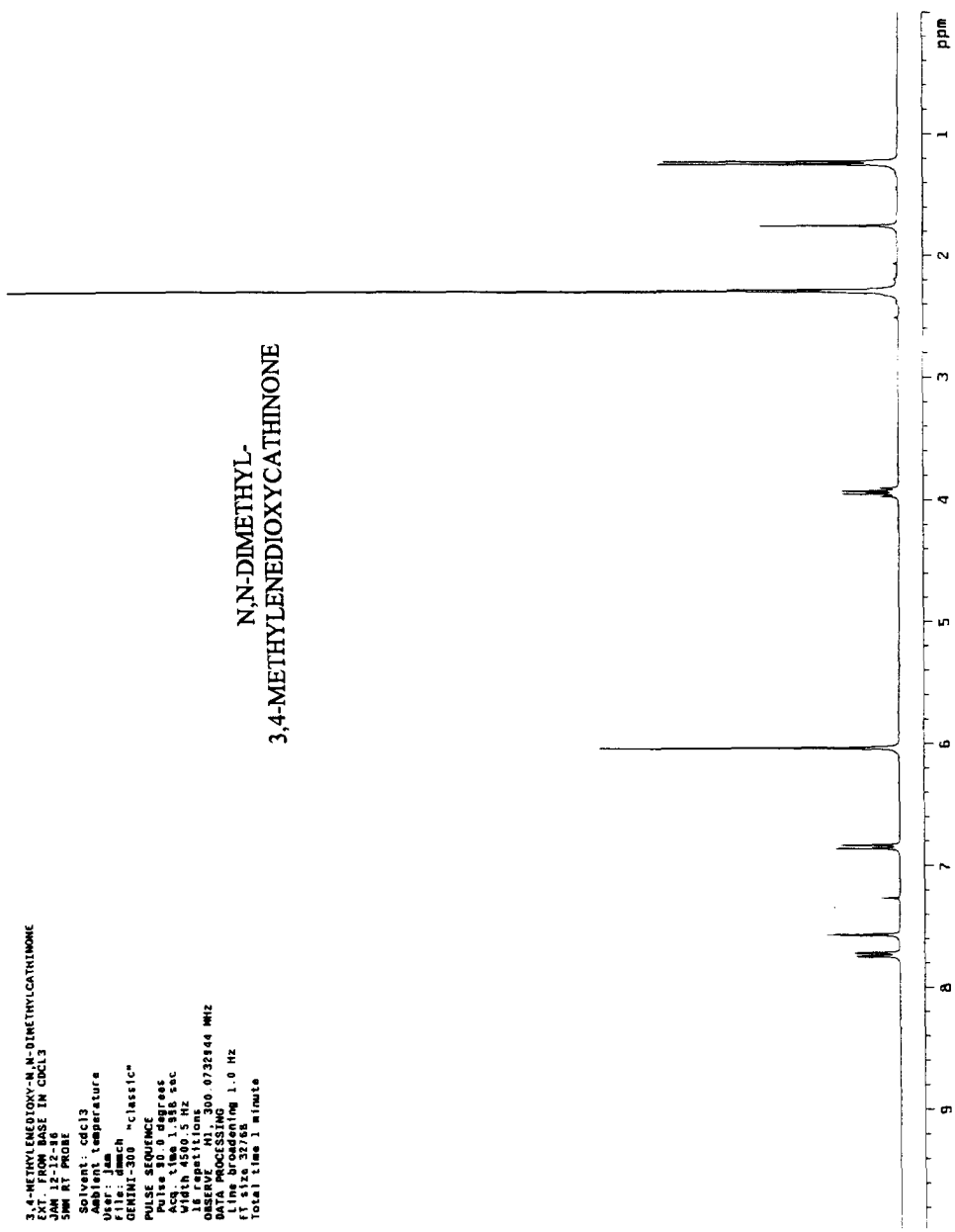

Fig. 6. (*continued*)

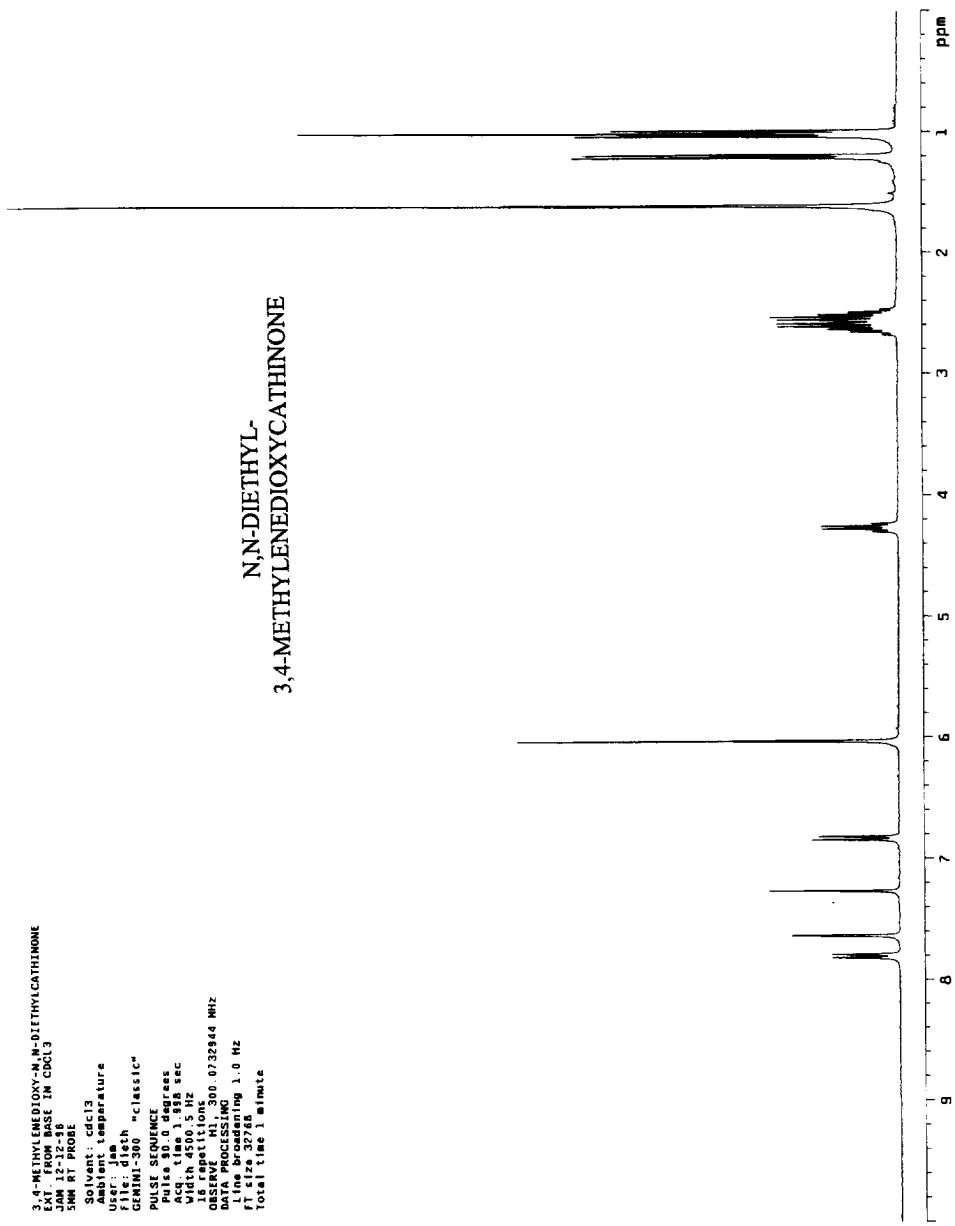

Fig. 6. (*continued*)

3,4-methylenedioxypropiophenone (3′,4′-methylenedioxyphenyl-1-propanone)[8], served as the precursor for compounds VII and VIII, which in turn served as the precursors for the reported 3,4-methylenedioxy-β-keto-amphetamine homologs. The C,H,N analysis for compound I·HCl (theory C, 52.30; H, 5.27; N, 6.10; found C, 52.24; H, 5.28; N, 6.07) and II·HCl (theory C, 54.22; H, 5.79; N, 5.75; found C, 54.14; H, 5.76; N, 5.74) was performed by Atlantic Microlab, Inc., Norcross, Georgia.

3. Results and discussion

Methylenedioxycathinone and four homologs, along with the precursors used for their synthesis, were examined by a variety of instrumental and chemical techniques which are representative of the wide spectrum of instrumental and analytical methods available to forensic drug laboratories. The results of each category of testing are discussed below. Based on the capabilities of individual analytical laboratories, selection of an appropriate combination of these methods will permit positive identification of Compounds I–V.

3.1. Presumptive tests

Although presumptive tests are rarely discussed in analytical papers, they can be of significant value in gathering information about an 'unknown' at the beginning stage of analysis. Presumptive tests generally indicate a positive result by formation of a certain color which is characteristic of a class of compounds (i.e. functional groups). By using a select assortment of 'color' reagents, it is often possible to narrow the identity of an unknown sample to a small number of compounds. Four presumptive tests (Table 2) are of particular use in helping to identify substituted amphetamine analogs. The Marquis' test is typically used to indicate the possible presence of amphetamine, methamphetamine, and/or dimethylamphetamine by reacting with them to form an orange color. Mecke's reagent yields an emerald green color which *instantly* turns to an intense Prussian blue in the presence of MDA and its N-substituted homologs. Because the methylenedioxy bridge is absent in the parent 'β-hydroxyamphetamines' and 'cathinones', they do not respond to Mecke's reagent. In contrast, an intense yellow color results with the methylenedioxycathinone homologs, and a color change from orange to brown occurs with the two methylenedioxy-β-hydroxyamphetamine analogs, when in contact with Mecke's reagent. Norephedrine, ephedrine and their diastereoisomers (generically, β-hydroxyamphetamine and β-hydroxymethamphetamine respectively) produce no color with this reagent, nor with the Marquis' test.

The secondary amine test (2° amine test, nitroprusside test) will distinguish the secondary amine methamphetamine from both amphetamine and *N,N*-dimethylamphetamine by exhibiting a deep blue color. Ephedrine and pseudoephedrine, even though

[8]Purchased from Frinton Laboratories, Vineland, N.J.

they possess a secondary amine function, do not react with this reagent, nor does 3,4-methylenedioxyephedrine. The Chen's test forms an immediate purple color when the third of the test reagents mixes with norephedrine, ephedrine or their diastereoisomers. With this three reagent test, cathinone and methcathinone give a mild orange color after 20–30 s. Approximate reaction times for the Chen's test and the five reactive β-keto amines are listed in Table 2. In case work, unknowns were found to contain ephedrine or pseudoephedrine in combination with methcathinone. In testing these exhibits, the immediate color response of the Chen's test is purple followed by a gradual fading over 45–75 s to the mild orange color of methcathinone.

When performing the secondary amine and/or Chen's tests, each of which require sequentially adding multiple components, a blank composed of the mixed reagents should accompany the test samples. This step provides an accurate reference for determining negative responses.

3.2. Gas chromatography

Two types of column coating, HP-1 and HP-17 (DB-17)[9] were examined using ephedrine as a reference standard (Table 3). Although HP-1 is a superior coating for separating these amines, N-acetylation (see Section 3.4) provides a means to sufficiently separate these analogs using an HP-17 liquid phase.

3.3. Infrared spectrometry

Infrared spectra of MDCATH and four of its homologs as the hydrochloride salts are presented along with spectra of the three precursors used in the synthesis of these ring substituted β-keto amines (Fig. 2). Conjugation of the carbonyl group with the methylenedioxyphenyl group results in absorption (1680–1665 cm^{-1}) within the theoretical 1685–1666 cm^{-1} range [23] for all of the compounds except VIII. Carbonyl overtones can usually be seen at twice the C=O stretch frequency [24] and this is particularly well illustrated in the spectrum of *N,N*-dimethyl-3,4-methylenedioxycathinone HCl. All of these compounds are easily differentiated by solid phase IR. Gas phase IR spectra, however, lack the fine structure associated with the solid phase spectra and differentiation of these compounds by vapor phase IR requires close scrutiny. Emphasis on comparison of rather small changes in intensity and wave number become important, particularly in the range of 3000–2750 cm^{-1} and again below 1100 cm^{-1}. Additionally, the two tertiary amines, IV and V, show a shift in the relative intensity of the absorptions at (1487–1485) cm^{-1} and (1439–1437) cm^{-1} when compared with their primary and secondary amine homologs. Each of the gas phase IR spectra also has an associated retention time which may facilitate positive identification. As GC eluates, the vapor phase spectra have an advantage of representing very pure compounds which don't suffer from solid state IR complications such as polymorphism and multiple hydrated forms.

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[9]HP-1: 100% bonded methylsilicone; HP-17 and DB-17 (J&W Scientific, Folsom, Ca.): 50% 'cross-linked' phenyl methyl silicone.

3.4. Mass spectrometry

The electron impact mass spectra of I–VIII, and the acetylated spectra of I–III, are presented in Fig. 4. Although MDCATH has a noticeable parent peak of about 3% of the base peak, the homologs show vanishingly small molecular ions (M^+) typical of phenethylamines. Adding several drops of acetic anhydride to the compounds (free bases in $CHCl_3$) allows formation of acetamides in the hot injection port of the GC. For Compounds I–III this provides an additional mass spectrum of each as the N-acetyl derivative and an accompanying retention time. Since Compounds IV and V (i.e. tertiary amines) are incapable of N-acetylation, this technique permits differentiation from primary and secondary amines (i.e. IV vs. III) based on their chemistry. The acetylated compounds retain their base peaks (B) and acquire a (B+42) fragment and an (M+42) molecular ion. Also of interest is the effect of the addition of bromine to Compound VI, to give Compound VII. Dual molecular ions at 256 and 258 Da represent the nearly equal distribution of abundances of isotopes ^{79}Br and ^{81}Br which are present in the brominated precursor.

Chemical ionization mass spectra are provided only for the amines (Fig. 5). Each of the spectra shows mass fragments of (M+1), (M+29) and (M+41) characteristic of methane ionization (Table 4) [25–27]. In I, II and III, an unusual fragment occurs at (M+1)−48. Based on comparison with a variety of related amphetamine analogs, formation of this fragment requires that three criteria be met: (1) a methylenedioxy bridge must be present on the phenyl group; (2) a ketone function must be present at the β carbon position and (3) there must be at least one amino hydrogen present. The CI mass spectrum (M+1)−48 fragment may then be explained as a loss of water (−18) involving the carbonyl oxygen and a loss of formaldehyde (−30) from the methylenedioxy bridge[10].

3.5. Proton nuclear magnetic resonance

The proton NMR spectra of I–V each provide the same series of chemical shifts above 3.8 ppm but with small changes in the observed sigma values among the homologs (Fig. 6). The singlet from resonance of the two methylenedioxy protons is found at 6.0–6.1 ppm while the protons directly attached at ring positions 2, 5 and 6 show a doublet between 7.55–7.85 ppm (H-5), a singlet between 7.4–7.7 ppm (H-2), and a doublet between 6.8–6.9 ppm (H-6). The other common resonances result from the proton on the amino bearing carbon giving a quartet (3.9–4.45 ppm) and the terminal methyl providing a doublet (1.2–1.35 ppm). Compounds I and II also exhibit broad resonances at 1.8 and 2.1 ppm respectively for the amino proton(s). Integration of the spectra should allow easy differentiation of II from IV and III from V. A more detailed account of the application of NMR spectroscopy (proton and carbon) to the identification of relevant MDA analogs has recently been published [28].

[10]Dr Fred W. McLafferty, Cornell University, Ithaca New York, personal communication 26 December 1996.

3.6. Melting points

Cathinone HCl and a number of its various analogs and homologs (as HCl) appear to be hygroscopic to some degree. The reported melting point ranges (Table 1) were obtained on samples dried under vacuum (12 mm) for at least 48 h. Approximate melting point ranges for each of the MDCATH HCl homologs were recorded while rapidly raising the bath temperature. The bath temperature for each compound was then dropped 10° below the observed initial melting point. An accurate melting point range was determined by raising the temperature at a slower rate of 2° per minute. Each of the β-keto amines sinters as the lower value of the melting point range is approached and then liquifies into a red-brown to dark brown melt. The melting is accompanied by effervescence typical of some previously reported cathinone analogs [29,30].

4. Conclusions

Over the past 35 years, clandestine chemists synthesized a variety of drugs based on substitutions to the structure of the amphetamine molecule. These analogs appeared in the illicit drug market without warning and proved difficult to identify when analytical data was not readily available for comparative purposes. One series of analogs which may be synthesized in clandestine drug manufacturing laboratories is based on the structures of MDA and cathinone: 3,4-methylenedioxycathinone. Use of the appropriate combination of chemical, physical and instrumental techniques presented here will allow rapid and conclusive identification of methylenedioxycathinone and four N-substituted homologs. The pertinent data for the identification of the three precursors used to synthesize these drugs is also included.

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