The 2013 “Research on Drug Evidence” Report
[From the 17th ICPO / INTERPOL Forensic Science Symposium]

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ABSTRACT: A reprint of the 2013 “Research on Drug Evidence” Report (a review) is provided.

KEYWORDS: INTERPOL, Illicit Drugs, Controlled Substances, Forensic Chemistry.

Important Information:

Distributed at the 17th ICPO / INTERPOL Forensic Science Symposium, Lyon, France, October 8 - 10, 2013.*

For pertinent background, see: Klein RFX. ICPO / INTERPOL Forensic Science Symposia, 1995 - 2016. “Research on Drug Evidence”. Prefacing Remarks (and a Request for Information). Microgram Journal 2016;13(1-4):1-3.

Citations in this report from the *Journal of the Clandestine Laboratory Investigating Chemists Association* were (and remain) Law Enforcement Restricted.

The "General Overview" (Talking Paper) was removed from this reprint (Editor's discretion).

This reprint is derived from the original electronic document, and is *not* an image of the best available hard copy (as was utilized for the 1995 and 1998 reports). For this reason, the pagination in the Proceedings is not retained in this reprint, some minor reformatting was done to eliminate deadspace, and all widow and orphan lines were left as is.

[* Due to travel restrictions in effect in late 2013, this report and the associated "General Overview" (Talking Paper) was not actually presented, but rather the report was only distributed to the attendees.]

Research on Drug Evidence

January 1, 2010 - June 30, 2013

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Preface Notes:

1. With the exception of synthetic cannabinoids and cannabimimetics, all references are subdivided by individual drug, drug group or class, or general topic, then chronologically, and finally alphabetically within each year (first author's last name). Individual synthetic cannabinoids and cannabimimetics are included in that drug group (i.e., not as individual drugs). In addition, and in contrast to past reports from this laboratory, references are organized as much as is practical by specific drug or drug group/class. This change is necessary because of the large numbers of similar types of "designer drugs," most notably the synthetic cannabinoids and cannabimimetics, the cathinones and related amphetamine-type-stimulants, and the methylenedioxyphenethylamines and related hallucinogens.

2. References from January 1, 2010 to June 30, 2010 are included because many were either not cited in the last review (because they had not yet been abstracted or printed), or were cited as "Ahead of Print" (i.e., without volume, issue, or page numbers). Some of the references from January 1, 2013 to June 30, 2013 in this report are similarly cited as "Ahead of Print;" all such references were still in "Ahead of Print" status as of June 30, 2013. Readers should be aware that the year listed with "Ahead of Print" may not reflect the eventual year of publication; however, the article's author(s), article title, and journal should remain the same regardless of the actual year of publication, allowing the full citation to be easily found by Internet searching.

3. Note that the following reference is law enforcement restricted, and is not available to the

general public: *Journal of the Clandestine Laboratory Investigating Chemists Association* (all years). All other references cited in this report were acquired from the "Forensic Chemistry" sections of Chemical Abstracts, and to the author's knowledge are non-restricted. [Please also note that the second quarterly issue of the 2013 *Journal of the Clandestine Laboratory Investigating Chemists Association* (i.e., 2013; 23(2)) had not been published by the reference cutoff date, June 30, 2013.]

1. Routine and Improved Analyses of Abused Substances

Improved methods of analysis, i.e., faster, more discriminatory, more sensitive, less costly, etc., are needed for all abused substances. Additionally, standard analytical data are required for previously unknown or rarely encountered substances and/or new "designer drugs."

Drug seizures and clandestine laboratory operations are continuously monitored to provide a comprehensive overview of new developments. Ongoing research in the forensic community, as well as in the general fields of analytical chemistry and toxicology, provide new and/or improved methods of analysis for abused substances. Reports providing standard analytical data for new drugs of abuse and/or improved analytical protocols for known drugs of abuse are generated for the forensic and enforcement communities.

1.A - General Reviews and Overviews
1.B - Individual Compounds or Substances
1.C - Common Groups or Classes of Compounds or Substances
1.D - Polydrug A: Mixed or Unrelated Named Compounds or Substances

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1.A - General Reviews and Overviews

2010 INTERPOL Triennial Report on forensic science (1); brief overview (2); **2011** Analytical Chemistry biannual review of forensic science (3); brief, conversational overview (4).

1.B - Individual Compounds or Substances (except individual synthetic cannabinoids and cannabimimetics)

Alprazolam: 2011 analysis by DART-TOF-MS (5);

Amphetamine: 2010 2H and 13C isotope ratios in amphetamine synthesized from benzaldehyde and nitroethane (6); impurity profiling (7); **2011** by Raman and SERS, with spectral analyses by ab initio calculations (8);

1-Benzyl-4-methylpiperazine: 2012 identification by MS, after derivatization with trifluoroacetic anhydride, and by NMR (9);

Buphedrone (2-(methylamino)-1-phenylbutan-1-one): 2013 characterization with GC/MS, HPLC-DAD, and LC-MS/MS (10);

Buprenorphine: 2011 by GC/MS (11);

2-(4-Chloro-2,5-dimethoxyphenyl)-N-[(2-methoxyphenyl)methyl]ethanamine (25C-NBOMe): 2013 characterization by GC-EI-MS (with and without derivatization with TFAA), LC-ESI-QTOF-MS, FTIR, and NMR (12);

meta-Chlorophenylpiperazine (m-CPP): 2011 characterization by easy ambient sonic-spray ionization, XRF, IMS, and NMR (13);

Citalopram: 2012 determination by chromatographic and spectrophotometric methods (14);

Cocaine: 2010 detection on clothing using Raman (15); transacetylation of benzocaine by acetylsalicylic acid to create N-acetylbenzocaine in cocaine (16); comparison of corona discharge ionization-IMS versus AP-CI-MS for detection of cocaine (17); a 20 year survey of cocaine seized in France (year range not specified in the abstract) (18); detailed evaluation of the mass spectrum of cocaine (19); **2011** detection of cocaine solutions in sealed bottles of (nominal) alcoholic beverages by Raman (20); determination on banknotes using an aptamer-based electrochemiluminescence biosensor (21); detection of 2,6-diisopropylnaphthalene as an adulterant in cocaine by GC/MS (22); detection of cocaine solutions in wine bottles by 1H-NMR (23); detection by TLC and cobalt thiocyanate (24); detection based on strand-displacement polymerization and fluorescence resonance energy transfer (25); analysis and classification using GC/IRMS to determine d13C values (26); use of the gold chloride microcrystalline test to identify cocaine and certain adulterants (27); temperature-dependent elimination of benzoic acid during pyrolysis of cocaine (28); analysis by TLC coupled to easy ambient sonic-spray ionization MS (29); use of metastable state nanoparticle-enhanced Raman for highly sensitive detection of cocaine (30); **2012** determination of phenyltetrahydroimidazothiazole enantiomers (present in cocaine) by chiral GC (31); detection by structure-switch aptamer-based CZE (32); determination of the time lag between coca leaf harvest and the seizure and analysis of illicit cocaine (33); analysis using differential mobility spectrometry-MS (34); by electrochemical detection (35); detection using a specialized fluorescence sensor (36); analysis of cocaine smuggled by dissolution in polyvinyl alcohol in a dance pad (37); quantification of binary mixtures of cocaine and adulterants using dispersive Raman, FTIR, and Principal Component Regression (38); analysis of Brazilian "oxi" cocaine (analytical methods not specified in the abstract) (39); **2013** by electrochemical determination (40); by GC/FID (41); detection of hygrine and cuscohygrine as possible markers (to distinguish coca chewing from cocaine abuse) by GC/MS (42); comparative analysis of solvent impurity profiles obtained by HS-GC/MS (43);

Diazepam: 2010 detection in spiked alcoholic beverages by fluorimetry (44);

3,4-Dimethylmethcathinone (3,4-DMMC): 2012 characterization by GC/MS, LC/MS, 1D- and 2D-NMR, IR, and UV (45);

2,5-Dimethoxy-3,4-dimethyl-beta-phenethylamine (2C-G): 2012 by GC-EI/MS (including after derivatization with trifluoroacetic anhydride), LC-ESI/QTOF-MS, LC-ESI/QTOF-MS/MS, FTIR, and 1H- and 13C-NMR (46);

2,5-Dimethoxy-4-nitro-beta-phenethylamine (2C-N): 2012 characterization by GC-EI/MS, LC/ESI-QTOFMS, FTIR, and NMR (including after derivatization with trifluoroacetic anhydride) (47);

2-(Diphenylmethyl)pyrrolidine: 2011 by GC-EI/CI-ion trap-MS and HPLC/DAD-ESI-MS (48);

N-Ethyl-alpha-ethylphenethylamine: 2013 characterization by GC/MS, LC-TOF-MS, and 1D- and 2D-NMR (49);

Ethylphenidate: 2011 characterization by MS, IR, and 1H- and 13C-NMR (50);

Fentanyl: 2012 impurity profiling using UHPLC-MS/MS (51);

Flunitrazepam: 2011 detection using a photocatalytic reaction with ZnO particles with monitoring by UV-Vis (52); **2012** detection in alcoholic beverages by DESI-MS (53);

Glaucine: 2010 detection in "legal highs" (54);

Heroin: 2010 a probabilistic approach to heroin signatures (55); profiling and classification of illicit heroin by GC/MS of acidic and neutral manufacturing impurities (56); by optimized GC/FID (57); analysis by FTIR (58); **2011** identification of levamisole and lidocaine acetylation reaction impurities in heroin (59); rapid and semi-quantitative presumptive testing (60); converting GC/MS heroin profiling to a UHPLC-MS/MS method (61); identification of adulterants and diluents in heroin by IR and/or Raman (62); **2012** analysis of trace elements by ICP-MS (63); comparative evaluation using a simplified clustering analysis (64); impurity profiling by GC (65); by GC (66); analysis of heroin containing aspirin, paracetamol, caffeine, theophylline, codeine, acetyl codeine, and monoacetylmorphine, by GC/MS (67); purification of street samples by prep-HPLC (68); analysis by ICP/MS (69); by reflectance NIR (70); impurity profiling based on the major alkaloids (acetylcodeine, 6-monoacetylmorphine, papaverine,

noscapine, codeine, and morphine) (71);

Human Growth Hormone (HGH): 2010 analysis by CE-ESI-TOF/MS (72);

Ketamine: 2010 study of the fragmentation pattern of ketamine-heptafluorobutyramide by GC/MS (73); **2012** detection in beverage residues by LC/MS and MS/MS (74); (see also Methoxetamine, below, and Reference # 528);

Khat (Catha edulis): 2010 preservation of cathinone in khat via drying (75); **2012** qualitative and quantitative analysis of cathinone, cathine, and phenylpropanolamine by GC/MS and GC/FID (76); **2013** analysis by CE (77);

Kratom: 2012 quantitative analysis of mitragynine, codeine, caffeine, chlorpheniramine, and phenylephrine in a kratom cocktail using HPLC (78); by HPLC/ESI-MS (with comparison of 3 different extraction techniques) (79); **2013** by HPLC- DAD (80);

LSD: 2010 quantitation by HPLC (81); **2012** LSD (and 9,10-dihydro-LSD) - by color testing, TLC, EASI-MS, HPLC-UV (82);

Marijuana and Marijuana-Derived Cannabinoids: 2010 tracing geographic and temporal trafficking patterns for marijuana in Alaska using stable isotopes (83); differentiation of fibre- and drug type seedlings by GC/MS and chemometrics (84); tracing retail cannabis in the U.S. using hydrogen and carbon isotope ratios to determine geographic origins, cultivation parameters, and trafficking patterns (85,86); evaluation of an experimental indoor hydroponic cannabis grow operation using the Screen of Green method (87); evaluation of an experimental indoor hydroponic Cannabis grow operation, using the "Screen of Green" yield estimation program, THC analysis, and DNA analysis (88); survey of the potency trends of THC and other cannabinoids in marijuana from 1993 to 2008 (89); analysis of marijuana seized in Novi-Sad, Serbia in 2008 (90); determination of THC, CBD, and CBN in edible oils by UHPLC-MS/MS (91); **2011** use of DNA collection cards for in-the-field sampling (92); differentiation of seedlings by GC/MS and Linear Discriminant Analysis, Partial Least Squares Discriminant Analysis, Nearest Neighbor Classification, Learning Vector Quantization, Radial Basis Function Support Vector Machines, Random Forest, and Artificial Neural Networks (93); a survey of cannabinoid ratios in marijuana seized in California from 1996 to 2008 (94); profiling and source determination by GF AAS and ICP OES (95); differentiation of drug and non-drug marijuana using a single nucleotide polymorphism assay (96); analysis of THC in industrial hemp crops in Morocco (97); differentiation of drug-type and fiber-type by multiplex PCR analysis (98); determination of the long term stability of select cannabinoids (method not reported in the abstract) (99); a formula for determining the yield and quality of indoor grow operations (100);

semi-prep scale isolation of tetrahydrocannabinolic acid A (THCA) using two flash chromatography systems (101); **2012** determination of THC by voltammetry (102); investigation of potential interferences by other drugs with the Fast Blue B and Duquenois-Levine color tests (103); a survey of the potency of marijuana grown in Albania (survey range not listed in the abstract) (104); isomerization of CBD and THC under positive ESI conditions (105); an investigation into the hypothesis of transgenic (genetically modified) marijuana (106); a PCR assay for the relative quantification of THCA synthase gene (107); analysis of DNA by CE for geo-sourcing (108); differentiation between very young drug- and hemp-type cannabis seedlings and cuttings by determination of select cannabinoids by HPLC-DAD (109); classification of cultivars based on analysis of cannabinoids and terpenoids (110); preliminary analysis of genetic diversity of hemp cultivars based on ISSR molecular markers (111); use of delta13C isotope ratios for differentiation of samples (112); a study of the effects of electrical lighting power and irradiance on indoor-grown marijuana potency and yield (113); by LC/API-MS and LC/API-MS/MS (114); determination of THC, CBD, and CBN in marijuana grown in northern Thailand, by GC/FID (115); a study of the long-term storage and stability of hash oil (methods not listed in the abstract) (116); a study of the long-term storage and stability of "cannabis resin" (methods not listed in the abstract) (117); identification and characterization of hybrid and/or high potency marijuana (methods not specified in the abstract) (118); a survey of the potency of marijuana seized in Japan in 2010 (methods not listed in the abstract) (119); use of ultrasound for improved extraction of cannabinoids for HPLC analysis (120); evaluation of the uncertainty of THC determined by HPLC (121); **2013** by HPLC-UV following cloud point extraction (122); by DNA analysis (123); by laser-ablation inductively-coupled plasma MS (LA-ICP-MS) - a review, covering many other applications (124); a study of marijuana potency from the 1970s to the 2000s (125); characterization of seeds by DNA analysis (126);

Mephedrone (4-Methylmethcathinone): 2010 by color testing, GC/MS, and FTIR (127); by LC (128); **2011** by GC/MS following derivatization with 2,2,2-trichloroethyl chloroformate (129); characterization of 2-, 3- and 4-methylmethcathinone (i.e., mephedrone and its two positional isomers) by GC/MS, NMR, and IR (130); synthesis and characterization (synthetic route and analytical methods not specified in the abstract) (131); an overview and literature review (132); **2012** determination of isotopic fractionation to link precursor to product in the synthesis of (±)-mephedrone (133); a literature review (134); a study of the degradation in alkaline solutions (135); **2013** by SERS with a portable Raman (136);

Mescaline/Peyote: 2013 analysis of "peyote tea" by GC/MS and GC/MS/MS in PCI mode (137);

Methamphetamine: 2010 enantio-discrimination of methamphetamine by circular dichroism using a porphyrin tweezer (138); an overview of law enforcement efforts against

methamphetamine production in New Zealand (139); isotope fractionation during precipitation (140); recovery and identification of trace methamphetamine and pseudoephedrine on impermeable surfaces in clandestine laboratories (141); identification of three byproducts found in methamphetamine synthesized by the Emde route (142); identification of iodine and red phosphorus using AccuTOF-DART (143); use of phosphorous acid flakes in the reduction of (pseudo)ephedrine to methamphetamine (144); screening of methamphetamine/methyl sulfone exhibits using Raman spectroscopy (145); **2011** analysis by UFLC (Ultra-Fast-LC) (146); an (unsuccessful) attempted synthesis by electrolytic reduction of pseudoephedrine (147); enantioseparation and identification of methamphetamine and the ephedrines using using trifluoroacetic anhydride derivatization and chiral GC/MS (148); analysis using by highly fluorescent polyfluorenes with NH2-terminated side chains (149); chiral analysis by CE with added cyclodextrins (150); a urea - based "one-pot" methamphetamine synthesis (151); chiral separation with CE using dynamically coated capillaries (includes "related compounds") (152); chiral analysis of the enantiomers of ephedrine, pseudoephedrine, chlorinated intermediates, and methamphetamine by derivatization with fluorinated acid anhydrides followed by GC on a cyclodextrin stationary phase, for impurity profiling of methamphetamine synthesized by the Emde method (153); a study of the efficacy of wipe sampling to determine contamination at clandestine laboratories (with analyses by LC/MS or GC/MS) (154); **2012** comparative analysis of impurity profiles from GC/FID (155); the environmental fate of clandestine laboratory waste (156); impurity profiling of Iranian seizures using GC/MS and LC/MS (157); an overview of abuse, treatment, and U.S. law (158); identification of (1S,2S)-1-methylamino-1-phenyl-2-chloropropane as a route specific marker impurity for methamphetamine synthesized from ephedrine via chloroephedrine (159); impurity profiling of methamphetamine synthesised by the Birch method (160); impurity profiling of methamphetamine synthesized using the Nagai method (161); critical evaluation of LLE and SPME methods for impurity profiling (162); detection of trace ephedrine and pseudoephedrine in high-purity methamphetamine by HPLC (163); degradation of 1-(1',4'-cyclohexadienyl)-2-methylaminopropane in soils (164); degradation of methamphetamine production precursors and byproducts in soils (165); chiral analysis of chlorinated intermediates of methamphetamine (from the Emde synthesis) by 1D- and 2D-NMR and GC/MS (166); analysis of a sample cut with diphenylmethane, by GC/MS (167); a study of the effects of synthetic conditions on the d13C, d15N, and d2H isotope ratios of the final product (168); determination of synthetic route via impurity profiling using GC/MS (169); preparation and certification of reference quality material (170); **2013** detection of pharmaceutical impurities in methamphetamine by GC/FID and GC/MS (171); impurity profiling of methamphetamine by CE using a highly sulfated gamma-cyclodextrin as a chiral selector (includes methamphetamine, amphetamine, ephedrine, pseudoephedrine, norephedrine, and norpseudoephedrine) (172); screening of methamphetamine, pseudoephedrine, and ephedrine by a portable lab-on-a-chip instrument (173); evaluation of the use of IMS in remediation of clandestine laboratories (174); influence of precursor solvent extraction on stable isotope signatures of methamphetamine

prepared from OTC pharmaceuticals using the Moscow and hypophosphorous syntheses (175); impurity profiling of methamphetamine synthesized from P2P prepared from phenylacetic acid (or its esters) (176);

Methiopropamine: 2011 characterization by IR, MS, and 1H- and 13C-NMR (177); (see also Reference # 250);

Methorphan: 2012 chiral analysis by GC/MS following derivatization with (-)-menthyl chloroformate (includes MS and NMR analyses of the derivatives) (178);

Methoxetamine: 2012 by NMR, MS, and IR (with comparisons with ketamine) (179);

2-(5-Methoxy-1-benzofuran-3-yl)-N,N-dimethylethanamine (5-MeO-BFE) (and its N-ethyl analog): 2012 characterization by MS, NMR, and IR (180);

4-Methoxyphencyclidine: 2011 characterization by MS, IR, and NMR (181);

4'-Methoxyphenyl-2-propanone: 2012 clandestine synthesis and characterization (182);

alpha-Methyl-3,4-methylenedioxyphenylpropionamide (MMDPPA): 2013 identified in Australia as an intermediate from helional to MDA (183; see also 184);

Methylenedioxyamphetamine (MDA): 2013 from helional (185; see also alpha-methyl-3,4-methylenedioxyphenylpropionamide);

3,4-Methylenedioxy-N-benzylcathinone (BMDP): 2013 characterization by LC/high res QTOF-MS, EI-MS, IR, and 1D- and 2D- 1H- and 13C-NMR (186);

Methylenedioxymethamphetamine (MDMA): **2010** use of stable isotope ratios to differentiate MDMA according to synthetic route (187); identification of some tertiary amines related to MDMA by GC- IRD (188); determination of synthetic route by ICP-MS (189); impurity profiles of MDMA prepared by four different methods (190); **2011** use of impurity profiling, stable isotope analyses, and pattern recognition techniques for characterization and sourcing (191); a historical overview (192); determination of volatile components of MDMA tablets with LC/MS and HS-SPME-GC/MS, for development of canine training aids (193); determination of volatiles by HS-SPME followed by GCxGC and GCxGC-TOFMS (194); by SERS using modified Silver nanoparticles (195); **2012** impurity profiling of MDMA prepared from piperine versus vanillin (196); isolation of MDMA using a specialized SPME cartridge with analysis by GC/MS (197); comparative analysis by GC×GC-TOF-MS (198); **2013** enantiomeric purification by batch

chromatography with a cyclodextrin chiral selector (199); impurity profiling of sassafras oils by GC×GC-TOF-MS (200);

Methylenedioxypyrovalerone (MDPV): 2010 characterization by GC/MS, NMR, FTIR, and UV (201);

4-Methylethcathinone (4-MEC): 2013 by GC/MS, HPLC-DAD, and LC-MS/MS (202);

N-Methylphthalimide: 2011 characterization by GC/MS, FTIR, and NMR (203);

4'-Methyl-alpha-pyrrolidinohexanophenone (MPHP): 2011 analysis by GC/MS, HPLC/DAD, and GC/FID (toxicological focus) (204);

3,4-Methylenedioxyphenylacetone (MDP2P): 2010 differentiation of methoxy methyl phenylacetones related to MDP2P by GC/IRD (205);

3,4-Methylenedioxypyrrolidinobutyrophenone (MDPBP): 2011 characterization by IR, MS, and 1D- and 2D- 1H- and 13C- NMR (206);

4-Methylthioamphetamine (4-MTA): 2012 impurity profiling of 4-MTA produced by the nitropropene route (207); identification of by-products produced by the Leuckart method, using MS, 1H- and 13C-NMR, IR, and crystallography (208);

Morphine: 2012 analysis by FTIR and Raman, with density functional theory (DFT) calculations (209); extraction from poppy seeds, with analysis by GC/MS and GC/FID (210); quantitation in a Chinese traditional medication, by HPLC (211); analysis by cyclic voltammetry, chronoamperometry, and differential pulse voltammetry (212);

Naphyrone (naphthylpyrovalerone, 1-naphthalen-2-yl-2-pyrrolidin-1-ylpentan-1-one): 2010 isomer determination by GC- ion trap-EI/CI-MS and 1D/2D NMR spectroscopy (213); **2012** an overview and literature review (214);

Oxycodone: 2010 analysis of pyrolysis products by GC and GC/MS (215);

Phencyclidine (PCP): 2013 false-positive immunoassay caused by MDPV (216);

Psilocybe Mushrooms: 2010 comparative analysis of hallucinogenic mushrooms using ATR and transflection IR (217); **2011** by DNA analysis (a review, also including some non-hallucinogenic, poisonous mushrooms) (218);

alpha-Pyrrolidinopentiophenone: 2012 by MS, NMR, and IR (219);

***Salvia divinorum*: 2010** thermal degradation products from Salvia divinorum smoke (220); **2012** differentiation from other Salvia species by GC/MS with principal components analysis (221); analysis of "spiked" plant materials by GC/MS (222); **2013** identification of Salvinorin A in Salvia divinorum (but not in 612 related Salvia species) by GC/MS (223); differentiation from marijuana and tobacco by DNA analysis (224);

Sibutramine: 2012 by TLC and TLC-densitometry (225); **2013** detection of illicit adulteration of botanical food supplements, by color tests, TLC, HPLC-DAD, MS, and NMR (226);

Zolpidem: 2012 by HPLC and MS (includes a degradation study) (227);

Miscellaneous Drugs: 2011 characterization of RTI-126 (228).

1.C - Common Groups or Classes of Compounds or Substances

Amphetamine-Type Stimulants (ATSs) and Related Phenethylamines (PEAs): 2010 analysis of ring and side chain regioisomers of ethoxyphenethylamines related to the controlled substances MDEA, MDMMA, and MBDB by GC/MS and GC/IRD (229); methamphetamine, 4-fluoro-, 4-chloro-, 4-bromo-, 4-iodo-, and 4-nitromethamphetamine - analysis by GC/MS following trifluoroacetyl derivatization (230); differentiation of regioisomeric ring-substituted fluorophenethylamines by product ion spectrometry (231); "Fly" and "Dragonfly" Compounds - synthesis and charaterization by GC/MS, LC/MS, and LC-MS/MS (232); **2011** GC/MS and GC/IRD studies on the ring isomers of N-methyl-2-methoxyphenyl-3-butanamines (MPBA) related to 3,4-MDMA (233); 4-methylthioamphetamine, 4-fluoroamphetamine, 4-methylamphetamine, 3-trifluoromethylamphetamine, MDA, 2,5-dimethoxyamphetamine, and 2,4,5- and 3,4,5-trimethoxyamphetamines - mass spectrometric properties and identification of some N,N-di-(beta-arylisopropyl)formamides (synthetic impurities) (234); 5- and 6-(2-aminopropyl)-2,3-dihydrobenzofuran - characterization by MS, IR, and NMR (235); amphetamine and methamphetamine - detection by digital image-based colorimetric tests (236); identification of (unspecified) ATSs by GC/MS and GC/FTIR (237); general classification of amphetamines versus non-amphetamines based on GC/FTIR and GC/MS with Principal Component Analysis coupled with Artificial Neural Networks (238); amphetamine, methamphetamine, pseudoephedrine, and five "amphetamine analogs" (not specified in the abstract) - field analysis using the Agilent Bioanalyzer (239); novel syntheses of ATS precursors (240); a review of methods for the chiral determination of ATSs (241); aminoindanes - a review

(242); **2012** 4- and 5-iodo-2-aminoindan - by MS, NMR, and IR (243); 2-, 3- and 4-methylmethamphetamine and 2-, 3- and 4-methylamphetamine - analysis by GC/MS, acetylation, and GC/IRD (244); "amphetamine-type illicit drugs" by a miniaturized gas sensor system using surface ionization (245); DOB and positional isomers - differentiation of various perfluoroacylated derivatives by GC/MS and GC/IRD (246); amphetamine, methamphetamine, ephedrine, pseudoephedrine, norephedrine, and norpseudoephedrine - enantioseparation by CE with contactless conductivity detection (247); a review of the chiral analysis of amphetamine "and related compounds" by CE and NMR (248); 25D-NBOMe, 25E-NBOMe, and 25G-NBOMe - characterization by GC-EI-MS (with and without derivatization with trifluoroacetic anhydride), LC-ESI-QTOF-MS (and MS/MS), FTIR, and NMR (249); **2013** methiopropamine and its 3-thienyl isomer - synthesis and analysis/differentiation by GC (250); o-, m-, p-chloro- and o-, m-, p-fluoro-amphetamine - by CE-LIF, following derivatization with fluorescein isothiocyanate (includes comparisons against CZE-UV, sweeping-MEKC-UV, and LC-Q-TOF-MS) (251); diethylpropion, fenproporex, and sibutramine - in counterfeit tablets, by ATR/FTIR (252); unspecified amphetamines and precursors - by a portable instrument combining miniaturized GC and IR Absorption Spectroscopy (253); 2-, 3-, and 4-methylamphetamine - synthesis and characterization by GC/MS, HR-ESI-MS, NMR, and IR (254); methamphetamine, MDMA, and other unspecified ATSs - by GC/MS after derivatization with iso-Bu chloroformate and SPME (toxicological focus) (255); methamphetamine, MDMA, amphetamine, DMA, and PMA - a review of impurity profiling and syntheses (256);

Anions: 2010 identification via complexation with meso-octamethylcalix(4)pyrrole and detection using EI-MS (257); **2011** by CE (258,259);

Barbiturates: 2010 mephobarbital, pentobarbital, and secobarbital - by MEKC-MS (toxicological focus) (260); **2011** spectrophotometric determination of barbituric acid in pharmaceuticals (261);

Benzodiazepines: 2011 determination of pK values by potentiometric titration (262); diazepam, estazolam, chlordiazepoxide, and triazolam - analysis by RP-HPLC (263); **2012** clotiazepam, clozapine, and pinazepam - analysis by micellar liquid chromatography (toxicological focus) (264);

Cathinones: 2010 mephedrone, butylone, 4-methyl-N-ethylcathinone, flephedrone, MDPV, and naphyrone - by GC-ion trap-MS (both EI and CI) and NMR (265); mephedrone, methylone, and bk-MBDB - characterization by FTIR, FT-Raman, 1H NMR, 13C NMR, GC/MS, and EI-HRMS (266); **2011** 4-fluoromethcathinone, pentylone, MDPBP, MDPV, and MPPP - by GC-(EI/CI)-MS and NMR (267); 4'-methylethcathinone (4-MEC) and 6 other methcathinone analogs (not specified in the abstract) by LC-MS/MS (268); analysis of isomeric byproducts and related

impurities in mephedrone and ethylcathinone (269); synthesis and analysis of various methylenedioxycathinones, including bk-DMBDB (270); by Raman (271); methylone, bk-MBDB, and bk-MDEA - a review, including analyses by GC/MS, LC/MS, and LC-MS/MS (toxicological focus) (272); **2012** 10 homologous and regioisomeric aminoketones related to MDPV - analysis by GC-EI-MS (273); 3,5-difluoromethcathinone and 3,5-dichloromethcathinone - synthesis and characterization by GC/MS, NMR, IR, and GC/IRD (274); the 2,3-isomers of MDPV, butylone, and methylone - synthesis and characterization by GC, IR, GC/MS, and 1H and 13C NMR (275); 4'-methyl-N-ethylcathinone (4-MEC) and 4'-methyl-N-benzylcathinone (4-MBC) - characterization (methods not specified in the abstract (276); buphedrone and pentedrone - synthesis and characterization by FTIR, Raman, 1H- and 13C-NMR, GC/MS, and ESI-HRMS (277); mephedrone, methedrone, and 17 others not specified in the abstract - chiral separation by cyclodextrin-modified CZE (278); methcathinone and 17 other cathinones (not specified in the abstract) - chiral analysis by GC/MS following derivatization with trifluoroacetyl-L-prolyl chloride (279); 22 cathinones (not specified in the abstract) - by positive ESI MS with in-source CID (280); cathinone, methcathinone, 4-methylmethcathinone, dimethylcathinone, and 4-methoxymethcathinone - by color testing (281); screening identification of methcathinone and 5 other cathinones by portable ATR/FTIR (282); 4-methylmethcathinone, three positional isomers of fluoromethcathinones, 4-methoxy-methcathinone, N-ethylcathinone, N,N-dimethylcathinone, buphedrone, and pentedrone - by GC/MS (283); "synthetic cathinones" - detection and screening using a portable ion trap DESI-MS (284); differentiation of isomeric N-alkylated fluorocathinones by GC-MS/MS (285); pentedrone and pentylone - characterization by MS, 1D- and 2D-, 1H- and 13C-NMR, and IR (286); **2013** mephedrone, methylone and MDPV - by ambient ionization MS using arrays of low-temperature plasma probes, and also following injection of trifluoroacetic anhydride directly into the plasma stream for online derivatization (287);

Ephedrines: 2010 N-acetylpseudoephedrine and N-acetylephedrine - synthesis and characterization by GC-MS, NMR, FTIR, LC-MS, and UPLC-MS (288); **2012** phenylpropanol-amine, cathine, ephedrine, pseudoephedrine, and methylephedrine - analysis by HILIC, with comparison versus RPLC (289); chiral separation of enantiomers of ephedrine and pseudo-ephedrine in ATSs using achiral modifiers in the gas phase (290); synthesis of alpha-amino-alcohols via the Akabori-Momotani reaction (291); **2013** comparison of RP-UHPLC and HILIC for quantitation, with medium-resolution accurate MS (292);

Erectile Dysfunction Drugs - Cialis (tadalafil), Levitra (vardenafil), and Viagra (sildenafil): 2010 detection of counterfeits by FTIR, NIR, and Raman (293); identification of (-)-trans-tadalafil, tadalafil, and sildenafil in counterfeit Cialis (294); **2011** development of "classification trees" based on infrared spectroscopic data to discriminate between genuine and counterfeit medicines (295); identification of counterfeits by impurity profiling (296); detection

of counterfeits by Raman (297); **2012** differentiation of legitimate and counterfeit medications by chemometrics and chromatography (298); detection of counterfeits by image processing and statistical analysis (299); analysis of counterfeit Cialis tablets using Raman microscopy and multivariate curve resolution (300); fingerprinting of sildenafil citrate and tadalafil tablets by XRF (301); identification of sildenafil and/or vardenafil using ESI-LC/MS (302); detection of adulteration of capsule shells (a novel and unusual "smuggling" technique) by HPLC-DAD, HPLC/MS, microscopy, and Raman (303); **2013** differentiation between counterfeit and authentic Cialis and Viagra by ATR/FTIR with PCA (304); analysis and profiling by UPLC/MS (305);

Ergot Alkaloids (see also LSD): 2012 quantitative analysis using electronic absorption, fluorescence, IR, Raman, CD, ESI-MS, and MALDI-MS (specific compounds not listed in the abstract) (306);

Fentanyl Derivatives: 2012 identification of trace level fentanyl derivatives with nonaqueous CE-ESI-MS/MS (307);

gamma-Hydroxybutyric acid (GHB) and gamma-Butyrolactone (GBL): 2010 use of IRMS to discriminate between seizures of GBL and for source determination (308); detection of GHB in solutions using a colorimetric sensor array (309); **2011** a study of the spontaneous formation of GHB from GBL in tap water (310); screening for gamma-hydroxybutyrate by ion chromatography (with comparison versus GC/MS) (311); detection of GHB and GBL in adulterated beverages, using 1H-NMR (312); **2012** sodium, potassium, magnesium and calcium salts of gamma-hydroxybutyrate - synthesis and characterization by FTIR, elemental analysis, X-ray powder diffraction analysis, color testing, and microcrystal testing (313); field testing for GHB with a rapid enzymic test (also includes commentary on MDMA, flunitrazepam, and ketamine) (314); **2013** a comprehensive study of the worldwide distribution of GBL using internet monitoring, comparison of packaging, and carbon isotopic measurements (315); in dietary supplements and foods, by GC/MS (using isotopologues for quantitation) (316);

Methylenedioxyphenethylamines and Related Compounds (note that methylenedioxy-substituted cathinones are categorized under "Cathinones"): 2010 identification of side chain regioisomers related to MDEA, MDMMA, and MBDB (317); **2011** methylenedioxy-2-aminoindans - synthesis and analysis of the 4,5 and 5,6 isomers by GC/MS, ATR/FTIR, and 1H- and 13C-NMR (318); **2012** MDA, alpha-methyl-3,4-methylenedioxy-phenylpropionamide (and 2-chloro-4,5-methylenedioxyamphetamine) - characterization by GC/MS, GC/IRD, ATR/FTIR, and NMR (319);

Papaver and Opium: 2010 by cyclodextrin-modified CE following ultrasound-assisted

extraction of Papaver (320); identification of opium poppies using 10 genetic markers (321); **2011** differentiation of P. somniferum, P. rhoeas, and P. setigerum by GC/MS and multivariate statistical analyses (322); identification of expressed sequence tag (EST) and simple sequence repeat (SSR) markers (323); determination and analysis of opium alkaloids and crude heroin in complex mixtures by surface-ionization MS (324); **2012** Papaver setigerum by genetic and chemical components analysis (325); opium - determination of 14N and 15N isotopes by proton induced gamma-ray emission (326);

Piperazines: 2010 differentiation of methylenedioxybenzylpiperazines by GC/IRD and GC/MS (327); BZP, mCPP, MeBP, MeOPP, MePP, and TFMPP - detection in "Legal Highs" by GC/MS and HPLC-DAD (328); **2011** differentiation of methylenedioxybenzylpiperazines and methoxymethylbenzylpiperazines by GC/IRD and GC/MS (329); BZP and TFMPP - analysis by ATR/FTIR and GC/MS (330); **2012** methoxybenzoylpiperazines (OMeBzPs) and methylene-dioxybenzylpiperazines (MDBPs) - differentiation using GC/MS, GC-TOF-MS, and GC/IRD (both underivatized and as perfluoroacylated derivatives (331); **2013** BZP - a review (social focus, but includes "analytical methodologies for the identification of BZP in forensic settings") (332);

Plant Materials: 2010 a review of poisonous plants (includes drugs) (333); **2011** use of cellulose d18O as an index of leaf-to-air vapor pressure difference in tropical plants (334); **2012** analysis of alkaloids from psychoactive plants by nonaqueous CE/MS (specific plants not listed in the abstract) (335); plant DNA fingerprinting - listed applications include "investigation of trade in illicit drugs" (336); **2013** identification of plant materials used as supporting matrices for pharmaceuticals, nutritional supplements, and illicit drugs, by DAD, evaporative light scattering detection, and MS (337); analysis of the plant materials used as support matrices, by DNA analysis, GC/MS, and LC/MS (338; see also Reference Number 352);

Steroids: 2010 correlation of the product ion profiles from ESI MS/MS with molecular structures (339); analysis by GC- microchip-AP-photoionization-MS (toxicological focus) (340); identification of anabolic steroids and derivatives using bioassay-guided fractionation and UHPLC/TOFMS analysis (341); **2011** testosterone - IRMS of various black-market products collected in Austria (342); a review of the literature from 2004-2010 (343); analysis by GC/MS using hydrogen as the carrier gas (toxicological focus) (344); **2012** prediction of GC relative retention times of trimethylsilylated derivatives (345); identification of methyltestosterone in counterfeit 4-chlorodehydromethyltestosterone products, by RP-HPLC-ESI-MS (346); elucidation of the *m/z* 97 ion from androst-4-en-3-one-based steroids by ESI-CID and IRMPD (347); **2013** (primarily) stanozolol, testosterone and nandrolone - a study of authentic and counterfeit products seized in Brazil from 2006 to 2011 (348);

Synthetic Cannabinoids and Cannabimimetics: [Notes: To aid searching for specific compounds, all compounds in this section are listed in alphabetical order within their individual citation (but not within the section). In addition, compounds are listed either by their acronym or full name as was specified in their respective abstract - no effort was made to transcribe acronyms to full chemical names or vice versa. Articles that include both synthetic cannabinoids and/or cannabimimetics with other drugs are detailed in the next section.] **2010** JWH-018 and JWH-073 - by color testing, TLC, GC/MS, and FTIR (349); a survey of synthetic cannabinoids and/or cannabimimetics containing products obtained from June 2008 to September 2009 in Germany/Europe (350); analysis of "Spice Gold" with GC/MS and solid probe MS (351); identification of the plants used as the base materials for products containing synthetic cannabinoids and cannabimimetics (352); JWH-018 - detection by TLC and GC/MS (353); analysis and identification of cannabicyclohexanol, CP-47,497, JWH-018, JWH-073, and oleamide in herbal products by GC/MS and LC/MS (354); an overview of synthetic cannabinoids and cannabimimetics (355); **2011** JWH-203 - characterization by LC/MS, GC/MS, LC with UV detection, NMR, and high-res MS (356); JWH-018, JWH-073, and 9 other unspecified synthetic cannabinoids - a survey of 33 smoking blend products, with analysis by GC/MS (357); JWH-015, JWH-018, JWH-019, JWH-020 JWH-073, JWH-081, JWH 200, JWH-250, WIN 55,212-2 and methanandamide - by LC-MS/MS (toxicological focus) (358); JWH-122 - characterization by NMR, "spectroscopy," and MS (359); JWH-201, JWH-250, and JWH-302 - differentiation by GC/MS fragment ion ratio comparisons (360); an overview and review of synthetic cannabinoids and cannabimimetics, including some GC/MS and LC-MS/MS data (361); (unspecified) analog of a CP 47,497-C8 type compound - by off-line LC-DAD-NMR (362); AM-694, AM-2201, JWH-122, RCS-4, and (2-methoxyphenyl)(1-pentyl-1H-indol-3-yl)methanone (a positional isomer of RCS-4) - analysis by LC/MS, GC/MS, and NMR (363); AM-694, JWH-019, JWH-122, JWH-210, and (4-methoxyphenyl)(1-pentyl-1H-indol-3-yl)methanone - analysis by LC/MS, GC/MS MS, and NMR (364); JWH-250 - identification and quantitation by GC/MS, LS/MS, high-res MS, and NMR (365); 1-pentyl-3-(1-naphthoyl)indole, 1-butyl-3-(1-naphthoyl)-indole, 1-hexyl-3-(1-naphthoyl)indole, and 3-[4-(1,1-dimethyloctyl)-2-hydroxyphenyl]-cyclohexan-1-ol - by "chromatography-mass spectrometry" (chromatographic method(s) not specified in the abstract) (366); JWH-018 and JWH-073 - detection by GC/MS (367); JWH-018, JWH-018 N-(2-methylbutyl) isomer, JWH-018 N-(3-methylbutyl) isomer, JWH-201, JWH-250, JWH-302 - isomer differentiation by GC/MS retention times (368); cannabipiperidiethanone - identification and characterization by GC/MS, LC/MS, high-res MS, and NMR (369); JWH- 015, JWH-073, JWH-081, JWH-200, JWH-250, JWH-251 - identification and quantitation by GC/MS, LS/MS, high-res MS, and NMR (370); JWH-018 and JWH-073 - detection by GC/MS (371); cannabicyclohexanol (CP-47,497-C8-homolog), JWH-018, JWH-073 - determination by GC/MS (372); **2012** AM2201, JWH-018, and JWH-022 - JWH- 018 and JWH-022 identified as combustion products of AM2201, as determined by GC/MS and Accu-TOF-DART (373); JWH-018 - by DART-TOF-MS (374); JWH-307 - characterization by NMR, GC-HRMS,

ESI-MS/MS, UV, and IR (375); JWH-018 and JWH-073 - purity levels of materials from three different on-line suppliers, as determined by HPLC-UV (376); "synthetic cannabinoids" (specific compounds not listed in the abstract) - analysis by MEKC-DAD (377); AM-694, JWH-018, JWH-019, JWH-073, JWH-081, JWH-210, and JWH-250 - analysis by GC/MS and MALDI-TOF MS (378); AM-679 and 1-pentyl-3-(1-adamantoyl)indole - by LC-UV-MS/MS, LC-TOF-MS, GC/MS, and NMR (379); AM-2201, JWH-018, JWH-019, JWH-073, JWH-081, JWH-122, JWH-200, JWH-203, JWH-210, JWH-307, and RCS-4 - analysis by LC-ESI-MS/MS (toxicological focus) (380); AM-694, AM-2201, JWH-018, JWH-019, JWH-081, JWH-122, JWH-203, JWH-210, JWH-250, JWH-307, MAM-2201, and RCS-4 - by LC/ESI-MS/MS (toxicological focus) (381); AM-1220 and (N-methylazepan-3-yl)-3-(1-naphthoyl)indole - by TLC, GC/MS, high-res MS, LC-HR-MS/MS, and NMR (382); 3-(1-adamantoyl)-1-pentylindole - identification by GC/MS, TLC, NMR, high-res MS, and GC-MS/MS (383); AM-694, AM-2201, CP 47,497 (C=8) (cannabicyclohexanol), JWH-018, JWH-019, JWH-073, JWH-081, JWH-200, JWH-210, JWH-250, RCS-4, and RCS-8 - analysis by TLC, GC/MS, HPLC, and LC-TOF-MS (384); 1-[(5-fluoropentyl)-1H-indol-3yl]-(4-methylnaphthalen-1-yl)methanone and JWH-412 - separation by flash chromatography and analysis by GC/MS and NMR (385); "synthetic cannabinoids" (five compounds not specified in the abstract) by DART-MS with collision-induced dissociation (386); AM-251 and JWH-015 - analysis by DART-MS (387); color testing for 24 (unspecified) indole-based cannabimimetics (388); an overview (389); naphthoylindoles - by ESI-QTOFMS (390); N-(1-adamantyl)-1-pentyl-1H-indole-3-carboxamide (APICA), N-(1-adamantyl)-1-pentyl-1H-indazole-3-carboxamide (APINACA), AM-1220, AM-1241, AM-1248, AM-2233, and CB-13 (CRA-13) - analysis by LC/MS, GC/MS, high-res MS, and NMR (391); 1-butyl-3-(1-(4-methyl)naphtoyl)indole - synthesis and characterization with GC/FID, 1H- and 13C-NMR, DSC, GC/MS, and elemental analysis (392); an overview and review (393); JWH-073 and its 4-methylnaphthoyl analogue - by TLC, NMR, GC/MS, and LC/MS (394); JWH-018, JWH-081, and 10 other (unspecified) "synthetic cannabinoids" - by GC/MS (395); JWH-018 - by GC/MS (396); **2013** JWH-018, JWH-019, JWH-073, and JWH-250 - by GC/MS (397); 5F-UR-144 and UR-144 - by GC/MS, LC-TOF-MS, and 1D- and 2D-NMR (398); AM-2201, JWH-203, JWH-210 and RCS-4 - by LC, high-res MS, LC-QTOF-MS, and NMR (399); 28 (unspecified) "synthetic cannabinoids" - by LC/ESI- MS/MS (toxicological focus) (400); cis- and trans- CP-47,497-C8 (and others not specified in the abstract) - extraction from plant materials by flash chromatography (401); azepane isomers of AM-1220 and AM-2233, AM-2233, and URB-597 - by LC/MS, GC/MS, "accurate MS," and NMR (402); unspecified "cannabimimetics" bearing 2,2,3,3-tetramethylcyclopropanecarbonyl moieties - by GC/MS, LC/MS, and NMR (403); JWH-213 - by LC-PDA-MS, GC/MS, high-res MS, and NMR (404); N-(1-amino-3-methyl-1-oxobutan-2-yl)-1-pentyl-1H-indazole-3-carboxamide (AB-PINACA) and N-(1-amino-3-methyl-1-oxobutan-2-yl)-1-(4-fluorobenzyl)-1H-indazole-3-carboxamide (AB-FUBINACA) - by LC/MS, GC/MS, high-res MS, and NMR (405); cannabicyclohexanol, JWH-018, JWH-073, JWH-081, JWH-122, JWH-210, JWH-250, and

RCS-4 - by GC/MS, LC-QTOF-MS, and HPLC (406);

Synthetic Cannabinoids and Cannabimimetics with Other Drugs: 2012 1-butyl-3-(4-methoxybenzoyl)indole, JWH-018, JWH-073, JWH-122, JWH-250, 1-pentyl-3-(4-methoxybenzoyl)indole, and phenazepam - detection in plant materials (analytical methods not specified in the abstract) (407); 12 "synthetic cannabinoids and cannabimimetics" (not specified in the abstract) and THC - by nano-LC/MS and nano-LC-MS/MS (408); AM-2201, AM-2202, JWH-019, JWH-203, JWH-210, mitragynine (Kratom), (1-(4-pentenyl)-1H-indol-3-yl)(naphthalen-1-yl)methanone - analysis by LC/MS, GC/MS, high-res MS, and NMR (409); **2013** AB-001, AM-2232, APINACA, N,5-dimethyl-N-(1-oxo-1-(p-tolyl)butan-2-yl)-2-(N'-(p-tolyl)ureido)benzamide, (4-ethylnaphtyl)-AM-2201 (EAM-2201), 5-fluoropentyl-3-pyridinoylindole, 5FUR-144 (synonym: XLR11), 4-hydroxy-diethyltryptamine (4-OH-DET), JWH-213, JWH-307, JWH-030, 4-methylbuphedrone, (4-methylnaphtyl)-AM-2201 (MAM-2201), (4-methylnaphtyl)-JWH-022 [synonym: N-(5-fluoropentyl)-JWH-122], N-(4-pentenyl)-JWH-122, UR-144, and URB-754 - detection on plant materials (methods not specified in the abstract) (410); (see also References Numbers 424, 432, 441, 467, 469, and 470);

Tryptamines (see also Psilocybe Mushrooms): 2010 a review of the analyses of psychoactive N,N-dialkylated tryptamines (411); characterization of the byproducts from the synthesis of DMT by reductive amination, using GC- ion trap-MS (412); profiling psychoactive tryptamine-drug syntheses by MS (to identify route specific impurities) (413); **2011** preparation and analytical characterization of twelve 5-ethoxy-N,N-dialkyl-tryptamines and their deuterated analogues (414); **2012** 5-methoxy-2-methyl-N,N-dialkylated tryptamines - synthesis and characterization by 1H and 13C NMR, GC-EI-IT-MS, and CI-IT-MS/MS (415); quantitation of substituted N,N-dimethyl-tryptamines in the presence of natural type XII alkaloids by HPLC, ESI-MS, MS/MS, MALDI-MS, and Raman (416); **2013** AMT (3-(2-aminopropyl)indole) and 5-IT (5-(2-aminopropyl)indole) - characterization using 1H- and 13C-NMR, GC-EI/CI-ion trap-MS, U/HPLC-DAD, and HPLC/MS (417).

1.D - Polydrug A: Mixed or Unrelated Named Compounds or Substances

2010 amphetamines, cocaine, codeine, heroin, and morphine - by CEC-ESI ion trap MS (418); 4-methylmethcathinone, 2-fluoromethamphetamine, alpha-phthalimidopropiophenone, and N-ethylcathinone by GC/MS, NMR, FTIR, and GC/IRD (419); 1,4-benzodiazepines and amfepramone - determination as adulterants in phytotherapeutic formulations by adsorptive cathodic stripping voltammetry (420); separation and detection of seven amphetamines, amphetamine, dextroamphetamine, methamphetamine, and MDMA by CZE with capacitively

coupled contactless conductivity detection (421); hallucinogenic mushrooms and khat by cation exchange LC (422); morphine, morphine HCl, cocaine HCl, codeine phosphate, papaverine HCl, pethidine HCl, and thebaine - differentiation with THz time domain spectroscopy (423); piperazines, phenethylamines (2Cs and FLYs), 4-substituted amphetamines, beta-keto-amphetamines (cathinones), 2,5-dimethoxyamphetamines, pyrrolidinophenones, and synthetic cannabinoids - a review of their analyses (toxicological focus) (424); MDMA, MDA, and methamphetamine in Ecstasy tablets by GC/FID (425); marijuana, cocaine, heroin, MDMA, amphetamine, methamphetamine (and other unspecified drugs) - detection using spectral fluorescence signatures (426); **2011** diazepam, flunitrazepam, and methadone - by FT-NIR (427); cocaine and MDMA - detection on textiles using micro-Raman (428); evaluation of the fragmentation pathways of various drugs of abuse (cannabinoids, ketamine, amphetamine, ATSs, cocaine, and opioids) by LC-QTOF MS/MS and MSE accurate-mass spectra (429); sibutramine, modafinil, ephedrine, norephedrine, metformin, theophylline, caffeine, diethylpropion, and orlistat - identification and quantification in diet aids by UHPLC-DAD (430); cocaine and heroin - an evaluation of impurity profiling for comparative analysis (431); herbal products [khat, Psilocybe mushrooms, opium, and "Spice"], designer drugs in tablet and powder form [e.g., mCPP, 3-fluoromethamphetamine (3-FMA), MDPV, and methylone], and anabolic steroids in oil and tablets - by DAPPI-MS (432); MDMA, ketamine, phenmetrazine, ephedrine, pseudo-ephedrine, caffeine, tramadol (possibly others not listed in the abstract) - analysis of Ecstasy tablets seized in Iran from 2007 to 2008, by physical characteristization, color testing, TLC, anion testing, residual solvent analysis, GC/MS, and LC/MS (433); methamphetamine, amphetamine, MDMA, MDEA, MBDB, MDA, and BDB - by GC/MS following derivatization with trifluoroacetic anhydride (434); heroin, dl-methamphetamine, dl-MDMA, and dl-ketamine - application of dispersive liquid-liquid microextraction and CE with UV detection for chiral separation and determination (toxicological focus) (435); cocaine and heroin - analysis of "crack" cocaine in Iran by TLC and GC/MS (proving that most such samples actually contained heroin) (436); benzodiazepines, beta-blockers, angiotensin-converting enzyme inhibitors, pheno-thiazines, dihydropyridine calcium channel blockers, diuretics, local anesthetics, vasodilators, anti-diabetic, antidepressant, analgesic, and antihistaminic drugs - by LC-MS/MS (toxicological focus) (437); methamphetamine, MDMA, pseudoephedrine, N-formylmethylamphetamine, and 1-benzyl-3-methylnaphthalene - a study of their degradation in soil (438); analysis of "Happy Water" (containing methamphetamine, caffeine, ketamine, and other components) - by GC/MS and GC/FID (439); morphine, codeine, and hydrocodone - by SERS (440); p-fluoroamphetamine, mephedrone, flephedrone, PPP (alpha-pyrrolidinopropiophenone), MDPV, bk-MBDB, pFBT (3-(p-fluorobenzoyl)-tropane), JWH-073, methylone (3,4-methylenedioxymethcathinone), and N-ethylcathinone - by GC/MS, UPLC-QTOF-MS, and NMR (441); m-CPP and MDMA tablets, cocaine, and LSD - by easy ambient sonic-spray ionization MS (442); Ecstasy Tablets - MDMA, methamphetamine, MDEA, MDA, amphetamine, caffeine, and lidocaine - by TLC and EASI-MS (443); methamphetamine, methamphetamine analogs, and MDMA - a theoretical study of the

energetics of the synthesis of various ATS and MDMA (including reactants, products and by-products) (444); cocaine and heroin - a survey of seizures in Luxembourg from 2005 to 2010 (445); bunitrolol, caffeine, cocaine, codeine, diazepam, doxepin, haloperidol, 3,4-methylendioxy-amphetamine, morphine, nicotine, and zolpidem - impact of solvent choice on the analysis of basic drugs by micro-LC/MS (toxicological focus) (446); methamphetamine, MDA, MDMA, and ketamine - detection by 2D THz signatures and spectral dynamics analysis (447); **2012** methandrostenolone, sildenafil, tamoxifen, quinine, clomiphene, dehydroepiandrosterone, anastrazole, clenbuterol, stanozolol, oxandrolone, liothyronine, finasteride, and melatonin in counterfeit drugs and pharmaceutical preparations seized from the black market among bodybuilders - RPLC-DAD and GC/MS (448); antidepressant drugs (sertraline, paroxetine, citalopram, venlafaxine, and fluoxetine) - determination by spectrofluorometry (449); mephedrone, BZP, MDAI, and TFMPP - by microcrystal testing, FTIR, and GC/MS (450); MDA, MDMA, methadone, cocaine, morphine, codeine and 6-monoacetylmorphine - analysis with CZE-TOF-MS (451); MBDB, MMDA-2, and D2PM (and possibly others not specified in the abstract) - enantiomeric separation after derivatization with (R)-(-)-DBD-Py-NCS by UHPLC, with fluorescence and MS detection (452); lidocaine and benzocaine - detection by HPLC with amperometric detection (453); MDMA, ketamine, cocaine, diazepam, phenobarbital, and barbital - analysis using a deep UV/Vis reflected optical fiber sensor (454); cocaine, codeine, nicotine, methadone, phenmetrazine, pentylenetetrazole, niketamide, fencamfamine, and caffeine - by GC/high-res-TOF-MS with a soft ionization source (455); atenolol, salbutamol and cocaine - detection of drug vapors using an ion funnel interface for secondary ESI-MS (456); acetaminophen, phenylephrine, glucose, and caffeine - noninvasive, quantitative analysis of simulated drug mixtures using SORS and multivariate statistical analysis (457); constituents of "legal highs" - MPDV, caffeine, butylone, TFMPP, lidocaine, 4-MEC, mephedrone, pFPP, BZP, and MDPBP - by GC/MS, LC-QTOF-MS, HPLC, and NMR (458); **2013** flunitrazepam, ketamine, and MDMA - detection by IMS (toxicological focus) (459); methoxetamine, 3-methoxyeticyclidine and 3-methoxyphencyclidine - characterization by GC- and CI- MS, NMR, and HPLC-DAD-ESI-MS/MS (toxicological focus) (460); 1,4-benzobenzodiazepines (clonazepam, flurazepam, alprazolam, midazolam, bromazepam, chlordiazepoxide, lorazepam, and diazepam) and antidepressants (bupropion, sertraline, paroxetine, and fluoxetine) - identification as adulterants in phytotherapeutic dieting formulations by voltammetry (461); anorexics (amfepramone, fenproporex, sibutramine), benzozodiazepinic anxiolytics (clonazepam, flurazepam, alprazolam, midazolam, medazepam, chlordiazepoxide, diazepam), antidepressants (bupropione, fluoxetine, sertraline, paroxetine), diuretics (hydrochlorothiazide, furosemide, chlortalidone, amiloride, spironolactone), and hypoglycemics (glimepiride, chlorpropamide, glibenclamide) - differentiation by a solid state electrochemical method (462); mephedrone, 5,6-methylenedioxy-2-aminoindane (MDAI), and MDMA - by SERS on copper coins coated with deposited silver (463); Psilocybe mushrooms, 5MeO-DIPT, tryptamine, MDMA and related compounds, and synthetic cannabinoids and cannabimimetics - an overview (464).

2. Instrument Focus

Forensic Chemists must maintain familiarity with updates in current instrumental techniques and become versant in new, improved methods of analysis.

Improved/existing and new technologies are reviewed and applied to both routine and specialized analyses of drugs. In cases where improved performance is observed, case reports are generated for the forensic community.

2.A - Polydrug B: Mixed or Unrelated Groups of Compounds or Substances

Named Groups of Compounds: 2011 opioids, tranquilizers, stimulants, and hallucinogens - analysis by flow-analysis methods with chemiluminescence or electrochemiluminescence detection (465); a review of the analytical methodologies used to determine adulterants in slimming phytotherapeutic formulations (466); designer cathinones, tryptamines, phenethylamines, and synthetic cannabinoids and cannabimimetics - an overview and review (467); phenethylamine, amphetamine, and tryptamine imine by-products - characterization by GC/MSD, IR, and NMR (468); **2012** (unspecified) synthetic cannabinoids, cannabimimetics, and cathinones - by DART-TOF-MS (469); cathinones, pyrrolidinophenones, tryptamines, and synthetic cannabinoids and cannabimimetics - a review of analytical methods (toxicological focus) (470); 24 phenylethylamines (including 8 cathinones), 3 piperazines, and 3 tryptamines (only MDA, MDMA, ethylamphetamine, and AMT were listed in the abstract) - cross- reactivity in immunosorbent assays (471); phenethylamines, tryptamines, piperazines and cathinones - a review of analyses by GC-EI/MS, LC-ESI/QTOF-MS, and (in some cases) by NMR and FTIR (472); **2013** cathinones, phenethylamines, tryptamines, and piperazines - by LC-QQQ-MS/MS in the MRM mode (toxicological focus) (473);

"Ecstasy Tablets": 2010 impurity profiling of tablets seized in Vietnam using GC and GC/MS (474); **2011** variation in likelihood ratios for same- and different-batch comparisons (specific compounds and analytical methods not specified in the abstract) (475); microwave-assisted extraction of tablets for improved impurity profiling (476); chemical profiling by analysis and identification of residual solvents by static headspace (477); **2012** detection of amines in Ecstasy tablets using a fluorogenic probe (478);

Abused Drugs and Pharmaceuticals in Municipal Wastewater Streams: 2010 by isotopic-dilution direct injection RP-LC-MS/MS (location not specified in the abstract) (479); from a wastewater treatment plant located in "the mid-Atlantic U.S.," by solid phase extraction and GC/MS (480); an overview and review of current methodologies (481); in Paris, France using HPLC-MS/MS after SPE extraction (482); in three Canadian cities (method not specified

in the abstract) (483); in Zagreb, Croatia using LC-MS/MS (484); **2011** by SPE and LC/MS, including a critical evaluation and verification of methodologies (484); a historical review (486); in Australia (methodologies not specified in the abstract) (487); a sampling strategy for sport villages to monitor doping (488); refining the estimation of illicit drug consumptions from wastewater analysis (489); for estimating total drug consumption in small, semi-enclosed population (methodologies not listed in the abstract) (490); **2012** by Mixed-Mode SPE and LC-QTOF-MS (491); for estimating cocaine consumption in the Brazilian Federal District (492); **2013** a study of the uncertainty associated with the estimation of community illicit drug consumption via analysis of sewage (493); by online-SPE-LC/MS (494);

"Illicit Drugs" - Including "Controlled Substances," "Drugs of Abuse," "Illicit Drugs," "Narcotics," "Seized Drugs" (and similar generic terms): 2010 a sensor for "drugs of abuse" (495); screening for "drugs of abuse" by LC-DAD (496); detection of "drugs" using neutron computerized tomography and artificial intelligence techniques (497); detection of "narcotics" using IMS (498); rapid analyses of "illicit drugs" by FTIR and GC/MS (499); rapid field air sampling and analysis of "illicit drugs" using dynamic planar SPME-IMS (500); determination of "illicit drugs" by UHPLC/MS (501); "illicit drug salt forms" by LC/MS (502); qualitative analysis of "narcotics" using Raman and chemometrics (503); identification of "illicit drugs" by teraHertz spectroscopy (504); detection of "illicit drugs" using a tagged neutron inspection system (505); QSAR study on GC/MS Retention Times of "illicit drugs" (506); **2011** "drugs of abuse" and pharmaceuticals - identification of active ingredients by AP glow discharge MS (507); a review and overview of adulterants in "illicit drugs" and their effects (508); acquiring LC/MS or GC/MS analyses following dissolution of microcrystalline test products from "drugs of abuse" (509); detection of "illicit drugs" on surfaces using DART-TOF-MS (510); detection of drugs by proton exchange reaction MS (511); analysis of "narcotics" by Raman (512); detection of "controlled substances" in tablets by ATR/FTIR (and LC-ESIMS) (513); analysis of "seized drugs" by HILIC (514); analysis of banknotes (Euros) from the Canary Islands for "illicit drugs" by LC and MS (515); analysis of "illicit drugs" by GCxGC (516); detection of packaged or concealed "illicit drugs" by spatially offset Raman (517); detection and identification of "illicit drugs" using neutron based techniques (518); detection of "street drugs" by 3-dimensional Spectral Fluorescent Signatures (519); analysis of "multicomponent illicit drugs" by IMS (520); recovery of "illicit drugs" from surfaces using electrostatic lifting and nanomanipulation, with analysis by nanospray ionization mass spectrometry (521); a review of analysis of "drugs of abuse" by Raman (522); screening for "illicit drugs" on banknotes by LC-MS/MS (523); **2012** a review of hyphenated LC techniques (listed applications include "drugs of abuse in alternative matrixes") (524); use of gold-plated Mylar lift films for Raman of "drug residues" (525); 18 (unspecified) "illegal adulterants" in herbal medicines and health foods for male sexual potency - by LC-EI-MS/MS (526); screening of "narcotic drugs" using MECC on a microfluidic device (527); fabrication and use of silver nanoneedles array for SERS and their application in rapid

detection of "narcotics" (stated to be especially sensitive for ketamine) (528); **2013** "forensic drug analysis" by microfluidic devices - an overview (529); an evaluation of the results of impurity profiling of "illicit drugs" from different analytical methods and/or from different laboratories (530); analysis of "seized drugs" by LC-ESI/MS/MS and AP-MALDI-MS/MS, with comparisons of the two techniques (531); an overview of advanced analytical instrumentation and methods for "drugs of abuse" (toxicological focus) (532);

Pharmaceuticals/Counterfeits (with a focus on differentiation of legitimate versus counterfeit products, or for monitoring quality control for legitimate pharmaceutics): 2010 use of portable Raman for identification of tablets and capsules (533); detection of counterfeits using hand-held Raman, infrared, and NIR spectrometers (534); an overview of the analysis of multi-component formulations by spectrophotometric methods (535); imaging pharmaceutical tablets and screening counterfeit drugs by infrared laser ablation metastable-induced chemical ionization (IR-LAMICI) (536); analysis by NIR chemical imaging (537); a review of the use of NIR imaging for pharmaceutical production and counterfeit detection (538); an overview and review of detection of counterfeits using portable NIR and Raman spectrometers (539); a review of the use of FTIR and ATR/FTIR imaging in pharmaceutical production (540); NIR hyperspectral unmixing for chemometric characterization of counterfeit tablets (541); an overview of the detection of counterfeit drugs using LC, CE, and NIR (542); overview and review of the detection of counterfeit drugs, using artemisinin derivatives to illustrate advances in the field (543); analysis by CE (544); identification by NIR (545); detection of counterfeits by NIR (546); an overview of the use of Raman in the pharmaceutical industry (547); application of 2D and 3D optical microscopy in the examination of suspect counterfeit tablets (548); identification by NIR and NIR chemical imaging (549); detection by NIR (550); identification of tablets by Raman and chemometrics (551); a review of the determination of drugs by TLC (552); tracing the origin of complex pharmaceutical preparations using surface desorption AP-CI-MS (553); detection of counterfeits by NIR (554); **2011** detection of counterfeit drugs by NIR (555); comparison of laboratory and handheld Raman for the identification of counterfeits (556); detection and identification of counterfeits by NIR (557); discrimination between legitimate and counterfeit products using NIR, Raman, GC/MS, and FTIR, with application of supervised classifiers (k-Nearest Neighbors, Partial Least Squares Discriminant Analysis, Probabilistic Neural Networks, and Counterpropagation Artificial Neural Networks) (558); a review of non-invasive analyses of turbid samples using deep Raman (559); isotopic finger-printing of active pharmaceutical ingredients by 13C-NMR (560); by portable Raman (561); use of DART-MS to screen tableted pharmaceuticals and detect counterfeits (562); detection and profiling of counterfeits by Raman and chemometrics (563); use of isotope-labeled excipients to identify legitimate and counterfeit products (564); an overview of "poor quality" drugs (565); detection by DOSY-NMR (566); detection of counterfeits by NIR diffuse reflectance spectroscopy (567); detection of counterfeits by quantitative NMR and DOSY NMR (568);

analysis by TLC with AccuTOF-DART MS (569); overview of detection using a portable NIR spectrometer (570); detection and analysis of counterfeit pharmaceutical tablet cores by ATR/FTIR and micro-ATR/FTIR imaging (571); discrimination of illicit tablets by surface granularity (572); identification of the components in drugs by near-infrared hyperspectral unmixing of tablets (573); an overview of counterfeit drugs (574); a review of rapid, noninvasive characterization of pharmaceuticals and counterfeits in packaging or containers using Raman (575,576); determination of the elemental distributions in tablets by confocal micro-XRF (577); invisible labeling of pharmaceuticals for identification and verification of authenticity (578); a review of chiral analyses of drugs (579); detection of counterfeits by vibrational spectroscopy (580); a review of methods used to detect counterfeits or confirm authenticity (581); overview and review of Raman for analysis of pharmaceuticals (582); an overview and review of counterfeiting (583); analysis of pharmaceuticals with hyperspectral Raman imaging and various chemometric methods (584); analysis of pharmaceuticals by DART-AccuTOF-MS following TLC separation (585); **2012** comparison of handheld to benchtop Raman instruments for the identification of authentic versus counterfeit tablets (586); detection of counterfeit tablets by transmission Raman (587); quality control screening and counterfeit detection using portable Raman (588); evaluation of differently manufactured pharmaceutical tablets (including illicit drugs and counterfeits) Raman hyperspectral images (589); use of laser-induced breakdown spectroscopy and support vector machines for classification of pharmaceuticals and counterfeits (590); by DART-MS - an overview (listed applications include "screening of counterfeit drugs") (591); analysis of "soft" pharmaceuticals and counterfeits (suppositories, etc.) by DART-MS (592); analysis of tablet packaging by Raman microscopy and 2D-correlation spectroscopy (593); monitoring and detection using NIR (594); analysis of residual solvents in counterfeits by GC/MS (595); differentiation of legitimate versus counterfeit drugs by NIR and chemometrics (596); 14 unspecified "sedative-hypnotic drugs" - detection in health foods and traditional Chinese medicines by GC/MS (597); **2013** a review of a paper-based test for screening for counterfeits (598); an overview of chromatographic and spectroscopic detection methods (599); by Raman (600); a review, focusing on HPLC and MS, but also discussing color testing, TLC, GC, Raman, NIR, FTIR, and NMR, using antimalarial drugs and sildenafil (Viagra) as illustrative examples (601); an overview of the use of GC/MS for "forensic substance identification" (602).

2.B - New and/or Improved Instrumental Techniques

Atomic Absorption Spectroscopy: 2012 a review, focusing on pharmaceuticals (listed applications include "forensic") (603);

Capillary Electrophoresis (and Related Techniques, including Tandem Techniques): 2011 CE - a review of the literature from 2006-2010 (focus is "natural products; " listed applications include pharmaceuticals and "toxicological compounds of interest to forensics") (604); **2012** evaluation and optimization of CZE for common drugs of forensic interest in aqueous matrices (605); CE - a review of the literature from 2009 to 2011 (listed focus includes illicit and abused drugs, ions, and small molecules of forensic interest) (606); **2013** a review of recent advances in electrodriven enantioseparations (listed applications include "pharmaceutical" and "forensic") (607);

Gas Chromatography: 2012 a review (listed applications include "bulk drugs") (608);

Infrared Spectroscopy: 2012 ATR/FTIR - a review (includes select chemical, pharmaceutical, and forensic applications) (609); IR of solid-dosage drug substances - an overview (610);

Infrared and Raman Spectroscopy: 2012 in Forensic Science (Reference Text) (611);

Ion Spectroscopy: 2012 IMS with an orthogonal acceleration sector TOF mass analyzer (designed for "forensic applications") (612);

Mass Spectrometry: 2010 identification of active compounds in tablets by flow-injection data-dependent tandem mass spectrometry combined with library searching (613); differentiation of structural isomers of "drug substances" using LC/Q-TOFMS and fragmentation prediction (614); **2011** ESI-MS - use of wooden toothpicks for facile loading and ionization of samples (615); ambient ionization mass spectrometry - an overview and review, including discussions of counterfeit and illicit drugs (616); DART-MS - a review (listed applications include pharmaceuticals and forensics) (617); a review of the applications of DESI-MS (includes "drugs," pharmaceuticals, and "forensics") (618); **2012** ambient desorption/ionization MS (ADI-MS) - an overview and review (listed applications include "forensics") (619); identification of unknowns utilizing accurate MS data and ChemSpider (620); an overview of recent advances (621); identification of unknowns using an API MS/MS library (622); **2013** ambient mass spectrometry - a review, including DESI, DART, and extractive ESI (listed applications include "forensic identification") (623); DESI-MS (listed applications include "illicit drugs") (624);

Microscopy: 2010 an overview (625);

Nuclear Magnetic Resonance Spectroscopy: 2012 high-precision 1H-qNMR - for determination of the purity of standards (626);

Raman: 2010 non-contact, in-the-field analysis of "hazardous materials" by portable Raman

operating in various modes (627); **2011** a review (includes forensic science applications) (628); **2012** multi-wavelength excitation Raman spectrometers and microscopes (listed applications include "narcotics identification") (629);

Solvent-Microextraction: 2013 a review (listed applications include forensic and pharmaceutical) (630);

Stable Isotope Analyses: 2010 recent advances (includes drugs) (631); position specific 13C analysis for determination of source and the natural attenuation of contaminants (632); a review of the use of stable isotopes in forensic science (633); **2011** an overview of the use of IRMS, proposing a 6-step methodological approach for application to specific forensic issues (634); a general review of the use of stable isotopes to determine source (635); **2012** an overview of the signature value of isotope deltas (636); **2013** a review of inter-laboratory comparability (637); tracking authentic pharmaceuticals by 2H- and 13C-NMR (638);

Thin Layer Chromatography: 2011 a review of TLC/MS (639); **2012** quantitative HPTLC-densitometry - converting TLC screening for counterfeit pharmaceuticals to HPTLC (640);

X-Ray Techniques: 2012 wavelength-dispersive XRF - for analysis of very small samples (listed applications include "forensic analysis") (641).

3. Miscellaneous Topics

Clandestine Laboratories - Appraisals and Safety: 2012 comparison of first responder decontamination procedures (642); testing of fire resistant fabrics after the application of flammable solvents (643); therapeutic detoxification of law enforcement personnel suffering from chronic occupational exposure to methamphetamine (644);

Education: 2011 analysis of a simulated drug sample by GC/MS and FTIR (645); analysis of a simulated drug sample by TLC and GC/MS (646); **2013** use of forensic science to teach method development in undergraduate analytical laboratories (647);

Legal Issues: 2010 legal issues (648); **2011** legal issues (649); **2012** brief news release concerning counterfeits (650); reference text (651);

Packaging: 2011 identification of plastic packaging used by body packers, by IR (652); **2012** a review of the use of SEM/EDS and FTIR to identify counterfeit pharmaceutical packaging (653); analysis of polyethylene cling film (commonly used for packaging illicit drugs) by ATR/FTIR (654);

Quality Assurance: 2010 measurement uncertainty in forensic/analytical testing (655); the uncertainty in measurement of the total mass of a substance packaged in numerous containers (656); **2011** comparison of the stability of stock solutions of drugs at freezer, refrigerator, and ambient temperatures (657); measurement uncertainty in sampling and analysis of illicit drugs (658); **2013** use of a software tool ("Drugs WorkBook") for the quantification of illicit drugs (659);

Sampling Plans: 2010 an Excel based sampling calculator (660); a probability-based sampling approach for the analysis of multiple containers of cocaine, heroin, or marijuana (661);

Soil: 2011 determination of source by XRF (662); **2012** analysis by Raman following oxidative sample preparation (663); an overview of forensic analysis for determining geographical source (664);

Other: 2010 an informal classification scheme for "designer drugs" in Israel (665); **2011** an overview of drug production and use in New Zealand (666); synthetic chemist David Nichols discusses his research on psychedelic compounds, commenting on how his products have been abused (667); **2012** Laboratory Information Management System (LIMS) - an overview and review (668).

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