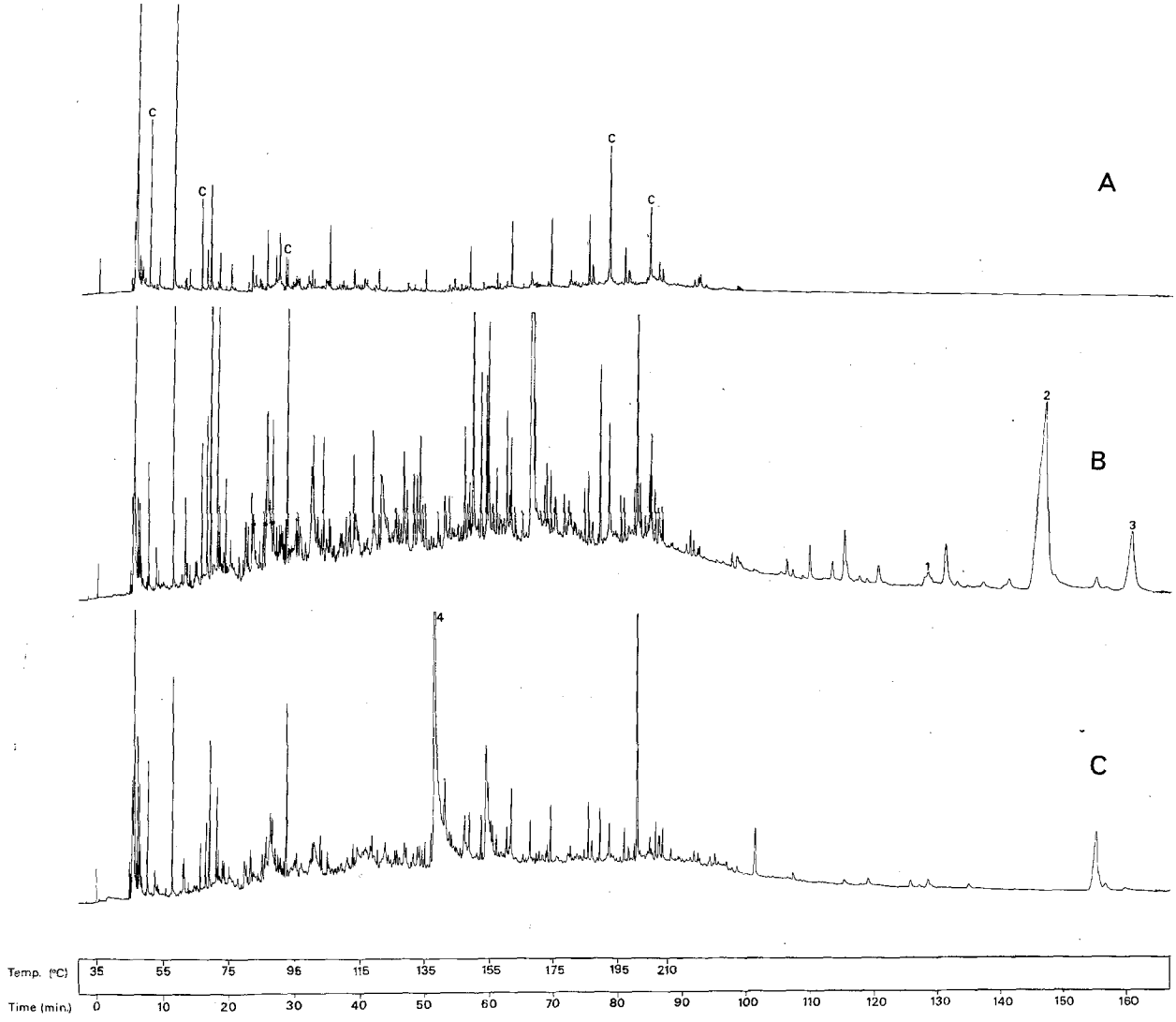
PRO EXPERIMENTIS

Detection of Marijuana Smoke in the Atmosphere of a Room

Much progress has been achieved in marijuana studies by the application of gas-liquid chromatography as an analytical tool. While the method is now almost exclusively used for the resolution of constituents of plant extracts, smoke composition studies have been less common. As with tobacco, marijuana smoke is an extremely complex mixture with hundreds of components; the limited amount of work in this area so far[1-5] has not paralleled the success of high-resolution gas chromatography and mass spectrometry in tobacco smoke analysis[6-9].

During the course of marijuana smoke studies[9], we observed that a characteristic and persistent odor is generated which differs from both tobacco smoke and unburned marijuana. If marijuana smoke contains characteristic compounds which can be determined in trace quantities, a method concerning the presence and type of marijuana smoke in a room atmosphere may be established to provide often needed court-room evidence. A concentration technique recently developed for studies of volatile compounds in physiological fluids[10,11] was used in conjunction with high-resolution capillary gas chromatography[12] to concentrate and separate trace constituents present in the air of a 36 m³ room.

A small glass tube (95 mm × 1.0 mm, i.d.) was packed with a 15 mm length of thermostable porous poly-*p*-2,6-diphenylphenylene oxide polymer particles[13] and conditioned at 350 °C for several h to remove volatile materials from the polymer surface. The tube was then connected to a vacuum line and room air pumped through for 1 h (flow rate 400 ml/min). Trace amounts of organic compounds present in the atmosphere of the room (presumably at less than ppb levels) are effectively concentrated in the tube which is later used as part of the sampling port in a commercial gas chromatograph. A high-efficiency glass capillary column then resolves the concentrated organics from the room atmosphere into individual



A) 'Background' chromatogram of the room. B) Chromatogram obtained after smoking a marijuana cigarette in the room. C) Chromatogram obtained after smoking a standard tobacco cigarette in the room. Chromatographic conditions: 60 m × 0.4 mm, i.d., glass capillary column coated with SF-96 silicone oil; injector temperature, 300 °C for 5 min during trapping; detector temperature, 230 °C. Peaks: 1. cannabidiol; 2. Δ^9-tetrahydrocannabinol; 3. cannabinol; 4. nicotine.

fractions detected by the flame ionization detector. The sampling port is maintained at 300 °C so that the sample is released from the polymer into the first part of a glass capillary column cooled by liquid nitrogen in order to avoid spreading of chromatographic fractions due to non-instantaneous desorption of sample. Cooling is stopped after 5 min and the column then programmed from 35 °C to 210 °C.

Profiles of volatiles present in the room in different circumstances are compared in the Figure. First, a blank from the polymer and the 'background' of the room were recorded (A). In this chromatogram, about 100 peaks can be seen which are presumably due to trace volatiles (paint constituents, plasticizers, etc.) from the furniture, books and other objects in the room. The fractions marked as 'C' are caused by the volatiles from the concentration column which cannot be removed by conditioning over a long period of time. The procedure was repeated after an experimental marihuana cigarette[14] had been smoked in the room by means of a syringe (35 ml puffs). A typical 'fingerprint' of marijuana smoke can be seen in (B) as compared to the different profile from a standard tobacco cigarette[15] in (C). Similar chromatograms were obtained with different commercial tobacco cigarettes. Δ^9-tetrahydrocannabinol, cannabinol and cannabidiol in marijuana smoke and nicotine in tobacco smoke were tentatively identified from their retention times. It is evident that many fractions are common to marijuana and tobacco. However, several distinctive peaks may be diagnostic for marijuana smoke in addition to the usual cannabinoids. Additional studies by combined gas chromatography and mass spectrometry will be necessary to reveal the structures of these compounds.

Further experiments have shown that marijuana smoke can be safely recognized in the presence of tobacco smoke even at much smaller concentrations than are generated from single cigarettes, and detection in much larger rooms should be possible.

Reproducibility of the described experiments is remarkable. It is very likely that this coupling of a concentration technique with high-resolution capillary gas chromatography will find wider use in the solution of a number of problems associated with the trace analysis of complex volatile mixtures at concentrations well below ppb levels.

Zusammenfassung. Mit einer Analysenmethode gelingt es, Marijuanarauch von einer Zigarette oder weniger durch Kombination von Anreicherungsverfahren mit hochauflösender Gaschromatographie in Zimmerluft nachzuweisen. Charakteristische Profile von 200 bis 300 Komponenten (darunter Cannabinoide), die sich deutlich von denen von Tabakrauch unterscheiden, wurden mit Hilfe von Glaskapillarsäulen gewonnen.

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[14] Experimental marijuana cigarettes containing 2.5% of Δ^9-tetrahydrocannabinol, supplied by the National Institute of Mental Health, Rockville, Maryland.
[15] Standard reference cigarettes, obtained from Tobacco-Health Research Institute, University of Kentucky, Lexington, Kentucky.

A New Method of Estimating Micropipette Tip Diameter

The difficulties involved in estimating the diameters of the tips of very fine electrolyte-filled micropipettes used in electrophysiology are well known. For many purposes it is desirable that the external diameter of the tip should be about 0.2μ (200 nm) or less, and this is well beyond the resolution of the light microscope. Some workers have used electron microscopy in special studies, but for most routine purposes the electrical resistance of the probe is measured to give an indication of tip diameter[1,2].

Estimates of tip diameter from resistance measurements are unreliable for a number of reasons. A group of apparently identical micropipettes frequently vary widely in resistance. This may be due to partial blockage of the tip by small particles flushed into it during filling. The micropipette resistance is non-Ohmic and depends on the direction, amplitude and duration of current flow. It is also strongly dependent on the taper angle at the tip and the resistivities of the filling and bathing media.

This short communication describes a simple and sensitive method for estimating tip diameter which appears to avoid the above unsatisfactory features. It is based on the method of filling very fine micropipettes described by Mullins and Noda[3] and used routinely in this laboratory. The micropipette is held in the air and 3 M KCl is injected into the barrel as close as possible to the tip, using a microsyringe. Capillary action then slowly ejects the remaining air in the micropipette through the tip. Motion of the solution meniscus towards the tip while it is some distance from it can be readily observed under an optical microscope of medium power, and the tip diameter can be calculated from the mensicus speed as shown below.

Consider the probe in the Figure which has an internal tip radius r_0. The solution meniscus is advancing towards the tip at speed v_1 when at a distance l_1 from the tip, where the radius of the pipette is r_1. Due to surface tension forces, the air pressure adjacent to the meniscus is $P_1 = P_0 + 2T/r_1$, where T is the surface tension at the interface and P_0 is atmospheric pressure.

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