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Altitudinal variation in leaf epidermal patterns of
Cannabis sativa

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SHARMA, G. K. (Dept. Biol. Sci., Univ. Tennessee, Martin 38238). Altitudinal variation in leaf epidermal patterns of *Cannabis sativa*. Bull. Torrey Bot. Club 102: 199-200. 1975.—Leaves of marihuana plants growing at low elevations, compared to ones growing at higher elevations, are smaller, dull-green in color, and have higher stomatal frequency. They also have longer and more numerous trichomes.

Cannabis sativa L. (marihuana), a plant of economic and medicinal importance, has been studied biochemically (Mechoulam 1970, Mechoulam et al. 1970) but its botanical and ecological aspects are not quite clear. It has been suggested (Adams 1940) that hot and dry climatic conditions are conducive to the production of more resin, which is secreted through the trichomes, and three types of trichomes have been described (Hammond and Mahlberg 1973) as the site of tetrahydrocannabinol. However, the role of environment on the leaf epidermal patterns of the plant is not completely understood and needs further investigation. This report deals with leaf epidermal patterns in marihuana populations growing in two diverse environments.

Methods. *Cannabis sativa* was collected from two different elevations in northern India where the plant grows wild. Population A, collected from the rural outskirts of Hoshiarpur (Panjab), was growing along roadsides at an elevation of 250 m, where summer day temperatures reach 40 C or more on the average. The general area is characterized by hot and xeric conditions. Population B was growing in the wild in the vicinity of Simla at an elevation of about 2,000 m, characterized by mild (15 C) summer day temperatures. Its surroundings were characterized by cool and humid conditions. The plants were collected in late July, 1973. Samples of each population consisted of 20 fully grown, pistillate plants. The length of the central leaflet of one mature leaf was measured per plant. For epidermal measurements, two leaflets were washed with distilled water and air-dried. Duco cement was ap-

plied on the upper and lower leaf surfaces (Williams 1973). Upon drying, the films were removed and a small portion from their central area examined at a magnification of 400X.

Results and discussion. Plants of population A were slender and dusty- to dull-green in color, while population B plants were quite stout and had a shiny, bright-green appearance. In addition, the leaves of population A were small and dull-green compared to the large, bright-green leaves of population B.

Table 1 lists only those features of the epidermis where differences in the two populations were statistically significant.

Table 1. Leaf characteristics¹ of a low altitude (A) and a high altitude (B) population of *Cannabis sativa*.

Pattern	Population A	Population B
Stomatal frequency ²	48.9±1.98	27.1±0.33
Trichomes		
Density/cm ² U*	63.8±1.20	28.3±2.20
L**	253.6±4.3	133.6±3.70
Length (µm) U	70.9±0.94	47.3±0.80
L	134.1±3.27	112.1±2.15
Central leaflet		
Length (cm)	8.4±0.11	10.8±0.20
Leaf color	dull green	bright green

¹ The values represent means of 20 measurements ± standard error of the mean. All data are of statistical significance ($P \leq 0.001$) as determined by means of a *t*-test.
² Mean stomatal frequency = stomata of the lower surface of leaves observed through a 40x objective and 10x ocular (field area = 0.152 mm²).
U = upper surface of leaf.
L = lower surface of leaf.
* Cystolith hairs present.
** Unicellular pointed trichomes present.

Stomatal frequency (defined in Table 1) was almost doubled in population A, which suggests that the hot and dry environment of population A may have induced such a trend. Similar results have been reported in other plants (Sharma and Dunn 1969, Sharma 1972). The presence of more abundant and longer trichomes in population A also suggests an adaptation to aridity, but variation in trichome type, length, and density, leaf size and color, and stomatal frequency in these populations can only be attributed to specific environmental or genetic causes upon further studies involving reciprocal transplants or test growth of seeds of varied provenance in transplant gardens or controlled growth chambers.

Since warm climate populations of marihuana are believed to produce more resin through trichomes and hence be more potent than cold climate populations (Bouquet 1950), it may be possible to employ some of these epidermal features in assessing the relative narcotic strength of *Cannabis* populations.

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