# *Cannabis* — A Polytypic Genus

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It has been a general assumption by botanists who have not worked taxonomically on the genus that *Cannabis* is monotypic. The preponderance of literature has treated it as such in the absence of any thorough taxonomic review to establish whether the epithet *sativa* must be restricted to a single morphologically distinct taxon within a more variable genus than presupposed or whether the specimens and literature concerning *Cannabis* permit the recognition of more than one specific epithet, in accordance with the most recent appearance of the *International Code of Botanical Nomenclature.*

Several aspects of the problem have been enlarged by recent publications attempting to clarify the problem of species distinctions. The excellent work of Small and Beckstead (1973), based almost wholly on cultivated or weedy material, concluded that there was but a single species of *Cannabis* (on the basis of published chemical data rather than presentation of morphological evidence), even though three distinct chemical phenotypes from three geographically disjunct latitudes were recognized and plotted on a scatter diagram. One of the several unfortunate aspects of this work was that plants growing in Ottawa under uniform conditions were not able to reach maturity in many instances, due to the abbreviated growing season; thus morphological distinctions could not always be accessed from a study of mature specimens. Furthermore, this limited growing season did not permit the study of perennial forms.

Most important is the fact that the overwhelming numbers of types described in floras of the world are not distinguished from one another by growth patterns under cultivation. The absence of discontinuities under cultivation does not take into account the phenomenon of hybridization and introgression which Schultes et al. (1974) suggest is an aspect of speciation in *Cannabis.* Hybrids have been published and have been given specific recognition: cf. *X. C. intersita* (Sojak in Novit. Bot. Del Sem. Hort. Bot. Univ. Carol Praga, 1960), a hybrid between *C. sativa* and *C. ruderalis.*

Quimby et al. (1973) have argued for a monotypic concept of the genus based upon studies of "marijuana" grown in Mississippi. No data are provided as to the precise characteristics assayed, the range of variation, or the repository of specimens studied; furthermore, the use of the term "marijuana" has a specific legal meaning and denotes only *C. sativa.* Schultes and two of his students (1974), studying these same plants, came to different conclusions from those of Quimby et al. It should further be noted the taxonomic studies are not being carried out in the Mississippi NIH plantation. The pinnatifid-leaved plant which Quimby identified as *Cannabis* was in reality a species of *Datisca.*

Regardless of the biological concept of species as held by different botanists who have worked with this genus, the question of the historical recognition of species and their valid and legitimate publication are questions to which the botanist must basically address himself. He must first become acquainted with the published historical treatments. For 221 years, there has been no type of Linnaeus' *C. sativa*! Precise typification of *C. sativa* L. was established only recently by Stearns

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(1974), who points out that, in the *Species Plantarum* of Linnaeus (1753), the published description is in accord with that in the earlier work of Linnaeus *Hortus Cliffortianus* (1738) and that the lectotype must be selected from the Cliffort Herbarium. Under the *International Code of Botanical Nomenclature*[2] either of the two specimens in this herbarium might be designated the lectotype. Since, according to Stearns, "the major characters for taxonomic division in *Cannabis* come from fruiting material," he chose *Hortus siccus Cliffortianus* fruiting specimen (p. 457 *Cannabis* no. 1, B) of *Cannabis sativa* L. as the lectotype. This specimen has seed 5 mm long and 3.5 mm broad. This designation by Stearns supercedes the choice made by Joyce and Curry (1970) in which they arbitrarily selected Linnaean Herbarium specimen 1117.2 (which was not in the Linnean Herbarium at the time of publication of the binomial in 1753) as typifying *C. sativa* L. Since this specimen in no way affected any of Linnaeus' publications, it is to be disregarded as pertinent to modern studies. The Linnaean specimen 11771, with obtuse and coarsely serrate leaves, was not cited in *Species Plantarum* and is not consistent with *C. sativa* as represented by the lectotype; it may very well represent what is now called *C. ruderalis.* Stearns also points out that the *Cannabis* Linnaeus knew was *C. sativa,* the hemp growing in northern Europe at that time for purposes of cordage. It will follow that subsequent characterizations of *C. sativa* must be consistent with the characteristics of the *Hortus Cliffortianus* specimen designated as *lectotype* and with the description of Linnaeus in his *Genera Plantarum* of 1754. (See International Code, Article 13, note 3, 1972.) It is in this latter work that Linnaeus presents his description and notes by use of an asterisk that he had based this account *on living material.* A translation of this Latin description is as follows:

Male: Calyx. Perianth five-parted: leaves oblong, acuminate-obtuse, concave.
Corolla. Absent.
Stamens. Filaments five and thread-like, short. Anthers oblong, quadrangular.

Female: Calyx. Perianth in one series, oblong, acuminate, opposite at the base, dehiscing longitudinally, persistent.
Corolla. Absent.
Pistil. Ovary minute, *Style* divided, sharply pointed, long. *Stigma* acute.
Perianth. Minimal. *Calyx* tightly closed.
Seed. Nut globose-depressed, bivalvate.

Schultes et al. (1974) make an important distinction between *Cannabis* that is truly wild (only in areas where it is native), weedy (having escaped cultivation), and cultivated (under domestication by man for one or more reasons), and they point out the importance of this distinction in the cases of other domesticated plants. Perhaps one thousand years of man-made selection combined with many thousands of years of natural selection has led to an enormous complexity in the tendency to vary. These factors, coupled with hybridization and introgression, make it impossible easily to ascertain species by disjunct variation when a multitude of species, their variants, and hybrids are grown under cultivation. What is important, however, is the ability to recognize wild, cultivated and weedy forms, to be aware of the historical context of their taxonomic treatment and their geographical distributions.

The polytypic concept of *Cannabis* dates to 1783 when Lamarck published an account of *C. indica* in his *Encyclopoedia* (Volume I) and fully contrasted it with the account of *C. sativa* Linnaeus, an account of which Lamarck, of course, was well aware. His information of *C. indica* was provided by the meticulous collector Sonnerat. The account is as follows (au-

Jean Baptiste Pierre Antoine de Monet de Lamarck, in Volume 1 (*Encyclopedique de botanique,* 1783, page 695) presents us with the original description of *Cannabis indica* and recounts the synonymy to that date:

[2] Article 13, note 3.

Chanvre des Indes, *Cannabis indica, Cannabis foliis alternis.* N, *Cannabis similis exotica.* Bauh. Pin. 320. *Cannabis peregrine, gemmis fructuum longioribus.* Moris. Hist. 3, p. 433, no. 2. *Kalengi-cansjava.* Rheed. Mal. 10, p. 119. t. 60. *Tsjeru-cansjava.* Ibid. p. 121 t. 61. *Bangue des Indiens. Dakka ou Bangua.* Hist. des Voyages, Vol. 5. p. 188.

This is the first post-Linnaen binomial distinction in which the obvious differences between two species of *Cannabis* are made clear; and they were clearly distinguished! On the same page, and in the same volume, he discusses *Cannabis sativa* L. and in the former species description makes note that it (*C. indica*) is a species "*. . . tres-distinguée de celle qui prècéde*" i.e., *C. sativa.* In translation (author's translation from the original French): *C. indica* ". . . is smaller, has greater ramification of the stems, which are tough and more cylindrical, and which is distinguished particularly in that the leaves are constantly alternate. Their foliage is strongly serrate, linear-lanceolate and very acuminate, the males bear five to seven leaflets, but those that are female may exhibit as few as three for each petiole and at the very tip are even able to be simple (as opposed to compound). The female flowers are velous on their calyx and bear long parallel styles. This plant grows in the Oriental Indies (v.s.). Its stem is strong, having a thin cortex rendering it incapable of providing fiber comparable to those others mentioned here which are in great usage. Its odor is strong and in some ways resembles that of tobacco." The author continues by describing the intoxicating qualities of the plant. He notes his debt to the botanist explorer Sonnerat, who aided him with his own field observations in the Indies.

By contast (again translating from the original French): *C. sativa* has

> . . . a stem four to six feet tall, obtusely quadrangular, slightly downy. Its leaves are opposite, the petioles terminating in a digitate pattern of around five lanceolate leaflets with acuminate tips severely dentate and in which the inferior leaflets are the smallest. The individual males, that is to say those that do not produce seed, bear their flowers disposed in small groups in the aces of the superior (upper) leaves and at the tip of the stem. The female individuals bear their flowers in the same manner, but are sessile in disposition, less apparent, and are principally noted for reason of their protruding styles . . . . This plant grows naturally in Persia according to Linnaeus but is often cultivated for reasons of its utility; it is already naturalized in Italy, in the Piedmont, in Switzerland, France, etc., and is frequently found around villages and on the border of fields and of woodlands. It keeps reseeding itself each year.

The following synonymy is given for *Cannabis sativa* L.:

> *Cannabis foliis oppositis.* N. *Cannabis.* Hall. Helv. no. 1616. Gars. t. 194. *Cannabis sativa mas* and *foemina.* Raj. Hist. 158.
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> **Cannabis foemina . . . Cannabis sativa.* Bauh. Pin. 320. Tournef. 535. *Cannabis soecunda.* Dod. Pempt. 535. *Sed folia perperam alterna.*
>
> **Cannabis mas . . . Cannabis erratica.* Bauh. Pin. 320. Tournef. 535. *Cannabis sterilis.* Dod. Pempt. 535. *Mala iterum quoad foliorum dispositionem.*

One of the primary distinctions that concurs with the morphological distinctions between these two species is the size of the fruit, usually termed a 'seed', more properly an achene, in which the testa has fused to the pericarp. *Cannabis sativa* has an achene roughly twice as large as that of *C. indica* and is highly compressed longitudinally, so that when pressure is applied to the periferal ridges of the achene, it easily falls apart; not so with the small, almost spherical achene of *C. indica.* It might be noted also that in the United States *Cannabis sativa* achieves heights of 18 to 20 feet in river deltas, whereas *C. indica* rarely exceeds four feet under any circumstances of cultivation, even in the lush, fertilized soils of Mississippi.

There has been much controversy over the nature of fixed variability and species in the genus *Cannabis.* Some botanists have ignored the tremendous geographical variation in the wild state (partly because so little is known of wild *Cannabis*) and have treated the entire genus as a single species. Such a simplistic approach reduces to synonymy those species now recognized as valid in Europe and Russia and by botanists in the United States who

have had the opportunity to study the enormous variability in sundry areas of the world. My recent observations in Turkey and those of Schultes and Klein in Afghanistan (written communication) are sufficient, together with the Russian studies of Zhukovskii (1964) and others, to argue for the recognition of at least three distinct species, one of which (*C. ruderalis* Janish.) is not found in the United States but seems to be restricted to the steppes and upper and lower regions of the Volga, Western Siberia, and Central Asia, but which is penetrating into eastern Europe as a weed.

In 1964, Zhukovskii described the genus as it exists in Russia and Russian dominated countries. That is to say, his descriptions of *Cannabis* do not encompass all of the variation that one might encounter in the many areas in which this genus is found growing, and the descriptions are terse. In his recent (1971) edition of his book, he still concurs with the polytypic concept. Another treatment of this genus by Vavilov and Bukinich (1929) was more thorough, but again stressed variation as it occurred in Afghanistan and Kafiristan, rather than in the entire range. The consequence of this study was the formulation of subspecies in part of the range. For example, the prominent carunculus on Kafiristan species of *Cannabis indica* led to the recognition of the subspecies *kafiristanica* Vav. This characteristic is constant only throughout Kafiristan and is absent in many other areas where *C. indica* is to be found in cultivation or growing wild.

Further evidence for enormous variability in the genus *Cannabis* is manifest in the number and arrangement of apertures on the pollen grains. These are easily observed, as the grains exceed 20 microns in diameter and are used as characteristics in diagnostic keys (Faegri and Iverson, 1966; Wodehouse, 1965). Oddly enough, while Faegri and Iverson position *Cannabis* under the tri-porate grains, Wodehouse (1965) notes that the aperture number in *Cannabis* is highly erratic "ranging from two to four pores (apertures), the mean being three"! Such data suggest that it would be foolhardy to make an exception for the genus *Cannabis* and attempt to encapsulate this variation under the dominion of a single binomial epithet. The palynological characteristics of a small vestibulum (sometimes absent) are fairly constant, equatorial limbs of a circular nature (pores not protruding), the tectum bending vertically to form sunken pores; grains in excess of 20 microns. The size fluctuates considerably, being greater in *C. sativa.*

To this date, twelve different "species" of *Cannabis* have been published, of which eight are both valid and legitimate. The genus has been placed in several different families (Artocarpaceae, Haloragaceae, Urticaceae, Moraceae, Cannabaceae, and Cannabinaceae). The family position of a genus is a much greater question than whether the genus be monotypic or polytypic. As late as 1960, Sojak published a note on a hybrid between *C. sativa* and *C. ruderalis* (*C.* × *intersita*) found in the Ukraine. Both annual and perennial species have been noted, and monoecious as well as dioecious specimens have been observed.

According to *Flora Europa* (ed. Tutin et al., 1964), the chromosome count for *C. sativa* is $2n = 20$, but Miller (1970) maintains that $2n = 18 + XX$ or XY, and notes that the genus is comprised of possibly more than one species and that "somatic karyotypes" have been imperfectly investigated. It may be that the count of $2n = 20$ represents a mistake in which the sex chromosomes were counted as part of the normal genomic bivalents, but this would more likely result in an interpretation of 19 pairs. The alternative explanation is that there are different taxa with a variety of chromosomal numbers. This is reinforced to a degree by the observation of heteromorphic pairs of chromosomes in certain monoecious strains (Miller, 1970).

Monoecious strains are not uncommon among cultivated species of *Cannabis*, and two explanations for this may be advanced: monoecious plants are all XX, and sex determination is relegated to heterozygous genes on the X-chromosomes and autosomes, or XX, XY, and YY monoecious plants occur with sex being

TABLE I
SOME MEAN ACHENE MEASUREMENTS IN *CANNABIS* SPECIES

| Species & area | length | width | seed coat |
|---|---|---|---|
| *C. sativa* | | | |
| Kansas | 4.5 | 3.5 | white |
| Orel, Russia | 5.0 | 3.8 | white |
| Afghanistan | 5.4 | 4.0 | white |
| *C. ruderalis* | | | |
| Saratov, Russia | 4.0 | 2.8 | mottled calyx, in part, persistent |
| *C. indica* | | | |
| Delhi, India | 4.0 | 2.5 | mottled |
| Izmir, Turkey | 3.8 | 3.0 | mottled and dark in color |
| *C. indica* var *afghanica* | | | |
| Afghanistan | 2.8 | 1.9 | mottled |
| *C. indica* var *kafiristanica* | | | |
| Kafiristan | 3.0 | 2.2 | mottled |

determined only by autosomes. Thus, we are left with these hypotheses until more concrete information becomes available. Zhukovskii (1964) noted that in experimental work monoecious plants are "homogametic, feminine types," and that "monoecious male-type" plants can be produced by abortion of the Y-egg cells in male type plants. This is only an imperfect and partial explanation.

These data stand in opposition to that of Small (1972), who on the basis of locally gathered and forensic material of limited range observed chromosomal uniformity and the absence of breeding barriers in *Cannabis*. He consistently found $2n = 20$, with minimal meiotic aberrations.

Zhukovskii (1964) correctly stated that *C. sativa* may still be found growing in the wild state and that neither *C. indica* nor *C. ruderalis* are its progenitors. *C. ruderalis* is found as a weed in cultivated fields in southeastern Russia and in central Asia. *C. ruderalis* is a small plant with marbled achenes distinctly articulated at the base easily detached for reasons of dissemination in the wild. Also, the carunculus in this species may be pronounced. This wild species has an achene that is about one-half the size of *C. sativa* fruit and over twice the size of the achenes of *C. indica*. Some mean values for achenes of each of these species are presented in Table I.

With respect to leaf morphology and phyllotaxy, it must be noted that, while *C. sativa* usually has opposite leaves, the phyllotaxy changes as one moves toward the flowering tip; this, however, is usual for most flowering plants. *C. indica*, on the other hand, generally has alternate leaves, but some of the lower leaves may be opposite in arrangement with numerous axillary branches.

Trichomes, or the indumentum, on *Cannabis* species show organographic variation, but the basic types are these: Glandular or peltate trichomes (scales) having an abbreviated stalk or neck and a series of cells in regular divisions up to 8 or 16 and encased in a membrane which is most probably the oxidized oil and resin being produced by these glandular cells. A second type of hair is the simple hair of one or several cells having no apparent physiological function. A third type is like the simple hair, but it has a large basal cell containing deposits of calcium carbonate; such hairs are called cystolyths. A fourth type of hair is that which produces but a single gland which is also resin producing. It is within this resin, or oil, that psychoactive compounds are found. As a generalization, the resinous glands are found in greatest abundance on the flowering shoots of female plants. Trichomes make their appearance on the first set of true leaves of the seedling. The stems of the plant also bear all four types of trichomes.

No single class of trichome is limited to any one species, nor is any of these absent from the plant body of any species of *Cannabis*. It should also be noted that these are not in themselves diagnostic in identifying the genus *Cannabis*, for all of them are found also on totally unrelated genera and species, notably in the mint family (Labiatae).

While the stem has few diagnostic features beyond the obtusely quadrangular aspect of young shoots of *C. sativa*, it should be stressed that this species, under cultivation, may exceed 18 feet in height and, consequently, forms a heavy wooden stem to support the growth. Such complex lignification is not common in *C. indica*. Such a dense woody habit was characteristic of those species of *Cannabis* (undoubtedly *C. sativa*) found growing in ancient China and from which the Chinese were able to carve heavy wooden canes. It is *C. sativa* also that is occasionally found growing as a perennial in subtropical to tropical areas.

A more thorough reassessment of this genus is needed, but, at this time, a preliminary report such as the above is advisable to elicit recognition of these three species, two of which are found growing as cultigens in the United States: *C. sativa* as a ruderal remnant from the once extensive hemp industry which dates to the 18th Century in the United States and *C. indica*, a more recent introduction, which is grown for reason of its intoxicating resins. The third species, *Cannabis ruderalis*, characterized by the Russian botanist Janishewsky in 1924, is not, so far as we know, found growing in the United States at this time. The Israel Program for Scientific Translation in 1970 presented us with an English version of *Flora of the U.S.S.R.*, in which the two species *C. sativa* and *ruderalis* are recognized as lidly published, legitimate species. These distinctions must be preserved, until they are reduced to synonymy in accordance with the *International Code* and as the result of thorough and substantial taxonomic study, not hearsay.

Most of the important literature following Lamarck's account was summarized in the *Index Kewensis* of 1895, published by Daydon Jackson under the patronage of Charles Darwin and under the direction of Joseph Hooker. This "keystone" to all botanical literature from the time of Linnaeus to the year 1885, with many supplements, together with author's names and place of publication errantly included synonyms for species. This practice was an editorial policy that was arbitrary and for that reason was discontinued in all of the supplements that have been issued from 1896 to the present. Unfortunately, some botanists do not seem to be aware that the *International Code of Botanical Nomenclature* does not recognize the synonymy in this first two-volume edition as valid.

The school of botany founded in Russia by the famous botanist Vavilov found *Cannabis* a genus worthy of investigation, and their experience in Russia and Asia led them in the 1920's to formulate a polytypic concept of the genus. The unavailability of Russia and work in Russian journals resulted in a general ignorance of their findings. Schultes et al. (1974) were the first Americans to alter the concept of the monotypic nature of the genus, although it seems that the British were aware of several species when, in the 1930's, they formulated legislation against the genus *Cannabis* not directed toward any one of its component species but including "any species of *Cannabis*."

Schultes has examined uniform plantings of *Cannabis* in Mississippi, cultivated under the auspices of the National Institutes of Health, and has also carried out field studies in Afghanistan; he has, furthermore, surveyed specimens in several of the largest herbaria of the world. The result of these extensive investigations led Schultes and his colleagues to the conclusion that there are several species in the genus. They present a key to three of these: *C. sativa*, *C. indica*, and *C. ruderalis*, leaving the total number of species as "still open to question." Listed are eight validly and legitimately published species, and the suggestion is made that "The time is long overdue when a full study of *Cannabis* taxonomy must be initiated."

This author spent a part of the summer of 1973 in Turkey, around Izmir, and

noted that *Cannabis* grown in this area was much dwarfed at maturity and densely branched at the base when grown under cultivation (presumably for the resin content rather than for fiber). The seed was smaller than that of *C. sativa*, heavily marbled, often dark. The compact inflorescence produced considerable quantities of a sticky resin and, at maturity, the seed fell from the plant. In no way was the plant comparable in habit to those weedy forms of *C. sativa* found throughout midwestern and southern United States, where they achieve a height of 20 feet at maturity and are so laxly branched as superficially to resemble bamboo. The latter are escapes of *C. sativa* brought to the United States in the 18th Century as a fibre crop. In *C. sativa*, the leaves are most often opposite one another, except near the inflorescence, where they become alternate. The seed of *C. sativa* is large, often exceeding five mm, and usually without marbling and compressed. In opposition to this, the plants in Turkey have a seed rarely exceeding four mm and plump (as opposed to being heavily compressed on one plane). In all features, these Turkish plants fit the description of *C. indica*, which was first described by Lamarck. Further, in the key provided by Schultes et al., the plants key out to *C. indica*. The absence of discontinuities under cultivation do not necessarily reflect geographically based discontinuities in nature, and it is upon the latter information that the taxonomist must formulate his concept of species. Until such time as contradictory evidence is presented, the genus *Cannabis* must be seen as polytypic, being comprised of at least three species.

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