Acta Botanica Hungarica 44(1–2), pp. 31–47, 2002

TAXONOMY AND MORPHOLOGY OF UNCULTIVATED HEMP (*CANNABIS SATIVA* L.) AS WEED IN HUNGARY

G. BENÉCS-BÁRDI

Plant and Soil Protection Service of Budapest and County Pest
H-2100 Gödöllő, Kotlán S. u. 3, Hungary, E-mail: neutex@mail.digitel2000.hu

(Received 20 April 2001)

In Hungary increasing problems are caused by hemp found in cultivated fields and waste areas. Results of nation-wide weed surveys demonstrate that area covered by and importance of the plant show a growing trend. The taxonomic status of weed hemp is not unambiguously cleared up in Hungary. Certain authors argue that weed hemp is the crop escaped and naturalized while others' opinion is that in Hungary wild hemp is present spontaneously, too. Based on her ten years' observations and surveys, the author gives the morphological characters of uncultivated hemp and attempts to clarify its taxonomic status accordingly.

Key words: *Cannabis ruderalis*, *C. sativa*, *C. sativa* subsp. *spontanea*, hemp, Hungary, morphology, taxonomy, wild hemp

INTRODUCTION

Hemp is one of the crops with the oldest history of cultivation in the world. It has been known and grown for several centuries in Hungary, too (the first record is found in the "Customs tariffs of Esztergom" issued in 1198). The varieties bred in Hungary are well-known throughout Europe. The crop area used to be several thousands of hectares before 1989, it has been suffering a considerable decrease only since the political changes.

The origin of the Hungarian word for "hemp" and widespread character of the plant are shown by the high number of localities bearing the name of the plant. In 1944, the register of old Hungarian localities contained 50 names like that. Today, passing by the fields outside the villages, it is almost certain that we happen to find a piece of land known as "Hemp field" by local people, though even the oldest persons do not remember that the crop was ever grown there.

Hemp (*Cannabis*) belongs to the family Cannabaceae named after this genus. Hop (*Humulus lupulus*) was classified into the same family (Soó 1970, Simon 1992, Borhidi 1998). There are two distinct opinions about the taxonomic relations within the genus *Cannabis*. One of them considers that there is a single, highly variable but monotypic species: *Cannabis sativa* L. and all the other

0236–6495/02/$ 5.00

names are synonymous, and this species represents the genus (Small 1975, Small and Cronquist 1976). According to the authors of the polytypic concept (Emboden 1974, 1977), the genus can be separated, undoubtedly containing individual species which can be further divided into taxa below species level (mainly subspecies). This approach considers the existence of at least two species: common hemp (*C. sativa* L.) and Indian hemp (*C. indica* Lam.). There are botanists distinguishing three species, in addition to the previous two, they still include the so-called wild hemp (*C. ruderalis* Janisch.) in this genus.

In Hungary, until recently, the taxonomy of Serebriakova (in Komarov's Flora SSSR 5: 40, 1940) was the most accepted one. According to her classification, the genus contains two species: Indian hemp (*C. indica*) used for drug and the common hemp (*C. sativa*). The latter species has two subspecies: the cultivated hemp (*C. sativa* subsp. *culta)* having geographical (ecological) races (northern, Central Russian, southern and Asian), and the other subspecies is wild hemp (*C. sativa* subsp. *spontanea*), which nowhere can be found in cultivation. Wild hemp is the same as the plant naturally growing as weed, described by Janischevski (1924) in Russia and later determined as *Cannabis ruderalis* by Hanf (Yarmolenko 1936, Mándy and Bócsa 1962, Hegi 1981, Hanf 1982).

The majority of identification keys and taxonomic manuals commonly used today in Hungary also describe the spontaneously occurring wild hemp under the name of *C. sativa* subsp. *spontanea* as a separate subspecies (Soó and Kárpáti 1968, Horánszky and Járainé-Komlódi 1991, Simon 1992), and they definitely distinguish it from the cultivated and escaped hemp (*C. sativa* subsp. *sativa*).

In Hungarian agriculture, increasing problems are caused by hemp found in the fields (mainly in cereals with lower plant density, maize, sugarbeet, sunflower and medicinal plants) and in waste areas (roadsides, sides of ditch, degraded black locust and popular plantations, shelter forest belts, refuse dumps and building areas). Results of the four nation-wide weed surveys (Tóth *et al.* 1999), started by Miklós Ujvárosi and conducted with practical purposes mainly by the specialists of the plant protection organization, demonstrate that the area covered by and importance of the plant show a growing trend (Table 1).

Professionals working in crop production and plant protection especially deal with hemp as a weed from practical aspects, they are seldom interested in taxonomic problems. If they still liked to look for an unambiguous answer to the question of the taxonomic status of the plant, they would encounter difficulties. Both Soó and Kárpáti in the "Plant identification handbook" edited by Hortobágyi (1968) and Simon's "Identification handbook of the vascular flora in Hungary" (1992) describe the spontaneously growing, short, wild hemp with 2.5–3.5 mm long and 2–2.5 mm wide, brownish fruit as subspecies

Table 1
Cover (%) and rank of hemp based on I–IV. national weed surveys in arable land

Site	1949–50		1969–70		1987–88		1996–97	
	rank	cover%	rank	cover%	rank	cover%	rank	cover%
Wheat	50	0.0813	47	0.0919	33	0.1268	23	0.1898
Wheat stubble	87	0.0730	46	0.1467	28	0.1271	22	0.3007
Maize	91	0.0162	50	0.0530	38	0.1091	31	0.2022

(subsp. *spontanea*). According to Soó and Kárpáti, tepals of this subspecies are developed, its female inflorescence is loose, while in case of the cultivated hemp, which may run wild, too, tepals are rudimentary or absent, female inflorescence is dense while fruits are greyish and larger, 3.5–5 mm long and 2.5–4 mm wide. The Hungarian herbological sources (Ujvárosi 1973, Hunyadi 1988, Németh 2000) describe that hemp escaped from growing and naturalized as *C. sativa* subsp. *sativa* in contrast with *C. sativa* subsp. *spontanea*, and state that Hungarian distribution of the subspecies can still be determined.

Ujvárosi (1973) mentions the morphological differences in compliance with Soó and Kárpáti's identification handbook (1968), but the recent works (Hunyadi 1988, Németh 2000), though distinguish the two subspecies, only give a single morphological description for both of them. In the hemp monograph of Mándy and Bócsa (1962) published in the series of "Hungary's cultivated flora", Járainé points out that there are conspicuous morphological differences between the cultivated or escaped and naturalized hemp and the real wild hemp. Wild hemp differs from the cultivated one by its lower size (60–150 cm), smaller leaflets (5–11 leaflets in the palmately compound leaf) and especially by the tiny, darker brown and mottled achenes.

As the supposed original homeland of hemp is Central Asia, majority of distribution data and descriptions on wild hemp can be found in the works of former Soviet authors (Yarmolenko 1936, Zhukovski 1950, 1971, Grossgeim 1967, Vasilchenko and Pidotti 1970). Hayek (1927–1933), Soják (1960), Hejný and Slavik (1988) record the occurrence of wild hemp in Romania, Bulgaria, Yugoslavia, Poland, Germany and Hungary. In the descriptions of the former and the Soviet authors wild hemp is a short (30–150 cm) plant with palmately compound leaves of 5–7 leaflets and much smaller, darker and more mottled fruits than cultivated hemp.

If, having the knowledge of all these, during weed survey, a herbologist finds a hemp plant in the field or in waste areas and tries to decide whether that plant is a real wild or an escaped hemp, he will be in a difficult situation. The problem almost never can be solved based on the morphological characters of the studied specimens. It is no wonder that well-trained professionals

avoid the denomination "wild hemp", they simply mention hemp. Thus they do not make any mistake, as according to the most recent results of hemp research (Ranalli 1999), it is the case of a single species, where variability derives from intraspecific taxa.

In spite of it, as I have been dealing – though mainly from plant protection aspects – with hemp for more than ten years, I believe it necessary trying to give a description on the plant as detailed as it is possible, contributing to the elucidation of the taxonomic problems.

METHOD

I have been conducting weed surveys since 1989, especially in the field. In connection with it, in 1989–1990 I passed over the country collecting and observing weeds almost in every main regions of the country in summer, autumn and spring. In addition to it, I participated in the last, the Fourth National Weed Survey in 1996–1997, when I was responsible for making the survey on 20 sites in county Pest (at each place twice a year, at two dates in wheat, wheat stubble and maize, in 10 fields per crop) and for processing the data. In summer and autumn of the year 2000 took place two weeks long surveys throughout the country offering possibility for studying hemp. In July and August, I made a survey on completely waste areas, too. Since 1995 I have frequently collected hemp from county Pest for purposes research to be carried out in the Institute of Pharmacognosy, Budapest. I have hemp specimens from nearly every part of the country in my herbarium.

I gave the morphological characters of the spontaneously occurring hemp based on experience obtained during surveys, measurings and drawings made on the site, laboratory examination of the living, collected plants and herbarium specimens.

RESULTS AND DISCUSSION

Morphological characters of spontaneously growing hemp in Hungary
Root system

The plant has a main root system with the taproot in the centre (Fig. 1b). Its diameter at the root-top is generally 15–20 mm. Sometimes, in soil rich in moisture and nutrients, this figure can be much higher. The root system generally penetrates to 30–40 cm depth, though its main part remains in the upper 10–20 cm layer. In sandy or sandy loam soils where the occurrence of hemp is

Fig. 1. Cannabis sativa L. (hemp). a = seedling, b = root and stem, c = staminate flower, d = pistillate flower, e = fruit (achene)

the highest, relatively few primary roots branch off spreading in horizontal direction in the soil and the main root remains rather short. However, in extremely dry seasons, the main root grows more vigorously than the lateral ones and tries to grow downwards to reach moisture. The situation is similar in more heavy, wet soils. The roots are light yellowish white, later they turn ochre. In older age of the plant the main root becomes tough.

Shoot system, stem

Hemp as a weed is an erect plant occurring in Hungary with a wide range of height from 30–50 cm to 2–2.5 m, to specimens overgrowing the head of bred sunflower plants. Size variability indicates that the plant sensitively responses to changes in the environmental effects and as it was experienced, development of the shoot system also depends on the circumstances. For example, hemp, on the bank of the ditch along the side road leading from Péteri to the main road No. 4, growing in high abundance and density together with *Urtica dioica, Sambucus ebulus, Lycium halimifolium, Chenopodium album, Atriplex nitens* and *A. tatarica* reaches 1.8–2 m height due to good water supply and competition conditions, and the plants scarcely branch. At the same time, in a drift-blown sandy soil with poor nutrient and water supply near Nyársapáti, hemp, growing sporadically at the edge of the potato field, hardly reaches 1 m height and branching of the specimens is intensive. Male flowered hemp plants are by 10–15% taller than the adjacent female ones.

The stem is longitudinally fluted. Four grooves run along the caulis which later turns tough, fibrous (Fig. 1b). The stem bears downwardly projecting hairs, which become harsh with age. Structure of the stem in young plants is solid, turning lacunose with age.

Leaf

Hemp has palmately compound leaves. Number of leaflets within the leaves ranges between 3 and 11, most frequently 5–7 (Figs 3–6). The first true leaves are simple, the second pair is generally triparted (Fig. 2). Number of leaflets gradually increases following upwards on the more developed plant and the highest number is reached in the middle of the shoot, while it decreases approaching the tip. On the apical, generative part of the shoot, the leaves, from the axils of which inflorescences are produced, have generally only 3–5 leaflets, even the leaves are quite simple, alternate (Figs 3 and 5). On the vegetative (lower) part, the leaves are opposite and lateral shoots are formed here, too.

The leaflets are expressly narrow (0.7–1.5 cm), linear, acuminate, lanceolate or wider lanceolate (1.5–2.5 cm). In the compound leaf, the central leaflet is the largest, the others are smaller. Length of the leaflet ranges between 3 and 15 cm, they are generally 4–15 times longer than wider. Their surface is pubescent and punctuated by glands.

Fig. 2. Hemp seedlings with 1–2 pairs of real leaves and young plant

Leaflets are serrately toothed. In case of the leaves with narrowly elongated lanceolate type leaflets (Figs 3 and 4), the shorter side of the serrate segment goes into the longer one 3–4 times. The tip of the serrate segment inclines quite forward, almost parallel with the midrib of the leaflet, thus the shorter

Fig. 3. Habitus of female flowered hemp plant with 5–7 narrow, linear, lanceolate leaflets in the palmately compound leaves

side has a wide U-shape. Sometimes dentation is deeper when the proportion of the shorter and longer sides are 1:1.5 or 1:2 and the serrate segment inclines forward like a claw.

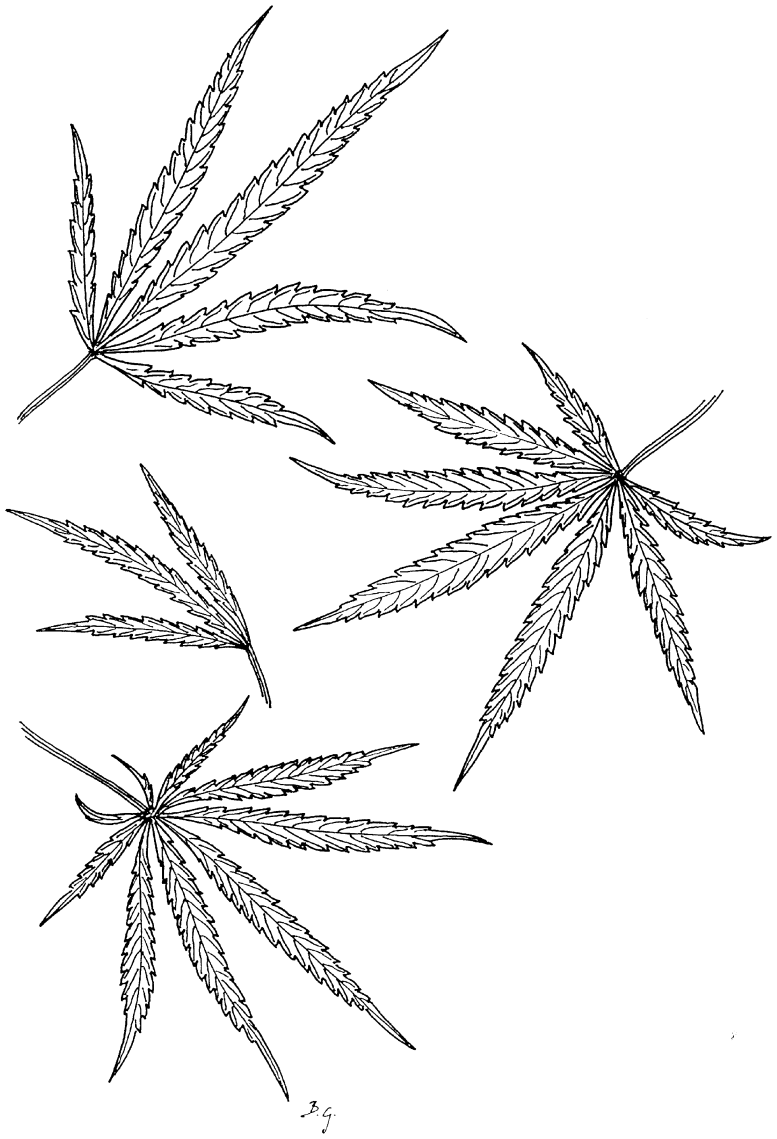

Fig. 4. 3, 5, 7, 9 narrowly lanceolate type leaflets in the palmately compound leaves

In case of the leaves with wider lanceolate type leaflets (Figs 5 and 6) dentation is deep (the proportion of the shorter and longer sides are 1:1.5 or eventually may reach 1:2 while the tip of the serrate segment more or less sticks out from the direction of the midrib and the shorter side sticks out with a slight arch.

Fig. 5. Habitus of male flowered hemp plant with 5–7 wider lanceolate leaflets in the palmately compound leaves

The petiole is stiff, grooved, hairy and fleshy. Its length can be 2–8 cm in the lower and central leaves. The base of the leaf is simply developed, 2 narrow, green, 3–4 mm long stipules may be attached to it.

Fig. 6. 3, 5, 7, 11 wider lanceolate type leaflets in the palmately compound leaves

Leaflets of hemp are generally light green, but on the types with 9–11, wider lanceolate leaflets, they can be darker green, too. Leaves of male hemp plants are generally slightly lighter (sometimes with yellowish tone) than those of female plants.

Foliage leaf disorders may occur on weed hemp. For example the outermost, smallest leaflets develop without teeth on the sides. Leaflets in the inner part of the leaf may branch into 2–3 directions forming compound leaves. Sometimes leaf sides interlace. It seldom occurs that, similarly to the cultivated fibre hemp, leaf margins are entire on the whole plant. Such specimens are small, without branching and have fewer leaves.

Flower and inflorescence

Hemp has a dimorphic sexual system, it is a dioecious plant (Figs 3 and 5). However, in stands on waste areas and in the fields transitional, monoecious types are found quite often (4–5%), too. For example specimens, producing mainly female inflorescence, develop also male flowers in the axils of lower branches and vice versa. Male flowered specimens are by 10–15% higher than female ones, their season is by 3–4 weeks shorter and finish their life cycle soon after flowering. In the middle of September only the "Christmas trees" of the female flowered plants rise along the sides of the roads and fields.

Hemp plants of both sexes have compound inflorescence containing leaf-like bracts (hypsophylls). Bracts are especially frequently found in female inflorescence (Fig. 1d), producing a compact, spike-like cyme, where lateral branches are quite short and cymes resemble clusters. As I observed in case of the type with 5–7 narrow lanceolate leaflets, female inflorescence is less compact, looser (Fig. 3) than on the type with 7–11, widely lanceolate leaflets, being more similar to fibre hemp. Diagram of female flowers: P(5)G(2).

Perianth of pistillate flowers is formed by two tepals which are developed on the type of plants with narrow leaflets and rudimentary on plants with wide leaflets, but they can be found in every case. The Hungarian authors (Soó and Kárpáti 1968, Ujvárosi 1973, Simon 1992) describe escaped and naturalized hemp with lacking or rudimentary tepals while records on subsp. *spontanea* are about plants with developed tepals.

Each flower is closely surrounded by an abruptly acuminate bract and their double stigmas stick out of it. Colour of the flowers is green or greenish-yellow, the protruding stigmas are whitish before fertilization and turn rusty with age.

Male flowers have a perigone consisting of 5, imbricate, yellowish green tepals with 5 stamens (Fig. 1c). Flower diagram: P(5)A(5).

Anthers are almost sessile with elongated prismatic shape and greenish white colour. The high number of staminate flowers form a raceme-like cyme. Pollens are produced in masses, their shedding is ensured by the mobility of peduncles and the conspicuous spreading of tepals during flowering.

Hemp is an anemophilous plant. Volume of pollen production is demonstrated by the fact that according to aeropalinological monitoring in Hungary, beside the allergenic *Ambrosia artemisiifolia* with the highest share of pollen load in the summer peak period of August and in September, hemp is among the main species contributing to it. Based on my observations, insects and bees visit male staminate flowers for collecting pollen, but they are not interested in the insignificant pistillate flowers at all.

Fruit

The fruit of hemp is dry and indehiscent (achene, Fig. 1e). It is commonly called "hemp seed", though it is morphologically more than that, as the single seed contained in the fruit is covered by the pericarp, even by the rest of the bract, too. The fruit is an elongated, ovate organ. The achene of acute apices, deprived of bracts is lighter or darker brownish, brownish grey, more or less bright, mottled with crescent shaped patterns. Mottled pattern is given by the mark of bracts and is not a real characteristic feature of the type or variety as it may be lost or can be washed off. The achene is 3.5–5 mm long and 2.5–3.5 mm wide ovate, slightly appressed with a blunt crest, and the scar at the base of the fruit gives a cut-off character to it. Its thousand seeds weight ranges between 6 and 12 g. Environmental conditions highly influence size of the fruit, weight and size within a plant stand, even within a single plant show a great variability and deviation. The fruits ripe on the plant following the rhythm of flowering, upwards from the base on the stem and outwards on the lateral shoots. After ripening, fruits easily fall out.

Seedling

Seedlings unfold their cotyledons above the soil surface. Cotyledons are fleshy, entire with short, rough hairs on the top side and smooth on the underside. Blades of cotyledons are elongated, ovate, closely sessile. There are conspicuous differences in size between the two cotyledons (Fig. 1a). One of them can reach 15–17 mm length, while the other is not more than 9–12 mm long. Width of the blades is similar, 3–5 mm. The more elongated cotyledon expressly resembles an obovate shape, while the shorter one has a typical ovate form, sometimes apiculate. There is no record in the studied Hungarian and international literature about the heteromorphic formation of cotyledons, and

the different drawings also show cotyledons of similar size and shape (Csapody 1968, Ujvárosi and Csapody 1970, Csapody and Jávorka 1976, Hegi 1981, Hanf 1982, Hunyadi 1988, Hejný and Slavik 1988, Németh 2000, Petrányi and Tóth 2000). In 1889 Ormándy, in his work entitled "The nature of hemp", published the drawing of a hemp seedling. In this figure the cotyledons are of similar size, but one of them is obovate, the other one is more ovate, slightly acuminate.

On the seedling the hypocotyl is dull green, cylindrical, its maximum length is 5–6 cm. The hairs projecting downwards become harsh with age. Cotyledons soon fall down from the young plants and the first true leaves of opposite standing take over their role. The leaf blade is wide lanceolate, simple, roughly serrate, pubescent and crinkly on the top side, and veiny on the underside. The first pair of true leaves is simple, the second one is generally triparted and the subsequent pairs are palmately compound with 5–11 leaflets (Fig. 2). The first internode of the epicotyl is 1.5–4 cm, the further internodes are longer.

Based on the above morphological description, hemp, growing as a weed, cannot be classified in the *C. sativa* subsp. *sativa* found in the Hungarian literature, but in certain morphological characters (e.g. height, sizes of the fruit, number of leaflets), it differs from the morphological traits of *C. sativa* subsp. *spontanea* and *C. ruderalis*, too. Some morphological characters (e.g. asymmetric sizes of cotyledons) have not been recorded or drawn in the Hungarian and foreign literature either.

When studying the topic, it must be taken into consideration that hemp had been present in the territory of the country before the Hungarian settlement (Hartyáni and Nováki 1975, Gyulai 1994), and the plant was generally involved in cultivation in the early Middle Ages (Czettler 1939, Molnár 1949). It is most likely that the plant arrived in Hungary by driven out from its original area and spreading from the north (Mándy and Bócsa 1962). The Central Russian local varieties might have easily escaped during cultivation and it cannot be completely excluded either that spontaneously growing, real wild hemp got in the territory of Hungary that time.

The latter view was hardly supported by the recognised authors of the past. In his famous book about the origin of cultivated plants, De Candolle (1894) mentions that hemp was surely found naturalized along the Caspian Sea, in Siberia near the Irtysh, in the Kirghizian steppe and also beyond Lake Baikal. However, discussing the occurrence in South and Central Russia and the southern part of the Caucasus, he records that "self-growing character of the plant is less certain in these areas, because they are quite highly populated and hemp seeds may easily spread out of the gardens".

Table 2
Morphological traits of *Cannabis sativa* subsp. *spontanea* based on surveys in Hungary and their comparison with those of *C. sativa* subsp. *spontanea* and subsp. *sativa* in the literature

Morphological traits	*C. sativa* subsp. *spontanea* (in the literature)	*C. sativa* subsp. *sativa* (in the literature)	*C. sativa* subsp. *spontanea* (based on surveys in Hungary)
Height (cm)	30–150	100–200	30–250
Number of leaflets	5–7 (9)	7–9 (11)	5–9 (11)
Size of fruit (mm)	long 2.5–3.5 wide 2–2.5	long 3.5–5 wide 2.5–4	long 3.5–5 wide 2.5–3.5
Colour of fruit	brownish, mottled with crescent shaped patterns	grey, smooth, without patterns	brownish or brownish grey, more or less bright, mottled with crescent shaped patterns
Tepals in pistillate flowers	tepals are developed	tepals are rudimentary or absent	tepals are rudimentary but they can be found in every case
Cotyledons	elongated, ovate	elongated, ovate	differences in size and heteromorphic formation

Among Hungarian authors, Péter Méliusz (Juhász) writes about hemp in his famous "Herbarium" in 1578: "Cannabus hemp. One of them is the wild hemp, the other one is domesticated, grown in gardens" (Melius 1979). In 1807 Diószegi and Fazekas state in the "Hungarian Herbal" that "wild hemp is the same species as the cultivated plant". Hazslinszky (1872) mentions that hemp may escape here and there. Feichtinger (1899) finds hemp a weed plant occurring in masses in waste areas, along the roads in county Esztergom. According to Wagner (1908), hemp is a plant grown for yarn, and becomes a weed when escaped. Jávorka (1925) says that naturally occurring hemp is the escaped version of the cultivated plant.

In any cases, it remains certain that near waters the plant was grown and processed at the edge of almost every village till the beginning of the 19th century, and cultivation concentrated to certain districts only by introducing the more valuable southern hemp forms in Hungary and by the beginning of the industrial processing of the crop.

There were time and space enough for the plant for escaping from cultivation as well as mixing and hybridization of the escaped and the eventual spontaneous forms, therefore by now, the subspecies *sativa* and *spontanea*, already described but not studied for geographical distribution must be revised.

One thing is certain: there are conspicuous differences in morphological traits among the cultivated hemp grown in Hungary and Europe and the hemp occurring in the wild as a weed plant. Weed hemp, similarly to cultivated hemp, shows a quite wide phenotypic variability: types, morphologi-

cally more similar to the cultivated plant (2–2.5 m height, large leaves with 9–11, wide lanceolate leaflets, dense female inflorescence), other types, more resembling the spontaneously growing wild form (1–1.5 m height, smaller leaves with 5–7 linear-lanceolate, looser female inflorescence) and plants with intermediate appearance can also be found.

The spontaneously growing hemp is classified as *Cannabis sativa* subsp. *spontanea*, but in certain morphological characters (size and colour of the fruit, tepals in the female flower, number of leaflets, plant height), as mentioned before, it differs from the descriptions in the literature, mainly from the descriptions of the Hungarian authors (Table 2).

REFERENCES

Borhidi, A. (1998): *A zárvatermők fejlődéstörténeti rendszertana.* – Nemzeti Tankönyvkiadó, Budapest, 484 pp.

Csapody, V. (1968): *Keimlingsbestimmungsbuch der Dikotyledonen.* – Akadémiai Kiadó, Budapest, 286 pp.

Csapody, V. and Jávorka, S. (1976): *Iconographia Florae partis meridionalorientalis Europae Centralis.* 2nd ed. – Akadémiai Kiadó, Budapest, 576 pp.

Czettler, J. (1939): *Az emberi gazdálkodás története.* – Budapest.

De Candolle, A. (1894): *Termesztett növényeink eredete.* – Term.tud. Társ., Budapest, 516 pp.

Diószegi, S. and Fazekas, M. (1807): *Magyar Füvészkönyv.* – Debrecen, 608 pp.

Emboden, W. A. (1974): Cannabis – a polytypic genus. – *Econ. Bot.* **28**: 304–310.

Emboden, W. A. (1977): A taxonomy for Cannabis. – *Taxon* **26**: 110.

Feichtinger, S. (1899): *Esztergom megye és környékének flórája.* – Esztergom.

Grossgeim, A. A. (1939–1967): *Flora of Caucasus.* – Akad. Izd., Moscow. (in Russian).

Gyulai, F. (1994): *A Kárpát-medence haszonnövényei a 9–10. században.* – In: Győrffy, Gy. (ed.): Honfoglalás és régészet. Akadémiai Kiadó, Budapest, pp. 247–258.

Hanf, M. (1982): *Ackerunkräuter Europas mit ihren Keimlingen und Samen.* – BASF Aktiengesellschaft, Ludwigshafen, 496 pp.

Hartyáni, B. and Nováki, Gy. (1975): Samen- und Fruchtfunde in Ungarn von der Neusteinzeit bis zum 18. Jahrhundert. – *Agrártörténeti Szemle*, Suppl., **17**: 1–22.

Hazslinszky, F. (1872): *Magyarhon edényes növényeinek füvészeti kézikönyve.* – Pest.

Hayek, A. (1927–33): *Prodromus Florae Peninsulae Balcanicae.* – Berlin.

Hegi, G. (1981): *Illustrierte Flora von Mitteleuropa.* – P. Parey, Berlin–Hamburg, 504 pp.

Hejný, S. and Slavik, B. (eds) (1988): *Kvetena 1.* (Flora l.). – Academia, Prague, 557 pp. (in Czech)

Horánszky, A. and Járainé Komlódi, M. (1991): *Növényrendszertani praktikum.* – Tankönyvkiadó, Budapest, 549 pp.

Hunyadi, K. (ed.) (1988): *Szántóföldi gyomnövények és biológiájuk.* – Mezőgazdasági Kiadó, Budapest, 484 pp.

Janischevski, (1924): *Bulletin of Univ. Saratov* **2**(2): 14.

Jávorka, S. (1925): *Magyar flóra.* – Stúdium Kiadó, Budapest, 346 pp.

Mándy, Gy. and Bócsa, I. (1962): *A kender*. – Magyarország kultúrflórája VII: 14., Akadémiai Kiadó, Budapest, 101 pp.
Melius, P. (1979): *Herbárium.* Faxim. ed. – Kriterion, Bukarest, 517 pp.
Molnár, E. (1949): *A magyar társadalom története az Árpádoktól Mohácsig*. – Akadémiai Kiadó, Budapest.
Németh, I. (2000): *A szántóföldi, kertészeti, erdészeti és élősködő gyomfajok jellemzése.* – In: Hunyadi, K., Béres, I. and Kazinczi, G. (eds): Gyomnövények, gyomirtás, gyombiológia. Mezőgazda Kiadó, Budapest, pp. 113–116.
Petrányi, I. and Tóth, Á. (eds) (2000): *Szántóföldi gyomcsíranövények.* – BFNTÁ, Budapest, 257 pp.
Ranalli, P. (1999): *Advances in hemp research.* – Food Prod. Press, Binghampton, USA, 272 pp.
Simon, T. (1992): *A magyarországi edényes flóra határozója*. – Nemzeti Tankönyvkiadó, Budapest, 892 pp.
Small, E. (1975): The case of the curious Cannabis. – *Econ. Bot.* **29**: 254.
Small, E. and Cronquist, A. (1976): A practical and natural classification for Cannabis. – *Taxon* **25**: 405–435.
Soják, J. (1960): Zur Verbreitung von Cannabis ruderalis Janisch. – *Novit. Bot. Prag.* **1960**: 19–20.
Soó, R. (1970): *A magyar flóra és vegetáció rendszertani-növényföldrajzi kézikönyve. IV*. – Akadémiai Kiadó, Budapest, 614 pp.
Soó, R. and Kárpáti, Z. (1968): *Növényhatározó II.* – Tankönyvkiadó, Budapest, 846 pp.
Tóth, Á., Benécs-Bárdi, G. and Balázs, Gy. (1999): *Results of national weed surveys in arable land during the past 50 years in Hungary.* – Proceedings II, Brighton Crop Protection Conference on Weeds, pp. 805–810.
Ujvárosi, M. (1973): *Gyomnövények.* – Mezőgazdasági Kiadó, Budapest, 833 pp.
Ujvárosi, M. and Csapody, V. (1970): *Szántóföldi gyomcsíranövények ábragyűjteménye.* – MÉM Növényvéd. Szolg., Budapest, 127 pp.
Vasilchenko, I. T. and Pidotti, O. A. (1970): *Identification handbook of weeds in area under irrigation.* – "Kolos" Izd., Leningrad, 367 pp. (in Russian)
Wagner, J. (1908): *Magyarország gyomnövényei.* – Pallas, Budapest, 384 pp.
Yarmolenko, A. (1936): *Cannabis sativa.* – In: Komarov, V. L. (ed.): Flora SSSR 5. Akad. Izd., Moscow–Leningrad, pp. 383–384.
Zhukovski, P. M. (1950): *Cultivated plants and their wild relatives.* – Akad. Izd., Moscow, 732 pp. (in Russian)
Zhukovski, P. M. (1971): *Cultivated plants and their wild relatives (systematic, geography, cytogenetic, ecology, origin).* 2nd ed. – "Kolos" Izd., Leningrad, 761 pp. (in Russian)