Genetic resources of the genus *Cucumis* and their morphological description (English-Czech version)

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ABSTRACT: Czech collections of *Cucumis* spp. genetic resources includes 895 accessions of cultivated *C. sativus* and *C. melo* species and 89 accessions of wild species. Knowledge of their morphological and biological features and a correct taxonomical ranging serve a base for successful use of germplasm in modern breeding. List of morphological descriptors consists of 65 descriptors and 20 of them are elucidated by figures. It provides a tool for *Cucumis* species determination and characterization and for a discrimination of an infraspecific variation. Obtained data can be used for description of genetic resources and also for research purposes.

Keywords: Cucurbitaceae; cucumber; melon; germplasm; data; descriptors; infraspecific variation; *Cucumis* spp.; wild *Cucumis* species

Collections of *Cucumis* genetic resources include not only cultivated species *C. sativus* (cucumbers) and *C. melo* (melons) but also wild *Cucumis* species. Knowledge of their morphological and biological features and a correct taxonomical ranging serve a base for successful use of germplasm in modern breeding.

Czech collection of *Cucumis* genetic resources is maintained in Olomouc by the Gene Bank Workplace of the Research Institute of Crop Production (RICP) (KŘÍSTKOVÁ, LEBEDA 1995). It consists of 794 *C. sativus* accessions, 101 *C. melo* accessions and 89 accessions of wild species (*C. africanus, C. anguria, C. heptadactylus, C. myriocarpus, C. prophetarum, C. zeyheri*) (KŘÍSTKOVÁ 2002a). Morphological data obtained during observation of wild *Cucumis* species do not always coincide with description of some species in monographs. The taxonomical ranging of some accessions should be re-considered. An international descriptor list for cultivated and wild *Cucumis* species was not elaborated till now.

A set of morphological descriptors for genetic resources of the genus *Cucumis* should serve a tool for species determination and for a discrimination of infraspecific variation.

TAXONOMY, BOTANICAL CHARACTERIZATION, KARYOLOGICAL STATUS, BIOCHEMICAL AND MOLECULAR MARKERS OF *CUCUMIS* SPP.

Taxonomy of the family Cucurbitaceae

The genus *Cucumis* belongs to the family Cucurbitaceae (WHITAKER, DAVIS 1962), order Cucurbitales. According to specific morphological features of tendrils, pollen grains and ovules, there are clear relation of this taxon with the order Passiflorales (NOVÁK 1961). Based on latest knowledge of cytology, cytogenetics, phytochemistry and molecular genetics (PERL-TREVES et al. 1985; RAAMSDONK et al. 1989), a new taxonomical classification of this family was created by JEFFREY (1989). The family is subdivided into two subfamilies. The subfamily Zanonioideae comprises species with a low economic impact. All economically important species are included in the subfamily Cucurbitoideae (Table 1).

Within Cucurbitaceae the tribe Melothrieae with the genus *Cucumis* are considered the most important ones under climatic conditions of the Middle Europe. The genus *Cucumis* is represented by 32 species (KIRKBRIDE 1993). Besides cucumber (*Cucumis sativus* L.) and melon (*C. melo* L.), the species *C. anguria* (West Indian gherkin) and *C. metuliferus* (African horned cucumber) are commercially explored in several areas as well. Other wild species originating mostly from arid and/or semi-arid regions of Africa, respectively, are cultivated as ornamental plants (*C. dipsaceus* – "hedgehog gourd", *C. myriocarpus* – "gooseberry gourd") (RUBATZKY, YAMAGUCHI 1997).

Origin, gene pool and crossing ability of *Cucumis* spp.

The South Africa is considered to be a centre of diversity for the genus *Cucumis*. The Indian centre, especially area under Himalayan mountains is probably the centre of diversity of *C. sativus*. This species represents an compact and isolated group and a subgenus *Cucumis*. The second subgenus *Melo* is divided into three groups.

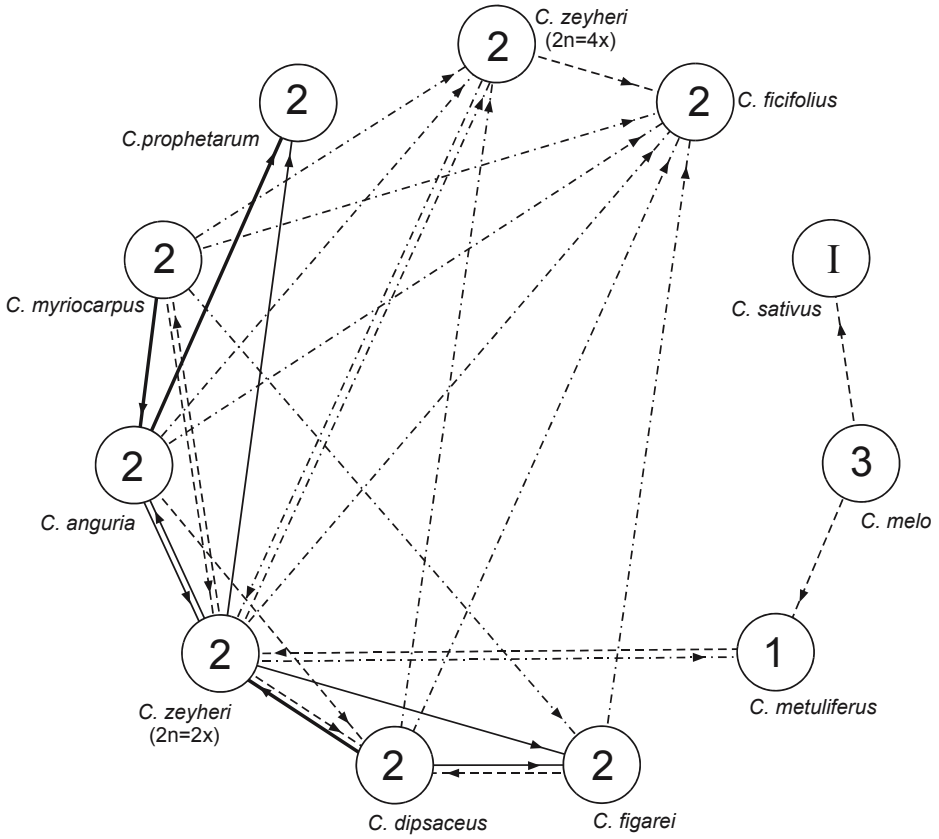


Fig. 1. Crossability polygon of *Cucumis* species (NIJS, VISSER 1985)
Obr. 1. Polygon křižitelnosti druhů *Cucumis* (NIJS, VISSER 1985)
I. *Cucumis* subgenus *Cucumis*, 1. *Cucumis* subgenus *Melo*, Metuliferus group,
2. *Cucumis* subgenus *Melo*, Anguria group, 3. *Cucumis* subgenus *Melo*, Melo group
♂ ⟶ ♀ crossing direction/ směr křížení
moderately to strongly self-fertile and cross-fertile hybrids
středně až vysoce fertilní kříženci
sparingly self-fertile and moderately cross-fertile hybrids
kříženci zřídka fertilní při samoopylování, středně fertilní při křížení
self-sterile, usually not cross-fertile hybrids
kříženci sterilní při samoopylování, obvykle sterilní při křížení
inviable seeds or seedlings
neživotná semena nebo semenáčky

Absence of line indicates that seeded fruits were not obtained.
Absence linie indikuje, že nebyly získány plody se semeny.

C. melo forms an independent group Melo. Other African species form the group Anguria (e.g. *C. anguria*, *C. africanus*, *C. dipsaceus*, *C. zeyheri*) and a group Metuliferus (*C. metuliferus*, *C. myriocarpus*, *C. sagittatus*) (JEFFREY 1989). A precise description of *Cucumis* species and a study of their cross-ability (NIJS, CUSTERS 1989; RAAMSDONK et al. 1989) (Fig. 1) contribute to the elucidation of evolutionary relations within genus and a determination of accessions of genetic resources. Recent taxonomy of the genus *Cucumis* elaborated by KIRKBRIDE (1993) is given in Table 2.

The primary gene pool of *C. sativus* consists of one species *C. hardwickii*, which is frequently considered as a variety of *C. sativus*. Secondary gene pool includes *C. hystrix*. Gene pools of *C. melo* were not exactly defined till now.

The genetic differences between both subgenera are a reason of the cross-incompatibility of *C. sativus* with other *Cucumis* species and limits the progress in cucumber breeding. The successful interspecific hybridization is related to the development of biotechnological methods (LEBEDA et al. 1993), e.g. embryo culture techniques that can rescue hybrid embryos (LEBEDA et al. 1999), a protoplast fusion (JARL et al. 1995; FELLNER, LEBEDA 1998) and a somatic hybridization (DABAUZA et al. 1998). New valuable characters can be introduce to the cucumber and melon genomes through transformation (VALLÉS, LASA 1994; NISHIBAYASHI et al.

Table 1. Basic taxonomical classification of the family Cucurbitaceae (adopted according to JEFFREY 1989)
Tabulka 1. Základní taxonomické členění čeledi Cucurbitaceae (upraveno podle JEFFREYE 1989)

Subfamily Podčeleď	Tribe Tribus	Genus Rod
Zanonioideae	Zanonieae	together 18 genera (about 80 species) celkem 18 rodů (asi 80 druhů)
Cucurbitoideae		together 100 genera (about 745 species) celkem 100 rodů (asi 745 druhů)
	Melothrieae	*Cucumis* (*n* = 7.12)
	Schizopeponeae	*Schizopepon* (*n* = 10)
	Joliffieae	*Momordica* (*n* = 11.14)
	Trichosantheae	*Trichosanthes* (*n* = 11)
	Benincaseae	*Benincasa* (*n* = 12)
		Lagenaria (*n* = 11)
		Citrullus (*n* = 11)
		Luffa (*n* = 13)
	Cucurbiteae	*Cucurbita* (*n* = 20)
	Cyclanthereae	*Cyclanthera* (*n* = 8)
	Sicyoeae	*Sechium* (*n* = 12)

n = chromosome number
n = počet chromozomů

1996). Knowledge in *C. sativus* breeding was treated by TATLIOGLU (1993).

Morphological description of *Cucumis* spp.

Plants have a bicolatheral vein fascicles and in their tissues, there are cystoliths (NOVÁK 1961). A specific metabolism of terpens leads to the production of cucurbitacins which can cause a poisoning of human and animals (FERGUSON et al. 1983).

Following morphological description is based on data of CHRTKOVÁ (1990), KIRKBRIDE (1993) and RUBATZKY, YAMAGUCHI (1997). Plants are annual herbs, exceptionally semishrubs, usually having a trailing or climbing growth habit, although some cucumber and melon cultivars have a bush habit. Root systems, rarely woody (*C. trigonus*) are extensive, but usually shallow, rarely tuberous (*C. kalahariensis*). Stems are angled, sulcate, not aculeate or rarely aculeate (*C. aculeatuc, C. ficifolius*), variously pubescent or rarely glabrous, with nonbreakaway hairs or rarely breakaway hairs (*C. sacleuxii*).

The branching pattern is sympodial. Nodes are geniculate or not geniculate. Each node has a single leaf and a simple tendril (sometimes curling), except of *C. humifructus* which has a fascicle of 5–8 tendrils and of *C. rigidus* which lacks them. Tendrils of *C. insignis* are either simple and bifid. Tendrils are variously pubescent, rarely glabrous or rarely aculeate.

Leaves are simple and petiolate. Petioles differs in length (with regard to the length of a leaf blade). Petioles are not aculeate or rarely aculeate, variously pubescent or rarely glabrous, with nonbreakaway hairs or rarely breakaway hairs. Majority of species has a uniform type of pubescence on the petioles. *C. sagittatus* and *C. thulinianus* have two pubescence types uniformly mixed over the entire petiole, and *C. myriocarpus* has three types separated into distinct zones on the petioles, retrose-strigose on the base, hirsute in the middle, and antrorse-strigose at apex. Leaf blade is circular, kidney shaped, triangular ovate, somewhat cordate to subcordate, narrowly to shallowly ovate, or rarely eliptic or triangular in outline, sometimes acute to broadly so, or truncate to subtruncate, rarely obtuse, sagittate, or hasttate at the base, with or sometimes without a basal sinus, three to five palmately lobed, with three to five angled portions, from shallow to deeply lobed and with a sharp to round sinuses. The apex is acute, acuminate, or rarely obtuse. Central leaf lobe is symmetrical, entire or sometimes pinnatifid. Leaf margin is dentate, double dentate to entire. Lateral leaf lobes are asymmetrical, or sometimes symmetrical, entire or sometimes pinnatifid. A leaf surface is rough to smooth to the touch.

Flowers are unisexual – pistillate or staminate, but hermaphrodite flowers also occur. They are very often in the group of Lemon cucumber. Sex expression is under genetic control but it is influenced by environment and/or chemical treatment (TRONÍČKOVÁ, PROCHÁZKOVÁ 1984). The inflorescence is unisexual, most species are monoecious. *C. humifructus* has only androgynous inflorescence (i.e. inflorescence with both male and female flowers and the female flower below the male ones). *C. metuliferus* has mainly unisexual inflorescence and a few gynecandrous ones (i.e. inflorescence with both female and male flowers and the female flower above the male ones). Cultivated forms of *C. sativus* have

Table 2. Taxonomy of the genus *Cucumis* (KIRKBRIDE 1993)
Tabulka 2. Taxonomie rodu *Cucumis* (KIRKBRIDE 1993)

Cucumis spp.	Chromosome number (*n*) Počet chromozomů (*n*)	Distribution Rozšíření
Subgenus *Cucumis*		Asia
C. sativus L.	7	India, Sri Lanka, Burma, China
C. sativus L. var. *hardwickii*	7	India
C. hystrix Chakravarty	7	India, Myanmar (Burma), China, Thailand
Subgenus *Melo* (Miller) C. Jeffrey		
Section/Sekce *Aculeatosi* Kirkbride		
Serie *Myriocarpi* Kirkbride		
C. myriocarpus Naudin		
subsp. *myriocarpus*	12	Lesotho, Mozambique, S. Africa, Zambia
subsp. *leptodermis* (Schweickerdt) Jeffrey & Halliday	12	S. Africa, Lesotho
C. africanus L.	12	S. Africa, Angola, Botswana, Namibia, Zimbabwe
C. quintanilhae R. Fernandes & A. Fernandes	?	S. Africa, Botswana
C. heptadactylus Naudin	24	S. Africa
C. calahariensis Meeuse	?	Botswana, Namibia
Serie *Angurioidei* Kirkbride		
C. anguria L.		
var. *anguria*	12	both vars Angola, Botswana, Cape Verde, Malawi, Mozambique, Namibia, S. Africa, Sierra Leone, Swaziland, Tanzania, Zaire, Zambia, Zimbabwe
var. *longaculeatus* Kirkbride	12	
C. sacleuxii Paillieux & Bois	12	Kenya, Madagascar, Tanzania, Uganda, Zaire
C. carolinus Kirkbride	?	Ethiopia, Kenya
C. dipsaceus Ehrenberg ex Spach	12	Ethiopia, Kenya, Somalia, Tanzania, Uganda
C. prophetarum L.	12	
subsp. *prophetarum*		Egypt, Mali, Mauritania, Nigeria, Senegal, Somalia, Sudan, Iran, Iraq, Israel, Oman, Qatar, Saudi Arabia, Yemen, Socotra, Syria, United Arab Emirates, Jordan
subsp. *dissectus* (Naud.) C. Jeffrey		Chad, Egypt, Ethiopia, Kenya, Mauritania, Niger, Rwanda, Somalia, Tanzania, Uganda, Saudi Arabia, Yemen
C. pubituberculatus Thulin	?	Somalia
C. zeyheri Sonder	12 (24)	Lesotho, Mozambique, S. Africa, Swaziland, Zambia, Zimbabwe
C. prolatior Kirkbride	?	Kenya
C. insignis C. Jeffrey	12?	Ethiopia
C. globosus C. Jeffrey	12?	Tanzania
C. thulinianus Kirkbride	?	Somalia
C. ficifolius A. Richard	12 (24)	Ethiopia, Kenya, Rwanda,Tanzania, Uganda, Zaire
C. aculeatus Cogniaux	24	Ethiopia, Kenya, Rwanda, Tanzania, Uganda, Zaire
C. pustulatus Naudin ex Hooker	12, 48, 72	Ethiopia, Chad, Kenya, Niger, Nigeria, Sudan, Tanzania, Uganda, Saudi Arabia, Yemen
C. meeusei C. Jeffrey	24	S. Africa, Botswana, Namibia

Table 2 (continuing) – Tabulka 2 (pokračování)

Cucumis spp.	Chromosome number (*n*) Počet chromozomů (*n*)	Distribution Rozšíření
C. jeffreyanus Thulin	?	Ethiopia, Kenya, Somalia
C. hastatus Thulin	?	Somalia
C. rigidus E. Meyer ex Sonder	?	S. Africa, Namibia
C. baladensis Thulin	?	Somalia
Serie *Metuliferi* Kirkbride		
C. metuliferus E. Meyer ex Naudin	12	Angola, Botswana, Ethiopia, S. Africa, Kenya, Malawi, Mozambique, Namibia, Senegal, Sudan, Swaziland, Tanzania, Uganda, Zaire, Zambia, Zimbabwe, Cameroon, Central African Republic, Liberia, Burkina Faso, Yemen
C. rostratus Kirkbride	?	Ivory Coast, Nigeria
Section/Sekce *Melo* (Miller) Kirkbride Serie *Hirsuti* Kirkbride		
C. hirsutus Sonder	12	S. Africa, Angola, Botswana, Burundi, Congo, Kenya, Malawi, Mozambique, Sudan, Swaziland,Tanzania, Zaire, Zambia, Zimbabwe
Serie *Humifructosi* Kirkbride		
C. humifructus Stent	12	S. Africa, Ethiopia, Angola, Kenya, Namibia, Zaire, Zambia, Zimbabwe
Serie *Melo* (Miller) Kirkbride		
C. melo L.		
subsp. *melo*	12	Africa, Iran, Afghanistan, Myanmar (Burma), China, India, Japan, Pakistan, Malesia, New Guinea, Australia, Figi, Papua New Guinea
subsp. *agrestis* (Naudin) Pangalo	12	Africa, Saudi Arabia, Yemen, China, Myanmar (Burma), India, Japan, Korea, Nepal, Pakistan, Sri Lanka, Thailand, Malaysia, Indonesia, New Guinea, Philippines, Australia, Guam, Papua New Guinea, Samoa, Solomon Islands, Tonga
C. sagittatus Peyritsch	12	S. Africa, Angola, Namibia

S. Africa (South Africa) = Jižní Afrika

many types of sexual expression (e.g. monoecious, gynoecious, andromonoecious, androdiecious, hermafroditic etc.).

Male inflorescence consists of solitary flowers, or fasciculate, racemose, paniculate, or rarely modified compound dichasial from 1–18 flowered, sessile or rarely pedunculate. Male inflorescence are often multiflowered and are rarely branched. When the inflorescences are branched, the male flowers are always pedicellate. Male flowers are 5-merous, pedicel is terete or rarely sulcate in cross section, variously pubescent or rarely glabrous, without bracteoles or rarely subtended by a bracteole (*C. heptadactylus*). Calyx consists of 5 or rarely 4 lobes, linear to oblong or narrowly to broadly triangular in outline, acute to narrowly so in apex, variously pubescent or rarely glabrous. Corolla is yellow, infundibular or rarely campanulate, variously pubescent or rarely glabrous. Corolla fused into a basal tube. Corolla leaves are elliptic to broadly so, ovate to shallowly so, obovate to narrowly so, or rarely oblong or broadly triangular in outline, narrowly to broadly acute or obtuse, and sometimes also mucronate at the apex. Three stamens are free, with separation from the free portion of the hypanthium above the ovary. Two of them are 2-thecate and one 1-thecate. Filaments are terete or radially compressed in cross section, glabrous or with basal puberculence and glabrous apically. Anther theceae is sigmoid, glabrous with the edges shortly pubescent. Anther connective is extended, obovate, oblong to narrowly so, transversely broadly oblong, or ovate, unilobate or rarely bilobate, obtuse or rarely acute in apex, minutely papillate, sometimes smooth, or rarely glabrous, fimbriate or crenulate at the apex. Disc is cylindrical or rarely consisting of three papillae, glabrous.

Female flowers are solitary or rarely in fasciclate inflorescences, sessile arise from leaf axils, very often from secondary branches. They are pedicellate and 5-merous. Pedicel is terete or sulcate in cross section, variously pubescent, with nonbreakaway hairs or rarely with breakaway hairs. Hypanthium is hour-glass shaped. The constricted portion and the lower bulge fused to the ovary. The upper bulge of hypanthium is free from the ovary. Free portion of hypanthium is campanulate. Ovary has 3–5 placentas with numerous horizontal ovules. Calyx has five, occasionally 4 or 6 lobes of the same shape as male flowers. Corolla is yellow, infundibular, with the same shape and types of pubescence as male flower. Corolla tube is present or absent. Three staminodes are present or rarely absent, separating from the free portion of hypanthium above the ovary. Style is terete in cross section, glabrous, subtented by a circular disc or rarely lacking one. Stigma is copular, lobate, or sometimes entire or sublobate, with 1–6 or rarely 9 finger-like projections on the margin.

Fruits are pendulous. Cucumber fruit can develop parthenocarpically. The pedicel is sulcate or sometimes terete in cross section, variously pubescent or rarely glabrous. Fruit is spherical, oval, oblong, elongated or blocky in shape and variable in size. Fruit surface varies in the number and size of scattered spiny tubercles (warts), or sharp soft hairs. It can be smooth and glabrous, sometimes deeply ridged or covered with a corky (reticulate) netting (e.g. for *C. melo*). Skin colour varies from pale to very dark green, sometimes with longitudinal indentations or stripes. In maturity the skin colour is white cream to orange brown. Inferior flesh colour can be white, green, pink, or orange. A unique feature of some *C. melo* cultivars is the formation of an abscission layer between peduncle and a fruit that coincide with fruit maturation.

Mature seeds have white, cream to yellow colour, they are smooth, compressed, ovoid to elliptic, immarginate, with an acute edge, unwinged or rarely apically winged. *C. humifructus* ("aardvarc cucumber") develops its fruits below ground.

Karyological status, biochemical and molecular markers of *Cucumis* spp.

Species *C. sativus*, *C. sativus* var. *hardwickii* (*C. hardwickii*), *C. hystrix* and *C. callosus* (not mentioned by KIRKBRIDE 1993) have the chromosome number $2n = 14$, the same value for other *Cucumis* species varies from 24 to 72, when $n = 12$ is multiplied (KIRKBRIDE 1993) (Table 2).

The mapping of *Cucumis* genome (HELM, HEMLEBEN 1997; HOSHI et al. 1998) and the study of biochemical and molecular markers provide the bases for the determination of duplicates within collections of genetic resources for the discrimination of differences among accessions (KATO et al. 1998) and for the identification of suitable markers for resistance to biotic and abiotic factors (LEBEDA, DOLEŽAL 1995; STAUB et al. 1996a,b; HOREJSI et al. 2000).

Classification and morphological types of *C. sativus*

From the viewpoint of a practical use of fruits, cucumbers are divided into salad and pickling ones. A common practice in the past was to use young fruits for pickling and later on, the biggest but green fruit as salad (e.g. cv. Delikates). An exact recent infraspecific classification of *C. sativus* was not elaborated till now. PODEŠVA (1959) listed following cucumber forms:

f. *viridis*: small warty and "spiny" fruits predominantly for pickling (e.g. From Znojmo, From Paris);
f. *flavus*: smooth yellow fruits with shape and size of a hen egg (e.g. Russian cornishons);
f. *albus*: elongated, thick, white fruits (e.g. White from Paris);
f. *longus*: elongated, cylindric, smooth fruits, green to yellow-green in colour (e.g. Mladoboleslavské salátnice, Rollison's Telegraph, Goliath);
f. *fastigiatus*: small fruits in clusters (e.g. Persian clustered, From Muromsk);
f. *opheocarpus*: very long, curved, snaked fruits (usually greenhouse cultivars);
f. *variegatus*: light green fruits with yellow or brown spots and stripes (e.g. Japanese, chiva, King Alexander);
f. *sikkimiae*: big, elongated, ovoid fruits, yellowish and brown-red netted (e.g. Indian netted).

Fresh market types of cucumbers have usually fruits with length to diameter ratio of about 4:1, thick skin, somewhat pointed stem and blossom ends, and usually white, preferable few spines. Cucumber types for pickling usually have fruits with length to diameter ratio of 2.5:1, light green colour and thin skin, relatively blocky at the stem and blossom ends, and many surface warts. Cucumber cultivars are generally classified into following groups (RUBATZKY, YAMAGUCHI 1997; GEORGE 1999):

1. Field cucumbers, with prominent white or black spines;
2. English cucumbers – greenhouse or forcing type of parthenocarpic cucumbers with seedless fruits;
3. Sikkim cucumber, originated in India, with reddish brown skins of fruits;
4. Oriental-type cucumber, popular in Japan and China, thin skinned, usually long and slender with considerable warts and spines;
5. Smoot-skinned Beit Alpha types, most popular in Middle East and north Africa, with light coloured, thin skinned fruits;
6. Lemon cucumber produces a round, creamy yellow skin fruit with large five-carpel seed cavity. Its sex expression is andromonoecious.

Very small, immature cucumber fruits are erroneously referred to as gherkins.

Table 3. Infraspecific classification of *C. melo* (PITRAT et al. 2000)
Tabulka 3. Infraspecifická klasifikace *C. melo* (PITRAT et al. 2000)

C. melo	
Subspecies/Poddruh	Morphological characteristics/Morfologická charakteristika
Group/Skupina	English name/Anglický název
subsp. *agrestis* Jeffrey	short hairs on ovary/krátké trichomy na semeníku
var. *conomon* Thunberg	Oriental pickling melon
var. *makuwa* Makino	
var. *chinensis* Pangalo	
var. *momordica* Roxburgh	Snap melon
var. *acidulus* Naudin	
subsp. *melo* Jeffrey	long hairs on the ovary/dlouhé trichomy na semeníku
var. *cantalupensis* Naudin	Netted melon, cantaloupe
var. *reticulatus* Séringe	
var. *adana* Pangalo	
var. *chandalak* Pangalo	
var. *ameri* Pangalo	
var. *inodorus* Jacquin	Winter melon/ Meloun Vladimírův
var. *flexuosus* Linnné	Snake or serpent melon, Armenian cucumber
var. *chate* Hasselquist	
var. *tibish* Mohamed	
var. *dudaim* Linné	Pomegranate, Queen Anne's pocket melon
var. *chito* Morren	Mango melon, Vine peach melon

Classification and morphological types of *C. melo*

The species *C. melo* expresses the largest variability in the fruit size, shape, colour, texture and taste within the genus *Cucumis* (WHITAKER, DAVIS 1962). Its recent infraspecific classification proposed by PITRAT et al. (2000) is based on the critical analyses of previous systems (e.g. from NAUDIN, ALEFELD, PANGALO, GREBENŠČIKOV, FILOV, JEFFREY, ROBINSON and DECKER-WALTERS) and a study of morphology of a contemporary spectrum of cultivars and wild forms. The phenotypic expression of this variation was analyzed also by molecular methods RAPD and ISSR (STEPANSKY et al. 1999). *C. melo* is divided into two subspecies, subsp. *agrestis* with five groups and subsp. *melo* with eleven groups (Table 3).

STANDARDS FOR REGENERATION AND EVALUATION

Regeneration

Plants of the genus *Cucumis* are cross-pollinated by insects. Basic information on regeneration of *Cucumis* spp. is given by GEORGE (1999). During regeneration of acccession in the Gene Bank Workplace RICP in Olomouc the international standards and the method of the regeneration accepted by the National Council for Plant Genetic Resources of the Czech Republic are followed.

Seeds are sown in mid- to end April to the sterile substrate (Perlite) in plastic pots (5–10 seeds) and at a cotyledon stage seedlings are transplanted to the plastic pots (diameter of 8.5 cm) with garden soil (two seedlings per pot) in the glasshouse (day/night temperatures of 20–25°C/10–15°C). The plantlets are transplanted, at a stage of two–three true leaves, to the isolation cages spaced of 2.3 × 5.5 m each, covered by glass or by plastic net, to four rows with 10 "nests" each. Two weeks later, seedlings except of the best developed one are cut out and removed from the nest. One accession is represented by 20 (minimum) or 40 (optimum) plants. Plants are trained vertically, watered and protected against diseases and pests. Before flowering a small colonies of honey-bees are placed to each cage. Harvested seeds are dried, cleaned and stored in glass jars under temperature of –5°C (active collection) or at –18°C (basic collection) in the main store of the Research Institute of Crop Production in Praha-Ruzyně. Detailed regeneration protocol is given by KŘÍSTKOVÁ (2002b).

Morphological and biological characters

The set of morphological descriptors (Table 4) provides the tools for species determination within the genus *Cucumis* and for a characterization of *Cucumis* infraspecific morphological variability. It was elaborated on the base of study of genetic resources in Gene Bank RICP, Workplace in Olomouc, *Cucumis* spp. monograph (KIRKBRIDE 1993), the descriptor lists published by

IBPGR (ESQUINAS-ALCAZAR, GULICK 1983), with regard to the descriptor list and codes for *Cucumis* spp. from Northcentral Regional Plant Introduction Station Ames (USA), (ANONYME 1989), the descriptor for *Cucumis sativus* L. published by VIR in Leningrad (USSR) (ANONYME 1980) and Guidelines UPOV for conduct of tests for distinctness, homogeneity and stability of *Cucumis sativus* (1978) and *Cucumis melo* (1987). The terminology of botanical morphology and elaboration of figures is based on FUTÁK et al. (1966), SUGDEN (1984), SLAVÍKOVÁ (1988) and BOBÁK et al. (1992).

The list contains 65 descriptors and 20 of them are elucidated by figures (Annex). Highly discriminating descriptors are marked with an asterisk (*) in the first column of the Table 4. Letter "S" indicates a species characterizing descriptor, state of descriptor marked with a letter "I" discriminates an infraspecific variation, letters in brackets are of a secondary significance.

Explanation of descriptor states are followed by examples of corresponding *Cucumis* species with literature cited and/or by accession number of genetic resource.

The format for a creation of this descriptor list follows the rule given by the National Council for Plant Genetic Resources of the Czech Republic and obtained data will be implemented to the central documentation of plant genetic resources EVIGEZ. Description data of *Cucumis* spp. genetic resources accessions will be available on the Czech web site of national database of plant genetic resources: www.vurv.cz.

For an adequate documentation of germplasm obtained data must be supplemented by the characterization and/or evaluation site descriptors according to IPGRI.

Resistance to biotic and abiotic factors

The resistance to biotic and/or abiotic factors respectively, must be evaluated in a separate trials (e.g. in growth chambers after artificial inoculation of pathogen) using an exact and published method, e.g. LEBEDA (1986).

The group of the most important diseases of *Cucumis* spp. includes *Cucumber mosaic virus* (CMV), *Watermelon mosaic virus* 2 (WMV-2), *Zucchini yellow mosaic virus* (ZYMV), angular leaf spot (*Pseudomonas lachrymans*), cucumber downy mildew (*Pseudoperonospora cubensis*) and cucurbit powdery mildew (*Erysiphe cichoracearum, Sphaerotheca fuliginea*). The economically important pests of *Cucumis* spp. are spider mite *(Tetranychus urticae)*, whitefly (*Trialeurodes vaporariorum*), thrips (*Thrips tabaci, Frankliniella occidentalis*), aphids (*Aphis gossypii, A. craccivor, A. middletoni*, *Macrosiphum euphorbiae, Myzus persicae*) and root-knot nematodes of the genus *Meloidogyne* (SCHWARZ et al. 1996).

The most important abiotic factors are low temperature, high temperature, high soil salinity, soil acidity, high soil moisture and high humidity.

Acknowledgements

Authors thank VERONIKA KŘÍSTKOVÁ for her technical assistance in elaborating of tables and figures in Annex. This research was developed within the framework of the National Programme of Conservation and Utilization of Plant Genetic Resources (Ministry of Agriculture of the Czech Republic).

Table 4. Morphological descriptors for *Cucumis* spp. genetic resources

Tabulka 4. Popisné znaky genových zdrojů rodu *Cucumis*

No.	Descriptor name	Descriptor state	Explanation Figure in Annex	Note	Pořad. číslo	Název znaku	Projev znaku	Vysvětlení Obrázek v příloze	Poznámka
1. Morphological descriptors					**1. Morfologické znaky**				
1.1. Plant					**1.1. Rostlina**				
1.1.1. * I (S)	Plant – growth habit	1 erect, bush 2 vine with distinct main stem 3 vine with many stems	main stem distinct, with shortened internodes (*C. sativus* CZ 09-H39-00687) *C. sativus* CZ 09-H39-00121 main stem cannot be identified (*C. prophetarum* CZ 09-H41-00554)	at botanical maturity	1.1.1. * I (S)	Rostlina – habitus (růstová forma)	1 vzpřímený, keřovitý 2 plazivý se zřetelným hlavním výhonem 3 plazivý s mnoha výhony	hlavní výhon zřetelný, se silně zkrácenými internodii (*C. sativus* CZ 09-H39-00687) *C. sativus* CZ 09-H39-00121 hlavní výhon nelze identifikovat (*C. prophetarum* CZ 09-H41-00554)	v botanické zralosti
1.2. Stem					**1.2. Stonek**				
1.2.1. * S	Stem – indumentum	0 glabrous 1 with breakaway trichomes 2 with nonbreakaway trichomes 3 with aculei	 *C. sacleuxii* (Kirkbride 1993) *C. sativus* *C. aculeatus* (Kirkbride 1993)	at botanical maturity	1.2.1. * S	Stonek – odění	0 holý 1 s ulomitelnými trichomy 2 s neulomitelnými trichomy 3 s ostny	 *C. sacleuxii* (Kirkbride 1993) *C. sativus* *C. aculeatus* (Kirkbride 1993)	v botanické zralosti
1.3. Tendrils					**1.3. Úponky**				
1.3.1. * S	Tendrils	0 absent 1 simple and solitary 2 simple in fascicles 3 both simple and bifid	*C. rigidus* (Kirkbride 1993) *C. sativus* *C. humifructus* (Kirkbride 1993) *C. insignis* (Kirkbride 1993)	at botanical maturity	1.3.1. * S	Úponky	0 nepřítomny 1 jednoduché a po jednom 2 jednoduché a ve svazcích 3 jednoduché i větvené	*C. rigidus* (Kirkbride 1993) *C. sativus* *C. humifructus* (Kirkbride 1993) *C. insignis* (Kirkbride 1993)	v botanické zralosti

1.4. Leaf					**1.4. List**				
1.4.1.1. * S (I)	Leaf blade – shape in outline	1 orbicular 2 ovate 3 elliptic 4 reniform 5 cordate 6 subcordate 7 triangular	Fig. 1.4.1.1.	fully developed leaf from the middle part of plant at botanical maturity	1.4.1.1. * S (I)	Listová čepel – tvar v obrysu	1 okrouhlý 2 vejčitý 3 eliptický 4 ledvinitý 5 srdčitý 6 opačně srdčitý 7 trojúhelníkovitý	obr. 1.4.1.1.	plně vyvinutý list ze střední části hlavního výhonu v době botanické zralosti
1.4.1.2.	Leaf blade – margin	1 entire 2 dentate 3 distantly dentate 4 irregularly dentate 5 double dentate 6 minutely distantly dentate 7 minutely distantly dentate with cilia	Fig. 1.4.1.2.	fully developed leaf from the middle part of plant at botanical maturity	1.4.1.2.	Listová čepel – okraj	1 celokrajný 2 zubatý 3 oddáleně zubatý 4 nepravidelně zubatý 5 dvojnásobně zubatý 6 drobně oddáleně zubatý 7 drobně oddáleně zubatý s brvami	obr. 1.4.1.2.	plně vyvinutý list ze střední části hlavního výhonu v době botanické zralosti
1.4.1.3. * S (I)	Divided leaf blade – depth of incisions	 3 palmatelylobed 5 palmatelyfid 7 palmatelypart 9 palmatelysect	Fig. 1.4.1.3. depth of incisions from blade margin to the base up to 1/3 up to 1/2 up to 2/3 more than 2/3	fully developed leaf from the middle part of plant at botanical maturity	1.4.1.3. * S (I)	Listová čepel dělená – hloubka zářezů	 3 dlanitolaločná 5 dlanitoklaná 7 dlanitodílná 9 dlanitosečná	obr. 1.4.1.3. hloubka zářezů od okraje k bázi čepele do 1/3 do 1/2 do 2/3 více než 2/3	plně vyvinutý list ze střední části hlavního výhonu v době botanické zralosti
1.4.1.4. * I (S)	Leaf blade – size of terminal lobe	0 without lobe 3 short 5 medium 7 long	Fig. 1.4.1.4. length (l) to width (w) ratio < 1 = 1 > 1	fully developed leaf from the middle part of plant at botanical maturity	1.4.1.4. * I (S)	Listová čepel – velikost terminálního laloku	0 bez laloku 3 krátký 5 střední 7 dlouhý	obr. 1.4.1.4. poměr délky (l) k šířce (w) < 1 = 1 > 1	plně vyvinutý list ze střední části hlavního výhonu v době botanické zralosti
1.4.1.5. * S (I)	Leaf blade – shape of apex of terminal lobe	1 acute 2 obtuse	Fig. 1.4.1.5.	fully developed leaf from the middle part of plant at botanical maturity	1.4.1.5. * S (I)	Listová čepel – tvar vrcholu terminálního laloku	1 ostrý 2 tupý	obr. 1.4.1.5.	plně vyvinutý list ze střední části hlavního výhonu v době botanické zralosti

No.	Descriptor name	Descriptor state	Explanation Figure in Annex	Note	Pořad. číslo	Název znaku	Projev znaku	Vysvětlení Obrázek v příloze	Poznámka
1.4.1.6. I	Leaf blade – terminal lobe – depth of incisions	0 without lobes 3 pinnatilobed 5 pinnatifid 7 pinnatipart 9 pinnatisect	Fig. 1.4.1.6. depth of incisions form blade margin to the main vein up to 1/3 up to 1/2 up to 2/3 more than 2/3	fully developed leaf from the middle part of plant at botanical maturity	1.4.1.6. I	Listová čepel – terminální lalok dělený – hloubka zářezů	0 bez laloků 3 peřenolaločný 5 peřenoklaný 7 peřenodílný 9 peřenosečný	obr. 1.4.1.6. hloubka zářezů od okraje k hlavní žilce do 1/3 do 1/2 do 2/3 více než 2/3	plně vyvinutý list ze střední části hlavního výhonu v době botanické zralosti
1.4.1.7. S (I)	Leaf blade – shape of base	1 cuneate 2 obtuse 3 truncate 4 sinuate 5 cordate	Fig. 1.4.1.7.	fully developed leaf from the middle part of plant at botanical maturity	1.4.1.7. S (I)	Listová čepel – tvar báze	1 klínovitá 2 tupá 3 uťatá 4 vykrojená 5 srdčitá	obr. 1.4.1.7.	plně vyvinutý list ze střední části hlavního výhonu v době botanické zralosti
1.4.1.8. I	Leaf blade – colour	1 light green 2 green 3 blue green 4 grey green		fully developed leaf from the middle part of plant at botanical maturity	1.4.1.8. I	Listová čepel – barva	1 světle zelená 2 zelená 3 modrozelená 4 šedozelená		plně vyvinutý list ze střední části hlavního výhonu v době botanické zralosti
1.4.1.9. I	Leaf blade – glossiness	1 matt 3 weak 5 medium 7 high		fully developed leaf from the middle part of plant at botanical maturity	1.4.1.9. I	Listová čepel – lesk	1 matný 3 slabý 5 střední 7 vysoký		plně vyvinutý list ze střední části hlavního výhonu v době botanické zralosti
1.4.2.1. * I (S)	Leaf petiole – length	3 short 5 medium 7 long	petiole length to blade length ratio < 0.6 0.6–1.2 > 1.2	fully developed leaf from the middle part of plant at botanical maturity	1.4.2.1. * I (S)	Listový řapík – délka	3 krátký 5 střední 7 dlouhý	poměr délky řapíku k délce čepele < 0.6 0.6–1.2 > 1.2	plně vyvinutý list ze střední části hlavního výhonu v době botanické zralosti

1.4.2.2. * S	Leaf petiole – indumentum	1 glabrous 2 single type of trichomes 3 two types of trichomes uniformely intermixed on each petiole 4 three types of trichomes on distinct zones on each petiole	*C. sativus* *C. sagittatus* (KIRKBRIDE 1993) *C. myriocarpus* (KIRKBRIDE 1993)	fully developed leaf from the middle part of plant at botanical maturity	1.4.2.2. * S	Listový řapík – odění	1 holý 2 jeden typ trichomů 3 směs dvou typů trichomů na každém řapíku 4 tři typy trichomů v oddělených zónách na každém řapíku	*C. sativus* *C. sagittatus* (KIRKBRIDE 1993) *C. myriocarpus* (KIRKBRIDE 1993)	plně vyvinutý list ze střední části hlavního výhonu v době botanické zralosti
1.5. Flower			**Fig. 1.5.**		**1.5. Květ**			**obr. 1.5.**	
1.5.1.1. *	Male flower – pedicel shape	1 cylindric, terete 2 sulcate	*C. africanus* (KIRKBRIDE 1993) *C. carolinus* (KIRKBRIDE 1993)		1.5.1.1. *	Samčí květ – tvar stopky	1 válcovitý, hladký 2 s podélnými rýhami	*C. africanus* (KIRKBRIDE 1993) *C. carolinus* (KIRKBRIDE 1993)	
1.5.1.2. * S	Male flower – bracteole subtending pedicel	0 absent 1 present	*C. sativus* *C. heptadactylus* (KIRKBRIDE 1993)		1.5.1.2. * S	Samčí květ – listenec u stopky	0 nepřítomen 1 přítomen	*C. sativus* *C. heptadactylus* (KIRKBRIDE 1993)	
1.5.1.3. *	Male flower – fusion of calyx leaves	0 free leaves 3 short 5 medium 7 long	portion of leaf length fused from base up to 1/3 up to 1/2 more than 1/2		1.5.1.3. *	Samčí květ – srůstání kališních lístků	0 lístky volné 3 krátké 5 střední 7 dlouhé	podíl srostlé části z celkové délky lístku do 1/3 do 1/2 více než 1/2	
1.5.1.4. *	Male flower – shape of calyx leaves	1 linear 2 oblong 3 triangular	Fig. 1.5.1.4.		1.5.1.4. *	Samčí květ – tvar kališních lístků	1 čárkovitý 2 podlouhlý 3 trojúhelníkovitý	obr. 1.5.1.4.	
1.5.1.5. S (I)	Male flower – size	3 small 5 medium 7 big	diameter “d” shown on the Fig. 1.5.1.7. d < 1.0 (cm) d = 1.0–2.0 (cm) d > 2.0 (cm)		1.5.1.5. S (I)	Samčí květ – velikost	3 malý 5 střední 7 velký	průměr „d“ naznačen na obr. 1.5.1.7. d < 1.0 (cm) d = 1.0–2.0 (cm) d > 2.0 (cm)	

No.	Descriptor name	Descriptor state	Explanation Figure in Annex	Note	Pořad. číslo	Název znaku	Projev znaku	Vysvětlení Obrázek v příloze	Poznámka
1.5.1.6. * S	Male flower – fusion of corolla leaves	0 free leaves 3 short 5 medium 7 long	fused portion up to 1/3 up to 1/2 more than 1/2		1.5.1.6. * S	Samčí květ – srůstání korunních lístků	0 lístky volné 3 krátké 5 střední 7 dlouhé	podíl srostlé části z celkové délky lístku do 1/3 do 1/2 více než 1/2	
1.5.1.7.	Male flower – corolla shape	1 infundibular 2 campanulate	Fig. 1.5.1.7.		1.5.1.7.	Samčí květ – tvar koruny	1 nálevkovitý 2 zvonkovitý	obr. 1.5.1.7.	
1.5.1.8. *	Male flower – shape of corolla leaves	1 elliptic 2 oblong 3 ovate 4 obovate 5 triangular	Fig. 1.5.1.8.		1.5.1.8. *	Samčí květ – tvar korunních lístků	1 eliptický 2 podlouhlý 3 vejčitý 4 obvejčitý 5 trojúhelníkovitý	obr. 1.5.1.8.	
1.5.1.9.	Male flower – shape of apex of corolla leaves	1 acute 2 mucronate 3 obtuse	Fig. 1.5.1.9.		1.5.1.9.	Samčí květ – tvar vrcholu korunních lístků	1 ostrý 2 hrotitý 3 tupý	obr. 1.5.1.9.	
1.5.2.1.	Female flower – peduncle shape	1 cylindrical 2 wider on the ovary			1.5.2.1.	Samičí květ – tvar stopky	1 válcovitý 2 rozšiřující se u semeníku		
1.5.2.2. * I	Female flower – shape of ovary	1 rounded 2 ellipsoid 3 cylindrical 4 ovoid	Fig. 1.5.2.2.		1.5.2.2. * I	Samičí květ – tvar semeníku	1 kulovitý 2 elipsoidní 3 válcovitý 4 vejčitý	obr. 1.5.2.2.	
1.5.2.3. * S	Female flower – indumentum on ovary	1 glabrous 2 trichomes 3 emergences 4 aculei			1.5.2.3. * S	Samičí květ – odění semeníku	1 holý 2 trichomy 3 emergence 4 ostny		
1.5.2.4. * I	Female flower – ovary "spine" colour	1 hyaline 2 brown 3 black	"spine" = bristle at apex of aculei or emergence		1.5.2.4. * I	Samičí květ – barva „ostnu" na semeníku	1 hyalinní 2 hnědá 3 černá	„osten" = terminální buňka na ostnu nebo emergenci	

1.5.2.5. * S (I)	Female flower – staminodes	0 absent 1 present			1.5.2.5. * S (I)	Samičí květ – staminodia	0 nepřítomna 1 přítomna		
1.5.2.6. * I (S)	Female flower – shape of stigma	1 entire 2 with 3 fingerlike projections 3 with 4 fingerlike projections 4 with 5 fingerlike projections 5 with 6 fingerlike projections 6 with 9 fingerlike projections	*C. humifructus* (Kirkbride 1993) *C. sagittatus* (Kirkbride 1993) *C. metuliferus* (Kirkbride 1993) *C. heptadactylus* (Kirkbride 1993)		1.5.2.6. * I (S)	Samičí květ – tvar blizny	1 celokrajná 2 se 3 prstovitými výběžky 3 se 4 prstovitými výběžky 4 s 5 prstovitými výběžky 5 s 6 prstovitými výběžky 6 s 9 prstovitými výběžky	*C. humifructus* (Kirkbride 1993) *C. sagittatus* (Kirkbride 1993) *C. metuliferus* (Kirkbride 1993) *C. heptadactylus* (Kirkbride 1993)	
1.6. Inflorescence					**1.6. Květenství**				
1.6.1. * S	Inflorescence – sexual type	0 solitary flowers only 1 unisexual 2 mixed			1.6.1. * S	Květenství – sexuální typ	0 pouze jednotlivé květy 1 jednopohlavné 2 květy samčí i samičí		
1.6.2.	Male inflorescence – morphological type	0 solitary flowers 1 fasciculate 2 racemose 3 paniculate	Fig. 1.6.2.		1.6.2.	Květenství samčí – morfologický typ	0 jednotlivé květy 1 svazčité 2 hroznovité 3 latovité	obr. 1.6.2.	
1.6.3.	Female inflorescence – morphological type	0 solitary flowers 1 fasciculate	Fig. 1.6.3.		1.6.3.	Květenství samičí – morfologický typ	0 jednotlivé květy 1 svazčité	obr. 1.6.3.	
1.7. Fruit					**1.7. Plod**				
1.7.1. * S	Fruit – place of development	1 above ground 2 geocarpicaly	*C. sativus* *C. kalahariensis* (Kirkbride 1993)		1.7.1. * S	Plod – místo tvorby	1 nad zemí 2 geokarpně	*C. sativus* *C. kalahariensis* (Kirkbride 1993)	
1.7.2. * I	Fruit – parthenocarpy	0 non detected 1 detected			1.7.2. * I	Plod – partenokarpie	0 nezjištěna 1 zjištěna		
1.7.3. * I (S)	Fruit – peduncle separation	3 easy 5 intermediate 7 difficult		at botanical maturity	1.7.3. * I (S)	Plod – oddělování stopky	3 snadné 5 střední 7 těžké		v botanické zralosti

No.	Descriptor name	Descriptor state	Explanation Figure in Annex	Note	Pořad. číslo	Název znaku	Projev znaku	Vysvětlení Obrázek v příloze	Poznámka
1.7.4.1. * I	Fruit – shape	1 rounded 2 globose 3 ellipsoid 4 cylindrical 5 ovoid 6 obovoid	Fig. 1.7.4.1.	at botanical maturity	1.7.4.1. * I	Plod – tvar	1 kulovitý 2 ploše kulovitý 3 elipsoidní 4 válcovitý 5 vejčitý 6 obvejčitý	obr. 1.7.4.1.	v botanické zralosti
1.7.4.2. * I	Fruit – neck	0 absent 3 short 5 medium 7 long	< 1/8 of fruit length 1/8–1/6 of fruit length > 1/6 of fruit length	at botanical maturity	1.7.4.2. * I	Plod – krček	0 nepřítomen 3 krátký 5 střední 7 dlouhý	< 1/8 délky plodu 1/8–1/6 délky plodu > 1/6 délky plodu	v botanické zralosti
1.7.4.3. * I	Fruit – stem-end shape	1 depressed 2 flatted 3 rounded 4 pointed	Fig. 1.7.4.3.	at botanical maturity	1.7.4.3. * I	Plod – tvar plodu u stopky	1 prohlubeň 2 plochý 3 kulatý 4 špičatý	obr. 1.7.4.3.	v botanické zralosti
1.7.4.4. * I	Fruit – flower-end shape	1 depressed 2 flatted 3 rounded 4 pointed	Fig. 1.7.4.4.	at botanical maturity	1.7.4.4. * I	Plod – tvar plodu u květního konce	1 prohlubeň 2 plochý 3 kulatý 4 špičatý	obr. 1.7.4.4.	v botanické zralosti
1.7.4.5. * I	Fruit – depth of longitudinal ribs	0 absent 3 superficial 5 intermediate 7 deep	up to 2 mm 2–5 mm more than 5 mm	at botanical maturity	1.7.4.5. * I	Plod – hloubka podélných rýh	0 bez rýh 3 povrchové 5 střední 7 hluboké	do 2 mm 2–5 mm více než 5 mm	v botanické zralosti
1.7.4.6. *	Fruit – blossom scar	3 obscure 5 intermediate 7 conspicious		at botanical maturity	1.7.4.6. *	Plod – jizva po květu	3 nezřetelná 5 střední 7 výrazná		v botanické zralosti
1.7.5.1. * S (I)	Fruit – skin texture	1 smooth 2 grainy 3 wrinkled 4 netted 6 finely warty 7 coarse warty 8 spiny 9 other		at botanical maturity	1.7.5.1. * S (I)	Plod – textura pokožky	1 hladká 2 zrnitá 3 zbrázděná 4 síťovitá 6 jemně bradavičnatá 7 hrubě bradavičnatá 8 ostnitá 9 jiná		v botanické zralosti

1.7.5.2. S	Fruit – corking of skin	0 absent 3 present		at botanical maturity	1.7.5.2. S	Plod – korkovatění pokožky	0 nezjištěno 1 zjištěno		v botanické zralosti
1.7.5.3. * I	Fruit – predominating skin colour	1 white 2 cream 3 yellow 4 orange 5 brown 6 green		at market maturity	1.7.5.3. * I	Plod – převládající barva pokožky	1 bílá 2 krémová 3 žlutá 4 oranžová 5 hnědá 6 zelená		v tržní zralosti
1.7.5.4. * I	Fruit – secondary skin colour	0 absent 1 white 2 cream 3 yellow 4 orange 5 brown 6 green		at market maturity	1.7.5.4. * I	Plod – sekundární barva pokožky	0 není 1 bílá 2 krémová 3 žlutá 4 oranžová 5 hnědá 6 zelená		v tržní zralosti
1.7.5.5. * I	Fruit – predominating skin colour	1 white 2 cream 3 yellow 4 orange 5 brown 6 green		at botanical maturity	1.7.5.5. * I	Plod – převládající barva pokožky	1 bílá 2 krémová 3 žlutá 4 oranžová 5 hnědá 6 zelená		v botanické zralosti
1.7.5.6. * I	Fruit – secondary skin colour	0 absent 1 white 2 cream 3 yellow 4 orange 5 brown 6 green		at botanical maturity	1.7.5.6. * I	Plod – sekundární barva pokožky	0 není 1 bílá 2 krémová 3 žlutá 4 oranžová 5 hnědá 6 zelená		v botanické zralosti
1.7.5.7. I	Fruit – longitudinal stripes	0 absent 3 short 5 medium 7 long	< 1/4 of fruit length 1/4–1/2 of fruit length > 1/2 of fruit length	at market maturity	1.7.5.7. I	Plod – podélné pruhy	0 nenií 3 krátké 5 střední 7 dlouhé	< 1/4 délky plodu 1/4–1/2 délky plodu > 1/2 délky plodu	v tržní zralosti

No.	Descriptor name	Descriptor state	Explanation Figure in Annex	Note	Pořad. číslo	Název znaku	Projev znaku	Vysvětlení Obrázek v příloze	Poznámka
1.7.5.8. * I	Fruit – "spine" size	0 without "spines" 3 small 5 medium 7 big	 diameter in the base < 2 mm 2–4 mm > 4 mm	at market maturity	1.7.5.8. * I	Plod – velikost „ostnů"	0 bez „ostnů" 3 malé 5 střední 7 velké	 průměr na bázi < 2 mm 2–4 mm > 4 mm	v tržní zralosti
1.7.5.9. * I	Fruit – "spine" density	0 without "spines" 3 sparse 5 medium 7 dense	 number of "spines" per cm^2 < 2 2–4 > 4	at market maturity	1.7.5.9. * I	Plod – hustota „ostnů"	0 bez „ostnů" 3 řídká 5 střední 7 hustá	 počet „ostnů" na cm^2 < 2 2–4 > 4	v tržní zralosti
1.7.6.1. I	Fruit – number of locules	1 less then three 2 three 3 four 4 more than four		at botanical maturity	1.7.6.1. I	Plod – počet pouzder semeníku	1 méně než tři 2 tři 3 čtyři 4 více než čtyři		v botanické zralosti
1.7.6.2. I	Fruit – external aroma	0 absent 1 present		at botanical maturity	1.7.6.2. I	Plod – vnější aroma	0 bez aroma 1 přítomno		v botanické zralosti
1.7.6.3. * I	Fruit – internal aroma	0 absent 1 present		at botanical maturity	1.7.6.3. * I	Plod – vnitřní aroma	0 bez aroma 1 přítomno		v botanické zralosti
1.7.6.4. * I	Fruit – flesh thickness	3 thin 5 medium 7 thick	Fig. 1.7.6.4.	at botanical maturity	1.7.6.4. * I	Plod – síla dužniny	3 slabá 5 střední 7 silná	obr. 1.7.6.4.	v botanické zralosti
1.7.6.5. * S (I)	Fruit – flesh texture	1 smooth, firm 2 grainy, firm 3 soft, spongy 4 fibrous, gelationous 5 fibrous, dry		at botanical maturity	1.7.6.5. * S (I)	Plod – textura dužniny	1 jemná, pevná 2 zrnitá, pevná 3 měkká, houbovitá 4 vláknitá, želatinozní 5 vláknitá, suchá		v botanické zralosti
1.7.6.6. * I (S)	Fruit – flesh colour	1 white 2 cream 3 yellow 4 orange 5 salmon 6 green		at botanical maturity	1.7.6.6. * I (S)	Plod – barva dužniny	1 bílá 2 krémová 3 žlutá 4 oranžová 5 lososová 6 zelená		v botanické zralosti

1.8. Seed					**1.8. Semeno**				
1.8.1. *	Seed – weight of 1,000 seeds	3 low 5 medium 7 high	< 20 (g) 20–30 (g) > 30 (g)	after drying to 8% m.c.	1.8.1. *	Semeno – hmotnost 1 000 semen	3 nízká 5 střední 7 vysoká	< 20 (g) 20–30 (g) > 30 (g)	po vysušení na 8 % vlhkosti
1.8.2. *	Seed – shape	1 flattened ellliptic 3 flattened ovoid			1.8.2. *	Semeno – tvar	1 ploše eliptický 3 ploše vejčitý		
1.8.3. *	Seed – coat colour	1 white 2 cream 3 yellow 4 orange		after drying to 8% m.c.	1.8.3. *	Semeno – barva osemení	1 bílá 2 krémová 3 žlutá 4 oranžová		po vysušení na 8 % vlhkosti
1.9. Root					**1.9. Kořen**				
1.9.2. S	Root – tubers	0 absent 1 present	*C. sativus* *C. kalahariensis* (KIRKBRIDE 1993)		1.9.2. S	Kořen – hlízy	0 nepřítomny 1 přítomny	*C. sativus* *C. kalahariensis* (KIRKBRIDE 1993)	
2. Biological features					**2. Biologické znaky**				
2.1. Reproductive strategy					**2.1. Reprodukční strategie**				
2.1.1. S	Life cycle	1 annual 2 perennial	*C. sativus* *C. meeusei* (KIRKBRIDE 1993)		2.1.1. S	Životní cyklus	1 jednoletá 2 vytrvalá	*C. sativus* *C. meeusei* (KIRKBRIDE 1993)	
2.1.2. * I	Hermafrodit flowers	0 absent 1 present			2.1.2. * I	Hermafroditní květy	0 nepřítomny 1 přítomny		
2.1.3. I	Sterility	0 non detected 1 male 2 female			2.1.3. I	Sterilita	0 nezjištěna 1 pylová 2 samičí		
2.1.4. * I	Reproductive strategy	1 monoecious 2 gynomonoecious 3 andromonoecious 4 dioecious 5 androecious (male line) 6 gynoecious (female line) 7 polygamous	Fig. 2.1.4.		2.1.4. * I	Reprodukční strategie	1 jednodomá 2 gynomonoická 3 andromonoická 4 dvoudomá 5 androecická (samčí linie) 6 gynoecická (samičí linie) 7 polygamická	obr. 2.1.4.	

No	Descriptor name	Descriptor state	Explanation Figure in Annex	Note	Pořad. číslo	Název znaku	Projev znaku	Vysvětlení Obrázek v příloze	Poznámka
2.2. Chemical composition					**2.2. Chemické složení**				
2.2.1. * I	Bitterness of cotyledons	0 non detected 1 detected		at cotyledon stage	2.2.1. * I	Hořkost děložních lístků	0 nezjištěna 1 zjištěna		ve stadiu děložních lístků
2.3. Resistance to biotic and abiotic factors					**2.3. Odolnost k biotickým a abiotickým faktorům**				
2.3.1. I	Factor	0 very high 1 high 3 medium 5 low 7 very low 9 none			2.3.1. I	Faktor	0 velmi vysoký 1 vysoký 3 střední 5 nízký 7 velmi nízký 9 žádný		
2.3.2. I	Reaction race specific	list of resistance factors			2.3.2. I	Reakce rasově specifická	přehled faktorů rezistence		

Note: An additional descriptor state "99" should be added to qualitative characters and should be used for accessions represented by heterogeneous populations (mixture of individuals with different expression of characters). Its specification should list all states observed.
Explanation of descriptor state are followed by examples of corresponding *Cucumis* species with literature cited and/or by accession number of genetic resource kept in the Czech Republic by the Research Institute of Crop Production in Praha-Ruzyně and documented by the system EVIGEZ.

Poznámka: Doplňková hodnota projevu znaku „99" by měla být přiřazena ke kvalitativním znakům a má být použita pro položky reprezentované heterogenními populacemi (směs jedinců s odlišnou expresí znaků). Její specifikace bude zahrnovat všechny pozorované hodnoty.
Vysvětlení projevu znaku je doplněno příklady odpovídajících druhů *Cucumis* s literárním odkazem nebo číslem položky genového zdroje uchovávaného v České republice ve Výzkumném ústavu rostlinné výroby v Praze-Ruzyni a evidovaného v rámci systému EVIGEZ.

Annex: Figures to the Table 4
Příloha: obr. k tab. 4

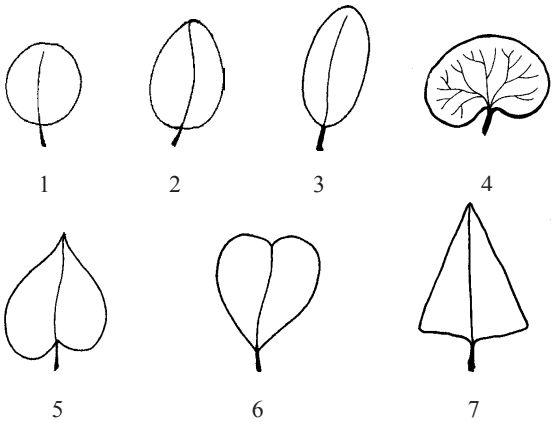


Figure 1.4.1.1. Leaf blade – shape in outline
Obrázek 1.4.1.1. Listová čepel – tvar v obrysu

1 orbicular – okrouhlý
2 ovate – vejčitý
3 elliptic – eliptický
4 reniform – ledvinitý
5 cordate – srdčitý
6 subcordate – opačně srdčitý
7 triangular – trojúhelníkovitý

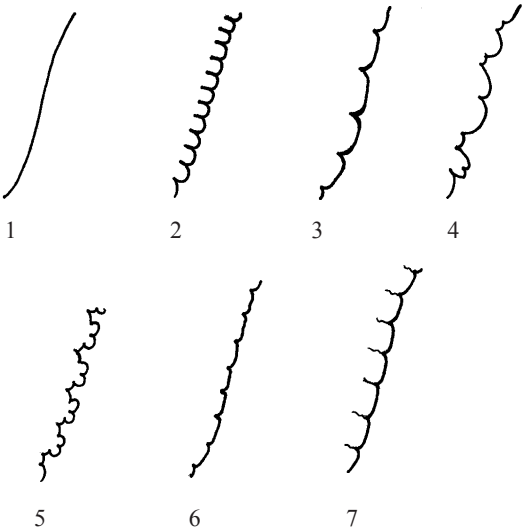


Figure 1.4.1.2. Leaf blade – margin
Obrázek 1.4.1.2. Listová čepel – okraj

1 entire – celokrajný
2 dentate – zubatý
3 distantly dentate – oddáleně zubatý
4 irregularly dentate – nepravidelně zubatý
5 double dentate – dvojnásobně zubatý
6 minutely distantly dentate – drobně oddáleně zubatý
7 minutely distantly dentate with cilia – drobně oddáleně zubatý s brvami

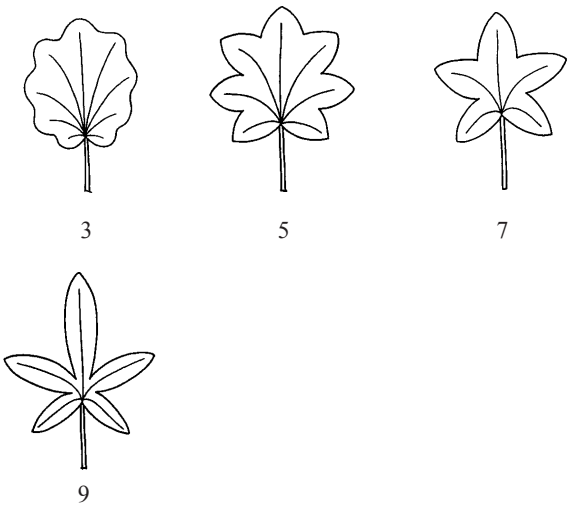


Figure 1.4.1.3. Divided leaf blade – depth of incisions
Obrázek 1.4.1.3. Listová čepel dělená – hloubka zářezů

3 palmatelylobed – dlanitolaločná
5 palmatelyfid – dlanitoklaná
7 palmatelypart – dlanitodílná
9 palmatelysect – dlanitosečná

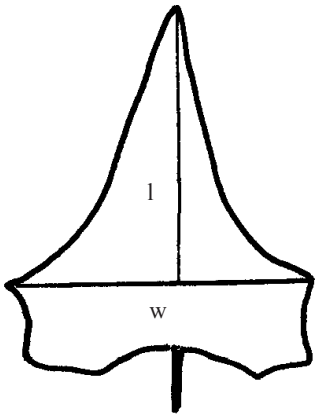


Figure 1.4.1.4. Leaf blade – size of terminal lobe
Obrázek 1.4.1.4. Listová čepel – velikost terminálního laloku

lenght (l) and width (w) of terminal lobe:
délka (l) a šířka (w) terminálního laloku

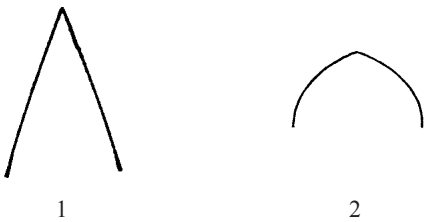


Figure 1.4.1.5. Leaf blade – shape of apex of terminal lobe
Obrázek 1.4.1.5. Listová čepel – tvar vrcholu terminálního laloku

1 acute – ostrý
2 obtuse – tupý

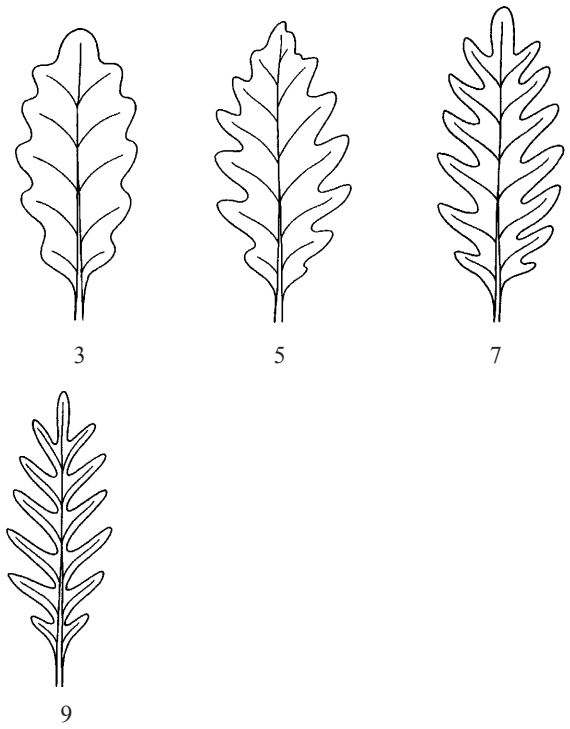


Figure 1.4.1.6. Leaf blade – terminal lobe – depth of incisions
Obrázek 1.4.1.6. Listová čepel – terminální lalok dělený – hloubka zářezů

3 pinnatilobed – peřenolaločný
5 pinnatifid – peřenoklaný
7 pinnatipart – peřenodílný
9 pinnatisect – peřenosečný

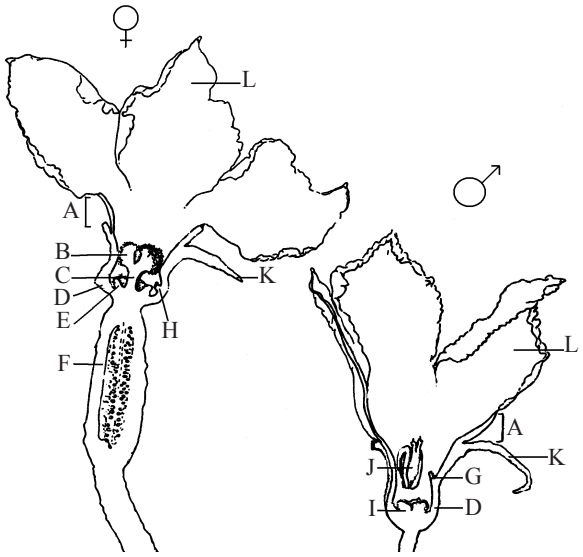


Figure 1.5. *Cucumis sativus* male and female flowers
Obrázek 1.5. Samčí a samičí květ *Cucumis sativus*
Description:
Popis:
A – corolla tube – korunní trubka
B – stigma – blizna
C – style – čnělka
D – hypanthium – češule
E – nectary – nektárium
F – ovary – semeník
G – filament – nitka
H – staminodium – zakrnělá tyčinka
I – pistillodium – disk (redukovaný pestík)
J – stamen – tyčinka
K – sepal – kališní lístek
L – petal – korunní lístek

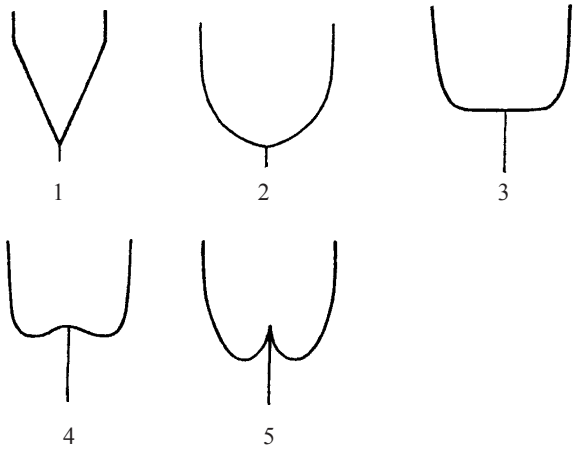


Figure 1.4.1.7. Leaf blade – shape of base
Obrázek 1.4.1.7. Listová čepel – tvar báze
1 cuneate – klínovitá
2 obtuse – tupá
3 truncate – uťatá
4 sinuate – vykrojená
5 cordate – srdčitá

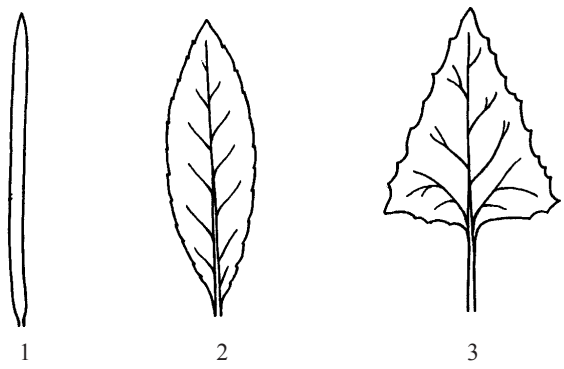


Figure 1.5.1.4. Male flower – shape of calyx leaves
Obrázek 1.5.1.4. Samčí květ – tvar kališních lístků

1 linear – čárkovitý
2 oblong – podlouhlý
3 triangular – trojúhelníkovitý

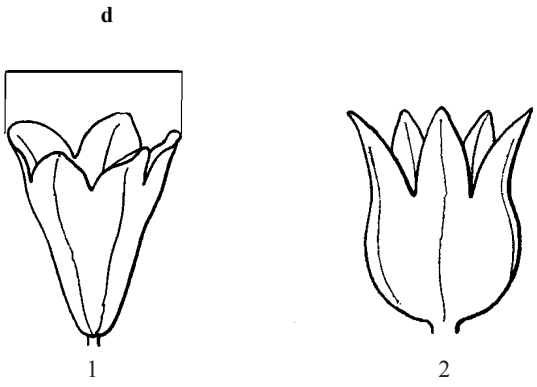


Figure 1.5.1.7. Male flower – corolla shape
Obrázek 1.5.1.7. Samčí květ – tvar koruny

1 infundibular – nálevkovitý
2 campanulate – zvonkovitý

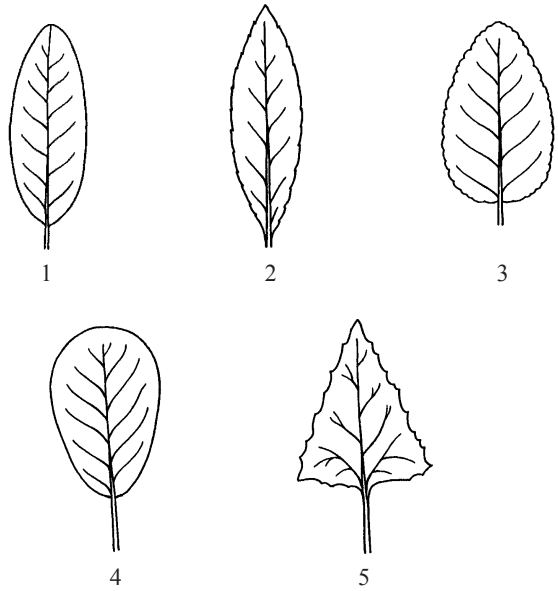


Figure 1.5.1.8. Male flower – shape of corolla leaves
Obrázek 1.5.1.8. Samčí květ – tvar korunních lístků

1 elliptic – eliptický
2 oblong – podlouhlý
3 ovate – vejčitý
4 obovate – obvejčitý
5 triangular – trojúhelníkovitý

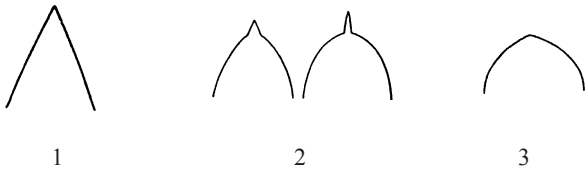


Figure 1.5.1.9. Male flower – shape of apex of corolla leaves
Obrázek 1.5.1.9. Samčí květ – tvar vrcholu korunních lístků

1 acute – ostrý
2 mucronate – hrotitý
3 obtuse – tupý

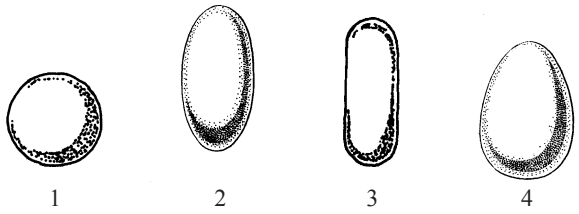
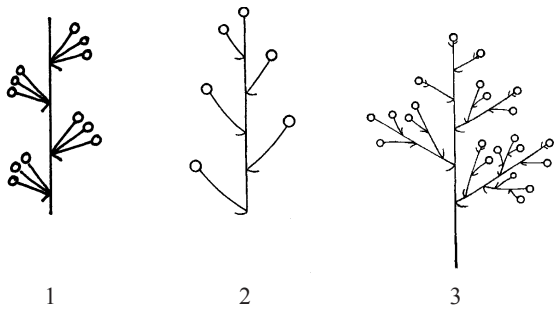


Figure 1.5.2.2. Female flower – shape of ovary
Obrázek 1.5.2.2. Samičí květ – tvar semeníku

1 rounded – kulovitý
2 ellipsoid – elipsoidní
3 cylindrical – válcovitý
4 ovoid – vejčitý



Figures 1.6.2. and 1.6.3. Inflorescence – morphological type
Obrázky 1.6.2. a 1.6.3. Květenství – morfologický typ

1 fasciculate – svazčité
2 racemose – hroznovité
3 paniculate – latovité

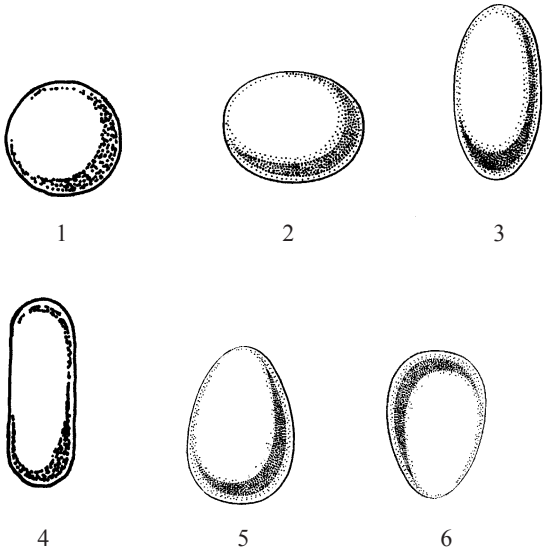


Figure 1.7.4.1. Fruit – shape
Obrázek 1.7.4.1. Plod – tvar

1 rounded – kulovitý
2 globose – ploše kulovitý
3 ellipsoid – elipsoidní
4 cylindrical – válcovitý
5 ovoid – vejčitý
6 obovate – obvejčitý

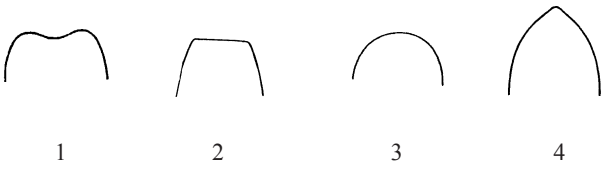


Figure 1.7.4.3. Fruit - stem-end shape
Obrázek 1.7.4.3. Plod – tvar u stopky
Figure 1.7.4.4. Fruit – flower-end shape
Obrázek 1.7.4.4. Plod – tvar u květního konce

1 depressed – prohlubeň
2 flatted – plochý
3 rounded – kulatý
4 pointed – špičatý

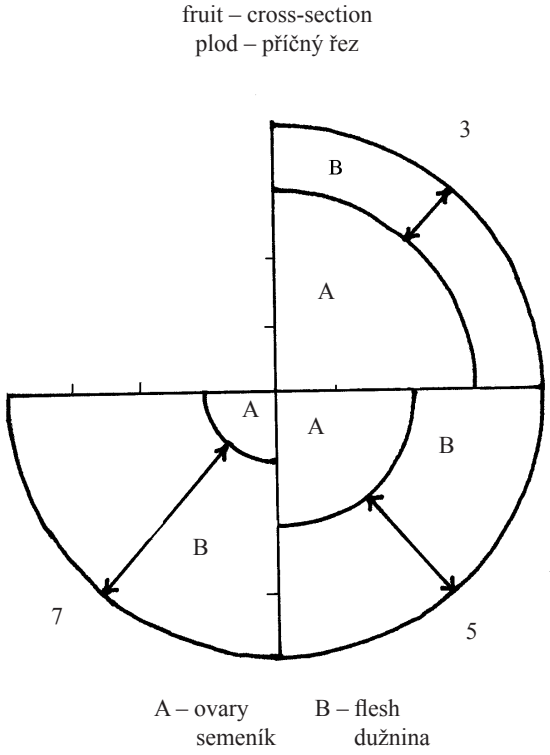


Figure 1.7.6.4. Fruit – flesh thickness
Obrázek 1.7.6.4. Plod – síla dužniny

3 thin – slabá
5 medium – střední
7 thick – silná

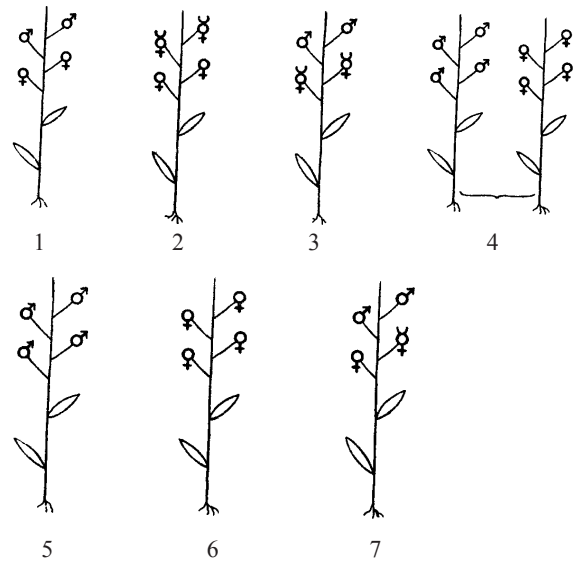


Figure 2.1.4. Reproductive strategy
Obrázek 2.1.4. Reprodukční strategie

1 monoecious – jednodomá
2 gynomonoecious – gynomonoická
3 andromonoecious – andromonoická
4 dioecious – dvoudomá
5 androecious (male line) – androecický (samčí linie)
6 gynoecious (female line) – gynoecický (samičí linie)
7 polygamous – polygamická

Genové zdroje rodu *Cucumis* a jejich morfologický popis (Anglicko-česká verze)

ABSTRAKT: Česká kolekce genových zdrojů rodu *Cucumis* zahrnuje 895 položek pěstovaných druhů *C. sativus* a *C. melo* a 89 položek planě rostoucích druhů. Znalost jejich morfologických a biologických vlastností a správné taxonomické zařazení jsou základem jejich úspěšného využití v moderním šlechtění. Soubor popisných znaků obsahuje 65 deskriptorů a 20 z nich je doplněno obrázkem. Tento soubor slouží jak k druhové determinaci a charakterizaci druhů rodu *Cucumis*, tak k určení infraspecifické variability. Získaná data mohou být využita pro popis položek genových zdrojů a k dalším výzkumným účelům.

Klíčová slova: Cucurbitaceae; okurka; meloun; genové zdroje; data; deskriptory; infraspecifická variabilita; *Cucumis* spp.; planě rostoucí druhy *Cucumis*

Collections of *Cucumis* genetic resources include not only cultivated species *C. sativus* (cucumbers) and *C. melo* (melons) but also wild *Cucumis* species. Knowledge of their morphological and biological features and a correct taxonomical ranging serve a base for successful use of germplasm in modern breeding.

Czech collection of *Cucumis* genetic resources is maintained in Olomouc by the Gene Bank Workplace of the Research Institute of Crop Production (RICP) (KŘÍSTKOVÁ, LEBEDA 1995). It consists of 794 *C. sativus* accessions, 101 *C. melo* accessions and 89 accessions of wild species (*C. africanus, C. anguria, C. heptadactylus, C. myriocarpus, C. prophetarum, C. zeyheri*) (KŘÍSTKOVÁ 2002a). Morphological data obtained during observation of wild *Cucumis* species do not always coincide with description of some species in monographs. The taxonomical ranging of some accessions should be re-considered. An international descriptor list for cultivated and wild *Cucumis* species was not elaborated till now.

A set of morphological descriptors for genetic resources of the genus *Cucumis* should serve a tool for species determination and for a discrimination of infraspecific variation.

TAXONOMY, BOTANICAL CHARACTERIZATION, KARYOLOGICAL STATUS, BIOCHEMICAL AND MOLECULAR MARKERS OF *CUCUMIS* SPP.

Taxonomy of the family Cucurbitaceae

The genus *Cucumis* belongs to the family Cucurbitaceae (WHITAKER, DAVIS 1962), order Cucurbitales. According to specific morphological features of tendrils, pollen grains and ovules, there are clear relation of this taxon with the order Passiflorales (NOVÁK 1961). Based on latest knowledge of cytology, cytogenetics, phytochemistry and molecular genetics (PERL-TREVES et al. 1985; RAAMSDONK et al. 1989), a new taxonomical classification of this family was created by JEFFREY (1989). The family is subdivided into two subfamilies. The subfamily Zanonioideae comprises species with a low economic impact. All economically important species are included in the subfamily Cucurbitoideae (Table 1).

Within Cucurbitaceae the tribe Melothrieae with the genus *Cucumis* are considered the most important ones under climatic conditions of the Middle Europe. The genus *Cucumis* is represented by 32 species (KIRKBRIDE 1993). Besides cucumber (*Cucumis sativus* L.) and melon (*C. melo* L.), the species *C. anguria* (West Indian gherkin) and *C. metuliferus* (African horned cucumber) are commercially explored in several areas as well. Other wild species originating mostly from arid and/or semi-arid regions of Africa, respectively, are cultivated as ornamental plants (*C. dipsaceus* – "hedgehog gourd", *C. myriocarpus* – "gooseberry gourd") (RUBATZKY, YAMAGUCHI 1997).

Origin, gene pool and crossing ability of *Cucumis* spp.

The South Africa is considered to be a centre of diversity for the genus *Cucumis*. The Indian centre, especially area under Himalayan mountains is probably the centre of diversity of *C. sativus*. This species represents an compact and isolated group and a subgenus *Cucumis*. The second subgenus *Melo* is divided into three groups. *C. melo* forms an independent group Melo. Other African species form the group Anguria (e.g. *C. anguria*, *C. africanus*, *C. dipsaceus*, *C. zeyheri*) and a group Metuliferus (*C. metuliferus*, *C. myriocarpus*, *C. sagittatus*) (JEFFREY 1989). A precise description of *Cucumis* species and a study of their cross-ability (NIJS, CUSTERS 1989; RAAMSDONK et al. 1989) (Fig. 1) contribute to the elucidation of evolutionary relations within genus and a determination of accessions of genetic resources. Recent taxonomy of the genus *Cucumis* elaborated by KIRKBRIDE (1993) is given in Table 2.

The primary gene pool of *C. sativus* consists of one species *C. hardwickii*, which is frequently considered as a variety of *C. sativus*. Secondary gene pool includes *C. hystrix*. Gene pools of *C. melo* were not exactly defined till now.

The genetic differences between both subgenera are a reason of the cross-incompatibility of *C. sativus* with

other *Cucumis* species and limits the progress in cucumber breeding. The successful interspecific hybridization is related to the development of biotechnological methods (LEBEDA et al. 1993), e.g. embryo culture techniques that can rescue hybrid embryos (LEBEDA et al. 1999), a protoplast fusion (JARL et al. 1995; FELLNER, LEBEDA 1998) and a somatic hybridization (DABAUZA et al. 1998). New valuable characters can be introduce to the cucumber and melon genomes through transformation (VALLÉS, LASA 1994; NISHIBAYASHI et al. 1996). Knowledge in *C. sativus* breeding was treated by TATLIOGLU (1993).

Morphological description of *Cucumis* spp.

Plants have a bicolatheral vein fascicles and in their tissues, there are cystoliths (NOVÁK 1961). A specific metabolism of terpens leads to the production of cucurbitacins which can cause a poisoning of human and animals (FERGUSON et al. 1983).

Following morphological description is based on data of CHRTKOVÁ (1990), KIRKBRIDE (1993) and RUBATZKY, YAMAGUCHI (1997). Plants are annual herbs, exceptionally semishrubs, usually having a trailing or climbing growth habit, although some cucumber and melon cultivars have a bush habit. Root systems, rarely woody (*C. trigonus*) are extensive, but usually shallow, rarely tuberous (*C. kalahariensis*). Stems are angled, sulcate, not aculeate or rarely aculeate (*C. aculeatuc, C. ficifolius*), variously pubescent or rarely glabrous, with nonbreakaway hairs or rarely breakaway hairs (*C. sacleuxii*).

The branching pattern is sympodial. Nodes are geniculate or not geniculate. Each node has a single leaf and a simple tendril (sometimes curling), except of *C. humifructus* which has a fascicle of 5–8 tendrils and of *C. rigidus* which lacks them. Tendrils of *C. insignis* are either simple and bifid. Tendrils are variously pubescent, rarely glabrous or rarely aculeate.

Leaves are simple and petiolate. Petioles differs in length (with regard to the length of a leaf blade). Petioles are not aculeate or rarely aculeate, variously pubescent or rarely glabrous, with nonbreakaway hairs or rarely breakaway hairs. Majority of species has a uniform type of pubescence on the petioles. *C. sagittatus* and *C. thulinianus* have two pubescence types uniformly mixed over the entire petiole, and *C. myriocarpus* has three types separated into distinct zones on the petioles, retrose-strigose on the base, hirsute in the middle, and antrorse-strigose at apex. Leaf blade is circular, kidney shaped, triangular ovate, somewhat cordate to subcordate, narrowly to shallowly ovate, or rarely eliptic or triangular in outline, sometimes acute to broadly so, or truncate to subtruncate, rarely obtuse, sagittate, or hasttate at the base, with or sometimes without a basal sinus, three to five palmately lobed, with three to five angled portions, from shallow to deeply lobed and with a sharp to round sinuses. The apex is acute, acuminate, or rarely obtuse. Central leaf lobe is symmetrical, entire or sometimes pinnatifid. Leaf margin is dentate, double dentate to entire. Lateral leaf lobes are asymmetrical, or sometimes symmetrical, entire or sometimes pinnatifid. A leaf surface is rough to smooth to the touch.

Flowers are unisexual – pistillate or staminate, but hermaphrodite flowers also occur. They are very often in the group of Lemon cucumber. Sex expression is under genetic control but it is influenced by environment and/or chemical treatment (TRONÍČKOVÁ, PROCHÁZKOVÁ 1984). The inflorescence is unisexual, most species are monoecious. *C. humifructus* has only androgynous inflorescence (i.e. inflorescence with both male and female flowers and the female flower below the male ones). *C. metuliferus* has mainly unisexual inflorescence and a few gynecandrous ones (i.e. inflorescence with both female and male flowers and the female flower above the male ones). Cultivated forms of *C. sativus* have many types of sexual expression (e.g. monoecious, gynoecious, andromonoecious, androdiecious, hermafroditic etc.).

Male inflorescence consists of solitary flowers, or fasciculate, racemose, paniculate, or rarely modified compound dichasial from 1–18 flowered, sessile or rarely pedunculate. Male inflorescence are often multiflowered and are rarely branched. When the inflorescences are branched, the male flowers are always pedicellate. Male flowers are 5-merous, pedicel is terete or rarely sulcate in cross section, variously pubescent or rarely glabrous, without bracteoles or rarely subtended by a bracteole (*C. heptadactylus*). Calyx consists of 5 or rarely 4 lobes, linear to oblong or narrowly to broadly triangular in outline, acute to narrowly so in apex, variously pubescent or rarely glabrous. Corolla is yellow, infundibular or rarely campanulate, variously pubescent or rarely glabrous. Corolla fused into a basal tube. Corolla leaves are elliptic to broadly so, ovate to shallowly so, obovate to narrowly so, or rarely oblong or broadly triangular in outline, narrowly to broadly acute or obtuse, and sometimes also mucronate at the apex. Three stamens are free, with separation from the free portion of the hypanthium above the ovary. Two of them are 2-thecate and one 1-thecate. Filaments are terete or radially compressed in cross section, glabrous or with basal puberculence and glabrous apically. Anther theceae is sigmoid, glabrous with the edges shortly pubescent. Anther connective is extended, obovate, oblong to narrowly so, transversely broadly oblong, or ovate, unilobate or rarely bilobate, obtuse or rarely acute in apex, minutely papillate, sometimes smooth, or rarely glabrous, fimbriate or crenulate at the apex. Disc is cylindrical or rarely consisting of three papillae, glabrous.

Female flowers are solitary or rarely in fasciclate inflorescences, sessile arise from leaf axils, very often from secondary branches. They are pedicellate and 5-merous. Pedicel is terete or sulcate in cross section, variously pubescent, with nonbreakaway hairs or rarely with breakaway hairs. Hypanthium is hour-glass shaped. The constricted portion and the lower bulge fused to the ovary. The upper bulge of hypanthium

is free from the ovary. Free portion of hypanthium is campanulate. Ovary has 3–5 placentas with numerous horizontal ovules. Calyx has five, occasionally 4 or 6 lobes of the same shape as male flowers. Corolla is yellow, infundibular, with the same shape and types of pubescence as male flower. Corolla tube is present or absent. Three staminodes are present or rarely absent, separating from the free portion of hypanthium above the ovary. Style is terete in cross section, glabrous, subtented by a circular disc or rarely lacking one. Stigma is copular, lobate, or sometimes entire or sublobate, with 1–6 or rarely 9 finger-like projections on the margin.

Fruits are pendulous. Cucumber fruit can develop parthenocarpically. The pedicel is sulcate or sometimes terete in cross section, variously pubescent or rarely glabrous. Fruit is spherical, oval, oblong, elongated or blocky in shape and variable in size. Fruit surface varies in the number and size of scattered spiny tubercles (warts), or sharp soft hairs. It can be smooth and glabrous, sometimes deeply ridged or covered with a corky (reticulate) netting (e.g. for *C. melo*). Skin colour varies from pale to very dark green, sometimes with longitudinal indentations or stripes. In maturity the skin colour is white cream to orange brown. Inferior flesh colour can be white, green, pink, or orange. A unique feature of some *C. melo* cultivars is the formation of an abscission layer between peduncle and a fruit that coincide with fruit maturation.

Mature seeds have white, cream to yellow colour, they are smooth, compressed, ovoid to elliptic, immarginate, with an acute edge, unwinged or rarely apically winged. *C. humifructus* ("aardvarc cucumber") develops its fruits below ground.

Karyological status, biochemical and molecular markers of *Cucumis* spp.

Species *C. sativus*, *C. sativus* var. *hardwickii* (*C. hardwickii*), *C. hystrix* and *C. callosus* (not mentioned by KIRKBRIDE 1993) have the chromosome number $2n = 14$, the same value for other *Cucumis* species varies from 24 to 72, when $n = 12$ is multiplied (KIRKBRIDE 1993) (Table 2).

The mapping of *Cucumis* genome (HELM, HEMLEBEN 1997; HOSHI et al. 1998) and the study of biochemical and molecular markers provide the bases for the determination of duplicates within collections of genetic resources for the discrimination of differences among accessions (KATO et al. 1998) and for the identification of suitable markers for resistance to biotic and abiotic factors (LEBEDA, DOLEŽAL 1995; STAUB et al. 1996a,b; HOREJSI et al. 2000).

Classification and morphological types of *C. sativus*

From the viewpoint of a practical use of fruits, cucumbers are divided into salad and pickling ones. A common practice in the past was to use young fruits for pickling and later on, the biggest but green fruit as salad (e.g. cv. Delikates). An exact recent infraspecific classification of *C. sativus* was not elaborated till now. PODEŠVA (1959) listed following cucumber forms:

f. *viridis*: small warty and "spiny" fruits predominantly for pickling (e.g. From Znojmo, From Paris);
f. *flavus*: smooth yellow fruits with shape and size of a hen egg (e.g. Russian cornishons);
f. *albus*: elongated, thick, white fruits (e.g. White from Paris);
f. *longus*: elongated, cylindric, smooth fruits, green to yellow-green in colour (e.g. Mladoboleslavské salátnice, Rollison's Telegraph, Goliath);
f. *fastigiatus*: small fruits in clusters (e.g. Persian clustered, From Muromsk);
f. *opheocarpus*: very long, curved, snaked fruits (usually greenhouse cultivars);
f. *variegatus*: light green fruits with yellow or brown spots and stripes (e.g. Japanese, chiva, King Alexander);
f. *sikkimiae*: big, elongated, ovoid fruits, yellowish and brown-red netted (e.g. Indian netted).

Fresh market types of cucumbers have usually fruits with length to diameter ratio of about 4:1, thick skin, somewhat pointed stem and blossom ends, and usually white, preferable few spines. Cucumber types for pickling usually have fruits with length to diameter ratio of 2.5:1, light green colour and thin skin, relatively blocky at the stem and blossom ends, and many surface warts. Cucumber cultivars are generally classified into following groups (RUBATZKY, YAMAGUCHI 1997; GEORGE 1999):

1. Field cucumbers, with prominent white or black spines;
2. English cucumbers – greenhouse or forcing type of parthenocarpic cucumbers with seedless fruits;
3. Sikkim cucumber, originated in India, with reddish brown skins of fruits;
4. Oriental-type cucumber, popular in Japan and China, thin skinned, usually long and slender with considerable warts and spines;
5. Smoot-skinned Beit Alpha types, most popular in Middle East and north Africa, with light coloured, thin skinned fruits;
6. Lemon cucumber produces a round, creamy yellow skin fruit with large five-carpel seed cavity. Its sex expression is andromonoecious.

Very small, immature cucumber fruits are erroneously referred to as gherkins.

Classification and morphological types of *C. melo*

The species *C. melo* expresses the largest variability in the fruit size, shape, colour, texture and taste within the genus *Cucumis* (WHITAKER, DAVIS 1962). Its recent infraspecific classification proposed by PITRAT et al. (2000) is based on the critical analyses of previous systems (e.g. from NAUDIN, ALEFELD, PANGALO,

GREBENŠČIKOV, FILOV, JEFFREY, ROBINSON and DECKER-WALTERS) and a study of morphology of a contemporary spectrum of cultivars and wild forms. The phenotypic expression of this variation was analyzed also by molecular methods RAPD and ISSR (STEPANSKY et al. 1999). *C. melo* is divided into two subspecies, subsp. *agrestis* with five groups and subsp. *melo* with eleven groups (Table 3).

STANDARDS FOR REGENERATION AND EVALUATION

Regeneration

Plants of the genus *Cucumis* are cross-pollinated by insects. Basic information on regeneration of *Cucumis* spp. is given by GEORGE (1999). During regeneration of acccession in the Gene Bank Workplace RICP in Olomouc the international standards and the method of the regeneration accepted by the National Council for Plant Genetic Resources of the Czech Republic are followed.

Seeds are sown in mid- to end April to the sterile substrate (Perlite) in plastic pots (5–10 seeds) and at a cotyledon stage seedlings are transplanted to the plastic pots (diameter of 8.5 cm) with garden soil (two seedlings per pot) in the glasshouse (day/night temperatures of 20–25°C/10–15°C). The plantlets are transplanted, at a stage of two–three true leaves, to the isolation cages spaced of 2.3 × 5.5 m each, covered by glass or by plastic net, to four rows with 10 "nests" each. Two weeks later, seedlings except of the best developed one are cut out and removed from the nest. One accession is represented by 20 (minimum) or 40 (optimum) plants. Plants are trained vertically, watered and protected against diseases and pests. Before flowering a small colonies of honey-bees are placed to each cage. Harvested seeds are dried, cleaned and stored in glass jars under temperature of –5°C (active collection) or at –18°C (basic collection) in the main store of the Research Institute of Crop Production in Praha-Ruzyně. Detailed regeneration protocol is given by KŘÍSTKOVÁ (2002b).

Morphological and biological characters

The set of morphological descriptors (Table 4) provides the tools for species determination within the genus *Cucumis* and for a characterization of *Cucumis* infraspecific morphological variability. It was elaborated on the base of study of genetic resources in Gene Bank RICP, Workplace in Olomouc, *Cucumis* spp. monograph (KIRKBRIDE 1993), the descriptor lists published by IBPGR (ESQUINAS-ALCAZAR, GULICK 1983), with regard to the descriptor list and codes for *Cucumis* spp. from Northcentral Regional Plant Introduction Station Ames (USA), (ANONYME 1989), the descriptor for *Cucumis sativus* L. published by VIR in Leningrad (USSR) (ANONYME 1980) and Guidelines UPOV for conduct of tests for distinctness, homogeneity and stability of *Cucumis sativus* (1978) and *Cucumis melo* (1987). The terminology of botanical morphology and elaboration of figures is based on FUTÁK et al. (1966), SUGDEN (1984), SLAVÍKOVÁ (1988) and BOBÁK et al. (1992).

The list contains 65 descriptors and 20 of them are elucidated by figures (Annex). Highly discriminating descriptors are marked with an asterisk (*) in the first column of the Table 4. Letter "S" indicates a species characterizing descriptor, state of descriptor marked with a letter "I" discriminates an infraspecific variation, letters in brackets are of a secondary significance.

Explanation of descriptor states are followed by examples of corresponding *Cucumis* species with literature cited and/or by accession number of genetic resource.

The format for a creation of this descriptor list follows the rule given by the National Council for Plant Genetic Resources of the Czech Republic and obtained data will be implemented to the central documentation of plant genetic resources EVIGEZ. Description data of *Cucumis* spp. genetic resources accessions will be available on the Czech web site of national database of plant genetic resources: www.vurv.cz.

For an adequate documentation of germplasm obtained data must be supplemented by the characterization and/or evaluation site descriptors according to IPGRI.

Resistance to biotic and abiotic factors

The resistance to biotic and/or abiotic factors respectively, must be evaluated in a separate trials (e.g. in growth chambers after artificial inoculation of pathogen) using an exact and published method, e.g. LEBEDA (1986).

The group of the most important diseases of *Cucumis* spp. includes *Cucumber mosaic virus* (CMV), *Watermelon mosaic virus* 2 (WMV-2), *Zucchini yellow mosaic virus* (ZYMV), angular leaf spot (*Pseudomonas lachrymans*), cucumber downy mildew (*Pseudoperonospora cubensis*) and cucurbit powdery mildew (*Erysiphe cichoracearum, Sphaerotheca fuliginea*). The economically important pests of *Cucumis* spp. are spider mite *(Tetranychus urticae)*, whitefly (*Trialeurodes vaporariorum*), thrips (*Thrips tabaci, Frankliniella occidentalis*), aphids (*Aphis gossypii, A. craccivor, A. middletoni*, *Macrosiphum euphorbiae, Myzus persicae*) and root-knot nematodes of the genus *Meloidogyne* (SCHWARZ et al. 1996).

The most important abiotic factors are low temperature, high temperature, high soil salinity, soil acidity, high soil moisture and high humidity.

Acknowledgements

Authors thank VERONIKA KŘÍSTKOVÁ for her technical assistance in elaborating of tables and figures in Annex. This research was developed within the framework of the National Programme of Conservation

and Utilization of Plant Genetic Resources (Ministry of Agriculture of the Czech Republic).

Kolekce genových zdrojů zelenin rodu *Cucumis* zahrnují nejen pěstované druhy *C. sativus* (okurka) a *C. melo* (cukrový meloun), ale také planě rostoucí druhy rodu *Cucumis*. Znalost jejich morfologických a biologických vlastností a správné taxonomické zařazení jsou základem jejich úspěšného využití ve šlechtění.

V rámci České republiky je kolekce genových zdrojů tykvovitých zelenin soustředěna na olomouckém pracovišti Genové banky Výzkumného ústavu rostlinné výroby v Praze-Ruzyni (KŘÍSTKOVÁ, LEBEDA 1995). Tvoří ji 794 položek *Cucumis sativus* L. (okurka setá), 101 položek *Cucumis melo* L. (meloun cukrový) a 89 položek planě rostoucích druhů (*C. africanus, C. anguria, C. heptadactylus, C. myriocarpus, C. prophetarum, C. zeyheri*) (KŘÍSTKOVÁ 2002a). Z porovnání morfologických charakteristik těchto položek s publikovanými popisy příslušných druhů vyplývá, že taxonomické zařazení některých položek je sporné. Dosud nebyl vypracován mezinárodně platný klasifikátor pro popis položek genových zdrojů rodu *Cucumis*.

Soubor popisných znaků pro položky genových zdrojů rodu *Cucumis* by měl sloužit jak k jejich druhové determinaci, tak ke klasifikaci infraspecifické variability.

TAXONOMIE, BOTANICKÁ CHARAKTERISTIKA, KARYOLOGICKÉ, BIOCHEMICKÉ A MOLEKULÁRNÍ ZNAKY *CUCUMIS* SPP.

Taxonomický přehled čeledi Cucurbitaceae

Rod *Cucumis* náleží do čeledi Cucurbitaceae (WHITAKER, DAVIS 1962), česky tykvovité (DOSTÁL 1989), resp. dýňovité (CHRTKOVÁ 1990), řádu Cucurbitales. Podle určitých morfologických znaků (např. úponků, pylových zrn a vajíček) lze odvodit zřetelné příbuzenské vztahy tohoto taxonu k řádu Passiflorales (NOVÁK 1961). Na základě nejnovějších poznatků cytologie, cytogenetiky, fytochemie a molekulární genetiky (PERL-TREVES et al. 1985; RAAMSDONK et al. 1989) bylo vytvořeno současné taxonomické členění čeledi tykvovitých (JEFFREY 1989). Čeleď je rozdělena do dvou podčeledí, přičemž podčeleď Zanonioideae zahrnuje druhy, které mají malý hospodářský význam. Všechny hospodářsky důležité druhy jsou součástí podčeledi Cucurbitoideae (tab. 1).

Z hlediska klimatických podmínek střední Evropy lze za nejvýznamnější tribus považovat Melothrieae, do něhož patří rod *Cucumis*. Podle současných taxonomických poznatků je rod *Cucumis* reprezentován 32 druhy (KIRKBRIDE 1993). Vedle okurky seté (*Cucumis sativus* L.) a melounu cukrového (*C. melo* L.) jsou v některých oblastech komerčně využívány také *C. anguria* ("West Indian gherkin") a *C. metuliferus* (African horned cucumber, kiwano). Ostatní planě druhy, které většinou pocházejí z aridních a semiaridních oblastí Afriky, jsou pěstovány jako okrasné rostliny (*C. dipsaceus* – "hedgehog gourd", *C. myriocarpus* – "gooseberry gourd") (RUBATZKY, YAMAGUCHI 1997).

Původ, genový pool a křižitelnost *Cucumis* spp.

Za primární genové centrum rodu *Cucumis* je považována Jižní Afrika. Indické genové centrum, zejména podhůří Himálaje, je pravděpodobným centrem vzniku *C. sativus*. Tento druh tvoří izolovanou a kompaktní skupinu a zároveň podrod *Cucumis*. V rámci druhého podrodu – *Melo* – zaujímá vyhraněné postavení *C. melo*, který tvoří samostatnou skupinu (Melo). Ostatní africké druhy tvoří skupinu Anguria (např. *C. anguria*, *C. africanus*, *C. dipsaceus*, *C. zeyheri*) a skupinu Metuliferus (např. *C. metuliferus*, *C. myriocarpus*, *C. sagittatus*) (JEFFREY 1989). Jednoznačný popis jednotlivých taxonů a studium křižitelnosti jednotlivých druhů (NIJS, CUSTERS 1989; RAAMSDONK et al. 1989) (obr. 1) přispívají k objasnění evolučních vztahů v rámci rodu a druhové determinaci položek genových zdrojů. Nejnovější taxonomické členění rodu podle KIRKBRIDE (1993) uvádí tab. 2.

Primární genový pool *C. sativus* je tvořen druhem *C. hardwickii*, který je někdy uváděn jako jeho varieta, sekundární genový pool zahrnuje *C. hystrix*. Genový pool druhu *C. melo* nebyl dosud přesně definován.

Genetická odlišnost obou podrodů je příčinou nekřižitelnosti *C. sativus* s ostatními druhy rodu *Cucumis* a ve svém důsledku omezuje pokrok ve šlechtění okurky seté. Úspěšná mezidruhová hybridizace je podmíněna rozvojem biotechnologických metod (LEBEDA et al. 1993), jako je například kultivace hybridních embryí *in vitro* (LEBEDA et al. 1999), fúze protoplastů (JARL et al. 1995; FELLNER, LEBEDA 1998) a somatická hybridizace (DABAUZA et al. 1998). Nové cenné vlastnosti genomu okurky a melounu mohou být získány cestou transformace (VALLÉS, LASA 1994; NISHIBAYASHI et al. 1996). Poznatky v oblasti šlechtění *C. sativus* zpracoval komplexně TATLIOGLU (1993).

Morfologický popis *Cucumis* spp.

Zástupci rodu *Cucumis* mají ve stoncích bikolaterální svazky cévní, v pletivech jsou časté cystolity (NOVÁK 1961). Specifický metabolismus terpenů vede k produkci cucurbitacinů, které mohou vyvolávat u lidí i zvířat zdravotní obtíže (FERGUSON et al. 1983).

Následující morfologický popis vychází z údajů CHRTKOVÉ (1990), KIRKBRIDE (1993) a autorů RUBATZKY a YAMAGUCHI (1997). Rostliny jsou jednoleté byliny, obvykle s poléhavou nebo popínavou lodyhou. Některé odrůdy okurek a melounů mohou mít v důsledku silně zkrácených internodií keřovitý habitus.

Kořenový systém je bohatý, avšak mělký. *C. trigomis* má kořeny zdřevnatělé, u některých druhů (*C. kalahariensis*) se vytvářejí kořenové hlízy. Stonky jsou pětihranné, rýhované, zřídka ostnité (*C. aculeatus, C. ficifolius*), různě pýřité, zřídka lysé, s chlupy lámavými nebo

nelámavými (*C. sacleuxii*). Větvení stonku je sympodiální. Nody jsou kolénkaté. Z každého nodu vyrůstá list a jednoduchý úponek (někdy spirálovitě zkroucený). *C. humifructus* má svazečky 5–8 úponků, u druhu *C. rigidus* úponky chybějí. Úponky druhu *C. insignis* jsou jak jednoduché, tak dichasiálně větvené (se dvěma rameny). Úponky jsou různě pýřité až ostnité, zřídka lysé.

Listy jsou jednoduché, řapíkaté. Řapíky jsou bez ostnů nebo zřídka ostnité, různě pýřité nebo zřídka lysé, s nelámavými nebo zřídka lámavými trichomy. Většina druhů má uniformní typ trichomů po celém řapíku. U *C. sagittatus* a *C. thulinianus* tvoří odění dva typy trichomů, které jsou rovnoměrně rozmístěné po celém řapíku. *C. myriocarpus* má tři typy trichomů umístěné na řapíku ve třech různých zónách: na bázi jsou nazpět směřující tvrdě štětinaté trichomy, ve středu měkce štětinaté trichomy a na vrcholu (tj. při bázi čepele) jsou

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