Description of morphological characters of lettuce (*Lactuca sativa* L.) genetic resources

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ABSTRACT: Lettuce (*Lactuca sativa*) is the most important crop in the group of leafy vegetables. It is characterized by considerable morphological and genetic variation. The crop comprises seven main groups of cultivars (including oilseed lettuce) differing phenotypically; they are usually described as morphotypes. Lettuce breeding is primarilly focused on various morphological features and resistance against diseases and pests. The accurate description of lettuce germplasm provides basic information useful for lettuce breeders. The construction of a lettuce descriptor list has been stimulated by the international genebank community. This list consists of 55 descriptors with 15 elucidated by figures. It provides a tool for detailed characterization of and discrimination within the intraspecific variation of *L. sativa*, verification of old varieties, and identification of putative duplicates and gaps in germplasm collections. These descriptors, along with descriptors of wild *Lactuca* species, provide an efficient analytical tool for studying the complex morphological variability of this genus and relationships among the species.

Keywords: biology; characterization; descriptors; gene bank collections; gene pool; germplasm conservation; morphotypes; origin; regeneration; resistance; taxonomy; variability

Lactuca sativa L. (Asteraceae) is considered as the most important vegetable in the group of leafy vegetables. It is almost exclusively used as a fresh vegetable in salads, but some forms are also cooked (Rubatzky, Yamaguchi 1997; Lebeda et al. 2007). Lettuce is produced commercially in many countries worldwide and is also widely grown as a vegetable in home gardens (Rubatzky, Yamaguchi 1997). It is especially important as a commercial crop in Asia, North and Central America, and Europe. China, U.S., Spain, Italy, India and Japan are among the world's largest producers (Lebeda et al. 2007; Mou 2008).

Diverse landraces and local varieties are cultivated in different regions, with a broad spectrum of landraces and old varieties held in the world's genebanks (Lebeda et al. 2007). Conventional and modern breeding methods are providing new cultivars well tailored for the specific needs of producers and consumers.

International cooperation among genebanks has been promoted by the International Plant Genetic Resources Institute (IPGRI), established in 1974. Since 1 December 2006, IPGRI and the International Network for the Improvement of Banana and Plantain (INIBAP) operate under the name *Bioversity International* (www.bioversityinternational.org). The need for broad international cooperation among European institutions holding collections of lettuce was expressed in the Eucarpia Conference on Leafy Vegetables Research and Breeding, held in 1999 in Olomouc, Czech Republic (Lebeda, Křístková 1999). In May 2000, in Vila Real, Portugal, the ECP/GR Vegetables Network Coordinating Group, acting with an IPGRI mandate, recommended to extend collaborative activities also to leafy vegetables (Lebeda, Boukema 2001). The *ad hoc* Group on Leafy Vegetables met for the first time during the ECP/GR Vegetables Network Meeting in Skierniewice, Poland, May 2003 (Lebeda, Boukema 2005). A proposal to establish a formal ECP/GR Working Group on Leafy Vegetables was prepared and endorsed by the ECP/GR Steering Committee in October 2003. The first meeting of the formal Working Group was

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held in Olomouc, Czech Republic, 13–14 October 2005 (Maggioni et al. 2008).

The International *Lactuca* Database (ILDB) was established in 2000 and is currently maintained at CGN, Wageningen, the Netherlands. The database concentrates primarily on passport data of all *Lactuca* species conserved in the world's genebanks (Stavělíková et al. 2002).

Descriptive data for each accession held by genebanks promote the efficient use of accessions in research and breeding. However, descriptor lists for lettuce accessions, as elaborated by each national genebank, are used only locally. The international project GENE-MINE, funded by the European Commission within the 5th Framework Programme, aimed at a broad study of wild *Lactuca* species, made considerable progress (Hodgkin 2004) and both Czech national and international descriptor lists for wild *Lactuca* species were developed (Doležalová et al. 2002a, 2003a; Křístková, Chytilová 2005).

A broad international descriptor list for cultivated lettuce, suitable and acceptable for the international genebank community has not yet been elaborated. A minimum set of the most important descriptors for *Lactuca sativa* genetic resources was composed in order to foster cooperation within the ECP/GR Working Group on Leafy Vegetable Genetic Resources (Lebeda, Boukema 2005). The next international project aimed at the group of leafy vegetables including cultivated lettuce, was adopted by the European Commission in 2006. In this paper, a draft descriptor list for accessions of cultivated lettuce is presented. After discussion within the genebank community, it can be used as a base for development of an international descriptor list. Together with descriptors for wild *Lactuca* species (Doležalová et al. 2002a, 2003a; Lebeda et al. 2004b), it will provide a tool to facilitate the characterization of lettuce genetic resources.

TAXONOMY, BOTANICAL CHARACTERIZATION, KARYOLOGICAL STATUS, BIOCHEMICAL AND MOLECULAR MARKERS OF *L. SATIVA*

Taxonomy of the genus *Lactuca*

The genus *Lactuca* L. belongs to the family Asteraceae (Compositae), the largest of the dicotyledonous families (Judd et al. 1999; Funk et al. 2005). The tribe Lactuceae of subfamily Cichorioideae, formerly known as the Cichorieae, is perhaps the best known and most easily recognized tribe of the family (Tomb 1977). In spite of that, precise delimitation of the genus *Lactuca* is problematic. Based on the available literature, the genus *Lactuca* comprises approximately 100 species; however the number of *Lactuca* taxa differs from author to author (Feráková 1977; Meusel, Jäger 1992; Bremer et al. 1994; Lebeda 1998; Lebeda, Astley 1999; Lebeda et al. 2004a, 2007).

Five major generic concepts of *Lactuca* were developed by Stebbins (1937), Tuisl (1968), Feráková (1977), Shih (1988), and Koopman et al. (1998). Stebbins (1937) defined the genus broadly (*sensu lato, s.l.*) and included the subgenera *Mulgedium* Cass., *Lactucopsis* Schultz-Bip. ex Vis. et Panč., *Phaenixopus* Cass., *Mycelis* Cass., and part of *Cicerbita* Wallr. (excluding *C. alpina*, with a coarse pappus and nearly columnar, slightly compressed achenes). Tuisl (1968) defined the genus in a narrow sense on the basis of morphological and anatomical studies of fruit, flower, involucre and pappus. He divided *Lactuca s.l.* into the following six genera: *Mulgedium* Cass., *Scariola* F.W. Schmidt (= *Phaenixopus* Cass.), *Cicerbita* Wallr., *Cephalorrhynchus* Boiss., *Steptorhamphus* Bunge and *Lactuca* L. The narrow generic concept of *Lactuca* has been supported among others, by Soják (1961, 1962), who accepted *Scariola* and treated *Lactuca* sect. *Mulgedium* (Cass.) C. B. Clarke on a generic level as *Lagedium* Soják (a genus of an intermediate position between *Lactuca* and *Mulgedium*), and also by Jeffrey (1975).

Feráková (1970, 1977), with regard to both above-mentioned classifications, created a new concept. The genera *Mulgedium*, *Lactucopsis* and *Phaenixopus* (*Scariola*) were re-classified into corresponding sections. She recognized four sections within the genus: *Mulgedium* (Cass.) C.B. Clarke, *Lactucopsis* (Schultz-Bip. ex Vis. et Panč.) Rouy, *Phaenixopus* (Cass.) Benth. and *Lactuca*, which was further divided into two subsections, *Lactuca* and *Cyanicae* DC, while *Mycelis* Cass., *Steptorhampus* Bunge and *Cephalorrhynchus* Boiss. were considered as separate genera.

A more recent revision of *Lactuca* is that of Shih (1988). He restricted the genus *Lactuca* to those species having 7–25 yellow ligular florets and 1–10 longitudinal ribs on each side of the achene, with an acute to filiform beak at its apex. Such a definition limits the genus to the *serriola*-like species from the sect. *Lactuca* subsect. *Lactuca* according to Feráková (1977), excepting *L. virosa* and *L. livida*, species with broadly elliptical, narrowly winged achenes.

A completely different concept of the lettuce gene pool was proposed by Koopman et al. (1998). Based on analysis of DNA ITS-1 sequences, supported with data from crossing experiments (Thompson et al. 1941; Chupeau et al. 1994; Maisonneuve et al. 1995; Mazier et al. 1999), he adjusted genus limitation to coincide with the lettuce gene pool. He stated that the species in subsection *Cyanicae* do not belong to the lettuce gene pool and therefore should be excluded from *Lactuca*. Section *Lactuca* subsection *Lactuca* would then comprise the primary and secondary gene pools, while the sections *Phaenixopus*, *Mulgedium* and *Lactucopsis* comprise the tertiary gene pool.

In the context of these past treatments, the taxonomy of *Lactuca* genetic resources, including seven sections (*Lactuca* [subsect. Lactuca and Cyanicae], *Phoenixopus, Mulgedium, Lactucopsis, Tuberosae, Micranthae and Sororiae*), and two geographical groups (the African and North American ones), has been elaborated by Lebeda and Astley (1999) and most recently been reviewed in detail by Lebeda et al. (2007).

Origins and genepools

Recent evidence indicates that the origin of cultivated lettuce is polyphyletic (DeVries 1997). It resulted from human selection within a large genepool of *L. serriola,* with simultaneous introgression of genes from other *Lactuca* species or, alternatively, as an independently selected species (Lindqvist 1960). The region of the Middle East (Egypt and Iran) is considered a centre of lettuce origin. Many wild *Lactuca* species occur between the Euphrates and Tigris Rivers (Zohary 1991).

The primary genepool of *L. sativa* is represented by its numerous cultivars, primitive landraces and by wild species with no crossing barriers – the cosmopolitan *L. serriola,* plus *L. aculeata, L. scarioloides, L. azerbaijanica, L. georgica, L. altaica* occurring in Asia and by *L. dregeana* from South Africa (Zohary 1991). *Lactuca saligna* belongs to the secondary gene pool. The tertiary gene pool includes *L. virosa* and some other wild species which can be crossed with *L. sativa* only with difficulty (DeVries 1990; van Soest, Boukema 1997; Lebeda et al. 2002, 2007).

Morphological description, karyological status, molecular and biochemical markers of *L. sativa*

Lactuca sativa is an annual glabrous herb with a thin tap root and an erect stem 30–100 cm tall, branched in the upper part. Leaves are spirally arranged, forming a dense rosette or a head before bolting. Their shape is oblong to transverse elliptic, orbicular to triangular, undivided to pinnatisect. The leaf margin is entire to setose dentate, often curly. Stem leaves are oblong elliptic, with a cordate base. The inflorescence (capitulum, head) is composed of 7–15 (35) yellow ligules (florets). The heads form a corymbose, densely bracted panicle. Anthocyanin can be distributed on the cotyledons and true leaves, stems and ligules. The involucre is 10–15 mm long, cylindrical; involucral bracts are broadly to narrow lanceolate, light green, with white margins, erect at the stage of fruit maturity. The fruit (achene) has 5 to 7 setose ribs on each side, a beak and a white pappus. Its length (including beak) is 6–8 mm, and its colour is white, cream, gray, brown or black. It is a diploid with a basic chromosome number of $n = 9$ (Dostál 1989; Rubatzky, Yamaguchi 1997; Doležalová et al. 2002b; Grulich 2004).

Electrophoretic detection of polymorphic proteins has been applied to the study of genetic variation among *L. sativa* cultivars and a wild *Lactuca* species (DeVries 1996; Lebeda et al. 1999; Doležalová et al. 2003b; Mizutani, Tanaka 2003). The application of molecular genotyping methods: RFLP (Restriction Fragment Length Polymorphism) (Kesseli et al. 1991), RAPD (Random Amplified Polymorphic DNA) (Yamamoto et al. 1994), AFLP (Amplified Fragment Length Polymorphism) (Hill et al. 1996; Johnson et al. 2000; Jeuken et al. 2001; Jeuken, Lindhout 2004; Kitner et al. 2008; Rajicic, Dehmer 2008), TRAP (Target Region Amplification Polymorphism) (Hu et al. 2005), minisatellites and microsatellite fingerprinting or SSR (Simple Sequence Repeat) (Witsenboer et al. 1997; Sicard et al. 1999; Van de Wiel et al. 1999) has contributed to the elucidation of various aspects of the taxonomy, variability and biodiversity of the genus. SSRs and AFLPs have also been used to characterize the entire lettuce collection of the Centre for Genetic Resources (CGN, Wageningen) (van Hintum et al. 2003; Jansen et al. 2006; Jansen, van Hintum 2007). An overview of these methods as applied to *L. sativa* germplasm screening and identification has been presented by Dziechciarková et al. (2004). The mapping of the *L. sativa* genome (Landry et al. 1987) and the study of biochemical and molecular markers provide tools for the determination of putative duplicates within collections of genetic resources, for the discrimination of differences among accessions (van Hintum 1999; Waycott et al. 1999; Van de Wiel et al. 1999; Sretenović-Rajičić et al. 2008), and for the identification of suitable markers linked to resistance to biotic and abiotic factors (Kesseli et al. 1994; Maňez et al. 1994; Toyomasu et al. 1995; Montesclaros et al. 1997).

Classification and morphological types of *L. sativa*

The species *L. sativa* is characterized by a high genetic diversity resulting from its polyphyletic origin and a complex domestication process (Kesseli et al. 1991). A survey of lettuce cultivars and classification of types was provided by Rodenburg (1960). The most recent comprehensive overviews of taxonomic and phenotypic analyses of lettuce cultivars were presented by DeVries and van Raamsdonk (1994), DeVries (1997) and Mou (2008). The crop comprises seven main groups of cultivars (including oilseed lettuce) differing phenotypically; they are usually described as morphotypes. The following treatment of *L. sativa* morphotypes is taken from Lebeda et al. (2007).

(1) **Butterhead lettuce** (var. *capitata* L. *nidus tenerrima* Helm) (Kopfsalat, Laitue pommé)
A heading type with soft and tender leaves, eaten raw. It is most popular in England, France, the Netherlands and other western and central European countries (Ryder 1986). In recent decades many cultivars have been bred and grown in the USA (Ryder 1999b; Mikel 2007).

(2) **Crisphead lettuce** (var. *capitata* L. *nidus jäggeri* Helm) (Iceberg type, Eissalat, Batavia)
A heading type with thick crisp leaves and flabellate leaf venation, eaten raw. It is mainly cultivated in the USA (Ryder 1999b; Mikel 2007). However, it is also grown now in western and central European countries, including the Netherlands, the United Kingdom, France, Spain, Belgium, Germany, Poland and the Czech Republic, as well as in Japan, China, and Australia (Lebeda et al. 2007).

(3) **Cos lettuce** (var. *longifolia* Lam., var. *romana* Hort. in Bailey) (Römischer Salat, Laitue romaine)
Plants with tall loose heads, which are sometimes tied up; oblong rigid leaves with a prominent midrib running almost to the apex, are eaten raw or cooked. The name of the morphotype is taken from the Greek island Cos (Kos), where the type has long been cultivated. Cos lettuce is most common in the Mediterranean countries of Europe, Western Asia and North Africa (Ryder 1986). According to Boukema et al. (1990), many landraces of this type maintained at the CGN genebank collection originated mainly from Egypt, Iran, Turkey and Syria.

(4) **Cutting lettuce** (var. *acephala* Alef., syn. var. *secalina* Alef., syn. var. *crispa* L.) (Gathering lettuce, Loose-leaf, Picking lettuce, Schnittsalat, Laitue à couper)
Non-heading type harvested as whole, open rosettes, occasionally as separate leaves, eaten raw. Cutting lettuces have been very popular in the U.S., Italy, France, the Czech Republic and Slovak Republic (DeVries 1997). This morphotype is extremely heterogeneous. Cultivars may have entire, curled or fringed leaves, from non-lobed to deeply incised margins. The leaves are elongated or broad, having various shades of green, and various patterns and intensities of anthocyanin pigmentation. The Greeks and Romans cultivated cutting lettuces. Boukema et al. (1990) stated that CGN genebank landraces of this type came from Turkey and Greece.

(5) **Stalk (Asparagus) lettuce** (var. *angustana* Irish ex Bremer, syn. var. *asparagina* Bailey, syn. *L. angustana* Hort. in Vilm.) (Stem lettuce, Stengelsalat, Laitue-tige)
Plants with swollen stalks, which are eaten raw or cooked like asparagus. Leaves can be eaten raw in a very young stage or cooked like spinach (Lebeda, Křístková 1995).
According to Lindqvist (1960) there are two types recognized within this group. The Chinese cultivars have light grey leaves resembling cos lettuce leaves; the second type has long lanceolate leaves with pointed apices. According to Helm (1954), stalk lettuce originated in Tibet, which would account for its extensive cultivation in China, in the Pamirs and India (Rodenburg 1960; DeVries 1997). However, the lettuce illustrated in Egyptian tombs is also stalk lettuce and dates back to about 2500 B.C. If lettuce originated in Mesopotamia, it is even older in the Middle East. Both asparagus types and cos-like types are found in Egypt. We think it is more likely that the original types migrated to the Far East overland, showing up there up to 1,500–2,000 years later. It is possible that Helm (1954) was referring to *L. indica*, which is common in the Far East and grown in China, Japan, and some Southeast Asian countries (Rubatzky, Yamaguchi 1997). Stalk lettuce material collected in Afghanistan appeared to be an intermediate between cos and stalk lettuces and is sometimes used as a food for livestock (Boukema et al. 1990).

(6) **Latin lettuce** (without scientific name)
Plants have loose heads with thick leathery leaves, dark green color and are eaten raw. It is mainly cultivated in the Mediterranean countries, including North Africa, and in South America (Rodenburg 1960).

(7) **Oilseed lettuce**
Because of the bitter taste of its leaves, this type is not eaten as a vegetable. Oilseed lettuce is characterized by a high percentage (35%) of oil in the seeds, which is used for cooking. The oil contains Vitamin E, an essential nutrient (Boukema et al. 1990). In Egypt, cultivation of oil-producing forms has continued to the present time (Ryder 1986). Boukema et al. (1990) mentioned that some of its forms may be either *L. serriola* or *L. sativa* or intermediate types between these two species.

Following the concept of DeVries and van Raamsdonk (1994), based on a detailed comparison from multivariate analysis of the vegetative characters of lettuce cultivars, two supergroups can be defined, one that includes the Butterhead group, the Crisphead (Iceberg or Cabbage) group, and Latin group; and the other comprising the Cos group, the Cutting group, and the Stalk (Asparagus) group.

Survey of *L. sativa* genetic resources maintained in gene bank collections

Considerable information is available about lettuce germplasm collections (Boukema et al. 1990; McGuire et al. 1993; Cross 1998; Lebeda 1998; van Hintum, Boukema 1999; Lebeda, Astley 1999; Ryder 1999a,b; Lebeda, Boukema 2001, 2005; Thomas et al. 2005; Lebeda et al. 2007; Mou 2008). These sources provide general information about the holdings, maintenance conditions, availability, evaluation, and documentation of the most important of the world's collections, emphasizing national genebanks and working collections. In addition, information about the holdings of the world's largest collections of leafy vegetable germplasm was summarized as part of the Food and Agriculture Organization's effort to present The State of the World's Plant Genetic Resources for Food and Agriculture (FAO 1998).

In the U.S., germplasm research regarding conservation, evaluation and utilization of lettuce resources is overseen by Leafy Vegetable Crop Germplasm Committees (CGC) under auspices of the US Department of Agriculture – Agricultural Research Service's National Plant Germplasm System.

STANDARDS FOR REGENERATION AND EVALUATION OF GENETIC RESOURCES ACCESSIONS

Regeneration of *L. sativa* accessions

Standards for regeneration of cultivated lettuce, used in gene banks of eleven European countries, were summarized within the framework of the ECP/GR Working Group on Leafy Vegetables (IPGRI) by Lebeda and Boukema (2005). In the Czech Republic, standards for regeneration for *L. sativa* accessions were adopted by the Council for Plant Genetic Resources of the Czech Republic (Chytilová et al. 2004).

The inflorescence of lettuce (capitulum), contains approximately 24 florets. They are highly developed for self-pollination and the crop is therefore largely self-fertilizing. However, some cross-pollination, up to 5%, can be observed between lettuce cultivars (George 1999). For commercial purposes, most authorities regard it as a self-pollinating crop and only require a physical barrier (e.g. adjacent sections of greenhouse) or a minimum of 2 m between different species for production of seed (George 1999). The regeneration of accessions kept by genebanks in insect-proof isolation cages is highly recommended to prevent potential cross-pollination and infection of LMV.

Under climatic conditions of the Czech Republic, accessions are regenerated in greenhouse isolation cages covered by glass or plastic net. Seeds are sown in the last third of March in Perlite; seedlings with well developed cotyledons are transplanted to beds in garden soil. By the end of April, plantlets with 10–12 well developed leaves are transplanted to soil under isolation cages. Each accession is represented by 15–20 plants spaced 50 × 50 cm.

Heading types and especially cultivars bred for cultivation in summer, are treated with aqueous solution of gibberellic acid (20–500 ppm GA_3) at least three times at 7–10 day intervals before heart formation. This treatment stimulates bolting and prevents the plants from rotting (George 1999).

Mature seeds are harvested periodically, by cutting the dry seed heads. Harvested seeds are dried at room temperature, cleaned, and further dried to 5–8% moisture content, placed in hermetically closed jars and stored at a temperature of about –5°C (George 1999). A new method of "ultra-dry seed" storage was successfully adopted for *L. sativa*. Seeds dried to 3% moisture content and stored in airtight jars at 20°C (Gómez-Campo 2006) kept good germination parameters equal to storage at –20°C (Astley 1985).

A SET OF DESCRIPTORS FOR ACCESSIONS OF *L. SATIVA*

Morphological and biological descriptors

A set of descriptors for cultivated lettuce has been developed for the characterization and evaluation genetic resources (Table 1, Figs.). In the Czech Republic, a set of minimum descriptors has been adopted by the Council for Plant Genetic Resources of the Czech Republic (Chytilová et al. 2004). An extensive list of descriptors also provides tools for determining interspecific hybrids of *L. sativa* with wild *Lactuca* species, and for the characterization of *L. sativa* intraspecific variability. This set was created from a broad study of the Czech collection of genetic resources (Superatová 2005), traditional and recent cultivars of lettuce (Křístková, Lebeda 1999), descriptions of *L. sativa* in Czechoslovak monographs (Feráková 1977), the Czech flora (Grulich 2004) and a broad description of important traditional cultivars (Rodenburg 1960).

"Codes for *Lactuca* evaluation descriptors" from the Centre for Genetic Resources (CGN), Wageningen, the Netherlands (Anonymous b) and the Western Regional Plant Introduction Station, Pullman, Washington, USA (Anonymous a), and "Guidelines for the conduct of tests for distinctness, homogeneity and stability, Lettuce (*Lactuca sativa* L.)" (UPOV 1981) were used as primary sources for the development of recent Czech descriptors. During the construction of this descriptor list, the authors also participated in the development of minimal descriptor lists for leafy vegetables, including *L. sativa*, within the framework of the ECP/GR Working Group on Leafy Vegetables (IPGRI) (Lebeda, Boukema 2005).

The descriptor list includes 55 characterization and evaluation descriptors, with 15 elucidated by figures in the Annex. Items comprising a minimal set of highly discriminating descriptors are marked with an asterisk (*).

Resistance to biotic and abiotic factors

Resistance to biotic and abiotic factors must be evaluated in separate trials by using precise, standardized methods (Lebeda 1986; Miranda, Lebeda 2008), such as pathogen tests in growth chambers after artificial inoculation.

The most important lettuce diseases include *Lettuce mosaic virus* (LMV), lettuce downy mildew (*Bremia lactucae*), *Sclerotinia* spp., *Microdochium panattonianum*, *Rhizoctonia solani*, *Pythium* spp., *Botrytis cinerea*, lettuce powdery mildew (*Golovinomyces cichoracearum*) and *Septoria* spp. (George 1999). The most important lettuce pests include the aphids, *Myzus persicae, Nasonovia ribisnigri* and *Pemphigus bursarius* (Reinink 1999; Lebeda et al. 2007).

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Table 1. Morphological descriptors for *Lactuca sativa* L.

No.	Descriptor name	Descriptor state	Explanation/ Figure in Annex	Note
1. Morphological descriptors				
1.1. Seedling				
1.1.1.	Cotyledons – colour	3 light green 5 green 7 dark green 99 other		at a stage of fully developed seedling
1.1.2.*	Cotyledons – anthocyanin presence	0 absent 1 on hypocotyl 2 on cotyledons 3 on hypocotyl and cotyledons		at a stage of fully developed seedling
1.1.3.	Cotyledons – shape	1 elliptic 2 ovate 3 obovate 4 orbicular 5 spatulate 99 other	Fig. 1.1.3.	at a stage of fully developed seedling

No.	Descriptor name	Descriptor state	Explanation/ Figure in Annex	Note
1.1.4.	Cotyledons – trichomes	0 absent 1 present		at a stage of fully developed seedling
1.2. Young leaf				
1.2.1.*	Young leaf – position	 1 prostrate 5 semi-erect 9 erect	angle of 5^{th}–6^{th} true leaf with horizontal platform 1°–10° 41°–50° 81°–90°	at a stage of 10–12 true leaves
1.2.2. *	Young leaf – colour	1 yellow green 2 light green 3 green 4 dark green 5 gray green 6 blue green 99 other		at a stage of 10–12 fully developed true leaves
1.2.3.1.*	Young leaf – anthocyanin – distribution	0 absent 1 on the veins 2 on the blade margin 3 diffused on the entire lamina 4 in spots on the entire lamina 99 other		at a stage of 10–12 fully developed true leaves
1.2.3.2.	Young leaf – anthocyanin – intensity of coloration	3 slight 5 moderate 7 intense		at a stage of 10–12 fully developed true leaves
1.2.4.1.	Young leaf – blade	1 entire 2 divided		at a stage of 10–12 fully developed true leaves
1.2.4.2.*	Young leaf – blade – shape in outline	1 oblong elliptic 2 elliptic 3 broad elliptic 4 orbicular 5 transverse elliptic 6 transverse broad elliptic 7 obovate 8 spathulate 9 triangular 99 other	Fig. 1.2.4.2.	at a stage of 10–12 fully developed true leaves
1.2.4.3.*	Young leaf – blade – shape of apex	1 truncate 2 rounded 3 obtuse 4 subacute 5 mucronate	Fig. 1.2.4.3.	at a stage of 10–12 fully developed true leaves
1.2.4.4.	Young leaf – blade – shape of base	1 short attenuate 2 medium attenuate 3 long attenuate	Fig. 1.2.4.4.	at a stage of 10–12 fully developed true leaves

No.	Descriptor name	Descriptor state	Explanation/ Figure in Annex	Note
1.2.4.5.*	Young leaf – blade – margin	1 entire 2 crenate 3 dentate 4 double dentate 5 setose dentate 6 serrate 7 double serrate 8 irregularly dentate 9 nibbled 99 other	Fig. 1.2.4.5.	at a stage of 10–12 fully developed true leaves
1.2.4.6.	Young leaf – blade – vertical margin undulation	0 none 3 slight 5 moderate 7 intense		at a stage of 10–12 fully developed true leaves
1.2.5.	Young leaf – trichomes	0 absent 1 present		at a stage of 10–12 fully developed true leaves
1.2.6.*	Young leaf – venation	1 pinnate 2 flabellate	Fig. 1.2.6.	at a stage of 10–12 fully developed true leaves
1.3. Adult outer leaf (and leaf of non-heading types of lettuce)				
1.3.1.*	Outer adult leaf – colour	1 yellow green 2 green 3 gray green 4 blue green 5 red and green 99 other		at a harvest maturity
1.3.2.	Outer adult leaf – intensity of colour	3 slight 5 moderate 7 intense		at a harvest maturity
1.3.3.1.*	Outer adult leaf – anthocyanin – distribution	0 absent 1 on the veins 2 on the blade margin 3 diffused on the entire lamina 4 in spots on the entire lamina 99 other		at a harvest maturity
1.3.3.2.	Outer adult leaf – anthocyanin – intensity of coloration	0 none 3 slight 5 moderate 7 intense		at a harvest maturity
1.3.4.*	Outer adult leaf – glossiness on the upper side	0 none 3 slight 5 moderate 7 intense		at a harvest maturity
1.3.5.	Outer adult leaf – surface profile	1 concave 2 flat 3 convex	Fig. 1.3.5.	at a harvest maturity
1.3.6.*	Outer adult leaf – blade	1 entire 2 divided		at a harvest maturity

No.	Descriptor name	Descriptor state	Explanation/ Figure in Annex	Note
1.3.7.*	Outer adult leaf – entire – shape of blade in outline	1 oblong elliptic	Fig. 1.3.7.1	at a harvest maturity
		2 elliptic		
		3 broad elliptic		
		4 orbicular		
		5 transverse elliptic		
		6 transverse broad elliptic		
		7 obovate		
		8 spathulate		
		9 triangular		
		99 other		
1.3.7.2.*	Outer adult leaf – entire – margin of blade	1 entire	Fig. 1.3.7.2.	at a harvest maturity
		2 crenate		
		3 dentate		
		4 double dentate		
		5 setose dentate		
		6 serrate		
		7 double serrate		
		8 irregularly dentate		
		9 nibbled		
1.3.8.*	Outer adult leaf – divided – depth of incisions		Fig. 1.3.8. depth of incisions from blade margin to the main vein	at a harvest maturity
		3 pinnatilobed	up to 1/3	
		5 pinnatifid	up to 1/2	
		7 pinnatipart	up to 2/3	
		9 pinnatisect	more than 2/3	
1.3.9.*	Outer adult leaf – shape of apex	1 truncate	Fig. 1.3.9.	at a harvest maturity
		2 rounded		
		3 obtuse		
		4 subacute		
		5 mucronate		
		99 other		
1.3.10.	Outer adult leaf – shape of blade base	1 short attenuate	Fig. 1.3.10.	at a harvest maturity
		2 medium attenuate		
		3 long attenuate		
1.3.11.*	Outer adult leaf – blistering	0 none		at a harvest maturity
		3 slight		
		5 moderate		
		7 intense		
1.4. Head, leaf rosette				
1.4.1.*	Head – formation	0 absent		at a harvest maturity
		1 present		
1.4.2.	Harvested part – size of head and/or a rosette		horizontal diameter	at a harvest maturity
		3 small	< 25 (cm)	
		5 medium	25–40 (cm)	
		7 large	> 40 (cm)	

No.	Descriptor name	Descriptor state	Explanation/ Figure in Annex	Note
1.4.4.1.*	Head – shape in vertical section	1 oblong elliptic 2 elliptic 3 broad elliptic 4 orbicular 5 transverse elliptic 99 other	Fig. 1.4.4.1.	at a harvest maturity
1.4.4.2.	Head – overlapping of leaves	0 none 3 partly 5 half 7 complete	Fig. 1.4.4.2.	at a harvest maturity
1.4.4.3.	Head – firmness	3 low 5 medium 7 high	established by palpation	at a harvest maturity
1.4.4.4.	Head – weight	3 low 5 medium 7 high	< 300 (G) 300–600 (G) > 600 (G)	at a harvest maturity
1.4.5.	Leaf rosettte – position of leaves	 1 very upright 3 upright 5 medium 7 flat 9 very flat	angle of leaves from middle part of rosette with horizontal platform 61°–90° 46°–60° 31°–45° 16°–30° 0°–15°	for non-heading types at a market maturity
Note: For description of leaves of non-heading types use descriptors for adult outer leaf (part 1.3.)				
1.5. Stem				
1.5.1.	Stem – length	 3 short 5 medium 7 high	length including inflorescence < 50 (cm) 50–80 (cm) > 80 (cm)	at a stage of a full flowering
1.5.2.	Stem – fasciations	0 absent 1 present		at a stage of a full flowering
1.5.3.*	Stem – anthocyanin	0 absent 1 present		at a stage of a full flowering
1.6. Flower, Inflorescence resp. (Fig. 1.6.)				
1.6.1.	Flower – colour of ligules	3 pale yellow 5 yellow 7 dark yellow 99 other		
1.6.2.1.	Flower – anthocyanin – distribution pattern on lower part of ligules	0 absent 1 in spots 2 on margin 3 diffused on surface 99 other		
1.6.2.2.	Flower – anthocyanin – intensity of coloration	3 slight 5 moderate 7 intense		

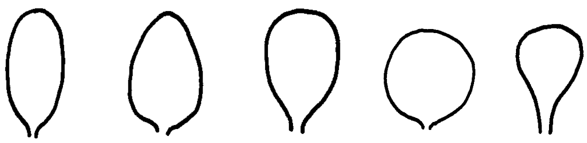
No.	Descriptor name	Descriptor state	Explanation/ Figure in Annex	Note
1.6.3.	Flower – margin of ligules		division of upper part of ligule	
		3 shallow	< 1 (mm)	
		5 medium	1–2 (mm)	
		7 deep	> 2 (mm)	
1.6.4.	Flower – anthocyanin in anther tube	1 absent		
		2 present		
1.6.5.	Flower – number of ligules in head	3 low	< 12	
		5 medium	12–20	
		7 high	> 20	
1.6.6.	Head – bracts – anthocyanin distribution pattern	0 absent		at a stage of a full flowering
		1 in spots		
		2 on margin		
		3 diffused on surface		
		99 other		
1.6.7.	Head – involucrum –trichomes	0 absent		
		1 present		
1.6.8.	Head – position of involucrum bracts	1 erect		at a stage of seed maturity
		2 reflected		
		99 other		
1.6.9.	Inflorescence – intensity of axillary sprouting (number of branches)	3 low	< 12	at a stage of a full flowering
		5 medium	12–20	
		7 high	> 20	
1.7. Fruit				
1.7.1.*	Achene – colour	1 white		after drying to a 15% R.H.
		2 grey white		
		3 cream		
		4 maroon		
		5 brown		
		6 grey		
		7 black		
		99 other		
1.7.2.	Achene – shape in outline	1 ovate		
		2 obovate		
		3 elliptic		
		99 other		
1.7.3.*	Fruit – "thousand seeds weight"	3 low	< 0.9 (G)	after drying to a 15% R.H.
		5 moderate	0.9–1.2 (G)	
		7 high	> 1.2 (G)	
2. Biological features				
2.1. Developmental stages				
2.1.1.*	Bolting	3 early	< 50	number of days after sowing to the visual symptoms of bolting in the field under a long day, without chemical treatment
		5 medium	50–70	
		7 late	> 70	
2.1.2.*	Flowering	3 early	< 60	number of days after sowing to the first fully developed flower in the field under a long day, without chemical treatment
		5 medium	60–80	
		7 late	> 80	

No.	Descriptor name	Descriptor state	Explanation/ Figure in Annex	Note
2.2. Resistance to biotic and abiotic factors				
	Factor	0 nonhost		
		1 very high		
		3 medium		
		5 low		
		7 very low		
		9 none		
2.2.1.	Reaction race specific	list of resistance factors		

An additional descriptor state = 99 is added to qualitative characters and should be used for accessions represented by heterogeneous populations (mixtures of individuals with different expression of characters). Its specification should list all states observed

* Highly discriminating descriptors

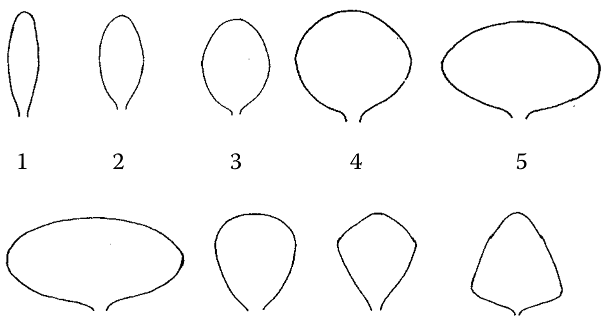
Annex: Figures to descriptors



1 2 3 4 5

Fig. 1.1.3. Cotyledons – shape

1 elliptic; 2 ovate; 3 obovate; 4 orbicular; 5 spatulate



1 2 3 4 5

6 7 8 9

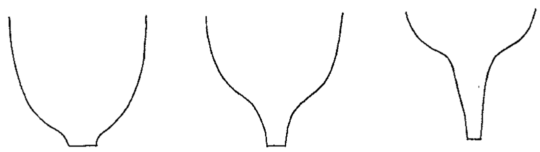
Fig. 1.2.4.2. Young leaf – blade – shape in outline and
Fig. 1.3.7.1. Outer adult leaf – entire – shape of blade in outline

1 oblong elliptic; 2 elliptic; 3 broad elliptic; 4 orbicular; 5 transverse elliptic; 6 transverse broad elliptic; 7 obovate; 8 spathulate; 9 triangular

1 2 3 4 5

Fig. 1.2.4.3. Young leaf – blade – shape of apex, and
Fig. 1.3.9. Outer adult leaf – shape of apex

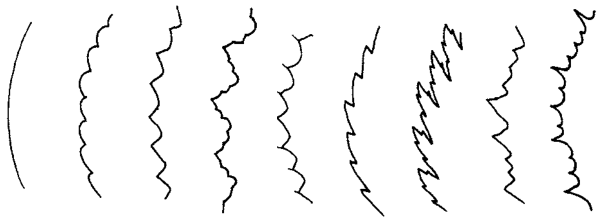
1 truncate; 2 rounded; 3 obtuse; 4 subacute; 5 mucronate



1 2 3

Fig. 1.2.4.4. Young leaf – blade – shape of base and
Fig. 1.3.10. Outer adult leaf – shape of blade base

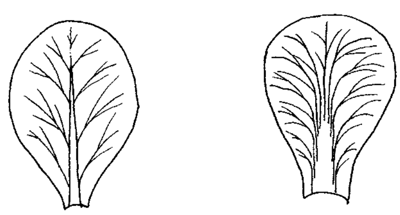
1 short attenuate; 2 medium attenuate; 3 long attenuate



1 2 3 4 5 6 7 8 9

Fig. 1.2.4.5. Young leaf – blade – margin and
Fig. 1.3.7.2. Outer adult leaf – entire – margin of blade

1 entire; 2 crenate; 3 dentate; 4 double dentate; 5 setose dentate; 6 serrate; 7 double serrate; 8 irregularly dentate; 9 nibbled



1 2

Fig. 1.2.6. Young leaf – venation

1 pinnate; 2 flabellate

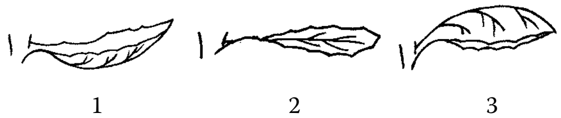


Fig. 1.3.5. Outer adult leaf – surface profile
1 concave; 2 flat; 3 convex

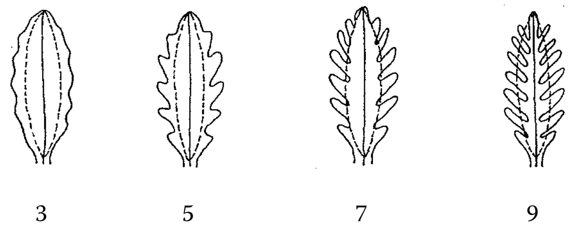


Fig. 1.3.8. Outer adult leaf – divided – depth of incisions
3 pinnatilobed; 5 pinnatifid; 7 pinnatipart; 9 pinnatisect

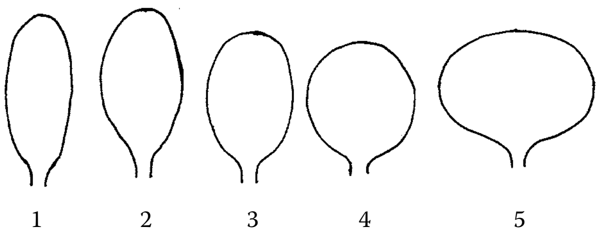


Fig. 1.4.4.1. Head – shape in vertical section
1 oblong elliptic; 2 elliptic; 3 broad elliptic; 4 orbicular; 5 transverse elliptic

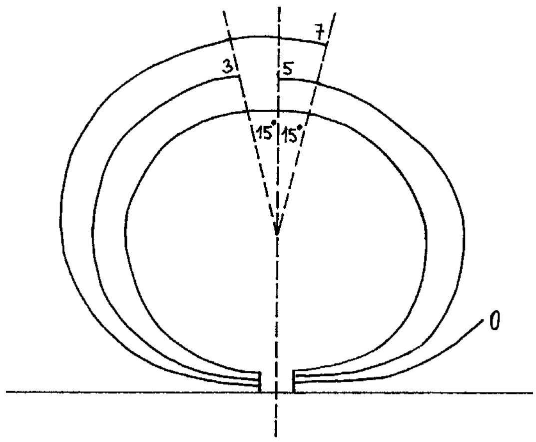


Fig. 1.4.4.2. Head – overlapping of leaves
0 none; 3 partly; 5 half; 7 complete

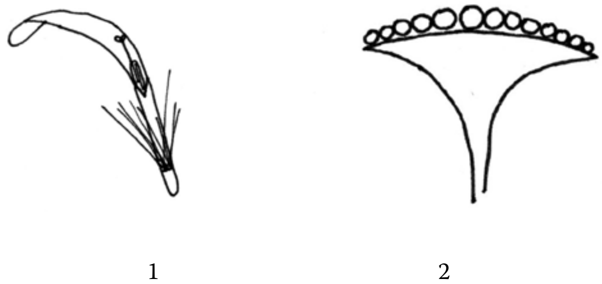


Fig. 1.6. Flower and Inflorescence
1 Flower (individual flower with ligule, anther tube, stigma, style and ovary with immature achene on the base), 2 Inflorescence = head

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Popis morfologických znaků genových zdrojů salátu (*Lactuca sativa* L.)

ABSTRAKT: Salát (locika setá, *Lactuca sativa*) je nejvýznamnější plodinou ze skupiny listových zelenin. Je charakteristický rozsáhlou morfologickou a genetickou variabilitou. Celkem zahrnuje sedm hlavních fenotypicky odlišných skupin odrůd (včetně salátu olejného), které jsou obvykle popisovány jako morfotypy. Šlechtění salátu je primárně zaměřeno na morfologické znaky, dále pak na odolnost proti chorobám a škůdcům. Přesný popis genových zdrojů salátu poskytuje základní informaci užitečnou pro šlechtitele. Vypracování souboru popisných znaků salátu bylo iniciováno a podporováno mezinárodním společenstvím genových bank. Předložený soubor sestává z 55 popisných znaků, přičemž 15 z nich je provázeno obrázky. Tento soubor znaků je důležitým nástrojem nejen pro detailní charakterizaci a určení vnitrodruhové variability *L. sativa*, ale i verifikaci pravosti starých odrůd, identifikaci možných duplicit a chybějících položek v kolekcích genových zdrojů. Tyto deskriptory, společně s deskriptory pro plané druhy rodu *Lactuca*, představují efektivní analytický nástroj pro komplexní studium morfologické variability tohoto rodu, ale i vztahů mezi jednotlivými druhy.

Klíčová slova: biologie; charakterizace; deskriptory; genofondové kolekce; genový pool; uchovávání genových zdrojů; morfotypy; původ; regenerace; odolnost; taxonomie; variabilita

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