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The weedy representatives of Proso Millet (*Panicum miliaceum, Poacaeae*) in Central Europe

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ABSTRACT: The Proso Millet (*Panicum miliaceum* L.) is divided in three subspecies:
1) susbsp. *ruderale*, in some literature mentioned as a progenitor of subsp. *miliaceum*, a subspecies widely distributed all over the world as a weed today and growing in Central Europe as well.
2) subsp. *agricolum*, subsp. nov., a weedy member of the (proso) millet with persistent glumes in fruits that easy fall off, and somewhat diffuse and nodding panicle, which is known in Central Europe from Alsace, Austria, Bavaria, Czechoslovakia, Hungary, NE Italy and Slovenia. This subspecies spreads quickly in maize fields treated with special herbicides. It has probably evolved from cultivated (proso) millet by a mutation process.
3) subsp. *miliaceum* which includes all cultivated forms and noncultivated ones with grains falling off hard but having weedy ecology.

Both weedy (and ruderal) subspecies have grey-olive to blackish grains, and subsp. *agricolum* is somewhat intermediate in grain characteristics between subsp. *ruderale* and subsp. *miliaceum*.

KEYWORDS: Weedy Proso Millet, *Panicum miliaceum*, Central Europe.

1. *Panicum miliaceum* subsp. *ruderale*

The Wild (Proso) Millet or Weed-Broomcorn Millet, *Panicum miliaceum* L. subsp. *ruderale* (Kitag.) Tzvelev (*P. miliaceum* L. var.

ruderale Kitag., described from China, Manshuria, in 1937, syn. *P. spontaneum* Lyssov ex Zhuk., nom. illegit.) is a generally accepted well defined but complicated weed-grass taxon. It can be characterized by the structures for effective natural seed dispersal at maturity, the brittle spikelets (for details cf. SCHOLZ 1983), in contrast to the grains not readily falling off, the typical trait of all the crops of *P. miliaceum* subsp. *miliaceum* (cf. LYSSOV 1975) and some weedy biotypes resembling the crop types (cf. BOUGH et al. 1986). Therefore, and because of absence of any true "wilds" in undisturbed primary habitats, it may have directly, probably even repeatedly and saltatorily, arisen from the ancestral crops. The rapid expansion over the globe in large cultivation areas of Corn (*Zea mays* L.) began only two decades ago (in 1970's), after the introduction of new control methods, and agree with the idea of recent origin of this type of millet. These facts stimulated further interests, mainly in the USA and Canada, which again resulted in profound comparative researches on both the weedy "black-seeded biotypes" (*P. miliaceum* subsp. *ruderale*) and the crops or crop-like weeds of this species (CARPENTER et HOPEN 1985, CAVERS et BOUGH 1985, MOORE et CAVERS 1985, BOUGH et al. 1986, COLOSI et al. 1988, cf. also other references). Electrophoretic isozyme studies conducted on seedlings grown from world-wide seed accessions of various *P. miliaceum* forms confirm, or at least are not in contrary to, the suggested recent origin of this weedy taxon (WARWICK 1987). Outside the New World and the Asiatic countries (cf. TZVELEV 1976), weedy populations of *P. miliaceum* subsp. *ruderale* have been observed in Austria (MELZER 1982, 1983, 1984, 1987, 1988, 1989, SCHOLZ 1983), Bavaria (LIPPERT 1984) and probably occur in Romania (cf. SAKOMOTO et KOBAYASHI 1982a, 1982b), Hungary (TERPÓ-POMOGYI 1976, without detailed description) and Ukraine (MOSYAKIN 1991), too. The earliest record from Europe dates back to 1888 (Italy, S. Tyrol, LIPPERT 1984).

It was also collected in the Eastern Slovakia (Humenné, railway station, 28.9.1990, V. Mikoláš [KO]), in southern Moravia (Modřice, near Brno, along railway, ca. 20 individuals, 20.10.1983, F.Kühn [BRNU], originaly determined as a false wild millet, rev. by V. Mikoláš as *P. miliaceum* subsp. *ruderale* and conf. by F. Kühn in the letter, 18.2.1991) and southwestern Slovakia (Imeľ, field of tobacco, X/1988, Z. Svobodová [KO, duplicate]). *Panicum miliaceum* subsp. *ruderale* is reported by SVOBODOVÁ from southwestern Slovakia without detailed localities (observed in 1988, 1989, 1990, SVOBODOVÁ 1991). In the newly proposed list of quarantine weeds of Czechoslovakia (JEHLÍK 1986) *P.*

miliaceum subsp. *ruderale* is included to the group of species with inner quarantine. JEHLÍK and SVOBODOVÁ prepare a detailed list of all known localities of weedy proso millet in Czechoslovakia (for the 2nd edition of Quarantine weeds of Czechoslovakia). It is not known which "wild" proso millet is distributed in Poland (cf. e. g. FREY et al. 1981, segetal occurrence in southern Poland), Latvia (cf. TABAKA et al. 1988, segetal and ruderal occurrence) and Lithuania (GUDZHINSKAS in the letter from 2.12.1990, and in preparation, too). Analysed samples (by L. Mihoková) from Imeľ and Humenné have 2n = 36, and 2n = ca. 36, respectively.

2. *Panicum miliaceum* subsp. *agricolum*

Some records of weedy *Panicum miliaceum* from ČSFR (Moravia and Slovakia) published under the name "v. *ruderale*" (KÜHN 1986, 1987, 1988), refer to another weedy taxon, which was first mentioned for Austria as "Unechte Unkraut-Hirse" (SCHOLZ 1983, MELZER 1984, 1987) and is also known from NE. Italy (Friaul) and N. Yugoslavia (Slovenia) as a pest (MELZER, pers. comm. 1989). Several seed samples collected by Kovács and Szabó (Berzsenyi College, Szombathely) in Hungary, e.g. 259, 362 (B), belong to this taxon, as well as (with high probability) a part of the records given by TERPÓ-POMOGYI (1976).

The main diagnostic characters are given in the following description (and in the Tab. 1):

Panicum miliaceum L. subsp. ***agricolum*** H. Scholz et Mikoláš, subsp. nova. - Typus: Austria, Carinthia: im Drautal bei Spittal, an Maisfeldern, 8.1984, H. Scholz 1984/1 (B: holotype; KO: isotype). Differt a *P. miliaceo* subsp. *ruderali* (Kitag.) Tzvelev panicula densiore nutante et glumis persistentibus maturitate (nec glumae pedicello disarticulatae). Differt a *P. miliaceo* subsp. *miliaceo* rhachillae spiculae internodio supero disarticulato et caryopside leviore necque non flosculo fertile tenuiore.

From *P. miliaceum* subsp. *ruderale* (Kitag.) Tzvelev, it differs by a more contracted nodding panicle and by the persistent glumes in fruiting condition (glumes not disarticulating from the pedicel).

From *P. miliaceum* subsp. *miliaceum*, it can be distinguished by grains easily falling off in fruiting condition, and by the ripe grains which are lighter and thinner.

Specimina visa:

Austria: Carinthia (Kärnten): südostl. Prerau bei Villach, auf einer Anschüttung, 6.9.1981, H. Melzer s. n. (B); südl. St. Veit an der Glan, in einem Maisfeld reichlich, 12.9.1976, H. Melzer s. n. (B); St. Kanzian

Panicum miliaceum	subsp. *agricolum*	subsp. *ruderale*
Panicle	+contracted, several -flowered, bent to one side	open, few-flowered, with erect-patent branches
Spikelet disarticulation	below the fertile floret ("grain"), glumes persistent	below the fertile floret and below the glumes. Spikelet often falling entire
Spikelet length	4.0-4.7 (-5.0) mm	(4.3-) 4.5-5.0 mm
Grain Colour	blackish to olivaceous brown (Austrian samples) grey-brown to light brown to dark brown to gray to grey-olivaceous brown (ČSFR)	blackish to olivaceou brown (Austrian s.) brown to (olivaceous)brown (ČSFR)
Grain length	2.6-3.2 mm (Austria) 2.7-3.3 mm (ČSFR)	2.6-3.1 mm (Austria) 2.6-2.9 mm (ČSFR)
Grain width	2.0-2.3 mm (Austria) 1.9-2.0 mm (ČSFR)	1.6-2.1 mm (Austria) 1.6-1.7 mm (ČSFR)
Weight per 100 grains	484-507 mg (Austria) 471-515 mg (ČSFR)	454-461 mg (Austria) 311-328 mg (ČSFR)

Table 1 - Austrian and Czechoslovakian weed and ruderale populations of *Panicum miliaceum*

Klopeiner See, im Maisfeld, 16.9.1989, H. Scholz s. n. (B). - Stiria (Steiermark): Graz, in Puntigam, in Mengen in Maisfeldern, 4.9.1981, H. Melzer s. n. (B).

Czechoslovakia: Moravia, southeastern part: Blatnička, in agro inter *Zea mays*, 17.10.1984, J. Bartoška (BRNU) (as var. *ruderale* by F. Kühn, rev. Jehlík as subsp. *ruderale*), Lednice, in agris "Plantace" sub. *Zea mays* copiose, 3.10.1984, F. Kühn (BRNU) (sub var. *ruderale*, rev. Jehlík as subsp. *ruderale*). Slovakia: Sl. oriento-occidentalis: prope Trnava: Leopoldov, in agro sub *Glycine max*, 5.9.1984, S. Vaverka (BRNU) (F. Kühn as var. *ruderale*, Jehlík rev. as subsp. *ruderale*). The specimens collected by Schwarzová in southwestern Slovakia probably also belong to this taxon: Podunajská nížina (Danubian Lowland), Šamorín, in

inundation area, 29.9.1989, Schwarzová (SLO) (det. as *P. miliaceum*), Čiliskov, in area of inundation (area of 30 x 2 m), 29.9.1989, Schwarzová (SLO) (det. as *P. miliaceum*). These two specimens have light grey-brown, small and narrow grains, which fall off more hard than those of the specimens mentioned above. The glumes are persistent and panicle is somewhat diffuse. Slovakia orientalis: Humenné, railway station and its surroundings, 28.9.1989, 28.9.1990, 25.9.1991 V. Mikoláš (KO). These specimens approach *P. miliaceum* subsp. *agricolum* by diffuse panicle, grey-brown, relatively thick grains and their quite easily falling off, and persistent glumes. But the grains are not always completely smooth at the disjoin area, it often has somewhat marked traces of breakage. It is not yet clear if it is an intermediate type between *P. miliaceum* subsp. *miliaceum* and *P. miliaceum* subsp. *agricolum*, which it resembles to such a great extent. However, the material is insufficient for a satisfactory assessment.

France: Elsass, Wittesheim, ruderalisierte Kiesfläche, 30. 8.1990, G. Hügin 7201 (B).

[Afghanistan: Prov. Bamian: Lil-Tal, ca. 1 km östl. Jakawlang-Basar, 2600 m, 10.9.1970, A. Dieterle 816 (B, M).]

In the New World it seems to be absent for the time being (no specimens of this taxon were found in the rich material on loan from the Vascular Plant Herbarium, Agriculture Canada, Ottawa, DAO).

Besides the grains readily falling off both weedy *Panicum* subspecies have in common shining, blackish to olivaceous brown, thin light grains. On the contrary, the grains of crop plant populations are usually thicker and more turgid (higher content of endosperm-starch, grain weight more than 500 mg per 100 grains). Somewhat transitive position of *P. miliaceum* subsp. *agricolum* in relation to the plants of some cultivated strains is obvious. Plants not very different from *P. miliaceum* subsp. *agricolum* have been collected several times in Upper Italy (S. Tyrol, Toscana, Venezia and Istria) from 1842 onwards (Herbarium Firenze, FI). They have tardily disarticulating spikelets, blackish thin grains ("var. *melanospermum*") and resemble strongly primitive cultivars, or seem more or less identical with them, but may more probably represent regressive forms which behave wild and are escapes from cultivation. Once established here and there (also outside Europe) its harmful weedy characters evolved subsequently. Thus, provided that this interpretation is correct, S. and SE. Central Europe with its old tradition of *Panicum miliaceum* cultivation (BERTSCH 1949, RENFREW 1973) is one of main gene and distribution center of *Panicum miliaceum* weeds.

Analysed samples of *P. miliaceum* subsp. *agricolum* (by L. Mihoková) from Klopein am Klopeiner See and Humenné have 2n = ca. 36 and 36, respectively.

3. *Panicum miliaceum* subsp. *miliaceum*, crop-like weedy biotypes.

High grain production, easy seed dispersal rather early in autumn time, and, most importantly, the "ability to form a long-time viable seed bank in the soil, making quick elimination from an area impossible" (BOUGH et al. 1986: abstract, about *P. miliaceum* subsp. *ruderale*) is crucial for weedy success, not only of *Panicum miliaceum* subsp. *agricolum* but also of *P. miliaceum* subsp. *ruderale*. Some strains of *P. miliaceum* subsp. *miliaceum* behave as weeds but not so agressively in comparison to subsp. *agricolum* and subsp. *ruderale*. These crop-like weedy biotypes have bigger grains (only crown and golden biotypes are somewhat lighter, cf. BOUGH et al. 1986), delayed fruit ripening and little seed dormancy (only dark red biotype have an inherent dormancy, cf. BOUGH et al. 1986), nevertheless, they can continuously infest farmland due to special harvesting practices and unintentional grain sowing every year. An example is given by a cornfield weed population of the yellowish-grained, nonfalling off type, recently observed in Austria, S. Carinthia, taxonomically treated here as *P. miliaceum* subsp. *miliaceum* (voucher specimens in B: Seelach am Klopeiner See, Scholz s. n., 25.9.1989, tab. 3). These plants, ca. two meters in height, are remarkable in having stems, the effuse panicle branches and the pedicel tips covered by sparse, spreading, white bulbous-based hairs (from Romania, cf. SAKOMOTO et KOBAYASHI 1982a: 48, mention cultivated *P. miliaceum* provided with hairy stems, "which is quite a rare character in common millet").

Comparatively intermediate and not thoroughly clear forms close to *P. miliaceum* subsp. *agricolum* (from eastern Slovakia, and possibly from southwestern Slovakia) were discussed above. It cannot be excluded that crown biotype from Canada (cf. BOUGH et al., 1986) is identical or close to this type. The attention should be paid to the occurrence of similar biotypes with more readily falling grains of *Panicum miliaceum*, particularly those with grey to brown coloured grains and more diffuse panicle.

In future, it would be useful to concentrate the studies on the following problems:

1. Relations between *Panicum miliaceum* subsp. *agricolum* and some bio-

grain colour	light ochre-yellow (cv. Unikum) grey-(grey-olive) (cv. Hanácké šedé)
grain lenght	2.9-3.2 mm
grain width	2.1-2.2 mm
weight per 100 grains	568-576 mg

Table 2 - Some characteristics of two approved cultivars of Czechoslovakian proso millet (*Panicum miliaceum* subsp. *miliaceum*) [for comparison]

types of subsp. *miliaceum*, e.g., the crown biotype (from Canada). Is *P. miliaceum* var. *ruderale* Kitag. the same as a parallel type (*P. miliaceum* subsp. *ruderale* auct. europ.) widely distributed all over the Central Europe? Are both types regressive forms arising from the cultivated millet?

2. What dormancy is found in *P. miliaceum* subsp. *agricolum*?
3. What is the autogamy of proso millet like? Does the hybridization occur between "wild" and cultivated proso millet?
4. What is the genetic nature of the disjoin area of fertile spikelet? Can intermediate forms of this character exist?
5. According to the data in the literature (e. g. BOLKHOVSKIKH et al. 1969, *Panicum miliaceum*, 2n = 36, 40, 49, 54, 72), it is important to investigate more samples of proso millet from the whole of the world (cultivated forms as well as "wild" ones).

	Panicum miliaceum subsp. *miliaceum* crop-like weedy biotype (Austria)	cultivars (partly by Conert 1979)
Spikelet lenght	4.5-5.5 mm	4.0-5.5 mm
Upper glume	13-15 (-17)-nerved	9-13-nerved
Sterile lemma	13-nerved	9-11-nerved
Fertile lemma	(7-) 9-nerved	7 (-9)-nerved
Weight per 100 grains	ca. 612 mg	500 mg, rarely below (Lyssov 1975)

Tab. 3 - Crop-like weeds and cultivars of *Panicum miliaceum* subsp. *miliaceum*

The above problems suggest the intricate nature of taxonomy and evolution of ruderal and weedy proso millet. It is probable that, as well as fatuoids in *Avena sativa* L. (cf. SCHOLZ 1991), *P. miliaceum* subsp. *agricolum* repeatedly evolves from *Panicum miliaceum* subsp. *miliaceum*. With regard to the existence of at least two noncultivated taxa of *Panicum miliaceum*, it resembles somewhat the situation in the systematics of *Hordeum vulgare* L. (cf. SCHOLZ 1986). However, *H. vulgare* subsp. *spontaneum* is only distributed in the Near East (on the other hand *P. miliaceum* subsp. *ruderale*, considered in some literature as the ancestor of cultivated millet, grows in the whole of world today), *H. vulgare* subsp. *agriocrithon* (in the same way as *P. miliaceum* subsp. *agricolum*) evolves probably repeatedly and directly from *Hordeum vulgare* subsp. *vulgare*.

Similar newly evolved weedy taxa are known in many other species of cereals (e. g. *Oryza fatua* evolving from *O. sativa*, cf. HEJNÝ 1953, or *Eragrostis pilosa* subsp. *subspontanea* evolved from cultivated *E. pilosa* subsp. *abyssinica*, cf. SCHOLZ 1988, etc.).

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Zusammenfassung

Die Rispen-Hirse (*Panicum miliaceum* L.) wird in drei Unterarten gegliedert :

1. subsp. *ruderale*, die in der Literatur bisweilen als Stammsippe der subsp. *miliaceum* erwähnt wird und heute weltweit, auch in Mitteleuropa, als Unkraut verbreitet ist.

2. subsp. ***agricolum***, subsp. nov., eine Unkrautform der Rispen-Hirse mit im Fruchtzustand festsitzenden Hüllspelzen, leicht ausfallenden Früchten und ziemlich lockerer, überhängender Rispe, die in Mitteleuropa aus Bayern, Elsass, NO.-Italien, Österreich, Slowenien, der Tschechoslowakei und Ungarn bekannt ist. Diese Unterart hat sich als Folge

des Herbizideinsatzes in Maisfeldern stark ausgebreitet und ist wahrscheinlich mutativ aus der kultivierten Rispen-Hirse entstanden.

3. subsp. *miliaceum*. Hierzu gehören alle kultivierten Formen und nicht in Kultur befindliche, aber als Unkraut vorkommende Sippen mit ziemlich festsitzenden Früchten.

Beide Unkraut- (und ruderale) Unterarten haben olivgraue bis schwärzliche Früchte. Subsp. *agricolum* ist in Fruchtmerkmalen etwas intermediär zwischen subsp. *ruderale* und subsp. *miliaceum*.

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