IDENTIFICATION GUIDE FOR

NEAR EASTERN GRASS SEEDS

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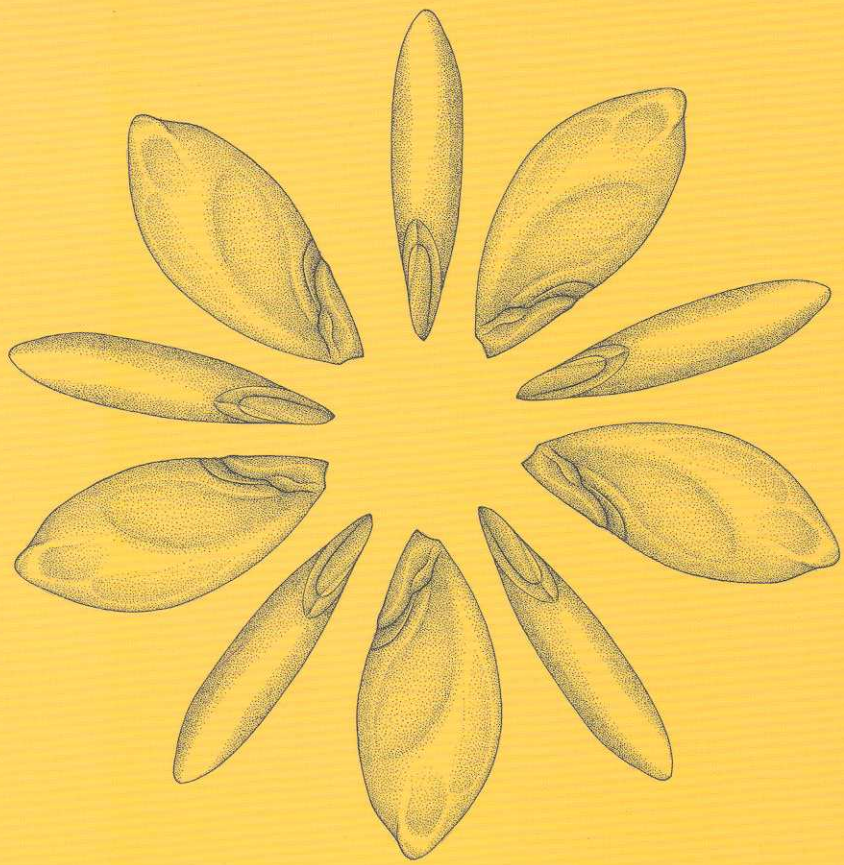
Illustrated by Jane Goddard



Contents

3.2 The caryopsis

3.2.1 Structure

The typical angiosperm fruit consists of two parts: the fruit wall (pericarp), enclosing the seed (Sendulsky *et al.* 1987). The pericarp develops from the ovary wall. It can be fleshy, as in a drupe such as a plum or a berry such as grape, or it can be dry. Dry fruits are either dehiscent, breaking open to release the seeds as in the legume (pod) of Fabaceae, or indehiscent, continuing to enclose the seed at maturity. The grass fruit is indehiscent. The second part of the fruit is the seed (used here in the strict botanical sense), developing from the ovule, with an outer wall, the testa, that develops from the two integuments that are the outer covering of the ovule. The seed is connected to the ovary wall by a funicle – the stalk of the ovule. The funicle leaves a scar on the surface of the seed, the hilum. In some plant families – e.g. the Fabaceae – the hilum is anatomically well defined and is useful for identification purposes. Caryopsis terminology is shown in Figure 3 (p. 12).

The grass fruit is termed a caryopsis because the pericarp is bonded to the seed wall. This anatomical property has important implications for identification criteria: in legumes, for example, the seeds fall out of the pericarp, with their testa exposed and easily available for study. There is thus a clear distinction between the anatomy of the pericarp (the pod) and the testa (the seedcoat). In grass caryopses, the pericarp and testa are adherent and must be studied together. Testa characters may be obscured by the overlying pericarp.

Although it is generally true that the grass pericarp is indehiscent and is united to the seedcoat, in some genera (e.g. *Crypsis*, *Eleusine* and *Sporobolus*) the pericarp is free and breaks open when moistened, expelling the seed. In these cases, the fruit is sometimes known as an achene (i.e. a dry, indehiscent fruit with a free pericarp), but is better regarded as a 'modified' or 'nucoid' caryopsis (Sendulsky *et al.* 1987). In some bamboos, a berry-like caryopsis forms with a fleshy pericarp, but bamboos are not native to the Near East.

3.2.2 Shape

Characteristics of the bran, hilum and embryo are dealt with in separate sections below. In this section, I consider the more general morphological characters of the whole caryopsis, i.e. its shape. Discussion of this by taxonomists is usually limited to vague statements about size and shape, whether the caryopsis is laterally or dorsally compressed or trigonous in transverse section, and whether there is a ventral furrow. Standard terms for caryopsis morphology are shown in Figure 3 (p. 12).

Caryopsis length

Caryopsis lengths are presented in Figure 4 (overleaf) in size order. This clearly shows a division between larger, often very variable grains over 3mm in length, and much less variable grains of genera under 3mm long. Virtually all the > 3mm genera belong to the tribes Triticeae, Bromeae, Stipeae, Poeae and Aveneae, immediately suggesting that length could be a useful diagnostic character.

The most striking feature is the long caryopses of the Triticeae and Bromeae compared to all other tribes. These two tribes are also striking for the wide range of caryopsis lengths within a genus. Although it is true that more reference material was measured for these tribes than the others, observation during measurements sug-

Table 4 Summary of distribution of main caryopsis characters by tribe (see Table 5 caption for explanation of the terms). For Compression, genera with a mix of compressed and non-compressed caryopses (LN and DN in Table 5) were assigned to dorsal or lateral compression classes respectively. The central column (None/Mix) includes genera with only non-compressed caryopses and those containing both laterally and dorsally compressed caryopses. The number of genera includes some genera divided into two morphological groups.

Subfamily	Tribe	Genera	Ventral groove			Hilum		Embryo length			Caryopsis length			Compression		
		n	Definite	Ambiguous	Absent	Linear	Basal	Long	Medium	Short	Long	Medium	Short	Dorsal	None/Mix	Lateral
Bambusoideae	Oryzeae	1			1	1			1				1			1
Pooideae	Nardeae	1	1				1			1		1		1		
Pooideae	Stipeae	5		1	4	5			1	4	1	2	2	3	1	1
Pooideae	Poeae	26	16	5	5	6	20		6	20		6	20	17	8	1
Pooideae	Hainardieae	1		1			1			1			1	1		
Pooideae	Meliceae	2			2	2				2			2	2		
Pooideae	Aveneae	29	15	3	11	5	24		9	20		5	24	10	6	13
Pooideae	Bromeae	3	3			3				3	2	1		2	1	
Pooideae	Triticeae	17	16		1	17				17	5	11	1	10	2	5
Arundinoideae	Arundineae	5	1	1	3		5	4	1				5	5		
Arundinoideae	Aristideae	2			2	2			1	1	1		1		1	1
Chloridoideae	Pappophoreae	1	1				1	1					1	1		
Chloridoideae	Eragrostideae	10		2	8		10	2	6	2			10	2	1	7
Chloridoideae	Cynodonteae	4			4		4	3	1				4	2	1	1
Panicoideae	Paniceae	9			9		9	7	2				9	9		
Panicoideae	Andropogoneae	12			12		12	11	1			5	7	9	2	1
	TOTAL		53	13	62	41	87	28	29	71	9	31	88	74	23	31
	%		42	10	48	32	68	22	23	55	7	24	69	58	18	24

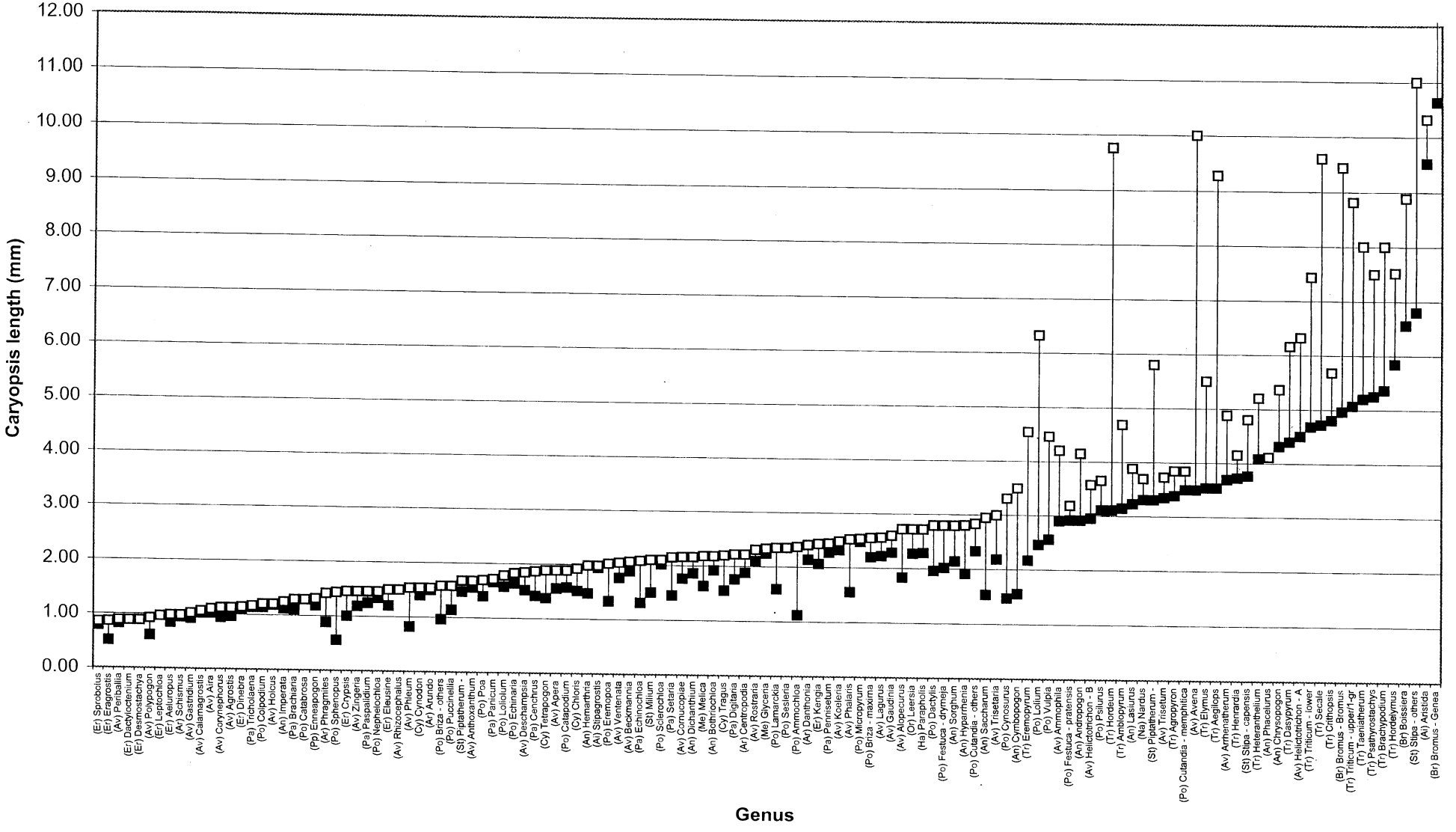


Figure 4 Caryopsis length organised by size ranges. A length of 3mm marks a clear division between small caryopses (< 3mm) and medium (3–5mm) and large (>5 mm) caryopses. Genus labels are prefixed by tribal affiliations (abbreviated). Black squares show the minimum, open squares show the maximum values.

Distribution and relationships
Perennial, c. 450 species in temperate regions throughout the world; in highlands in the Near East. Hills, plains and meadows. Identification to species is highly problematic and often depends on study of leaf anatomy. The division into sections follows the *Flora of Turkey*. Section *Bovinae* is known to be closely related to *Lolium*, particularly *L. multiflorum*.

Seed morphology
Two groups have been defined on the basis of differing hilum lengths. Too few species have been assessed to allow any sectional pattern to be determined.

Glumes: light papery
Lemma and palea: light papery, both adherent

***Drymeja* group**
Dorsal view: L:B 29–38; short embryo (17–32)
Lateral view:
Ventral view: grooved; short linear hilum (40–45%)
Cross-section: dorsally compressed (T:B 52–76)
Length: short (2.02–2.79mm)

***Pratensis* group**
Dorsal view: L:B 23–34; short embryo (27–37%)
Lateral view:
Ventral view: grooved; long linear hilum (69–93%)
Cross-section: dorsally compressed (50–86)
Length: medium (2.91–3.18mm)

Other genera
Festuca caryopses, particularly of *F. pratensis*, are very similar to those of *Lolium*[15] but are markedly smaller. *Festuca* grains are also very similar to *Micropyrum*, another closely related genus. *Micropyrum*[16] seeds have more parallel sides, not widening towards the apex. All three genera show the strong impression of the palea on the ventral side, resulting in a very clearly defined (even if not deep) V-shaped ventral furrow. This feature makes these three genera highly distinctive.

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15. *LOLIUM*

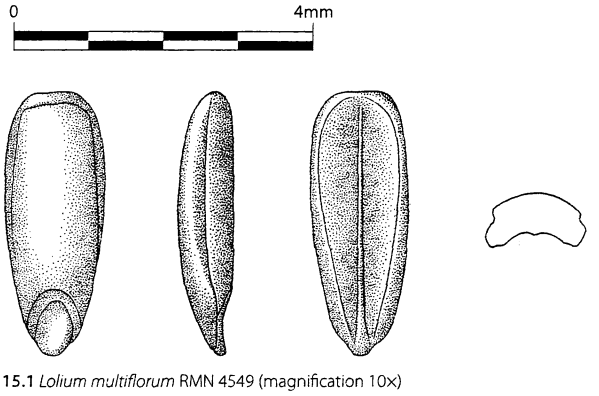
Group 1
1. *L. multiflorum* Lam.[1]◆
2. *L. perenne* L.[1]
3. *L. rigidum* Gaudin[1]◆
   syn. *L. loliaceum* (Bory & Chaub.) Hand.-Mazz.
4. *L. subulatum* Vis.[2]

Group 2
5. *L. persicum* Boiss. & Hohen. ex Boiss.◆
6. *L. remotum* Schrank[1]
7. *L. temulentum* L.
   i. var. *temulentum*[1]◆
   ii. var. *arvense* (With.) Liljebl.

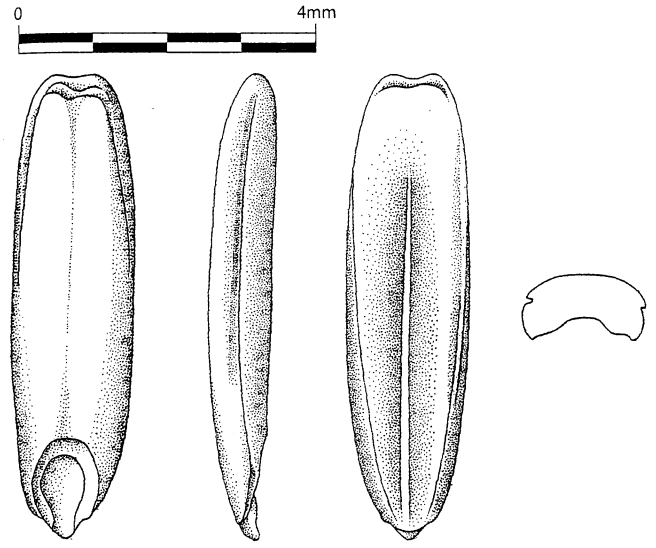
Distribution and systematics
Perennial or annual, about eight species, native to Europe, North Africa and temperate Asia; important as forage crops, lawn grasses and weeds of crops. The genus is understudied and its phylogeny poorly understood, but a division into the two groups defined here is widely supported. Two species, *L. remotum* and *L. temulentum*, are only found in crop fields, of flax (and, recently, *Ornithopus sativus*) and cereals respectively. In the Near East, *L. temulentum* is restricted to areas with a more Mediterranean-type climate (Scheibe 1934). *L. remotum* is today mainly restricted to central and northern Europe, but is archaeologically attested from the Near East and Aegean. The origin of these species remains unclear, but they probably share a common pre-agrarian ancestor. Isozymes and other genetic evidence suggest that *L. persicum* is the most closely related of the other species. It grows abundantly in central and eastern Turkey and the 'inner' Near East. It is also largely restricted to fields and may thus also represent an obligate segetal weed rather than the wild ancestor. This group of three species is well defined. Species relationships in group 1 are less certain, but the species probably form one group. *L. perenne*, *L. multiflorum* and *L. subulatum* are closely related, as is the highly variable *L. rigidum* which has been proposed as the ancestral species for *L. multiflorum* and *L. perenne* (which would be a surprising reversal of the more usual evolution from perennial to annual). *L. multiflorum* is believed to be native to Europe but is common on wasteground in the Near East. *L. subulatum* is a relatively uncommon form closely related to *L. rigidum* but with larger spikelets.

Endophytic fungi infect the fruits, stems and leaves of some species of *Lolium*, *Festuca* and some other genera. The infection results in the production of alkaloid toxins (still poorly characterised) that are poisonous to grazing animals and humans. The best documented instance is *Lolium temulentum*, known since ancient times as a contaminant of flour which can lead to poisoning of humans (p. 14).

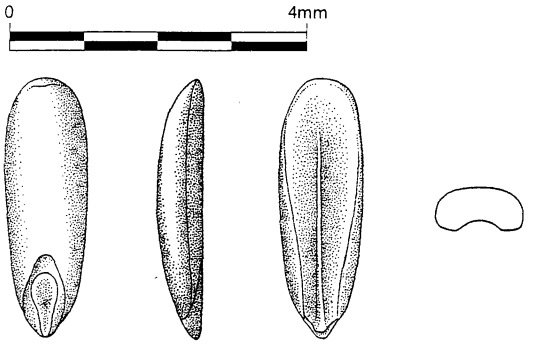
Seed morphology
Glumes: tough papery
Lemma and palea: tough papery, both adherent, distinctly punctate
Dorsal view: L:B 20–35; short embryo (21–40%)
Lateral view: grooved
Ventral view: grooved; long linear hilum (72–92%)
Cross-section: dorsally compressed (T:B 45–77)
Length: medium (3.49–6.32mm)



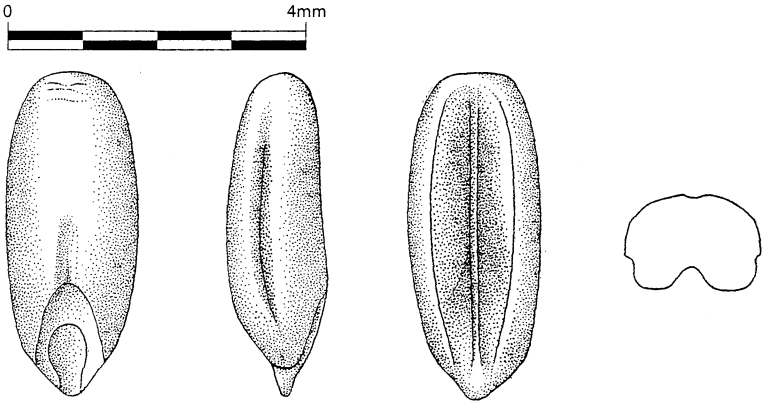
15.1 *Lolium multiflorum* RMN 4549 (magnification 10×)



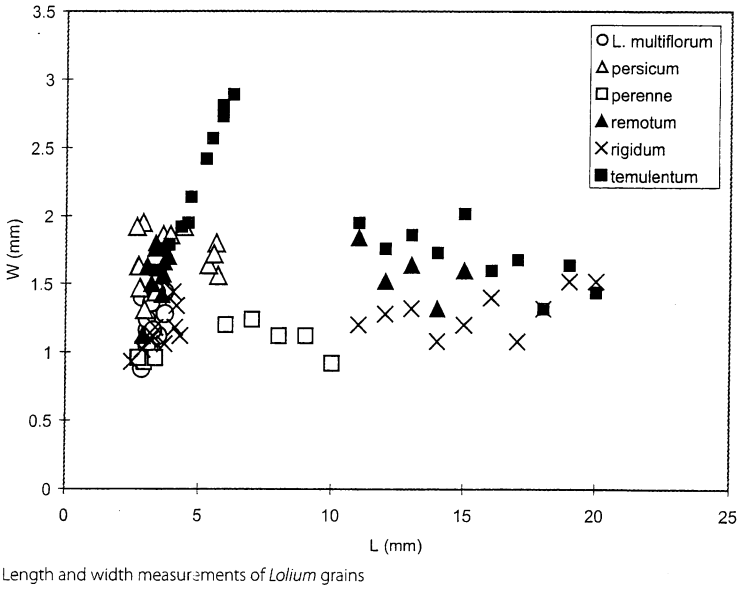
15.5 *Lolium persicum* GCH 3809 (magnification 10x)



15.7 *Lolium rigidum* NM 943 (magnification 10x)



15.10 *Lolium temulentum* RMN 697 (magnification 10x)



Length and width measurements of *Lolium* grains

Notes

V-shaped scutellum on most but not all caryopses. The distinctive, punctate, lemma and palea often remain attached to charred material. Within the genus, well-preserved material can usually be identified to one of four groups:

1. *L. perenne/multiflorum/rigidum*: not turgid, relatively flat dorsal surface, short (< 4.5mm in reference material).
2. *L. persicum*: not turgid, relatively flat dorsal surface, caryopses variable in length but often over 5mm, overall distinctly larger than the first group.
3. *L. remotum*: turgid (swollen, rounded), short caryopses (< 4mm).

4. *L. temulentum*: turgid (swollen, rounded), caryopsis highly variable depending on position of floret in spikelet, but usually over 4mm long.

Variability in *Lolium* caryopsis size and shape and the effects of charring make secure identification of small numbers of caryopses difficult. The characteristics of the grains – and the presence of more than one morphological group – will be far easier to detect in reasonably large samples of grains.

Other genera

See under *Festuca*[13]. *Lolium* grains are sometimes confused for those of *Hordeum*[88], but are easily distinguished by the V-shaped palea grooves on the ventral face.

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16. *MICROPYRUM*

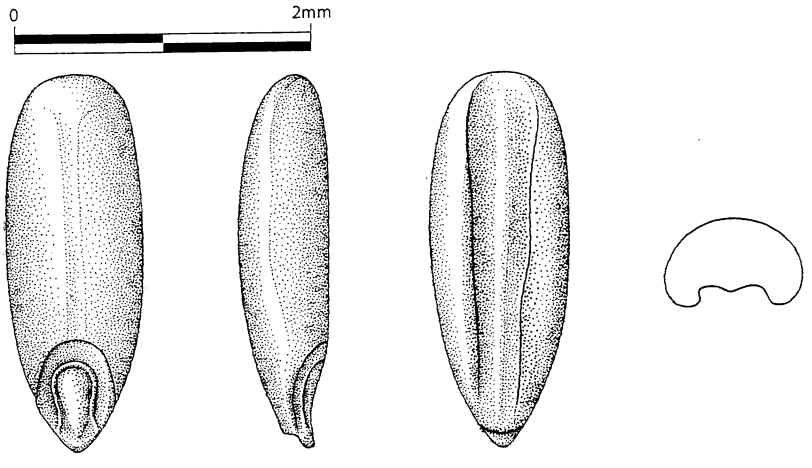
1. *M. tenellum* (L.) Link[1]◆

Distribution and systematics

Annual, three species in Mediterranean region. Dry open places.

Seed morphology

Glumes: tough papery
Lemma and palea: tough papery, both adherent
Dorsal view: L:B 26–33; short embryo (23–38%); striations
Lateral view: grooved
Ventral view: grooved; long linear hilum (69–93%)
Cross-section: dorsally compressed (T:B 59–76)
Length: short (2.48–2.53mm)



16.1 *Micropyrum tenellum* RMN 7526 (original magnification 20×)

Notes

V-shaped scutellum sometimes present.

Other genera

See note under *Festuca*[13].

Index to genera

Grasses are of major importance to archaeobotanists and other scholars who investigate the ecology and subsistence of human populations through much of the Old World. This group of plants provided a varied and important set of food resources to hunter-gatherers in addition to the wild material for domestication of the world's most productive crop plants, and the wide variety of the weeds that infest cultivated fields.

Archaeobotanical studies constantly encounter the carbonised grains of grasses, cultivated and wild, but the vast diversity of wild species that are potentially present has made identification of archaeological material fraught with difficulties. This volume provides an invaluable tool for mastering these difficulties. Based on years of laboratory study of an extensive reference collection, this book gives expert guidance for the identification and interpretation of grass seeds, focusing on those species that occur in the Near East and Europe.

Extensively illustrated by drawings of grains and graphs of morphometric data, in total 122 genera of grasses are covered, including discussion of subgeneric taxonomy and variation, with citations of key taxonomic studies. A multi-access key enables grains to be keyed into identification groups. Interpretation of the archaeological occurrence of species will be aided by biogeographic information included in the descriptions.

Identification Guide for Near Eastern Grass Seeds provides an unrivalled handbook to the identification of carbonised or desiccated grass grains and should be an essential part of any archaeobotanical laboratory. It will also be of use to taxonomists and seed analysts.

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