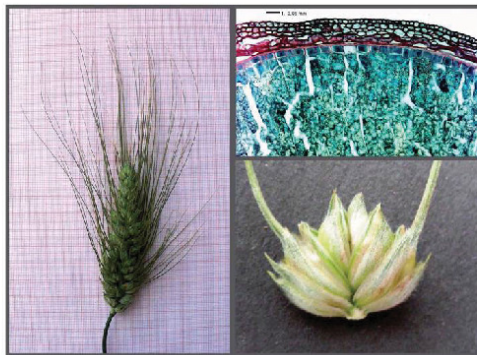




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Chapter 2

Egyptian Wheat: A Review

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Wheat (various species of the genus *Triticum*) is a grass with so many important uses that it is cultivated worldwide. Wheat is one of the first cereals known to have been domesticated. Wheat is not only an important crop today, it has also influenced human history. Wheat was a key factor enabling the emergence of city-based societies at the start of civilization because it was one of the first crops that could be easily cultivated on a large scale, and had the additional advantage of yielding a harvest that provides long-term storage of food. Bread wheat is known to have been grown in the Nile Valley by 5000 BC and it is believed that the Mediterranean region was the centre of domestication. The archaeological record suggests that this first occurred in the regions known as the Fertile Crescent, and the Nile Delta. The civilization of West Asia and of the European peoples has been largely based on wheat.

Wheat grain is a staple food used to make flour for leavened, flat and steamed breads, cookies, cakes, pasta, noodles and couscous; and for fermentation to make beer, many different alcoholic spirits including grain whiskey and vodka, and recently, biofuel. The husk of the grain, separated when milling white flour, is bran. Wheat germ is the embryo portion of the wheat kernel. It is a concentrated source of vitamins, minerals, and protein, and is sustained by the larger, starch storage region of the kernel - the endosperm. Some wheat is planted as a forage crop for livestock, straw made from stems and leaves can be used as bedding for livestock, or as a construction material for roofing thatch.

2.1 A Brief History of Wheat Classification

The existence of many different varieties of wheat has been recognized for more than 2300 years. Theophrastus (1916), a pupil of Plato in his “Enquiry Into Plants” written about 300 years B.C. states: There are also many kinds of wheat which take their names simply from the places where they grow as Libya, Pontic, Thracian, Assyrian, Egyptian, Sicilian. They show differences in their capacities in general and especially in their value as food (Clark and Bayles 1939).

Theophrastus mentioned many of the differences between these kinds of wheat and his observations were repeated and amplified in the first century B.C. and later on. The following notes were presented in the translation in Columella’s (1745) book entitled “Of Husbandry” (Clark and Bayles 1939): “*Triticum* common bare wheat which has little husk upon it was, according to Varro, a name given formerly to all sorts of grain beaten or bruised out of ears by

trituration or threshing; but afterwards it was given to a peculiar species of grain of which there are many sorts which take their names from the places where they grow as African, Pontic, Assyrian, Thracian, Egyptian, Sicilian, etc., which differ from one another in color, bigness and other properties too tedious to relate. One sort has its ear without beards and it either grows in winter or in summer. Another sort is armed with long beards and grows up sometimes with one, sometimes with more ears. Of these, the grains are of different sorts: some of them are white, some reddish, some round, others oblong, some large, others small. Some sorts are early ripe, others late in ripening. Some yield a great increase, some are hungry and yield little. Some put forth a great ear, others small. One sort stays long in the hose (follicle), another frees itself very soon out of it. Some have a small stalk or straw, others have a thick one as the African. Some are clothes with few coats, some with many as the Thracian. Some grains put forth only one stalk, some many stalks.”

According to Percival (1921), pre-Linnean botanists of the sixteenth and seventeenth centuries generally adopted the classification of the cultivated wheats suggested by Columella, dividing them into two sections:

I. Species of *Triticum* or wheats whose ears have a tough rachis and grains so loosely invested by the chaff that they fall out when the ears are threshed.

II. Species of *Zea*, whose ears possess a fragile rachis which breaks into short lengths and grains so firmly enclosed by glumes that they are separated from the latter with difficulty.

Those comprising the *Zea* section are often spoken of as spelt wheat, the term spelt being used in a generic sense and embracing *T. monococcum* (Einkorn), *T. dicoccum* (Emmer) and *T. spelta* (common spelt). The real classification work, however, started with Linnaeus who placed all the cultivated wheat under the genus *Triticum*. In the first edition of his “Species Plantarum” (1753), he mentioned five species: *T. aestivum* (Bearded spring wheat); *T. hybernum* (Beardless winter wheat); *T. turgidum*; *T. spelta*; and *T. monococcum*. He divided the common wheat into two species: *T. aestivum* (awned spring wheat) and *T. hybernum* (awnless winter wheat) apparently believing that all spring wheats were bearded and all winter wheats beardless. In the second Edition of his Species Plantarum (1764), he added to the previous classification *T. polonicum*. Later, in 1781, his son introduced the species *T. compositum*, a form of *T. turgidum* with proliferous ears.

Lamarck (1786) in “Encycl. Methodique” recognized five species: *T. aestivum* (*T. aestivum* L. + *T. hybernum* L. + *T. turgidum* L.); *T. compositum* L.; *T. polonicum* L.; *T. spelta* L.; and *T. monococcum* L. Villars (1787) in the “Histoire des plantes de Dauphine” referred all the wheats to seven species: *T. vulgare* (*T. aestivum* L.); *T. touzelle* (*T. hybernum* L.); *T. turgidum* L.; *T. maximum* (a wheat resembling *T. polonicum*); *T. compositum* L.; *T. spelta* L.; and *T. monococcum* L.

Schrank (1789) arranged the cultivated wheats in three species: *T. cereale*, with the two varieties *T. aestivum* and *T. hybernum*; *T. spelta* L.; and *T. dicoccon* Schrank. Desfontaines (1800) established the species *T. durum* Desf. for the group of wheats having long awns and long vitreous kernels.

Host (1805) extended the list of *Triticum* to eleven species: *T. vulgare* (a form of *T. durum* Desf.); *T. compositum* L.; *T. turgidum* L.; *T. zea* (*T. spelta* L.); *T. spelta* L. (*T. amyleum* Ser.); *T. polonicum* L.; *T. monococcum* L.; *T. hordeiforme* (a form of *T. durum* Desf.); *T. villosum* (a pubescent white glumed of *T. durum* Desf.); *T. compactum* Host; and *T. atratum* (a variety of *T. amyleum* with dark, brown or black pubescent glumes). Host was the first botanist who united the Linnean *T. aestivum* and *T. hybernum* under one species: *T. vulgare*; he also first described and named *T. compactum* Host, to include the club wheats.

Persoon, in his ‘Synopsis Plantarum’ (1805) united *T. aestivum*, *T. hybernum* and *T. durum* under one species *T. sativum*. Seringe (1819) arranged the common and club wheats into 10 groups based on the following characters: density of the ear, beardness, ear colour, kernel colour and hairyness of the glumes. Metzger (1824) followed the same system as Seringe but considered in addition the winter and the spring habit of growth.

Alefeld (1866) classified the wheats into two genera and species: *T. vulgare* and *Deina polonica*; the latter contained four subspecies or varieties of Polish wheat, *T. polonicum*, and the former was divided into many subspecies containing all other races of *Triticum*.

Koernicke (1873) and Koernicke and Werner (1885) prepared the most complete classification of wheat. They recognized three species:

- 1- *T. vulgare* Vill. (Common wheat)
- 2- *T. polonicum* L. (Polish wheat)
- 3- *T. monococcum* L. (Einkorn or small spelt)

T. vulgare was divided into six subspecies:

A) Rachis tough, grains easily separated on threshing:

1- *T. vulgare* Vill. (Common wheat)

2- *T. compactum* Host (Dwarf wheat)

3- *T. turgidum* L. (English wheat)

4- *T. durum* Desf. (Hard or Macaroni wheat)

B) Rachis fragile, grains firmly enclosed in the glumes.

5- *T. spelta* L. (Common spelta)

6- *T. dicoccum* Schrank (Emmer)

Koernicke and Werner followed Alefeld's system of applying Latin names to the botanical groups. Vilmorin (1889) grouped the wheats into 50 sections according to their characters. Each section was briefly described and the synonyms were given. The common and club wheats were considered as one species. Hackel (1896) classified the genus *Triticum* according to a key very similar to the one adopted by Koernicke and Werner. He recognized three species: *T. sativum* Lamarck which includes: *spelta*, *dicoccum* and *tenax*.; *T. monococcum* L.; and *T. polonicum* L. which includes *vulgare*, *compactum*, *turgidum* and *durum* as subrace.

Howard and Howard (1909) classified the wheats of India largely according to the methods of Koernicke and Werner. They also considered in details the characters used for classification. Schulz (1913) assembled the first phylogenetic classification of wheat from the morphological view point by studying the phylogenetics. He divided the genus *Triticum* into three major taxonomic groups: Einkorn, Emmer, and Dinkel. These three groups do not only differ morphologically but also according to the resistance to fungi diseases, serum reaction, etc. Einkorn is a diploid species, has spikelets with one grain only (in others 2-4), and paleas splitting at maturity. Emmer is a tetraploid species with glumes strongly keeled from the base to the summit. The culm is entirely filled with or at least with a thick layer of pith. Dinkel is a hexaploid species with glumes, at least in the lower half, not or faintly keeled. The culm is with little or no pith.

Flaksberger (1915) published extensive treatises on the taxonomy of Russian wheat, and considered Schulz's series as aggregate species. In the monograph by Percival (1921), these series are expressed in terms of Species I Perciv. and Species II Perciv., respectively. Sakamura (1918) supported Schultz's classification in his pioneering cytological study, and found that Schultz's three wheat groups also differ in their chromosome number; the einkorns are diploid

($2n = 2x = 14$), the emmers are tetraploids ($2n = 4x = 28$), and the dinkels are hexaploids ($2n = 6x = 42$). Kihara (1919) provided information on genome constitution, phylogeny and the evolution of *Triticum* species.

In 1919, Vavilov increased the extent of the genus *Triticum* L. by inclusion of a new species of tetraploid wheat, *T. persicum* Vav. (*T. carthlicum* Nevski). Percival (1921) described and classified a large number of wheat varieties of the world and discussed the morphology of the wheat plant. He also described for the first time tetraploid naked wheats: *T. orientale* Perciv. (*T. turanicum* Jakubz.), *T. pyramidale* Perciv., and a hexaploid species, *T. sphaerococcum* Perciv. He divided the wheat forms into eleven groups distributed into two species. Within these groups Percival used the term “race” instead of the term “species” and his classification came as follows:

Species I.	<i>T. aegilopoides</i> Bal.	Wild small spelt
race 1	<i>T. monococcum</i> L.	Small spelt
Species II.	<i>T. dicoccoides</i> Korn.	Wild emmer
race 2	<i>T. dicoccum</i> Schubl.	Emmer
race 3	<i>T. orientale</i> Percival	Khourassan wheat
race 4	<i>T. durum</i> Desf.	Macaroni wheat
race 5	<i>T. polonicum</i> L.	Polish wheat
race 6	<i>T. turgidum</i> L.	Rivet or cone wheat
race 7	<i>T. pyramidale</i> Percival	Egyptian cone wheat
race 8	<i>T. vulgare</i> Host	Bread wheat
race 9	<i>T. compactum</i> Host	Club wheat
race 10	<i>T. sphaerococcum</i> Percival	Indian dwarf wheat
race 11	<i>T. spelta</i> L.	Large spelt or dinkel

Kajanus (1927) found it appropriate to consider Schulz’s above-mentioned series as species: *T. monococcum* (L.) Kajanus (diploids), *T. acuminatum* Kajanus (tetraploids), *T. obtusatum* Kajanus (hexaploids), which he then subdivided into subspecies and retained specific names for the latter. In 1928, Flaksberger’s classification was a significant step forward. He established sections within the genus *Triticum*: 1) Monococca Flaksb., 2) Dicoccoidea Flaksb. and 3) Speltoidea Flaksb. This grouping gained acceptance of many triticologists. Zhukovsky (1928) described a new species, *T. timopheevii*, which has 14 haploid chromosomes and is very resistant to several diseases. Thereafter, the genus *Triticum* L. was supplemented by species as follows: *T. macha* Dekapr. et Menabde (1932); *T. vavilovii* Jakubz. (1933); *T. abyssinicum* Vav. (1939); *T. aethiopicum* Jakubz. (1947); *T. palaeocolchicum* Menabde (1940); *T. karamyshevii* Nevski (1935); *T. araraticum* Jakubz. (1947); *T. ispahanicum* Heslot (1958); *T. zhukovskyi* Menabde et Ericzjan (1960); *T. militinae* Zhuk. et Migusch. (1969); *T. petropavlovskyi* Udacz. et Migusch.

(1970); *T. sinskajae* A. Filat. et Kurk. (1975); *T. jakubzineri* Udacz. et Schachm. (1976); *T. kiharae* Dorof. et Migusch.

Vavilov et al. (1931) published a “contribution to the knowledge of the 28 chromosome groups of cultivated wheat”. Zhukovsky (1933) described and classified botanically the wheat varieties of Anatolia. Nevski (1934) modified the Flaksberger’s classification (1928), who arranged the wild and cultivated one-grained wheats as *Sectio Crithodium* (Link) Nevski, the tetraploid species as *Sectio Orthatherum* Nevski, and the hexaploid species as *Sectio Spelta* Nevski. In addition, he distinguished *Sectio Gigachilon* Nevski for the species *T. polonicum* L. Flaksberger (1935) presented the result of extensive studies on the origin and classification of the species and varieties of wheat of the world. Flaksberger (1939) revised and enlarged his earlier publications on the species and varieties of wheat of the world. He and his associates recognized the species grouped according to chromosome number with their common names used in the United States as follows: Diploid series (14 chromosomes): *T. spontaneum* Flaks. and *T. monococcum* L.; tetraploid series (28 chromosomes): *T. dicoccoides* Körn., *T. timopheevi* Zhuk., *T. dicoccum* (Schrank) Schübl., *T. durum* Desf., *T. abyssinicum* Vav., *T. turgidum* L., *T. polonicum* L. and *T. persicum* Vav.; and Hexaploid series (42 chromosomes): *T. spelta* L., *T. vulgare* (Vill.) Host, *T. compactum* Host, *T. sphaerococcum* Perci. and *T. macha* Dek.& Men.

Clark and Bayles (1939) published a “classification of wheat varieties grown in U.S.” which followed the classification of Flaksberger (1939). They classified all varieties of eight species of *Triticum* grown in U.S. with a description for all of them. Schiemann (1948) published a monograph of wheat taxonomy in addition to barley and triticale. She classified the genus *Triticum* in the same manner as Flaksberger (1939) did, except for differences in nomenclature and incorporation of *T. compactum* Host in *T. aestivum* L. under the name of *T. aestivum aestivo-compactum* Schiem. Menabde (1948) abandoned the subdivision of the genus into sections and arranged the wheat species on a phylogenetic basis into four series (groups) of species: 1) segetal and wild; 2) primary; 3) secondary; 4) geographical races. Sinskaya (1955) subdivided the genus *Triticum* into three sections. In doing so, she rejected the criteria of naked vs. chaffy grains and of ploidy level.

Mac Key (1975) subdivided the genus *Triticum* into sections on the basis of genetic data obtained: 1) Monococca Flaksb.; 2) Dicoccoidea Flaksb.; 3) Speltoidea Flaksb., and thus reduced all the diversity of wheats to six species. Tzvelev (1976) subdivided the genus *Triticum* into sections: 1) Monococcon Dum.; 2) *Triticum* and 3) *Pyrachne* Dum. In this classification both the

ploidy level and the character of naked vs. chaffy grains are ignored. Dorofeev et al. (1979) published the complete monograph on *Triticum* (table 1) in flora of cultivated plants in Russian language which is nowadays to be translated into English.

Löve (1984) reclassified the genus *Triticum* with nomenclatural corrections. The classification was part of a taxonomic revision of the Tribe Triticeae. Following a broad interpretation of the biological species concept, Löve defined genera by their unique genome constitution, either as genera of diploids or polyploids. Thus, the genus *Triticum* was split into three genera, each corresponding to one of three ploidy levels in the genus as follows:

Genus *Crithodium* Link (A genome)

Crithodium jerevani (Tumanian) Á.Löve (4x)

Crithodium monococcum (L.) Á.Löve

subsp. *monococcum* Boiss. and subsp. *aegilopoides* (Link) Á.Löve

Crithodium urartu (Tumanian ex Gandilyan) Á.Löve

Genus *Gigachilon* Seidl (BA genome)

Section *Gigachilon*

Gigachilon aethiopicum (Jakubz.) Á.Löve

Gigachilon polonicum (L.) Seidl

subsp. *polonicum*, subsp. *carthlicum* (Nevski in Kom.) Á.Löve, subsp. *dicoccoides*

(Körn. ex Asch. & Graebner) Á. Löve, subsp. *dicoccum* (Schrank ex Schübler)

Á.Löve, subsp. *durum* (Desf.) Á.Löve, subsp. *palaeocolchicum* (Menabde) Á.Löve &

D.Löve, subsp. *turanicum* (Jakubz.) Á.Löve and subsp. *turgidum* (L.) Á.Löve

Section *Kiharae* (Dorof. & Migush.) Á.Löve

Gigachilon timopheevii (Zhuk.) Á.Löve

subsp. *timopheevii* and subsp. *armeniicum* (Jakubz.) Á.Löve

Gigachilon zhukovskyi (Menabde & Ericzjan) Á.Löve

Genus *Triticum* L. (BAD genome)

Triticum aestivum L.

subsp. *aestivum*, subsp. *compactum* (Host) Thell., subsp. *hadropyrum* (Flaksb.)

Tzvelev, subsp. *macha* (Dekapr. & Menabde) MacKey, subsp. *spelta* (L.) Thell., subsp.

sphaerococcum (Percival) MacKey and subsp. *vavilovii* (Jakubz.) MacKey