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შ ე ს ა ვ ა ლ ი

საქართველოს სახელმწიფო ევროპისა და აზიის კონტინენტებს შორის მდებარეობს და მისი ტერიტორია წარმოადგენს მიწათმოქმედების სხვადასხვა ცივილიზაციების გზაჯვარედინს. იგი ხასიათდება ნიადაგურ-კლიმატური პირობების სიჭრელით, არის მრავალი სასოფლო-სამეურნეო კულტურის სამშობლო და გამოირჩევა უძველესი ორიგინალური მიწათმოქმედებითა და ეთნიკური ტრადიციების მრავალფეროვნებით. სწორედ ამაზე მიგვანიშნებს ჩვენი ქვეყნის ძველი ბერძნული სახელწოდება „გეორგია“.

მეცნიერული გამოკვლევებით მტკიცდება, რომ ველური ხორბლის გაკულტურების და კულტურულ მცენარეთა წარმოშობის ერთ-ერთი უძველესი და მნიშვნელოვანი კერა წინა აზიასთან ერთად კავკასია და საქართველოა. საქართველოს ტერიტორიაზე გავრცელებული ხორბლის მონოგრაფიული შესწავლით დადგინდა მეტად მრავალფეროვანი სახეობრივი, სახესხვაობრივი და ჯიშური შედგენილობა, რომლითაც სხვა ქვეყნებს შორის გამოირჩევა ხორბლის გვარის ენდემიზმის და პოლიმორფიზმის მაღალი დონით.

საქართველოს ტერიტორიაზე აღმოჩენილი და აღწერილია ხორბლის ბოტანიკურ გვარში შემავალი 14 ბუნებრივი სახეობა, რაც შეადგენს ამ გვარში შემავალ კულტურულ სახეობათა 66%-ს, მათ შორის 5 ენდემური სახეობაა: ზანდური - T. timopheevii Zhuk, კოლხური ასლი - T.Karamyschevii Nevski, დიკა - T. persicum Vav., ჰექსაპლოიდური ზანდური - T. zhukovskyi Men.& Eriz, მახა - T. macha Dekapr.&Men (ნასყიდაშვილი პ. 1983). ამას ემატება ის ფაქტიც, რომ საქართველოში აღმოჩენილი და აღწერილია ხორბლის 154-ზე მეტი სახესხვაობა და ადგილობრივ (ავტოქტონური) ჯიშ-პოპულაციათა დიდი მრავალფეროვნება.

ხორბლის კულტურის ისეთი სახეობები, რომლებიც ევოლუციურად ძალიან ახლოს დგანან ხორბლის ველურ სახეობებთან შემონახულია მხოლოდ საქართველოს აგროკულტურაში.

საქართველოს პრიორიტეტს კულტურული ხორბლის გაჩენაში, ადასტურებს როგორც არქეოლოგიური მონაპოვარი, ისე აგრიკულტურის ეთნოგრაფიული და სხვა მონაცემები და კვლევები. ამასვე ადასტურებს ის გარემოება, რომ ათასწლეულების განმავლობაში ქართველი ხალხის სამეურნეო ყოფაში უკანასკნელ დრომდე ფუნქციონირებდა როგორც ხელით სამუშაო სამიწათმოქმედო სამეურნეო იარაღების, ისე სახნავი საშუალებების დიდი მრავალფეროვნება, განვითარების დინამიკაში უმარტივესიდან რთულისაკენ.

საქართველოს არქეოლოგიურ ძეგლებზე (არუხლო, ხრამის დიდი გორა, შულავერის გორა, გადაჭრილი გორა, იმირის გორა და სხვ.) ჩატარებულმა რადიოკარბონულმა კვლევებმა გამოავლინა ხორბლის კარბონიზებული ნაშთები, რაც მკვლევარებს საშუალებას აძლევს გამოთქვან მოსაზრება, რომ ძველი წელთაღრიცხვის VI ათასწლეულში აღნიშნულ ტერიტორიაზე არსებობდა განვითარებული მწარმოებლური მეურნეობა, რომელიც დასტურდება ბრინჯაოსა და ანტიკურ ხანაშიც. ასე რომ, 8000 წლის წინ ჩვენი ქვეყნის ტერიტორიაზე დაწყებული ქართული ხორბლის თესვა-მოყვანა უწყვეტად გრძელდებოდა და ამ საქმიანობას აქაური მოსახლეობა დღესაც გულმოდგინედ ეწევა. რიგი თვისებრივი

უპირატესობის გამო, მათზე და მათ ნამზადზე მოთხოვნილება საზოგადოებაში უფროდაუფრო იზრდება. აღნიშნული მოთხოვნილება იწვევს ქართული ხორბლის ფართობების და გავრცელების მიკროზონების არეალის ზრდას. გარდა „პური ჩვენი არსობისა“, ხორბალს საქართველოში იყენებენ როგორც სამკურნალო მცენარეს.

კულტურული ხორბლის ფორმები მათი განვითარების მიხედვით ორ ჯგუფად შეიძლება დავყოთ: კულტურის პირველადი და კულტურის მეორადი ჯგუფი. კულტურის პირველადი ჯგუფი შედგება ხორბლის ისეთი ფორმებისაგან, რომელთა ბუნებაში ჯერ კიდევ შენარჩუნებულია ამ მცენარის ველური თვისება, ხოლო კულტურის მეორადი ჯგუფი შეიცავს ხორბლის უაღრესად გაკულტურებულ ფორმებს, რომელთა ბუნებაში უკვე სრულიად გამქრალია ხორბლის ველური ნიშნები. მხოლოდ ქართულ ხორბლებშია დაცული ისეთი ფორმები, რომლებიც ენათესავება ხორბლის გარეულ ფორმებს; ასეთია ზანდური, კოლხური ასლი, მახა. კულტურის პირველადი სახეობები, რომლებიც ენათესავებიან ველურ ხორბლებს, მარტოოდენ ქართულ კერაშია შენარჩუნებული. ხორბლის ქართული ჯგუფის (ზანდური, კოლხური ასლი, მახა) კულტურის პირველადობას ამჟამადაც ადასტურებს მისი ბიოლოგიური თავისებურება – თავთავის მტვრევადობა, კილიანობა და ის პირველადი სამკელი იარაღი, რომელიც დღესაც დაცულია ჩვენში „შნაკვის“ სახელწოდებით. მხოლოდ ქართველ ხალხში დაცული ხორბლის პირველადი კულტურის ფორმების შემდგომი ევოლუციისა და განსახლების შედეგად წარმოიშვა მსოფლიო მიწათმოქმედების საწარმოო ჯიშები. ხორბლის ასეთი განძი არც ერთ სხვა ხალხს არ გააჩნია. ეს ფაქტი და მასთან ხორბლის გვარის პოტენციალის კონცენტრაცია მხოლოდ და მხოლოდ ქართველურ ხალხთა აგრიკულტურაში კარგად ასახავს ქართულ პირველად სახეობათა როლს ამ მცენარის საერთო ევოლუციაში (თ. სადუნიშვილი, 2021).

საქართველომ მსოფლიოს ხორბლის კულტურის სახით უნიკალური მრავალფეროვნება შეუქმნა, რომელიც საშუალებას იძლევა შეიქმნას თანამედროვე ინტენსიური ტიპის ხორბლის ჯიშები.

ქართული ხორბლის ენდემური სახეობები და ადგილობრივი ჯიშები ჩვენი ქვეყნის ერთ-ერთ პრიორიტეტულ აგროკულტურას წარმოადგენს, რომლის შენარჩუნებას და დაცვას უდიდესი მნიშვნელობა აქვს ქვეყნის ისტორიის, ეთნოგრაფიისა და ტრადიციული პროდუქტების წარმოების თვალსაზრისით, რაც სრულიად შეესაბამება კონფერენციის ძირითად თემას.

I N T R O D U C T I O N

The state of Georgia is located between the continents of Europe and Asia, and its territory is a crossroads of various farming civilizations. It is characterized by a variety of soil and climatic conditions, is the birthplace of many agrarian cultures and is distinguished by ancient original farming and diversity of ethnic traditions. This is what the old Greek name of our country "Georgia" indicates.

Scientific research proves that one of the oldest and most important centers of the cultivation of wild wheat and the origin of cultivated plants is the Caucasus and Georgia, along with Asia. A monographic study of wheat spread on the territory of Georgia revealed a very diverse species with wide variety of composition, which distinguishes the wheat genus from other countries characterized by a high level of endemism and polymorphism.

14 natural species included in the botanical genus of wheat have been discovered and described on the territory of Georgia, which makes up 66% of the cultivated species included in this genus, among which are 5 endemic species: Zanduri - T. timopheevii Zhuk, Kolkhuri copy - T. Karamyschevii Nevski, Dika - T. persicum Vav., hexaploid Zanduri - T. zhukovskyi Men.& Eriz, Makha - T. macha Dekapr.& Men (Naskydashvili P. 1983). Added to this is the fact that more than 154 varieties of wheat have been discovered and described in Georgia and a great diversity of local (autochthonous) varieties-populations.

Such types of wheat culture, which according to their evolution are very close to the wild types of wheat, are preserved only in the agriculture of Georgia.

The priority of Georgia in the emergence of cultivated wheat is confirmed by archaeological findings, ethnographic and other agricultural data and studies. This is also supported by the fact that for thousands of years in the agricultural life of the Georgian people, until the last time, a great variety of hand-operated agricultural tools and plowing tools were used, which developed in dinamics from the simplest to the most complex ones.

Radiocarbon studies carried out at the archaeological sites of Georgia (Arukhlo, Khrami Didi Gora, Shulaveri Gora, Gadachrili Gora, Imiri Gora, etc.) revealed the carbonized remains of wheat, which allowed the researchers to express the opinion that in the 6th millennium BC, a productive farming was developed in the mentioned area, which is confirmed in the Bronze Age and even in Antiquity. So, the sowing and cultivation of Georgian wheat, which started 8000 years ago on the territory of our country, continued non-stop, and the local population of Georgia is diligently engaged in this activity even today. Due to a number of qualitative advantages, the demand for the products made of wheat is increasing in the society. This demand leads to an increase in the area for Georgian wheat and its distribution of microzones. In addition to being "bread of our being", wheat is used as a medicinal plant in Georgia.

Cultivated wheat forms can be divided into two groups according to their development: primary culture group and secondary culture group. The primary group of culture consists of those forms of wheat in which the wild character of this plant is still preserved in nature, and the secondary group of culture contains highly cultivated forms of wheat in which the wild features of wheat have already completely disappeared. Only Georgian wheats have preserved forms that are related to wild forms of wheat; Such as: Zanduri, Kolkhuri Asli, Makha. The primary types of culture, which are closely related to wild wheat, are preserved only in the Georgian heartland.

The primacy of the culture of the Georgian group of wheat (Zanduri, Kolkhuri Asli, Makha) is confirmed even now by its biological peculiarity - the brittleness of the head, the keeliness and the primary harvesting tool, which is still preserved in our country under the name of "shnakvi". Later, as a result of the further evolution and wide settlement processes, the primary wheat culture forms appeared.

Such treasure is preserved only among the Georgian people, the production varieties of the world agriculture emerged. No other nation has such a treasure of wheat. This fact and the concentration of the potential of the wheat genus in the agriculture of the Georgian people well reflects the role of the Georgian primary species in the overall evolution of this plant (T. Sadunishvili, 2021).

Georgia has created a unique diversity in the form of wheat culture of the world, which allows to create modern intensive types of wheat varieties.

Endemic species of Georgian wheat and local varieties are one of the priority agricultural crops of our country, the preservation and protection of which is of great importance in terms of the country's history, ethnography and production of traditional products, which is completely consistent with the main theme of the conference.

ხორბლის (Triticum Austuvum L.) ქართული ჯიშის მნიშვნელობაზე კვებასა და ჯანმრთელობის განმტკიცებისათვის

ზურაბ ბუკია - სოფლის მეურნეობის მეცნიერებათა აკადემიური დოქტორი
ივ.ჯავახიშვილის სახელობის თბილისის სახელმწიფო უნივერსიტეტი, ალ. ნათიშვილის მორფოლოგიის ინსტიტუტი; თბილისის სახელმწიფო სამედიცინო უნივერსიტეტი, ვლ. ბახუტაშვილის სახელობის სამედიცინო ბიოტექნოლოგიის ინსტიტუტი; თბილისი, საქართველო. zurabukia@gmail.com

აბსტრაქტი. ნაშრომში წარმოდგენილია ცნობები ხორბლის (Triticum Austuvum L.) ქართული ჯიშის მნიშვნელობაზე კვებასა და მედიცინაში. გატარებულია აზრი იმის შესახებ,რომ ჩვენი ქვეყანა ხორბლის წარმოშობის ერთ-ერთ უძველესი კერაა და ხორბალი ჩვენი ყოფითი იდენტობის უმნიშვნელოვანესი კომპონენტია.

მთავარი აქცენტი გაკეთებულია ხორბლის ქართული სელექციური ჯიშის ანტიოქსიდანტური აქტივობისა და ფენოლური ნაერთების შემცველობის მაჩვენებლების შესწავლაზე მცენარის ზრდა-განვითარების პერიოდში.

აპრობირებული მეთოდები სელექციისა და გონივრული აგროტექნიკა ქმნის მყარ საფუძველს ქართული ხორბლის როლის უფრო ფართოდ გამოკვეთისათვის, როგორც ჩვენი მთავარი სასურასთო გარანტისა,აგრეთვე მის ფართოდ ჩასაყენებლად ადამიანის ჯანმრთელობის დაცვის სამსახურშიც.

საკვანძო სიტყვები: ხორბალი,კვება,ჯანმრთელობა,ანტიოქსიდანტობა.

On The Importance of The Georgian Variety of Wheat (*Triticum Austuvum* L.) for Nutrition and Health Promotion

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Abstract. The paper presents information on the importance of the Georgian variety of wheat (Triticum Austuvum L.) in nutrition and medicine. It is argued that our country is one of the oldest centers of origin of wheat and wheat is the most important component of our existential identity.

The main focus is on the study of the indicators of antioxidant activity and phenolic compounds content of the Georgian selective variety of wheat during the growth and development period of the plant.

Proven methods of selection and reasonable agro-techniques create a solid foundation for the wider role of Georgian wheat as our main food guarantee, as well as for its widespread use in the service of human health protection.

Keywords: Wheat, Nutrition, Health, Antioxidant

Introduction and justification of the topic. As is known, our country is one of the oldest centers of origin of wheat. Moreover, wheat, along with vines, are the most important components of our former identity. It is also undeniable that farming culture, folk selection and traditional Georgian cuisine have always been at a high level.

In general, an infallible argument for assessing the nutritional value of wheat grain is its organoleptic properties. A special role is assigned to the amino acid composition of proteins. It contains a small amount of glutamic acid (21.9%), tryptophan (0.8%), cystine (1.1%), methionine (1.4%) and tyrosine (1.8%); proteins in wheat are up to 13.0%, sugar is 1.45%, there is a complex of vitamins and others.

There are many reports in the literature that wheat is widely used in other fields besides food.

All the listed properties are abundantly present in Georgian varieties of wheat, which, first of all, we have to thank for the variety, organoleptic properties and climatic and soil conditions of wheat growing regions of Georgia.

Wheat is specially grown as a medicinal product. Moreover, its beneficial properties are used for the overall health of the body, increasing appetite and improving peristalsis. Its tincture is a great remedy for heart diseases.

Let's dwell on the antioxidant properties of one well-known Georgian variety of wheat ("Vardzia"): The bioactive compounds present in the plant play a great role in human life. These compounds are also of great importance in medicine. Many representatives of the plant world are distinguished by the content of such compounds. It should be noted that sometimes this or that representative of the plant contains these useful substances in all organs.

It is interesting to isolate the bioactive compounds of the above-named variety of the legume family and to study their antioxidant activity, which, together with their main virtues, will allow us to standardize the products according to compounds and effectiveness on human health.

The data of the detailed study of the biomorphology and phenology of the test plants provide the basis for determining the similarity-difference parameters between the test plants and determining the optimal period of accumulation of useful substances in the plant.

The present paper refers to the well-known representative of the Poaceae family, the Georgian variety of wheat - Vardzia.

The morphology, biology and phenology of the variety of plants were studied under controlled conditions (with a five-day interval) - from the end of germination - to the full ripening of the grains - in order to determine the dynamics of accumulation of bioactive compounds in plants and the favorable period when their consumption is most useful.

Object and method. As we indicated, we took for research the Georgian wheat variety "Vardzia", a representative of Poaceae Born family acclimatized and naturalized in Georgia.

It is known that Autumn wheat is more adapted - its root system is better embedded in the soil and absorbs nutrients better. The specific share of its distribution in the world is greater. It is the same in our country.

„Vardzia“ is a soft wheat, the Latin name of the variety is Triticum Austivum var. ferrugineum (Alef.) Manst. The variety-population from Khulugo was bred in the Agricultural Research Institute of Georgia through chemical mutagenesis by the effect of a 0.015% solution of the chemical mutagen NMM (nitrosomethylurea) on the seeds. Allowed for distribution in wheat production regions since 1994.

The variety according to the type of development is optional. It grows to a height of 80-85 cm. The head is loose, the grain is red, semi-pin-shaped.

The length of the head is 8-9 cm. The average yield per hectare is 4.0-4.5 tons. The mass of 1000 grains is 43 grams. The number of grains in the head is 60-72 pieces of grain.

On the test plot, the elements indicating the physical state of the atmosphere were recorded using a common method. During the research period, the climatic characteristics were typical for the Kartli region and did not deviate from the norm.

The study of the biological characteristics of the test plants was carried out through phenological observation and biometric measurement.

The grain goes through phases, which are related to quantitative and qualitative changes. The characteristic phenophases of wheat - germination-emergence, tillering, ripening, heading, flowering and grain maturity - were taken into account when taking samples.

We determined the character of plant germination with three percentages of germination: 10%, 50% and more than 50%.

We took leaf and grain samples every fifth day from the end of germination until the grains were fully ripe and analyzed them to determine the dynamics of the accumulation of bioactive compounds. We took samples for biochemical analysis in the amount of 1 gram. We dried them, and did alcohol extraction.

Total phenols in the sample were determined using the Folin-Dennis reagent;

We processed the data using the variational statistics method. For each data set, we also set confidence parameters. Agro-technical measures were carried out on the trial plot according to the current agro-rules.

Results and discussion. The results of the test confirmed the hypothesis that the area of genotyping affects the content of bioactive substances and its dynamics in the plants of the test variety.

Table 1

The Results of Studying the Dynamics of Accumulation of Phenolic Compounds and Antioxidant Activity in Different Periods After Germination

Variety	Graduation of emergence	Date of sampling	From the end of germination (day) 5 days	Optical density (nm)	Common phenols (mg/10 g)	Antioxidant activity (sec)
“Vardzia”	22.03	27.03	15 day	0,488	5,0	70
	22.03	6,04	25 day	0,488	5,0	70
	22.03	16.04	35 day	0,488	5,0	70
	22.03	26.04	45 day	0,320	1,125	130
	22.03	6.05	55 day	0,320	1,125	130
	22.03	16.05	65 day	0,293	1,00	180
	22.03	26.05	75 day	0,293	1,00	180
	22.03	5.06	85 day	0,293	1,00	180
	22.03	15.06	95 day	0,128	0,625	190
	22.03	25.06	105 day	0,128	0,625	190
	22.03	5.07	115 day	0,202	1,125	180
	22.03	15.07	125 day	0,202	1,125	180
	22.03	25.07		0,340	1,500	130

The peak of the content of bioactive compounds coincides with the first period after the end of germination - 15-25 days after the end of germination. The high rate of phenolic compounds and antioxidant activity also occurs in the same period.

The results of the study confirmed the high degree of adaptability of the research breed in Kartli. The plants optimally passed the period from the end of germination to the full ripening of the grain. Such conditions created the basis for determining the optimal period of accumulation of bioactive compounds in test plants, which is, naturally, the peak of their commercial value.

As a result of the study, the optimal period was established 15-25 days after the end of germination. During this period, the maximum amount of phenolic compounds is synthesized in plants.

Conclusion. Wheat is the most important component of our existing identity. There are all resources in our country for raising the organoleptic quality of the main argument of its grain's – nutritional value.

Proven methods of selection and reasonable agro-techniques create a solid foundation for the wider role of Georgian wheat as our main food guarantee, as well as for its widespread use in the service of human health protection.

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ჰექსაპლოიდი ხორბლების D გენომის *Wknox1* გენის თავისებურებები

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აბსტრაქტი. წარმოდგენილი კვლევის მიზანია ჰექსაპლოიდური ხორბლის (*Triticum aestivum* L.) გენეტიკური დახასიათება *Wknox1* გენის მეოთხე ინტრონისა და მეხუთე და მეექვსე ეკზონებს შორისი ინტრონის პჯრ პროდუქტების მიხედვით. 20 ჰექსაპლოიდური ხორბლის ნიმუშის *Wknox1d* უბნის მეოთხე ინტრონისა და *Wknox1b* მეხუთე და მეექვსე ეკზონებს შორისი უბნის პჯრ-ზე დაფუძნებული ჰაპლოტიპების ანალიზია წარმოდგენილი. *Wknox1b* უბნის მეხუთე და მეექვსე ეგზონებს შორისი უბნის პჯრ-ზე დაფუძნებულმა ჰაპლოტიპების ანალიზმა აჩვენა, რომ 157 ფწ ინსერციის ზოლი (588 ფწ) არის *T. turgidum* subsp. *durum* cv. "Langdon"-ში, CS-ში და 'წითელ დოლში'. ეს ზოლი არ აქვს ტეტრაპლოიდურ *T. turgidum* subsp. *carthlicum*-ს, *T. aestivum* L. subsp. *carthlicoides*-ს და *T. aestivum* subsp. *macha*-ს (M1–M13). რბილი ხორბლის *Wknox1d* უბნის მეოთხე ინტრონში დაფიქსირდა 122 ფწ ინსერცია. ეს ზოლი (411 ფწ) არ იყო ყველა ტეტრაპლოიდური ხორბლის ნიმუშში და დაფიქსირდა რბილი ხორბლის ყველა ქვესახეობაში. მახას ქვესახეობაში (11 ნიმუში) დაფიქსირდა 453 ფწ ზოლი. *Wknox1d* უბნის მეოთხე ინტრონისა და *Wknox1b* უბნის მეხუთე და მეექვსე ეკზონებს შორისი ინტრონის უბნების პჯრ პროდუქტების ანალიზი იძლევა ვარაუდის გაკეთების საშუალებას იმის შესახებ, რომ ჰექსაპლოიდური ხორბლის ორი ნიმუში, *T. aestivum* subsp. *macha* var. *Palaeocolchicum*-ი და var. *letshckumicum*-ი განსხვავდება მახას დანარჩენი ნიმუშებისაგან 42 ფწ ინსერციის

(AGTTTGCACACCTGAACATTTTGCATTATGTTCGGGAGCCTA) არსებობით *Wknox1d* ინტრონში. ამ შედეგის ერთი შესაძლო ახსნა არის ის, რომ შესაძლებელია ჰექსაპლოიდური ხორბლის ფორმირებაში ორმა *Aegilops tauschii* Coss.-ის (A) და (B) ფორმამ მიიღო მონაწილეობა D გენომის გავლით: *Ae. tauschii* (A)—მახა (1–5, 7, 8, 10–12), და *Ae. tauschii* (B)—მახა M6, M9, *T. aestivum* subsp. *aestivum* 'CS' და 'წითელი დოლი'.

The Peculiarity of *Wknox1* Gene of Hexaploid Wheats (*Triticum aestivum* L.) D Genome

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Abstract. The aim of the presented study is a genetic characterization of the hexaploid wheat (*Triticum aestivum* L.) by PCR-based haplotype analysis of the fourth intron of *Wknox1d* and of the fifth-to-sixth-exon region of *Wknox1b* of 20 hexaploid wheat samples. PCR-based haplotype analysis of the fourth intron of *Wknox1d* and of the fifth-to-sixth exon region of *Wknox1b* of all 20 hexaploid wheat samples was carried out. Fifth-to-Sixth Exon Region of *Wknox1b* PCR-based haplotype analysis of the fifth-to-sixth exon region of *Wknox1b* showed that the 157-bp MITE inserted band (588 bp) is present in *T. turgidum* subsp. *durum* cv. 'Langdon', CS, 'Red Doly'. This band is absent in tetraploid *T. turgidum* subsp. *carthlicum, T. aestivum* L. subsp. *carthlicoides*, *T. aestivum* subsp. *macha* (M1–M13). In the fourth intron of Wknox1d in common wheat, a 122-bp MITE insertion has been reported. The MITE containing band (411 bp) was missing in all tetraploid wheat accessions and was observed in all subspecies of common wheat. In the case of subsp. *macha* (11 samples) the 453 bp band was observed. PCR-based haplotype analysis of the fourth intron of *Wknox1d* and the fifth-to-sixth-exon region of *Wknox1b* provides an opportunity to make an assumption that hexaploid wheats *T. aestivum* subsp. *macha* var. *palaeocolchicum* and var. *letshckumicum* differ from other macha samples by the absence of a 42 bp insertion (AGTTTGCACACCTGAACATTTTGCATTATGTTCGGGAGCCTA) in the fourth intron of *Wknox1d*. One possible explanation for this observation would be that two *Aegilops tauschii* Coss. (A) and (B) participated in the formation of hexaploids through the D genome: *Ae. tauschii* (A) - macha (1–5, 7, 8, 10–12), and *Ae. tauschii* (B) - macha M6, M9, *T. aestivum* subsp. *aestivum* cv. 'Chinese Spring' and cv. 'Red Doly'.

Keywords: *Triticum aestivum* L.; Sequencing; PCR; Indels; *Wknox1* gene

Introduction

Wheat is the leading grain crop in the world. It originated in the Fertile Crescent approximately 10,000 years ago and has since spread worldwide. There are 2 biological species of hexaploid wheat - *T. aestivum*, genome BBA^uA^uDD and *Triticum zhukovskyi* Menabde & Ericz., $GGA^uA^uA^mA^m$. *T. zhukovskyi* and its predecessors (*Triticum monococcum* L. and *Triticum timopheevii* (Zhuk.) Zhuk.) form a separate lineage irrelevant to the evolution of the principal wheat lineage, which is formed by *T. aestivum* and its predecessors *Aegilops tauschii* Coss. and *Triticum turgidum* L. (Dvorak et al. 2012).

T. aestivum lineage is divided into domesticated hulled and free-threshing lineages. Free-threshing includes *T. aestivum* subsp. *aestivum*, *T. aestivum* subsp. *compactum* (Host) Mackey, *T. aestivum* subsp. *sphaerococcum* (Percival) Mackey, *T. aestivum* subsp. *carthlicoides* nom. nud. (Table 1; Table 2).

Table 1. List of hexaploid wheats

	Species	**Genome**	**Plasmon**
Hulled *T. zhukovskyi*		$GGA^uA^uA^mA^m$	G
Hulled *T. aestivum*			
	T. aestivum subsp. *spelta* Thell.	BBA^uA^uDD	B
	T. *aestivum* subsp. *macha* (Dekapr. et Menabde) Mackey		
	T. aestivum subsp. *vavilovii* Jakubz.		
Free-threshing *T. aestivum*	*T. aestivum* subsp. *aestivum*		
	T. aestivum subsp. *compactum* (Host) Mackey		
	T. aestivum subsp. *sphaerococcum* (Percival) Mackey		
	T. aestivum subsp. *carthlicoides* nom. nud.		

Table 2. Jacubciner's classification system (1958) According to Yen a. Yang (Yang 2020)

Congretio	**Species**	**Distribution areas**	**Habits**
Hexaploidea	**Cultivated hulled**		
2n = 42	*T. zhukovskyi* Men.et Er.	Georgia	Springness
	T. macha Dek.et Men.	Georgia	Winterness
	T. spelta L.	Iran, south Germany, Spain	Winterness, Springness
	Cultivated naked grain		
	T. aestivum L.	All over the world	Springness, winterness, half winterness
	T. compactum Host	Transcaucasia, Kazakhstan, Asia Minor, Afghan, Chile	Springness, winterness, halfwinterness
	T. vavilovii Jakubz.	Armenia	Winterness
	T. sphaerococcum Perc.	Pakistan, India	Springness

Hexaploid wheat *T. aestivum* subsp. *carthlicoides* was found by Kuckuck (1979) near the border of Turkey, Armenia and West Georgia. This hexaploid wheat showed the subsp. *carthlicum*-like spike morphology. Hulled lineage includes spelt wheat *T. aestivum* subsp. *spelta* Thell., macha *T. aestivum* subsp. *macha* (Dekapr. et Menabde) Mackey and *T. aestivum* subsp. *vavilovii* Jakubz. In hulled

wheats glumes tenaciously enclose seeds, and strong mechanical force is needed to liberate seeds from glumes during threshing.

According to Dekaprelevich Georgia is characterized by the largest number of cultivated wheat species in the world; altogether, 12 species of wheat were found here. Only 3 narrowly endemic species *Triticum abyssinicum* Vav., *T. sphaerococcum* and *T. spelta* are absent (Dekaprelevich 1941).

South Caucasus (notably Georgia) and their earlier residents played an important role in wheat formation. 17 domesticated species and subspecies of *Triticum* are known. Georgian endemic wheat species include one *Triticum* species and four subspecies (Menabde 1948, 1961, Hammer et al. 2011):

1. *Triticum turgidum* subsp. *palaeocolchicum* (Menabde) A. Love
2. *Triticum turgidum* subsp. *carthlicum* (Nevski) A. Love
3. *Triticum timopheevii* subsp. *zhukovskyi* (Menabde & Ericzjan) L. B. Cai
4. *Triticum zhukovskyi* Menabde & Ericzjan
5. *Triticum aestivum* subsp. *macha* (Dekapr. & Menabde) McKey

All these cultivated species and subspecies have been found in West Georgia, except subsp. *carthlicum* which was distributed in East Georgia as well. All these species and subspecies grew in the territory of Georgia until the middle of the last century.

The 'Wheat Enigma"' was termed the observation that wild predecessors of five Georgian endemic wheat subspecies are found in Fertile Crescent quite far from the South Caucasus (Gogniashvili et al. 2015; Beridze 2019). One possibility to explain 'Wheat Enigma' is that speakers of Proto-Georgian language could be moved to the Mesopotamia after migration from Africa to the Arabian Peninsula where wheat was domesticated. Further they could migrate to South Caucasus together with domesticated wheat subspecies (Beridze 2019; Pagel et al. 2013).

The examination of genealogical data provides insights into the evolutionary history of a species. The wide application of gene genealogies for evolutional studies in plants is identifying DNA sequences with levels of ordered variation within chloroplast, mitochondrial, or nuclear genomes (*Shall an Olsen 2000).* Traditionally, extranuclear DNA, such as chloroplast DNA (cpDNA) is considered as an effective tool of genealogic studies (Yamane and Kawahara 2005; Matsuoka et al. 2005; Tabidze et al. 2014; Gogniashvili et al. 2015).

Another effective tool of gene genealogies study for *Triticum* species is three homoeologous loci of wheat *Wknox1* gene, functioning at shoot apical meristems (SAM) (Morimoto et al. 2005). A comparative study of the three *Wknox1* genomic sequences revealed accumulation of numerous mutations particularly in the fourth intron and the 5'-upstream region. Later Takumi a. Morimoto (2015) reported the discovery of a new allele for the 5th-to-6th exon region of the *Wknox1b KNOTTED1*-type homeobox gene in a common wheat subspecies (*T. aestivum* subsp. *Carthlicoides*).

The purpose of the present investigation was to carry out the comparative analysis of complete cpDNA sequences of 20 hexaploid wheat accessions (*T. aestivum* subsp. *aestivum*, 2 samples; *T. aestivum* subsp. *compactum*, 2 samples; *T. aestivum* subsp. *sphaerococcum*, 1 sample; *T. aestivum* subsp. *carthlikoides*, 4 samples; *T. aestivum* subsp. *spelta*, 3 samples; *T. aestivum* subsp. *macha*, 6 samples; *T. aestivum* subsp. *vavilovii*, 2 samples.

The second aim of the present investigation was to carry out a PCR-based haplotype analysis of the 4th intron of *Wknox1d* and of the 5th-to-6th exon region of *Wknox1b* of all 20 hexaploid wheat samples.

Materials and Methods

Plant material, DNA isolation

The seeds of hexaploid wheat samples were received from the seed bank of the Agricultural University of Georgia (the late Prof. P. Naskidashvili) and Institute of Botany (Ilia State University, Tbilisi, Georgia) (ISU); U.S. National Plant Germplasm System (GRINGlobal); The National BioResource Project - WHEAT Centre (Graduate School of Agriculture, Kyoto University, Japan); The Scientific Research Center of Agriculture (SRCA) (Georgia) and Tel Aviv University (Israel). The seeds were germinated in water at room temperature. Total genomic DNA extraction from young leaves are described earlier (Gogniashvili 2018; Li et al. 2018). For detection of SNP (single nucleotide polymorphism) and Indels (insertion/deletion) and phylogeny tree construction computer programs Mafft and Blast were used (Katoh 2019; Altschul 1990).

PCR analysis of three homoeologous wheat Wknox1 gene

The genomic sequences of the *Wknox1d* 4th intron regions were amplified by PCR using the primer pair of Takumi a. Morimoto (2005): 5'-AAAAAAAAGGTTAAATGGAC-3' and 5'-ACCTTATACATGATTGGGAA-3'. The *Wknox1b* 5th-to-6th exon region was amplified by PCR using the primer pair 5'-GCTGAAGCACCATCTCCTGA-3' and 5'-CATGTAGAAGGCGGCGTTAG-3'. The DNA fragments (PCR products) were excised from the agarose gel. The DNA extraction and purification from the agarose gel was done by the QIAquick Gel Extraction Kit (QIAGEN). PCR products were purified with GenElute PCR Clean-Up Kit (Sigma-Aldrich), dye labeled using a Big Dye Terminator Kit (Applied Biosystems), and sequenced on Applied Biosystems 3700 genetic analyzer (Laboratory Services Division of the University of Guelph, ON, Canada).

Results

PCR analysis of three homoeologous loci of wheat Wknox1 gene

Wknox1d 4th intron region

In the present investigation, the genomic sequences of the *Wknox1d* 4th intron regions were amplified by PCR using the primer pair of Takumi a. Morimoto (2015) (Table 3). A common wheat, *T. aestivum* subsp. *aestivum* cv. 'Chinese Spring' (CS), and a durum wheat, *T. turgidum* subsp. *durum* cv. 'Langdon' (Ldn), were used for PCR as control and the amplified DNA fragments were visualized on an agarose gel. In the 4th intron of *Wknox1d* in common wheat, a 122-bp MITE insertion has been reported (Morimoto et al. 2005). The MITE-containing band (411 bp) was missing in all tetraploid wheat accessions and was observed in all subspecies of common wheat. In the case of subsp. *macha* (11 samples) the 453 bp band was observed. In the case of two macha samples (M6 and M9) the MITE-containing band typical for other hexaploid subspecies (411 bp) were detected.

Table 3. PCR-based haplotype analysis of the 4th intron of *Wknox1d*. A 122-bp MITE insertion specifically observed at the D-genome locus of *Wknox1* generates the upper bands (411 bp) in hexaploid wheat accessions (except *Triticum aestivum* L. subsp. *compactum*) and 453 bp in macha accessions

Sample	**PCR product, bp**				
	277, 284	375	400	411	453
Triticum aestivum subsp.*aestivum* cv. 'Chinese Spring' (CS)	+	+		+	
Triticum aestivum subsp. *aestivum* var. *ferrugineum* (Alef.) Mansf. cv. 'Red Doly' (RD)	+	+		+	
Triticum aestivum subsp. *carthlicoides* (Cc1, Cc2. Cc3. Cc4)	+	+		+	
Triticum aestivum subsp. *compactum* (Com2)	+				
Triticum aestivum subsp. *compactum* (Com1)	+	+		+	
Triticum aestivum subsp. *sphaerococcum* (Sph1)	+	+		+	
Triticum aestivum subsp. *macha* (M6, M9)	+	+		+	
Triticum aestivum subsp. *macha* (M1, M2, M3, M4, M5, M7, M8 M10, M11, M12)	+		+		+
Triticum aestivum subsp. *spelta* (splt1, splt2, splt3)	+	+		+	
Triticum vavilovii (Arm) (Vav1)	+	+		+	
Triticum vavilovii (Eur) (Vav2)	+	+		+	
Triticum turgidum subsp. *carthlicum* var. *rubiginosum*	+				
Triticum turgidum subsp. *durum* cv. 'Langdon' (Ldn)	+				

In 2% agarose gel PCR-amplified hexaploid wheat 4th intron of *Wknox1d* DNA region gives 4 bands: N1 (280 bp), N2 (375 bp), N3 (411 bp), band N4 (453). Bands N3 and N4 were cut out and sequenced. In the case of band N4 (453) 42 bp insertion was detected in the position 7009 – AGTTTGCACACCTGAACATTTTGCATTATGTTCGGGAGCCTA (Fig. 1).

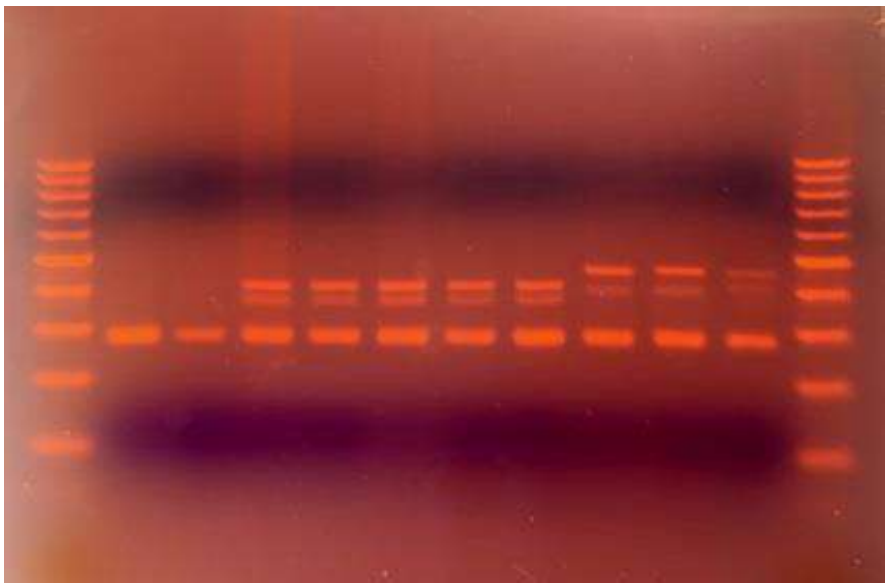

Figure 1. 2% agarose gel electrophoresis of PCR-amplified hexaploid wheat 4th intron of *Wknox1d* DNA region.
Lanes: 2 *T. turgidum* subsp. *carthlicum,* 3 *T. turgidum* subsp. *durum* (Ldn), 4 *T. aestivum* subsp. *aestivum* (CS), 5 *T. aestivum* subsp. *carthlicoides,* 6 *T. aestivum* subsp. *carthlicoides,* 7 *T. aestivum* subsp. *macha* (M_6), 8 *T. aestivum* subsp. *macha* (M_9), 9 *T. aestivum* subsp. *macha* (M_1), 10 *T. aestivum* subsp. *macha* (M_2), 11 *T. aestivum* subsp. *macha* (M_3); Lanes 1, 12 - 100 bp DNA marker

Discussion. It is widely believed that the birthplace of *T. aestivum* is a region from Transcaucasia to southwestern Caspian Iran (Dvorak et al. 1998). The first step in the evolution of cultivated wheat was the formation in the Northern Mesopotamia of a tetraploid species with an A^uA^uBB genome (Schneider et al. 2008). Approximately 7000 years ago, the hexaploid bread wheat *T. aestivum* L. (BBA^uA^uDD) arose in the southwestern Caspian Iran and Transcaucasia by allopolyploidization of the cultivated Emmer wheat *Triticum dicoccum* Schrank with the Caucasian *Ae. tauschii* (Dvorak et al. 1998; Dubcovsky and Dvorak 2007; Wang et al. 2013; Yorgensen e al. 2017; Allaby et al. 2017).

It should be noted that *Ae. tauschii* was found in the western Caucasus as well (Ketskhoveli 1969; Kolakovskii 1981). According to authors "*Ae. squarrosa* (*Ae. tauschii*) grows in lowlands and mountain foothills, rarely in dry and humid silty areas up to the middle of the mountain, mainly in desert, semi-desert and field vegetation, as well as weeds in Abkhazia, Samegrelo, Imereti, Guria, Adjara, Kartli, in outer Kakheti, Gardabani" (Ketskhoveli 1969). It can be assumed that two *Ae. tauschii* (A) and (B) participated in the formation of hexaploids through the D genome: *Ae. tauschii* (A) - macha (1-5, 7, 8, 10-12) - and *Ae. tauschii* (B) - macha M6, M9, CS, RD (Table 3).

T. aestivum subsp. *catrhlicoides* most likely originated in Western Transcaucasia (Kukuck 1979); In 1967 Kuckuck has found populations with *carthlicium* and *carthlicoides* types near the border of East Turkey (Ardahan and Kars Provinces, Turkey) and West Georgia. This hexaploid wheat accession showed the subsp. *carthlicum*-like morphology. Subsp. *carthlicum* was proposed to have originated from spontaneous hybridization between subsp. *carthlicoides* and cultivated emmer wheat, *T. turgidum* subsp. *dicoccon* (Schrank) Thell. Subsp. *carthlicoides* should be considered as the original and elder genotype from which genes for the particular morphology of the ear were transferred together with the Q-factor to *T. carthlicum* (Kukuck 1979; Takumi and Morimoto 2015). According to Kuckuck this region was distinguished by a tremendous genetic variation in wheat including *T. dicoccum, T. carthlicum* and *T.*

aestivum subsp. *macha* (Kukuck 1979). It can be assumed that subsp. *carthlicoides* took partin the formation of the subsp. *macha* as an ancestor.

One of the 4 subspecies of wheat detected in Georgia is hexaploid domesticated, hulled wheat *T. aestivum* subsp. *macha* (Gogniashvili et al. 2018). This subspecies was detected in West Georgia in 1928 and described by Dekaprelevich and Menabde (Dekaprelevich and Menabde 1932). It is endemic to Georgia and is cultivated along with tetraploid West Georgian wheat (*T. turgidum* subsp. *palaeocolchicum*) (Dorofeev et al. 1979).

PCR-based haplotype analysis of the 4th intron of *Wknox1d* and the 5th-to-6th exon region of *Wknox1b* of all 20 hexaploid wheat samples was carried out. PCR-based haplotype analysis of the 4th intron of *Wknox1d* and the 5th-to-6th exon region of *Wknox1b* provide an opportunity to make an assumption that hexaploid wheats *T. aestivum* subsp. *macha* var. *palaeocolchicum* and var. *letshckumicum* differ from other macha samples by the absence of 42 bp insertion in the 4th intron of *Wknox1d*. It can be assumed that two *Ae. tauschii* (A) and (B) participated in the formation of hexaploids through the D genome: *Ae. tauschii* (A) - macha (1-5, 7,8,10-12) - and *Ae. tauschii* (B) - macha M6, M9, *T. aestivum* subsp. *aestivum* cv. 'Chinese Spring' and cv. 'Red Doly'. Another possible explanation would be that the insertion might have arisen during the diversification process of common wheat after polyploidization.

In recent years, wheat yields have not increased per hectare, which is important due to the growing world population. Transferring agronomically important genes from wild relatives to common wheat has been shown to be an effective genetic resource for hexaploid wheat improvement. Advances in new technologies have made the complete wheat reference genome available, which offers a promising future for the study of wheat improvement that are essential to meet global food demand (Li et al. 2018).

Conclusions

Based on the 4th intron of *Wknox1d* hexaploid wheats *T. aestivum* subsp. *macha* var. *palaeocolchicum* and var. *letshckumicum* actually differ from other macha samples by the absence of 42 bp insertion in the 4th intron of *Wknox1d*.

Two *Aegilops tauschii* Coss. (A) and (B) participated in the formation of hexaploids through the D genome: *Ae. tauschii* (A) - macha (1-5, 7, 8, 10-12) - and *Ae. tauschii* (B) - macha M6, M9, *T. aestivum* subsp. *aestivum* cv. 'Chinese Spring' and cv. 'Red Doly'.

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ხორბლის მოყვანასთან დაკავშირებული ეთნომუსიკალური ტრადიციები აღმოსავლეთ საქართველოში

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საქართველო მიწათმოქმედების უძველესი ქვეყანაა. ამაზე არაერთი უძველესი ქართული თუ უცხოური საისტორიო წყარო თუ ლიტერატურული ძეგლი და მათში დაცული ცნობები მეტყველებს. მნიშვნელოვანია ისიც, რომ საქართველოს სხვადასხვა კუთხემ შემოინახა შრომის იარაღებისა თუ შრომის პროცესებთან დაკავშირებული რიტუალების მრავალფეროვანი სახეობა და სახელწოდება.

ერთ-ერთი უმთავრესი კულტურა, რომელიც ოდითგან საქართველოში მოჰყავდათ, ხორბალი და მისი ნაირგვარი ჯიშები იყო. საქართველოს ტერიტორიაზე შემორჩენილი ხორბლის ყველაზე მეტად ენდემური სახეობანი ძველი საქართველოს სამიწათმოქმედო კულტურის მაღალ დონეზე მეტყველებს. ხორბალი მოჰყავდათ მთაშიც და ბარშიც, - ამის მიხედვითაც განასხვავებდნენ მარცვლეულის ჯიშებს.

ისევე როგორც ყოფის ყველა მომენტი, საქართველოში შრომის პროცესიც მუდამ სიმღერით იყო თანხლებული. სოციალური გარემოს ცვლილებებისა და მზარდი ტექნიკური პროგრესის მიუხედავად, დღემდე შემოგვრჩა *გუთნური, კალოური, სანიავებელი, მუშური, ოდური* თუ *მკის* სიმღერები.

შესრულების წესიდან და გარემოდან გამომდინარე, აღმოსავლეთ საქართველოში გვაქვს ხორბლის მოყვანასთან დაკავშირებული ერთ, ორ და სამხმიანი შრომის სიმღერები. ერთხმიანია ძირითადად *ურმულები* და *გუთნურები,* ხოლო ორ და სამხმიანია კოლექტიურ შრომასთან დაკავშირებული სიმღერები, რომლებიც ადამიანთა ჯგუფის მიერ სრულდება: *მუშური, კალოური* და *მკის* სიმღერები.

მრავალხმიანობის ტიპებიდან თითქმის ყველგან გაბატონებულია ბურდონული მრავალხმიანობა. ზოგიერთ შემთხვევაში შეიძლება შევხვდეთ ოსტინატური ტიპის მრავალხმიანობის ნიმუშებსაც (ფრაგმენტულად თუ მთელი სიმღერის მანძილზე).

სიტყვიერი ტექსტები შინაარსობლივად მრავალფეროვანია. უფრო ხშირად ისინი შრომის პროცესს ასახავენ და მომუშავეთა წახალისებას ემსახურებიან. აქ მნიშვნელოვანია

შეძახილებიც: ისინი ხან გამამხნევებელი სიტყვები თუ შორისდებულებია, ხან კი მწყობრად, ერთგვაროვანი მეტრ-რიტმით განმეორებადიჩანართები, - სილაბური ჯგუფები, - რომლებიც შრომის რიტმის ორგანიზებაში ეხმარებიან მომუშავეთ. შრომის პროცესის ზოგიერთ მონაკვეთში სატრფიალო და საშაირო ტექსტებიც ჩნდება.სამუშაოსდასრულებისას საფერხულო ან საცეკვაო სიმღერებიც ითქმოდა.

შრომის პროცესებთან არაპირდაპირადაა დაკავშირებული სხვადასხვა სახის რწმენა-წარმოდგენები და მათი შესატყვისი სიმღერები, როგორიცაა, მაგალითად, ე. წ. საწესო შრომის სიმღერები, რომლებიც სამუშაოზე გასვლის წინა რიტუალის დროს სრულდებოდა, ან - ამინდის მართვის სიმღერები (ლაზარე, გონჯა), რომლებიც უამინდობის შემთხვევაში შესაბამისი რიტუალის თანხლებით სრულდებოდა.

დღეისათვის შრომის სიმღერების სიცოცხლისუნარიანობა არა ბუნებრივ ყოფაში, არამედ, აუდიოჩანაწერებისა და ეთნოფორების ცოცხალი მეხსიერების მეშვეობით, სცენაზე განმტკიცდა.

საკვანძო სიტყვები: ნამგლური, მუშური, ჰეგი ოგა, გუთნური, კალოური, კევრული.

Ethnomusical Traditions Related to Wheat Cultivation in East Georgia

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Georgia is an ancient agricultural country. This is evidenced by many ancient Georgian and foreign historical sources, literary monuments and the references preserved in them. It is also significant, that different types and names of tools and rituals related to labor processes have survived in different parts of Georgia.

One of the most important crops grown in Georgia since ancient times was wheat and its different varieties. The most endemic types of wheat preserved in the territory of Georgia speak of the high level of farming in ancient Georgia. Wheat was grown in both highland and lowland regions – depending on this, varieties of grain were distinguished.

Like every moment of daily life, work process in Georgia was always accompanied by a song. Despite the changes in the social environment and the growing technological progress, the songs *Gutnuri, Kalouri, Saniavebeli, Mushuri, Oduri* and *Mkis* have survived to this day.

Depending on the performance manner and environment, in East Georgia there are single, two- and three-part labor songs related to the cultivation of wheat. Urmuli and Gutnuri songs are mostly single-part; whilst the songs related to collective work, which are performed by a group of people, such as *Mushuri, Kalouri* and *Mkis* are two - and three-part.

Of the polyphony types, *Bourdon* polyphony predominates almost everywhere. In some cases *Ostinato*-type polyphony is encountered (fragmentarily or throughout the entire song).

Verbal texts are varied in content. Most often, they reflect the labor process and serve to encourage workers. Here also important are exclamations: sometimes these are words of encouragement or interjections; sometimes, the ordered, repeated inserts with uniform meter and rhythm, – syllabic groups, – which help the workers organize the rhythm of work. In some sections of labor process, love and humorous texts also appear. Upon completion of work, round-dance and dance songs were also performed.

Indirectly related to work process are different types of beliefs and their corresponding songs, e.g. the so-called rite work songs, performed during the ritual before setting to work, or the songs for weather

management (*Lazare, Gonja*), which were performed in the event of bad weather, accompanied by the corresponding ritual.

To date, the viability of labor songs has been reinforced not in their natural environment, but on the stage through audio recordings and the living memory of tradition bearers.

Key words: Namgluri, Mushuri, Hegi-Oga, Gutnuri, Kalouri, Kevruli.

Georgia is an ancient agricultural country. This is evidenced by many ancient Georgian and foreign historical sources and literary monuments and the references preserved in them. Significant references to the existence of agriculture among Georgian tribes from ancient times are preserved in foreign and ancient Georgian historical sources, in the descriptions of traveling missionaries, literary monuments (literary works of Vakhushti Bagrationi, King Archil, Teimuraz I, Teimuraz II, Alexandre Jambakur-Orbeliani and others), in a number of Georgian legends and narrations.

Ancient agricultural tools, unearthed by archaeological excavations, their dialectally diverse names, the abundance and variety of rituals related with labor processes in different parts of Georgia - speak of Georgia as an ancient agricultural country.

One of the most important crops grown in Georgia since ancient times was wheat. The most endemic species of wheat surviving on the territory of Georgia testify to the antiquity and high level of agriculture in Georgia. Wheat was cultivated in both highland and lowland regions of the country - according to this, varieties of grain were distinguished.

Like every moment of daily life, labor process in Georgia was always accompanied by singing.

From the first decade of the 20th century, dozens and hundreds of labor songs were documented e.g. in the works of Dimitri Arakishvili, the founder of Georgian ethnomusicology, in the mountains and lowlands of East Georgia. My paper is mainly based on the expedition materials and researches of folklorist Giorgi Svanidze in the 1910s, as well as ethnographic materials and monographic publications of ethnomusicologists Tamar Mamaladze and Giorgi Garakanidze.

Despite the changes in social environment and growing technical progress, the songs such as *Gutnuri, Kalouri, Saniavebeli, Namgluri, Mushuri, Oduri* or *Mkis* have survived to this day.

The surviving audio recordings and music notations of Mtiuletian and Mokhevian variants of *Namgluri* musically clearly relate to Kartli-Kakhetin examples of *Namgluri*, however they are at different stages of development.

Examples of traditional music also confirm cultivation of particular varieties of wheat and grain crops in mountain regions.

Of polyphony types, bourdon polyphony predominates in labor songs almost everywhere. In some cases, we also encounter the examples of ostinato type polyphony – fragmentarily or throughout the song, when the same intonation or melodic formula is repeated in one or all voice-parts with the same frequency (especially often in bass-part).

Depending on the rule of performance and the environment, in East Georgia there are single-, two- and three-part labor songs related to the cultivation of wheat. *Urmuli* and *Gutnuri* songs are mostly single-part, two- and three-part examples are related to collective work, and are performed by a group of people: *mushuri*, threshing and reaping songs.

Gutnuri (plowing), *kalouri* (threshing) and *kevruli* (threshing board) songs are included in the group of *Orovela*. According to Tamar Mamaladze, in Kartli-Kakheti there are three types of Orovela songs:

- *Kalos orovela – Kevruli*, called *Kalospiruli* or *Kalouri* in some places;
- *Gutnis orovela* – ploughing song;
- Winnowing song

The structure and musical characteristics of Kakhetian and Kartlian orovelas are basically identical. Folk singers distinguished two kinds of orovela – "Banit orovela" (orovela with bass) and orovela to be sung alone. According to tradition bearers *Gutnuri orovela* was sung together with bass-part, whilst the man on the threshing board would sing it alone…

The melodies of ploughing Orovela songs are mostly recitative, in minor mode; the meter is rhythmically varied and lyrical, melodious in character. The meter-rhythm of these songs obeys the

meter of the verse, is based on the syllables of the verse. They are characterized in improvisation and variation of the melody, which gives more freedom to a singer and his creative imagination. In general, improvisation, creativity and variety are main performance features of East Georgian labor songs. On the one hand, people safeguarded and preserved traditional intonations and forms of songs, the rules and manner of their performance, but at the same time, as is usually the case in folk performance, they "flew freely" in the musical tissue, easily creating new variants during each new performance. Singing facilitated labor process and encouraged the workers.

Process of reaping included different moments: reapers heading to the field, reaping of the field, sharpening of sickles, a lunch break, finishing the work and heading back home. Each of these was accompanied by a corresponding song. Reaping was accompanied with *namgluri* songs – when sharpening sickles and reaping the cornfield; round-dance or dance songs were sung upon completing the work.

In Kakheti, reaping process is accompanied with several songs, corresponding to certain moments of the process. Here is what a tradition bearer told Tamar Mamaladze: "When we got to the cornfield, we would cut a loaf of bread and drink a glass of wine each. We would say a prayer, select the best reapers as leaders, and then disperse in rows across the cornfield. Each row was led by its leader. The leader was followed by reapers. Each reaper had a sheaf collector to tie sheaves… First, we would sharpen sickles and sing *Namgluri* or *Namgalo*. When we started working, we would sing short *Mushuri*, then *Haralalo*… These were followed by faster songs: first *Herio* and, when the labor process accelerated we would compete with each other and sing *Hegi-oga.* During both labor and singing, one was the leader..."

When considering a labor song as an ethnomusical example, along with musical parameters, we certainly take into account **verbal text,** environment of performance and purpose.

Structure of song lyrics, content of poetic text, which is organically combined with music, plays no less important role than the musical side – melody, rhythm and meter. Verbal texts of labor songs are diverse in content. Lively, free improvisation is characteristic of musical and verbal texts; although traditional verses, associated with specific songs, are also encountered in labor songs. For instance: *Aghzevans tsaval marilze* is only suitable for *Urmuli*, *Gadi gamodi gutano* – only for *gutnuri*, etc. Frequently labor process is reflected in song lyrics. In this regard also important are exclamations: sometimes these are words of encouragement or interjections, sometimes, orderly repeated inserts with uniform meter and rhythm, – syllabic groups, which help workers organize the rhythm of labor (*heka-oka, heg-og, hop-hopuna*, etc.).

In some parts of labor process, there also appear **love** and **humorous texts**. Sometimes it may seem that such lyrics do not correspond to the genre of the song. But, it must be said that these seemingly inappropriate, not infrequently scabrous texts carry the traces of ancient beliefs and sacred rituals, which were held to please the fertility deities.

Various beliefs and their corresponding songs are indirectly associated with labor processes, such as, for example, **ritual labor songs**, which were sung during the ritual before going to work, as well as the **songs for weather change** (*Lazare*, *Gonja*), which were performed as accompanied by an appropriate ritual in case of bad weather. **Women's role** in wheatfield works should be highlighted separately: in some places women reaped the cornfield, this was the case in East Georgian mountains – Gudamakari: my grandmother, Sopio Tsiklauri-Chokheli, used to tell me that they took children in cradles to the wheatfield, where they would feed them and put to sleep, not to waste time... In Racha, when a woman reaped a wheatfield alone, she would hum *Korkali* in a low voice and remember her deceased relatives or her past unlucky life...

Reaping songs were also widespread in West Georgia. Millet and corn cultures somewhat "oppressed" the tradition of wheat cultivation, and the songs corresponding to this activity gradually disappeared. However, the song *Odiada*, surviving in Lechkhumi to this day, belongs to the type of *mushuri* songs and was performed when sharpening sickles. Like most of such songs, *Odiada* is performed antiphonally, by two choirs.

In addition to the songs to be performed directly in labor process, the songs such as: *Mumli mukhasa, Shavlego, Chiti da petvi* and others were sung when having rest in the field or upon returning home.

Today, labor songs are no longer heard in wheatfield; their vitality, has been preserved through audio recordings and the living memory of tradition bearers, family and stage performances. However, we believe that restoration of traditional labor processes in the form of one-off projects, will allow for the revival of corresponding songs.

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შენიშვნები ხორბლის 4.5 ენდემური სახეობის შესახებ და მათი ადგილი *Triticum*-ის ახალ კლასიფიკაციაში

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აბსტრაქტი. საქართველო ცნობილია ხორბლის კულტივირებული სახეობების მრავალფეროვნებით. ჩანაწერები მოიცავს ინფორმაციას დღემდე შემორჩენილი სახეობების *Triticum aestivum* (6n), *dicoccum* (4n), *durum* (4n), *monococcum* (2n), *spelta* (6n) და *turgidum* (4n) sensu stricto და "ისტორიული" *T. carthlicum* (4n), *karamyschevii* (4n), *macha* (6n), *polonicum* (4n) და *timopheevii* (4n)-ის ფერმერების მიერ მოყვანის შესახებ. არც ერთი სხვა ქვეყანა ახლოსაც არ არის ამ მაჩვენებელთან. მათგან ორი საქართველოს ვიწრო-ლოკალური ენდემია (*karamyschevii* და *macha*), და კიდევ ორი, *carthlicum* და *timopheevii*, თითქმის ენდემურია - პირველი ცნობილია ასევე აღმოსავლეთ თურქეთიდან, მეორე ასევე სომხეთიდან და ნახჩევანიდან. ველური ნათესავი *T. boeoticum* დაფიქსირდა ბათუმთან ახლოს.

საქართველოს ენდემებიდან ოთხი დიდ ცვალებადობას აჩვენებს აღნუსხულ/ რეკონსტრუირებულ, ისტორიულ ფართობში ისევე როგორც აღწერილ სახეობისშიგა ვარიაციებში. მონაცემები *carthlicum*-ის ნათესების შეჯამებული ფართობის შესახებ არ არის, თუმცა მითითებულია სახეობის შიგა 52 ტაქსონის შესახებ; *karamyschevii*-სთვის მითითებულია 40 – 50 (სავარაუდოდ მეტი) ჰა და 3 ტაქსონი, *macha*-სთვის 50 ჰა და 49 ტაქსონი, ხოლო *timopheevii* -ისთვის 300 – 500 ჰა (ძირითადად „ზანდურის“ შემადგენლობაში *monococcum* ერთად) და 4 ტაქსონი. მიუხედავად ისტორიული კულტივაციისა, თესლის ex-situ კოლექციები ინარჩუნებს წვდომას ამ ენდემურ სახეობებზე, როგორც სასურველი თვისებების მქონე რესურსზე. გენბანკებში დაცულია 672 (*carthlicum*)-ის, 590 (*timopheevii*)-ის, 232 (*macha*)-ს და 75 (*karamyschevii*)-ის ნიმუში (Knüpffer 2009). ეს რიცხვები არ ნიშნავს გენეტიკური მრავალფეროვნების მაქსიმალურ წარმოდგენას.

„0.5“ საქართველოს ენდემი *T.* ×*zhukovskyi*, არის შემთხვევითი ჰიბრიდი რომელიც წარმოიქმნა ფართოდ გავრცელებული *T. monococcum* × ენდემური *T. timopheevii* -ის

შეჯვარების შედეგად. ჯერჯერობით მისი ხელახლა შექმნა შეუძლებელია რომ აღარაფერი ვთქვათ მის კომერციულ მოყვანაზე.

Triticum-ის ახალი კლასიფიკაცია აერთიანებს პლოიდურ დონეებს (2n, 4n, 6n) და გენომის ტიპებს (A, BA, GA, BAD), რის შედეგადაც მიღებულია მხოლოდ ხუთი სახეობა და 13 არატიპიური ქვესახეობა. საქართველოს ენდემები მიღებულია და დასახელებულია შემდეგნაირად: *T. aestivum* subsp. *macha, T. turgidum* subsp. *carthlicum, T. turgidum* subsp. *georgicum* და *T. timopheevii* subsp. *timopheevii*. *Triticum* × *zhukovskyi* არის ჰიბრიდების ნაცრისფერ ზონაში და მუტაციაზე დაფუძნებული "მეორადი" ტაქსონი.

საკვანძო სიტყვები: ენდემური, საქართველო, ნომენკლატურა, ტაქსონომია, ხორბალი

Notes on the 4.5 Georgian Endemic Wheat Species and Their Place in a New *Triticum* Classification

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Georgia is known for its diversity in cultivated wheat species. Records of farmer's cultivation include the extant *Triticum aestivum* (6n), *dicoccum* (4n), *durum* (4n), *monococcum* (2n), *spelta* (6n), and *turgidum* (4n) *sensu stricto*, and the "historic" *T. carthlicum* (4n), *karamyschevii* (4n), *macha* (6n), *polonicum* (4n), and *timopheevii* (4n). No other country comes close. Of these, two are strict Georgian endemics (*karamyschevii* and *macha*), and another two, *carthlicum* and *timopheevii*, are near-endemics – the former also known from eastern Turkey, the latter also from Armenia and Nakhchivan. The wild relative *T. boeoticum* has been recorded near Batumi.

The four (in shorthand) Georgian endemics show great variation in reported / reconstructed, historic acreage as well as in described infraspecific variation. Data for *carthlicum* indicate no estimation of acreage and 52 botanical taxa below species level; for *karamyschevii* 40 – 50 (likely more) ha and 3 taxa, for *macha* 50 ha and 49 taxa, and for *timopheevii* 300 – 500 ha (mainly as part of "Zanduri" in combination with *monococcum*) and 4 taxa. While historic in cultivation, *ex-situ* seed collections maintain access to these species as a source of desired traits. Gene banks hold 672 (*carthlicum*), 590 (*timopheevii*), 232 (*macha*), and 75 (*karamyschevii*) accessions (Knüpffer 2009). These numbers do not imply a maximum representation of genetic diversity.

The "0.5" Georgian endemic is the accidental hybrid *T.* ×*zhukovskyi*, resulting from the more widespread *T. monococcum* × the endemic *T. timopheevii*. It has thus far been impossible to re-create it, let alone cultivate it commercially.

A new classification of *Triticum* combines ploidy level (2n, 4n, 6n) and genome type (A, BA, GA, BAD), resulting in only five species and 13 non-typical subspecies. The Georgian endemics are accepted and named as: *T. aestivum* subsp. *macha*, *T. turgidum* subsp. *carthlicum*. *T. turgidum* subsp. *georgicum*, and *T. timopheevii* subsp. *timopheevii*. *Triticum* ×*zhukovskyi* is in the *Grey Zone* of hybrids and mutation-based "secondary" taxa.

KEYWORDS: Endemic, Georgia, nomenclature, taxonomy, wheat

INTRODUCTION

Georgia [საქართველო; Romanised: Sakartvelo] is known for its diversity in cultivated wheat species. The diversity of recorded farmer's cultivation includes seven extant wheat species and four "historic" ones. In addition, *Triticum polonicum* has been recorded in Georgia. This species is *de facto* historic but incidental, and even recent, commercial cultivation in the Messinia Region of the Peleponnese, Greece, was reported as the dominant part of a mixture with durum- and bread wheat (Ricos Thanopoulos, pers. comm.). The four historic wheats are all "Georgian" with two being strict endemics (*Triticum karamyschevii* and *T. macha*) – that is they have always been limited to the present-day boundaries of Georgia – while two others (*Triticum carthlicum* and *T. timopheevii*) are near-endemics as there has been cultivation in adjacent parts of northeast Turkey (*T. carthlicum*) or rare occurrences in Armenia and Nakhchivan, Azerbaijan (*T. timopheevii*). The recording of 12 cultivated wheat species in a single country is, however, unrivalled for the wheat genus. To this richness the natural occurrence of one of the four wild wheat relatives (the diploid *T. boeoticum*) has to be added through a record from near Batumi in the southwest of the country (*Kovarski* s.n. in herbarium WIR).

This paper investigates the four cultivated Georgian wheats in aspects of their correct names and their application as defined by a [designation of a] nomenclatural type, with in addition some considerations on their actual and/or potential distribution.

The notion of a "0.5 Georgian endemic" is intended to be a bit thought-provoking. It refers to the accidental hybrid *T.* ×*zhukovskyi*, only found in Georgia and resulting from what was likely a unique event. It is the natural hybridisation of the more widespread *T. monococcum* and the (near-) endemic *T. timopheevii* – a remarkable event as both parents are self-fertilising. However, the more pressing issue here is whether *T.* ×*zhukovskyi* is a cultivated species in the first place: it has thus far been impossible to even re-create it, let alone cultivate it commercially. This diverges fundamentally from my formulated definition of a "cultivated species," for which see below.

Correct naming of any botanical taxon is of prime importance. It allows for communication and understanding among practitioners in many fields – not only botany itself but plant breeding, seed banking, agronomy, pathology, entomology, farming systems analysis, palaeobotany, *et cetera* – and for them to be certain which name is intended for which entity. Better still: which name is the *correct* name that ideally should be adopted by all concerned? Unfortunately, this is easier desired than achieved.

To enable a practical outcome of a taxonomic revision of the wheat genus *Triticum* L. (Linnaeus 1753: 85) I formulated two Principles of which the second one applies here in particular (see below for more notes on both). In it, a "cultivated species" is defined as "the total of all *cultivars* developed within it, united under a *botanical* name and its application through a *nomenclatural type*." This unites both cultivated- and botanical taxonomy, as well as nomenclature; the latter two are the focus of this paper. To this end the guidance provided by the *International Code of Nomenclature for algae, fungi, and plants* (hereafter abbreviated as the *Code*; Turland *et al.* 2018) rather than that of the *International Code of Nomenclature for Cultivated Plants* (ICNCP or Cultivated Plant Code; Brickell *et al.* 2016) is emphasised.

The botanical *Code* outlines six *Principles* (nothing to do with my own ones), of which nos II, III, and IV are the most relevant. They state that names of taxonomic groups are determined by means of nomenclatural types (II), that the nomenclature is based upon priority of publication (III), and that each taxonomic group with a particular rank … can bear only one correct name, the earliest that is in accordance with the rules… (IV). Next to the Principles the *Code* consists of *Articles*, which contain rules that guide any scientist to apply the botanical group (in short: a *taxon*) names correctly. (There are also many *Recommendations*, but these do not "rule.") As will be demonstrated, the correct names at different ranks of the four Georgian cultivated species and the one hybrid display much confusion since their relatively recent initial publication.

Of note is that a name of a species is defined in the *Code* as a binary combination of the name of the genus followed by a single specific epithet (Art. 23.1), and that of a subspecific taxon is the combination of the name of a species and an infraspecific epithet with a connecting term denoting its rank (Art. 24.1). Names can then have either one of three statuses through the application of the Articles, which will determine what needs to change to lead to the only acceptable status: (1) that of a valid, and thus legitimate and acceptable one. Otherwise, (2) a name can be *illegitimate* (usually for either Art. 52.1

– being superfluous as an older one exists that should have been used under the rules, or Art. 53.1 – being a later homonym of an older name that is spelled exactly the same), or (3) a name can be *not validly published* (usually as ruled by Arts. 36, 37, 39, and 40) and then "does not exist" in terms of nomenclature. The (3) third option for any name includes the lack of rules for its citation, and their indication, in the nomenclature sections below, as "names" only (see, for example, *T. tubalicum* Dekapr.) whereas options (1) and (2) are labelled "synonyms". All options 1 – 3 are involved in the nomenclature of the *basionyms* and later synonyms of the Georgian taxa. (A basionym is the legitimate, previously published name on which a new combination or name at new rank is based, cf. the *Glossary* of the *Code*.) Another frequently encountered rule is that a name has no priority *outside the rank at which it is published* (Art. 11.2). This is demonstrated by the names of *T. turgidum* L. subsp. *georgicum* (Dekapr. & Menabde) Mac Key ex Hanelt and *T. karamyschevii* Nevski, which apply to the same taxon but are at different ranks.

Lastly, the *Code* defines in Articles 7 – 9 the function and designation of *nomenclatural types*, which govern the use of the name to which they are attached. When a type is chosen by another author than the one who published the name he or she is usually designating a *lectotype* (see Arts. 9.3, 9.12) when an element of the original publication can be used. When the only suitable elements appear ambiguous or insufficiently clear in their expression of essential characters, an *epitype* (see Art. 9.9) can be designated in addition to better fix the use of the name (see *T. aestivum* subsp. *macha*). When original material is not existing or missing a *neotype* (see Art. 9.8) can be selected (see *T.* ×*zhukovskyi*). The types fix the application of the name (see Art. 9.1), and thus of the taxon it represents. It is therefore surprising that this essential element left much to be desired in a well-studied genus such as *Triticum* – and that includes the 4.5 Georgian endemics!

THE GEORGIAN WHEAT TAXA

The Georgian wheat species are here presented alphabetically by species epithet, followed alphabetically by the final epithet (as there are two subspecies of *Triticum turgidum* involved). The presentation, including that of the Georgian hybrid *T.* ×*zhukovskyi*, includes the citation of the applied Articles where relevant. With all taxa the nomenclature is not exhaustive but offers an impression of its history. Accepted names at species- and subspecies level are both in **bold** to reflect a forthcoming *Triticum* revision that will offer parallel classifications of "species + subspecies + genome type" and only of "species"; see the chapter on a new wheat classification, below.

Triticum aestivum L. subsp. **macha** (Dekapr. & Menabde) Mac Key (1954: 586); Maisaia (2009: 53). – **Lectotype:** the illustrations with analysis of Figs 5 – 7 in Dekaprelevicz and Menabde's (1929) paper of *T. dicoccum* Schrank ex Schübl. var. *palaeoimeretinicum* Dekapr. & Menabde. **Epitype (Fig. 1):** the illustrations and photograph of ears of *T. macha* var. *palaeoimeretinicum* (Dekapr. & Menabde) Dekapr. & Menabde presented in Figs 5 and 6 of Dekaprelevicz and Menabde's (1932) paper. Both lectotype and epitype will be formally designated in a forthcoming publication by this author and Marine Mosulishvili (herbarium TGM of the Georgian National Museum, Tbilisi, Georgia). – Note: There is no type for the name *Triticum macha* at any rank. Therefore, in order to define it, the type of one of its included varieties, *palaeoimeretinicum* (Dekapr. & Menabde) Dekapr. & Menabde, has been selected instead. This name was originally published under *T. dicoccum* and was selected because the variety was reportedly the most widespread and occurred as the "prevailing form".

Basionym, selected homotypic synonyms and names:

Triticum dicoccum Schrank ex Schübl. var. *palaeoimeretinicum* Dekapr. & Menabde (Dekaprelevicz & Menabde 1929: 234); Supatashvili (1929: 93; "var. *palaeoimeretinicum*, placed recently apart by M-rs L. Dekaprelevich and V. Menabde"). The basionym.

Triticum macha Dekapr. & Menabde (Dekaprelevicz & Menabde 1932: 14).

Triticum macha Dekapr. & Menabde var. *palaeoimeretinicum* (Dekapr. & Menabde) Dekapr. & Menabde (Dekaprelevicz & Menabde 1932: 23, "*palaeoimereticum*").

Triticum macha Dekapr. & Menabde group *normale* Dekapr. & Menabde (Dekaprelevicz & Menabde 1932: 20, 42), **not validly publ.** (Art. 26.2). – Note: Dekaprelevicz and Menabde divided their new *T. macha* into two groups, *densiusculum* Dekapr. & Menabde and *normale*. From the context (and the epithet itself) it is obvious the latter name was intended for the "typical" varieties and *macha* should

have been used.

Triticum spelta L. subsp. *macha* (Dekapr. & Menabde) Dorof. (Dorofeev 1966: 30, 33), **not validly publ.** (Art. 41.5).

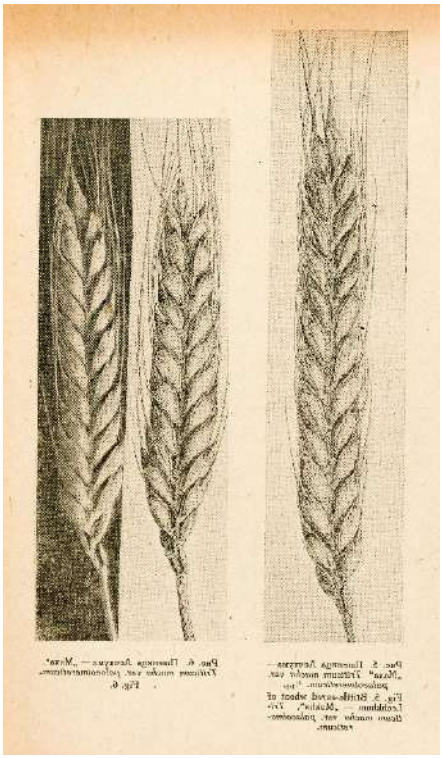

Fig. 1. The epitype of *T. aestivum* subsp. *macha*: the illustrations and photograph of ears of *T. macha* var. *palaeoimeretinicum* presented in Figs 5 and 6 of Dekaprelevicz and Menabde's (1932) paper. PHOTO: PAUL LITTLE.

Other names at species level:

Triticum tubalicum Dekapr. (Dekaprelevicz 1942b: 445); Dekaprelevicz (1954: 55, "*Tubalicum*" and under "conspecies" *macha*), **not validly publ.** (Art. 39.1). – Voucher not indicated.

Triticum imereticum Dekapr. (Dekaprelevicz 1942a: 921); Dekaprelevicz (1942b: 446, under "conspecies" *macha*), **not validly publ.** (Art. 39.1). – Voucher not indicated.

DISTRIBUTION. A native of western Georgia as part of an "old culture" (Dekaprelevicz 1961: 19). Its cultivation was considered to have been wider than when Makha was described and sampled from "Lechkhum" in the 1930s when the total area of cultivation was estimated at about 50 ha (Dekaprelevicz & Menabde 1932: 14, 38), making it the smallest known cultivation area of any cultivated wheat (sub-) species. The location of its re-discovered cultivation was described as a rather inaccessible region with steep gorges northwest of Kutaisi where *macha* and other spelting wheats were cultivated in small patches among bread wheats (Dekaprelevicz 1961: 19).

GERMPLASM COLLECTIONS. Knüpffer (2009: 51) reported 232 *ex-situ* germplasm collections. In all four cases of the Georgian wheats these numbers are moderate compared to those of most other (as in non-bread and -durum) wheats. However, they are still far greater than those of the few herbarium specimens identified for the four species that can reasonably be considered to have ultimately originated from a farmer's setting.

Triticum turgidum L. subsp. **carthlicum** (Nevski) Á.Löve & D.Löve (Löve & Löve 1961: 49). – **Type:** "Persian Black Wheat", cult. from seed "obtained from Haage and Schmidt, Erfurt, Germany", by *J. Percival* s.n. in Reading, UK (lectotype RNG! – a single spike indicated by "Black Persian." of "var. **persicum**, Perciv." from "(Germany.)" mounted on sheet 12 (no. 5 when numbering left-to-right)

in box I [1] of "A collection of Wheats" by Prof. J. Percival, to be formally designated in a forthcoming publication; isolectotypes BM!, GAT!, K!, WIR).

Basionym, selected homotypic synonyms and names:

Triticum persicum Vavilov (1919: 177, 178), **not validly publ.** (Art. 36.1(a): the use of "preliminary" on both pages in the description (*tom. cit.*)).

Triticum dicoccum Schrank ex Schübl. var. *persicum* Percival (1921: 196, author as "mihi"). The basionym.

Triticum persicum (Percival) Vavilov ex Zhuk. (Zhukovsky 1923: 46, author as "Vav."), **nom. illegit.** (Art. 53.1), non Aitchison & Hemsley in Aitchison (1888).

Triticum carthlicum Nevski (1934: 685), a replacement name for the older but illegitimate *Triticum persicum* (Percival) Vavilov ex Zhuk.

Triticum paradoxum Parodi (1940: 49), **nom. illegit.** (Art. 52.1). – Note: A *nom. nov.* that Parodi created in 1940 for *T. persicum* (Percival) Vavilov ex Zhuk., but of which he later realised that the older *T. carthlicum* Nevski from 1934 was overlooked.

Triticum dika Siharulidze (1946: 73, 87; on p. 87 in Russian summary as "Tr. dika (persicum)", **nom. illegit.** (Art. 52.1). – Note: The notation on p. 87 shows that the species name directly referred to the older *persicum* and it is thus illegitimate for Art. 52.1.

Triticum ibericum Menabde (1948: 47), **nom. illegit.** (Art. 52.1). – Note: Menabde included 16 new formas, placed within the varieties that Zhukovsky created in *T. persicum*. He named this wheat "Dika" (*tom. cit.* 54), the common vernacular for *carthlicum*, and even cited Nevski's (1934) older *carthlicum*!

Gigachilon polonicum (L.) Seidl ex Á.Löve subsp. *carthlicum* (Nevski) Á.Löve (Löve 1984: 496).

DISTRIBUTION (Fig. 2). Zhukovsky (1923: 54) noted that Vavilov had received seeds from Haage & Schmidt for research. The company informed him that they originated "in all probability" from Persia (nowadays Iran). Perhaps because of this uncertainty Zhukovsky then located the new species in "Central Transcaucasia" before describing varieties from parts of what is now Georgia: Doushet [Dusheti], Gori and Tbilisi. According to Roshevitz (1937: 341) *T. persicum* was *not* found in Persia itself, but only in the Caucasian republics of Georgia and Armenia. In the latter country it was found by Dekaprelevicz (cf. Percival 1926: 207) and more recently by Gandilyan and Nazarova (2010: 97). For Türkiye, Zhukovsky (1933: 808) reported *T. persicum* from the eastern *Vilayets* [provinces] of Anatolia borderering "Transcaucasia". Gökgöl (1939: 945 – 946) reported it as mainly cultivated in the provinces of Artvin, which borders Georgia, and Kars, which borders Armenia. Historic cultivation in Georgia of *Dika* included the Racha-Lechkhumi, Zemo [upper]- and Kvemo Svaneti, Becho, as well as the Sachkhere and Chiatura districts in Imereti (Maisaia 2009: 65, citing sources). Pure stands were still recorded in the 1950s in Svaneti and Racha; in the 1960s Dika was still second only to *aestivum* in Racha but growing as admixtures only in Lechkhumi. The 1970s and -80s showed a decline (Maisaia, *loc. cit.*, citing sources) in their estimation of the changing distribution of the three main varieties over the period 1920 – 1990. Cultivation was more or less concentrated in three regions in Georgia (**Fig. 2**). However, it has since declined and a concerted effort by ICARDA in 2001 in Georgia noted "strong genetic erosion" (Rusishvili *et al.* 2010: 9). It may now have disappeared altogether.

Unfortunately, a constant factor with all references that describe its cultivation is the lack of any data – or even guesses – on the actual extent in hectares sown to *carthlicum*, including the detailed study by Rusishvili and colleagues in Georgia. (Nana Rusishvili informed me that their study was solely archaeobotanical and did not purport to lead to any statement on the extent of past cultivation.) In view of all the reports and additional advice I estimate the historic acreage to have been in the order of 5,000 hectares.

GERMPLASM COLLECTIONS. Knüpffer (2009: 51) reported 672 *ex-situ* germplasm collections of *T. carthlicum*.

Triticum turgidum L. subsp. **georgicum** (Dekapr. & Menabde) Mac Key ex Hanelt (2001: 2573). – **Lectotype:** the illustrations of Tab. [სურ = "picture" or "drawing"] 2, Figs 1 – 3 in Supatashvili's (1929: unpaged insertion between pages 92 and 93) paper, designated for *T. dicoccum* Schrank ex Schübl. var. *chvamlicum* Supat. by Mosulishvili *et al.* (2017: 519).

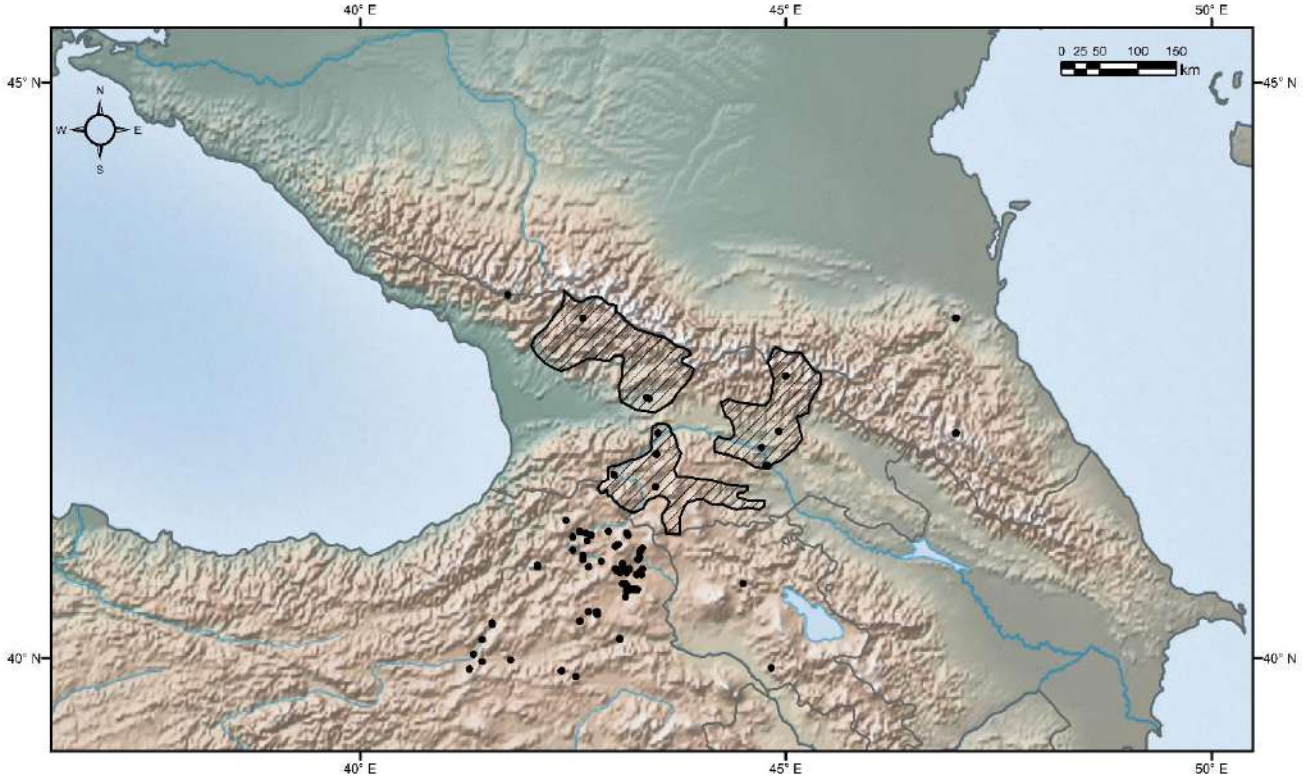

Fig. 2. Distribution of *Triticum carthlicum* in Georgia and Türkiye. MAP: MAURICIO DIAZGRANADOS.

Basionym, selected homotypic synonyms and names:

Triticum dicoccum Schrank ex Schübl. var. *chvamlicum* Supat. (Supatashvili 1929: 92); Mosulishvili *et al.* (2017: 519). The basionym.

Triticum dicoccum Schrank ex Schübl. grex *georgicum* Dekapr. & Menabde (Dekaprelevicz & Menabde 1932: 14). – Note: A replacement name at different rank.

Triticum karamyschevii Nevski (1936: 127). – Note: A replacement name at species level.

Triticum macha Dekapr. & Menabde subsp. *georgicum* (Dekapr. & Menabde) Flaksb. (Flaksberger 1939: 202). – Note: a hexaploid species with a tetraploid subspecies.

Triticum palaeocolchicum Menabde (1940: 686, "*palaeo-colchicum*"); Mosulishvili *et al.* (2017: 519), **nom. illegit.** (Art. 52.1). – Note: At species level *T. karamyschevii* (q.v.) precedes and illegitimacy of *T. palaeocolchicum* is maintained after the rejection of a proposal by Mosulishvili *et al.* (2017: 519) to conserve it over the older Nevski one.

Triticum georgicum (Dekapr. & Menabde) Dekapr. (Dekaprelevicz 1942a: 920), **nom. illegit.** (Art. 52.1).

Triticum chvamlicum (Supat.) Tumanian (1948: 5), **nom. illegit.** (Art. 52.1).

Triticum turgidum L. subsp. *palaeocolchicum* Mac Key (1966: 268), **nom. illegit.** (Art. 52.1).

Gigachilon polonicum (L.) Seidl ex Á.Löve subsp. *palaeocolchicum* Á.Löve (Löve 1984: 497), **not validly publ.** (Art. 41.5: citation of later homotypic synonym instead of basionym).

DISTRIBUTION. A relic wheat, grown as part of *Makha* in the Racha-Lechkhumi and Lower Svaneti regions of northwestern Georgia, and of which the acreage (in the 1930s) was estimated at around 40 – 50 ha (Dekaprelevicz & Menabde 1932: 7, 38). The acreage would make the distribution of *georgicum* only 10% of "Zanduri" in the same regions. *Makha* was originally seen as the mixture of what is now *macha*- and *georgicum* wheat, thus combining 6n and 4n forms. In addition to the regions cited in the literature and noted through personal communication cultivation was reported from Imereti, Samegrelo, and Adjara. Obviously, the *actual* area of this wheat is only a fraction of this, but my estimation is of more than 50 ha in total.

GERMPLASM COLLECTIONS. Knüpffer (2009: 51) reported 75 *ex-situ* germplasm collections.

Triticum timopheevii (Zhuk.) Zhuk. (Zhukovsky 1928: 64) [subsp. **timopheevii**]. (**Fig. 3 – right spike**). – **Type:** Georgia, Kartalina superior [Shida Kartli administrative region, N part of Gori District], prope Asarma, 1922, *P. M. Zhukovsky* s.n. (holotype WIR not identified; reported (iso) type not found in TBI or TGM (Marine Mosulishvili, pers. comm.), and if ever existed then considered lost). – **Lectotype:** the illustrations with analysis of Figs 1 – 4 in Zhukovsky's (1924: 2) paper in Zap. Nauchno-Prikl. Otd. Tiflissk. Bot. Sada, vol. 3, to be formally designated in a forthcoming publication by this author and Marine Mosulishvili (Ilia State University, Tbilisi, Georgia).

Fig. 3. Lateral view of mature spikes of *Triticum militinae* (left), cultivated at the National Botanic Garden of Georgia, Tbilisi, Georgia, and of *Triticum timopheevii* subsp. *timopheevii* (right), grown at Wakehurst, West Sussex, UK. PHOTO: PABLO GÓMEZ BARREIRO.

Basionym, selected homotypic synonyms and names:

Triticum dicoccum Schrank ex Schübl. var. *timopheevii* Zhuk. (Zhukovsky 1924: 1). The basionym.

Triticum timopheevii Zhuk. var. *typicum* Zhuk. (Zhukovsky 1928: 64), **not validly publ.** (Art. 26.2). – Note: Considered synonymous with the autonym variety *timopheevii* by Dorofeev *et al.* (1979: 316).

Triticum turgidum L. emend. Bowden var. *timopheevii* (Zhuk.) Bowden (1959: 671, with f. *timopheevii* on p. 672) *pro parte* (excluding forma *zhukovskyi*). – Note: Bowden's concept united a 4n species with a 6n forma.

Triticum turgidum L. subsp. *timopheevii* (Zhuk.) Á.Löve & D.Löve (Löve & Löve 1961: 50), **not validly publ.** (Art. 41.5: a later combination was presented as the basionym).

Gigachilon timopheevii (Zhuk.) Á.Löve (Löve 1984: 497, with subsp. *timopheevii*).

DISTRIBUTION. *Triticum timopheevii* is mainly known from Georgia: upper Kartalinia (referring to the historic "Kartli" part of present-day central-eastern Georgia), and the Imereti and Racha-Lechkhumi regions in western Georgia (Zhukovsky 1928: 64, Supatashvili 1929: 97, Dekaprelevicz & Menabde 1932: 36). The total acreage was estimated at 300 – 500 ha but the striking uniformity of *timopheevii* with only two distinguished botanical varieties (at the time) was noted by Dekaprelevicz and Menabde (*loc. cit.*), in

contrast to the variation within the much smaller (ca. 50 ha only) cultivation of Makha (for which see the Distribution of *T. aestivum* subsp. *macha*, above). Still, the Zanduri acreage was described as being "…one field sown … on [meaning: compared with] 15 – 12 fields sown with naked wheat…" (assumed to be *aestivum*). Cultivation throughout the 1940s – 1990s was reported from the Racha-Lechkhumi and "Imereti (Samegrelo)" (the latter region referring to what actually are adjacent but separate entities) regions (Maisaia 2009: 43, citing sources) but it appears to have been a rarity, with "common" cultivation in the 1960s in Lechkhumi as the exception. Before narrowing down to Racha-Lechkhumi, historic distribution in the 12th century during the time of the great poet Shota Rustaveli was much wider, including the Mukhrani Plain (NW Tbilisi) and Gardabani (SE Tbilisi) in central-eastern Georgia (Dekaprelevicz 1942a, as cited by Samadashvili *et al.* 2019: 7). The actual acreage of timopheevi wheat is surely much more limited than the total of the regions cited in the literature and estimated as a few hundred hectares at most.

Morrison (2007: 272) reported additional distribution in Armenia and northeastern Türkiye; the former is confirmed, but not the latter. Cultivation in Nakhchivan, part of Azerbaijan, is also noted. These isolated findings make this "Georgian wheat" actually a near-endemic.

GERMPLASM COLLECTIONS. Knüpffer (2009: 51) reported 590 *ex-situ* germplasm collections of *T. timopheevii*.

Triticum ×zhukovskyi Menabde & Ericzjan (1960: 732). – **Type:** Georgia ("Georgia, culta in Letschchumi"), "Zanduri", s.loc., *s.coll. (Menabde & Ericzjan?)* s.n. [reprod. USSR, Dagestan ASSR, VIR station at Derbent, 20 June 1968, *Ju. D. Soskov* 499] [produced from VIR-k-43063] (neotype: WIR, to be formally designated in a forthcoming publication; isoneotypes: B!, G!, GAT!, K!, LD!, W!).

Selected homotypic synonyms and name:

Triticum turgidum L. (var. *timopheevii*) f. *zhukovskyi* (Menabde & Ericzjan) Bowden (1959: 672). – Note: Bowden's concept unites a 4n species with a 6n forma. See also at the *T. timopheevii* synonymy.

Triticum timopheevii (Zhuk.) Zhuk. var. *zhukovskyi* (Menabde & Ericzjan) Ros.Morris & Sears (Morris & Sears 1967: 20 – 21, on both pages indicated as "*comb. nov.*"), **not validly publ.** (Art. 41.5).

Triticum timopheevii (Zhuk.) Zhuk. subsp. *zhukovskyi* (Menabde & Ericzjan) L.B.Cai (Cai in Cai *et al.* 1991: 220). – Note: As with Bowden, above, this reflects a concept that unites a 4n species with a 6n forma.

= **Triticum timopheevii** (Zhuk.) Zhuk. subsp. **timopheevii** ♀ × **T. monococcum** L. subsp. **monococcum** ♂ (similarity of ×*zhukovskyi* cytoplasm points at the *timopheevii* parent being the ♀).

DISTRIBUTION. As a mixture, "Zanduri" itself was only ever cultivated in the Racha-Lechkhumi-, Imereti- and Samegrelo regions of western Georgia at between 400 – 800 m altitude (Maisaia 2009: 35). However, this accidental hybrid is probably known only from one location in Lechkhumi. It has – to my knowledge – never been cultivated for commercial purposes but only reproduced for research as it is only the second *natural* hexaploid wheat after *aestivum*.

GERMPLASM COLLECTIONS. Knüpffer (2009: 51) reported 64 accessions of this hybrid, present in some 22 gene banks around the world. They may well *all* or *nearly all* be subsequent cultivations of samples from the original K-43063 (Badaeva *et al.* 2016: 943); for K-43063 see at the neotype, above.

TOWARDS A NEW CLASSIFICATION OF THE WHEAT GENUS

For a classification of such a well-studied plant group to be successful (i.e. acceptable by the "wheat community") one has to make a number of considerations. There are so many taxa published in *Triticum* that you need decisions not about the taxa themselves but about whole categories of taxa. You then need to decide which categories are included or excluded and on what basis. And you need to keep an eye on the acceptance of the final result as this will be judged by both lumping or splitting / principled or more flexible / theoretically or more practically inclined, taxonomists on one side and the usually practical "agricultural sector" on the other. After all, the latter may be much more impacted by a complicated system – or the lack of it – than the scientific world.

To this end I developed two Principles in order to (1) delineate the genus, and (2) define what should be considered a "cultivated species". Many decisions to clarify the taxonomic confusion have followed from here even though a 100% decision about "in/out" of accepted taxa has proven elusive. And this is

before many differing opinions about what constitute *Triticum* and what should be part of it / not be part of it come into view! The Principles are as follows:

1. "The genus consists only of cultivated species and their direct wild relatives" as defined in *Gene Pool 1* [or GP-1] of the Gene Pool concept by Harlan and de Wet (1971), leading to the exclusion of allied genera such as *Aegilops, Amblyopyrum, Secale,* and *Haynaldia*, which all are part of the GP-2 (Harlan and de Wet 1971: 511)
2. "Each accepted *cultivated taxon* is the total of all *cultivars* created within it, held together by a *botanical name* with an associated *type* to define its use" (or: how to combine cultivated plant taxonomy in a botanical framework)

The first Principle, broadly emanating from relatively easy crossability of included members, defines the genus *Triticum* as here accepted: 14 cultivated taxa and their four direct wild relatives (*T. boeoticum* and *T. urartu* both 2n, *T. araraticum* and *T. dicoccoides* both 4n). These 18 are considered the *core taxa*. Of the 14 cultivated ones there is ample evidence of current and/or historic cultivation *by farmers*. Whether their material can be seen as landraces, old cultivars or "modern" cultivars is irrelevant for the definition as set out in the second Principle: they are all "cultivars" in the sense of farmer cultivation, taking it out of cultivation on research plots, or when making selections in order to develop future cultivars, etc. The four Georgian cultivated wheat species are included in the core as in all cases their commercial cultivation is well known – even if now considered "historic". In this respect, the cultivated material of the Georgian wheats may well be considered *landraces* when viewed from the present-day backwards.

The "core" can be classified in two ways, each with their own merits: (a) reflecting both Principles + a species definition by genome type. This is leading to 1 genus, 3 sections, 5 genome-defined species, and 13 non-typical subspecies (examples of the latter are: *T. aestivum* subsp. *aestivum* as a "typical" subspecies with *T. aestivum* subsp. *macha* as a non-typical one). Or (b) a scheme where all 13 subspecies are elevated to species, creating a "flat" system of 18 species within the 3 sections. The latter system is usually adopted by gene banks while the species do not reflect their genome constitution.

In addition to the core, the following categories have been identified:

(1). Around 30 names of taxa, mainly species and botanical varieties, could not be identified with certainty as their types are either lost or ambiguous or were never designated in the first place. Circumstantial evidence places them, however, within the core 18 taxa, sometimes in more than one.

(2). A gazetteer of almost 3,000 taxa (the great majority is at the rank of botanical variety, but a plethora of ranks is involved), which are all within the 18 core ones. That would make them as much part of the genus as the "core" itself, but their acceptance would greatly complicate the taxonomy of the genus – to put it mildly. The conundrum is here that by their very nature they have to be accepted and, in practice, are not accepted at the same time. A few would come close to incorporation into the accepted classification with the strongest example being a recognition of the generally distinguishable Ethiopian durum wheats (founded by Vavilov (1931: 26) as *Triticum durum* Desf. subsp. *abyssinicum* Vavilov). However, I would propose a "yes/no" decision for all – and then advocate a clear "no" for this category in order to avoid much decision making and the chaos of a genus that includes 3,000+ taxa.

The following groups obstruct a clear-cut yes/no decision for the generic delimitation:

(3). Three varieties and one species described for fossil remains of wheat plant parts (mainly carbonised seeds). All authors describe their uncertainty as to the identification, but the real issue here is whether fossil taxa should be included in a genus of extant taxa.

(4). A limited number of "theoretical" or "evolutionary" taxa, created in evolutionary schemes. These have no relation to any real, existing entities but obviously are part of the wheat phylogeny as devised by the authors.

(5). Taxa described on the basis of a natural- or induced mutation: seven species and 123 infraspecific taxa; an example is *Triticum militinae* Zhuk. & Migush. (**Fig. 3 – left spike**), a mutation within the cultivated *T. timopheevii* gene pool. This group is open to new discoveries and creations, and therefore, in theory, will be continuously adding new taxa to the genus – a reason *not* to include them in the "core" group!

(6). Taxa described on the basis of a stable (-enough) form identified in a filial generation after an initial cross involving any of the accepted 18 core taxa of *Triticum*. This group includes 57 species, *Triticum* ×*zhukovskyi* Menabde & Ericzjan among them, and 84 infraspecific taxa, and is, similarly to (5), open to new discoveries and creations.

One group is excluded from *Triticum*:

(7). A large number of taxa have initially been published in *Triticum* but are to be excluded for taxonomically not belonging in the genus as defined here (and with most other authors for that matter). The current totals include more than 720 taxa of which more than 680 refer to species or lower ranking units.

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ქართული გენეტიკური ხაზის როლი რბილი ხორბლის წინაპრის - *Aegilops tauschii* Coss.-ის ევოლუციაში

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აბსტრაქტი. რბილი ხორბლის წინაპარი *Aegilops tauschii* Coss. (ადრე ცნობილი, როგორც *Ae. squarrosa* L.) არის ველური ერთწლიანი დიპლოიდური ხორბლის სახეობა, რომელიც გავრცელებულია ცენტრალურ ევრაზიაში. ამ სახეობას აქვს სამი გენეტიკურად გამორჩეული შიდასახეობრივი ხაზი, TauL1, TauL2 და TauL3. *Ae. tauschii*-ს TauL3 გენეტიკური ხაზი ამჟამად ცნობილია მხოლოდ საქართველოდან. TauL3-ის წვლილის გასარკვევად სახეობების გენეტიკურ დივერსიფიკაციაში, ჩატარდა პოპულაციის სტრუქტურის ანალიზი. ამ ანალიზმა გამოიყენა გენომის მაღალი წარმადობის გენოტიპირება 210 ნიმუშზე, რომელიც მოიცავს მთელი სახეობის დიაპაზონს. შედეგებმა აჩვენა, რომ TauL3-ის გენეტიკური წინაპრების მცირე, მაგრამ შესამჩნევი პროპორციები იყო ექსკლუზიურად წარმოდგენილი TauL1 და TauL2 ნიმუშებში, რომლებიც მიღებულ იქნა დასავლეთ ნაწილში გავრცელებული სახეობებიდან, ხოლო აღმოსავლეთ ნაწილიდან მიღებული ნიმუშები TauL3-ის გენეტიკური წინაპრების მხოლოდ უმნიშვნელო ნაწილს წარმოადგენდნენ. ეს აღმოჩენა წარმოშობს ახალ სამუშაო ჰიპოთეზას TauL3 ხაზის როლის შესახებ *Ae. tauschii*-ს ევოლუციაში: *Ae. tauschii*-ს TauL3 გენეტიკურ ხაზს შესაძლოა წარსულში ჰქონოდა ფართო გეოგრაფიული გავრცელების დიაპაზონი და შესაძლოა მონაწილეობდა გენეტიკურ დიფერენცირებაში *Ae. tauschii*-ს TauL1 და TauL2 ხაზებთან ბუნებრივი ჰიბრიდიზაციის გზით, რომელიც შეინიშნება დღეს არსებულ *Ae. tauschii*-ის ნიმუშებში. გარდა ამისა, თავთავის წვეროს ფორმის ცვალებადობის ანალიზმა (ConvNet/CNN-ზე დაფუძნებული მეთოდი) აჩვენა, რომ TauL1, TauL2 და TauL3 ნიმუშები იყო ერთმანეთისგან დაცილებული ღერძებით განსაზღვრულ მრავალგანზომილებიან სივრცეში, რომლებიც კორელაციაშია ნიმუშების თავთავის წვეროს ფორმის ცვალებადობასთან. ეს დაკვირვება გულისხმობდა თავთავის წვეროს ფორმის კომპონენტების არსებობას, რომლებიც პოტენციურად შეიძლება გამოირჩეოდნენ როგორც *Ae. tauschii*-ის TauL3-ის, ისე TauL1 და TauL2 ხაზებისთვის. ერთად აღებული, ეს დასკვნები ხაზს უსვამს *Ae. tauschii*-ზე შემდგომი გენეტიკური კვლევების აუცილებლობაზე საქართველოში. ასეთი კვლევები აღრმავებს ჩვენს გაგებას სახეობების ევოლუციის შესახებ და ხელს უწყობს მის ოპტიმალურ გამოყენებას ხორბლის მოშენებაში.

საკვანძო სიტყვები: გენეტიკური რესურსები, საქართველო, შიდასახეობრივი დივერსიფიკაცია, ფენოტიპირება მანქანათმცოდნეობის გამოყენებით, მწვერვალების ფორმის ვარიაცია

Role of a Georgian Lineage in the Evolution of *Aegilops tauschii* Coss., an Ancestor of Bread Wheat

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An ancestor of bread wheat, *Aegilops tauschii* Coss. (formerly known as *Ae. squarrosa* L.) is a wild annual diploid wheat species that spreads in central Eurasia. This species has three genetically distinctive intraspecific lineages, TauL1, TauL2, and TauL3. The TauL3 *Ae. tauschii* is currently known from Georgia only. To elucidate the contribution of TauL3 to the species' genetic diversification, a population structure analysis was conducted. This analysis employed high-throughput genome-wide genotyping on a set of 210 accessions spanning the entire species range. The results showed that small but detectable proportions of the TauL3 genetic ancestry were exclusively exhibited in the TauL1 and TauL2 accessions derived from the western part of the species range, while the accessions derived from the eastern part showed only negligible portions of the TauL3 genetic ancestry. This finding posits a novel working hypothesis regarding the role of the TauL3 lineage in the evolution of *Ae. tauschii*: TauL3 *Ae. tauschii* might have had a broad geographic range in the past and played a part in the formation of the genetic differentiation pattern observed in current *Ae. tauschii* through natural hybridization with TauL1 and TauL2 *Ae. tauschii*. Furthermore, an analysis of spike shape variation using a machine learning approach (specifically, convolutional neural network (CNN)-based method) showed that the accessions from TauL1, TauL2, and TauL3 were distinct from one another in a multidimensional space defined by the axes correlating with spike shape variation patterns. This observation implied the presence of spike shape components that could potentially serve as distinguishing features for TauL3 *Ae. tauschii* as well as for TauL1 and TauL2 *Ae. tauschii*. Taken together, these findings underscore the necessity for further genetic studies on *Ae. tauschii* in Georgia. Such studies deepen our understanding of the species' evolution and facilitate its optimal use in wheat breeding.

Keywords: Genetic Resources, Georgia, Intraspecific Diversification, Phenotyping Using Machine Learning, Spike Shape Variation

Introduction *Aegilops tauschii* Coss. (formerly known as *Ae. squarrosa* L.) is a wild annual diploid wheat species that spreads in central Eurasia from northern Syria, Turkey, Transcaucasia, Iran to Turkmenistan, Afghanistan, Pakistan, northern India, central Asia, and central China. The habitats of this self-pollinating morphologically variable species are ecologically diverse: roadsides, wastelands, arable lands, grasslands, craggy slopes, temperate forests, and sandy seashore (van Slageren, 1994). *Ae. tauschii* (DD genome) is agronomically important because it is thought to have given rise to the ancestor of bread wheat (*Triticum aestivum* L. subspecies *aestivum*, AABBDD genome) as the male parent through natural hybridization with *T. turgidum* L. (AABB genome) and its subsequent genome doubling of the F_1 hybrid (Kihara, 1944; McFadden & Sears, 1944). This species serves as a primary genetic resource in breeding practices, thus studies to understand the *Ae. tauschii*'s natural variation patterns provide valuable basis for wheat improvement.

Much work has been done to clarify the genetic structure of *Ae. tauschii* (for example, Nakai, 1978; Gogniashvili et al., 2016; Zhao et al., 2018; Zhou et al., 2021). Genome-wide genotyping studies showed that *Ae. tauschii* has distinctive genealogical structure: two large lineages (TauL1 and TauL2) and a small lineage (TauL3) (Matsuoka et al., 2013). TauL1 is widespread within the species range; its sublineage TauL1a occurs mainly in the western part, and TauL1b occurs mainly in the eastern part. TauL2, which is restricted to the western part of the species range, has two sublineages: TauL2a, which tends to occur in the western part, and TauL2b, which tend to occur in the eastern part (Matsuoka et al.,

2015). TauL3 is currently known from Georgia only. The genetic distance to the common wheat D genome is much shorter in TauL2 and TauL3 than in TauL1 (Matsuoka et al., 2013).

The accessions of the TauL3 lineage are genetically distinctive from those of other lineages. In a seminal study conducted by Gogniashvili et al. (2016), complete *de novo* chloroplast genome sequences were obtained from nine *Ae. tauschii* and two *Aegilops cylindrica* Host accessions collected in East Georgia. The comparison of the TauL3 and TauL1 chloroplast genomes revealed 28 single nucleotide polymorphisms and a 27-base-pair indel. On the other hand, the difference between the TauL1 and TauL2 chloroplast genomes was minimal, with only four nucleotide sites differing. Additionally, TauL3 seems to coincide with the 9^1s population collected in Dagestan, which displayed marked differences from other populations in terms of isozyme and chloroplast DNA variation (Dudnikov, 1998; Dudnikov, 2012). If this is the case, it is possible that some TauL3 populations may be found outside of Georgia.

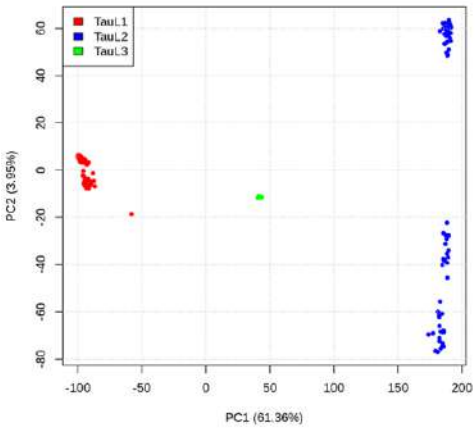

Figure 1 Graph of the first two axes from a PCA based on GRAS-Di SNP variations.

TauL3 and intraspecific genetic diversification The genetic distinctiveness observed in TauL3 suggests that it may represent an evolutionary isolated lineage. Additionally, phylogenetic studies based on chloroplast DNA variation indicated that TauL1 and TauL2 diverged from the TauL3 lineage, implying that TauL3 had a key role in the evolution of *Ae. tauschii* (Dudnikov, 2012; Gogniashvili et al., 2016). To investigate how TauL3 contributed to the species' genetic diversification, we conducted a comprehensive population structure analysis of *Ae. tauschii* using a high-throughput genome-wide genotyping approach. We obtained approximately five million next generation sequencing reads (150 base pairs in length) using the GRAS-Di method (Enoki & Takeuchi, 2018) for each of the 210 accessions that represent the entire species range (133 accessions from TauL1, 68 accessions from TauL2, and five accessions from TauL3). Subsequently, we called a total of 44,880 qualified single nucleotide polymorphisms (SNPs) across the 210 accessions relative to the *Ae. tauschii* AL8/78 reference genome (Wang et al. 2021) using BWA-MEM (Li, 2013), BCFtools (Danecek et al., 2021), and a self-made filtering script. Finally, we estimated the genetic ancestry profile for each accession using Struct-f_4 based the SNP genotype dataset (Librado & Orlando 2022).

A principal component analysis (PCA) of the SNP genotype dataset showed that *Ae. tauschii* had three lineages that were separate on the PC1 axis, confirming our previous findings regarding the species' intraspecific genetic structure (Figure 1). Furthermore, the population structure analysis revealed that small but detectable proportions of the TauL3 genetic ancestry (about 2%) were exclusively exhibited in the TauL1 and TauL2 accessions derived from the western part of the species range, while the accessions derived from the eastern part showed only negligible portions of TauL3 genetic ancestry (Figure 2).

The west-biased distribution of the TauL3 genetic ancestry may offer a novel working hypothesis on the role of the TauL3 lineage in the evolution of *Ae. tauschii*. This suggests that TauL3 *Ae. tauschii* might have had a broad geographic range in the past and potentially hybridized with TauL1 and TauL2 *Ae. tauschii* within its previous distribution range. Such hybridization might have played a part in the formation of the west-to-east pattern of genetic differentiation observed in TauL1 *Ae. tauschii*. In the case of TauL2, the accessions with the TauL3 ancestry were primarily clustered in the Caspian region. This suggests that the possible hybridization between TauL2 and TauL3 might have influenced the genetic differentiation of TauL2 *Ae. tauschii* specifically in that region.

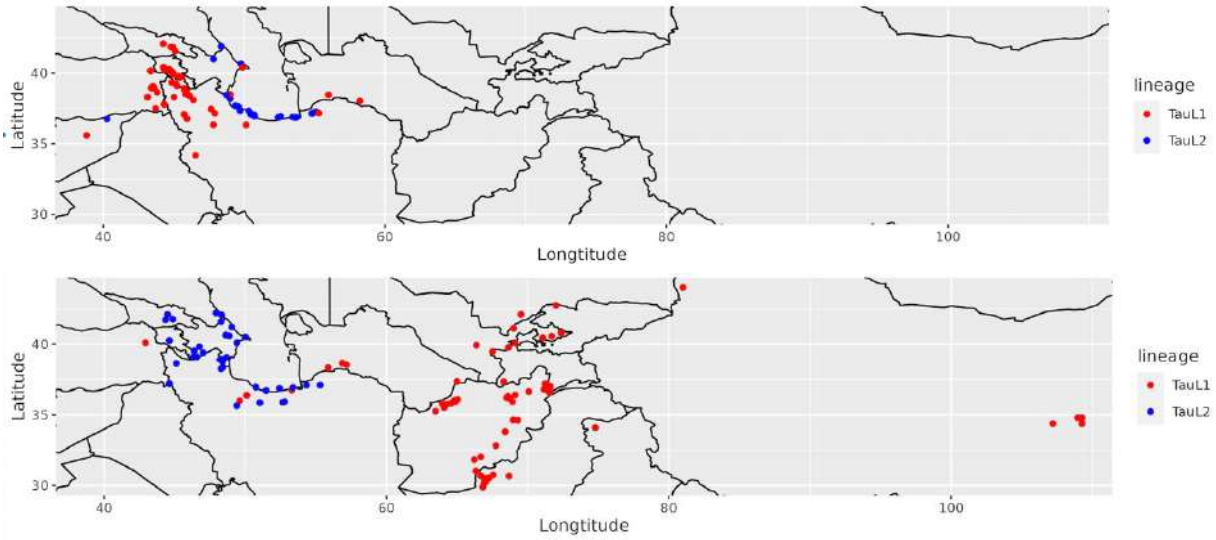

Figure 2 Geographic distribution maps of *Ae. tauschii* accessions having the TauL3 genetic ancestry (proportions > 1%) (top) and those not having the TauL3 genetic ancestry (proportions ≤ 1%) (bottom).

TauL3 and spike shape variation Identifying TauL3 *Ae. tauschii*, as well as TauL1 and TauL2 *Ae. tauschii*, based on morphology is currently difficult, even though the TauL3 lineage is genetically very distinctive. The difficulties in correctly assigning *Ae. tauschii* plants to specific lineages using morphological keys pose practical obstacles in quickly selecting appropriate genebank accessions for breeding. Furthermore, if any morphological keys existed for the TauL1, TauL2, and TauL3 lineages, they would be very useful in field studies that focus on the ecology of *Ae. tauschii*. One important step to address these issues to clarify the extent to which spike shape, one of the key traits in the classification of the wheat species, distinguishes the *Ae. tauschii* lineages.

In *Ae. tauschii*, the spike shapes vary from cylindrical to moniliform. Spike shape is one of the key traits used to classify the *Ae. tauschii* subspecies: *Ae. tauschii* Coss. subspecies *tauschii* and *Ae. tauschii* Coss. subspecies *strangulata* (Eig) Tzvel. (Hammer, 1980). However, the classification practice is often not straightforward because specimens that have intermediate spike shapes are often encountered. Some recent monographs do not formally describe these subspecific taxa (van Slageren, 1994).

We analyzed the *Ae. tauschii* spike shape variation patterns using a convolutional neural network (CNN)-based phenotyping method. This method offered an advantage in classifying the spike shape continuum between cylindrical and moniliform by automatically extracting spike shape features from digital images and developing classification models based on supervised learning, utilizing the "lineage" (i.e., TauL1, TauL2, or TauL2) as the label for each accession. For this analysis, we used 1,460 scanned images dried spike samples obtained from the set of 210 accessions. The ResNet-152 model (He et al., 2015) was trained in a supervised fashion using the scanned images and the corresponding

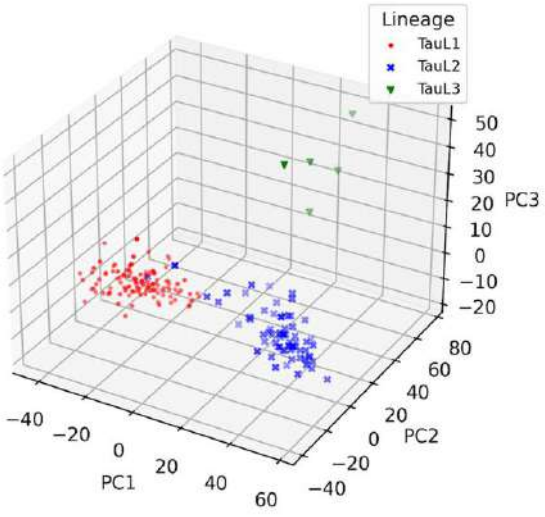

Figure 3 Graph of the first three axes from a PCA based on the ResNet-152 feature vectors, depicting the spike shapes of *Ae. tauschii*.

"lineages" labels. In a 5-fold cross-validation, the trained model exhibited a high classification accuracy (F1 score = 0.98).

A PCA of the feature vectors obtained using the trained model showed that the accessions from TauL1, TauL2, and TauL3 were largely distinct from one another in a multidimensional space defined by the axes correlating with spike shape variation patterns (Figure 3). Notably, the PC3 axis effectively differentiated the TauL3 accessions from the TauL1 and TauL2 accessions, suggesting the presence of spike shape components that could potentially serve as distinguishing feature for TauL3 *Ae. tauschii*.

Conclusion Georgia is renowned as a home to diverse *Ae. tauschii*. In the state, not only TauL3 but also TauL1 and TauL2 can be found. The findings reported above highlight the importance of conducting comprehensive studies on the genetic and phenotypic diversity of *Ae. tauschii* in Georgia. Such studies will further deepen our understanding of the species' evolution and, ultimately, enable its effective use in wheat breeding.

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ხორბლის მოყვანის ტრადიცია ართვინის რეგიონში (თურქეთის რესპუბლიკა)

გულ მუქერრემ ოზთურქი
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ართვინის რეგიონში (თურქეთის რესპუბლიკა) ოდითგანვე იყო განვითარებული მიწათმოქმედება. აქაური მკვიდრი მოსახლეობა მუდამ მისდევდა მემინდვრეობას, მეხილეობას მებოსტნეობას. მემინდვრეობის დარგებიდან არსებობდა მდიდარი ტრადიცია ადგილობრივი, ენდემური ხორბლის მოყვანისა. ასევე, განვითარებული იყო ფეტვის კულტურა, ქერი, პარკოსნები: ცერცვი, ბარდა, მოგვიანებით ლობიო და სხვ.

დღეისათვის სახნავ - სათესი სავრგულების დიდი ნაწილი ეთმობა სიმინდის კულტურას. ფრიად შემცირებულია ხორბლის ნათესები.

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დიდი ცვლილებები განიცადა რეგიონში მარცვლეული კულტურების მოყვანის წესმა მასშემდეგ, რაც ძველ ენდემურ ჯიშებს (დიკა, დოლი) ჩაენაცვალა ახალი სახეობები. ამ კუთხით ყურადღებას იქცევს ტოპონიმი „დოლისყანა“, სოფლისა და ამ სოფელში აღმართული შესანიშნავი ტაძრის სახელი, ის პირდაპირ კავშირშია „დოლის“ ხორბალთან.

ხვნა - თესვა, მკა და ლეწვა, ცხადია, შესაბამის სამუშაო საშუალებებს მოითხოვდა. აქ გავრცელებული იყო ქართული სახვნელები: არუნა, ჯილღათი, ზოგჯერ რკინის სახვნელიც, სხვა საშუალებები: კანჯი, ფარცხი, ფოჩხი, ნამგალი/მანგალი, სალექი საშუალება - კევრი, ნიჩაბი, ფიწალი, გობ-სანიავებლები და სხვ. ხორბალი იფქვებოდა წისქვილში. ოჯახებს ჰქონდათ ქვის ხელსაფქვავებიც და სანაყებიც.

მიწათმოქმედება ართვინის რეგიონში მესაქონლეობასთან იყო შერწყმული და სიმბიოზური ხასიათი ჰქონდა. ამიტომ აქ გამწევი ძალა იყო უღელი ხარი.

საკვანძო სიტყვები: ართვინი, ხორბალი, ტრადიცია, ენდემური, დოლისყანა.

Tradition of Wheat Cultivation in Artvin Region (Republic of Turkey)

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Agriculture has been developed in the Artvin region (Republic of Turkey) since immemorial times. The native population here has always followed agriculture, fruit growing, and gardening. There was a rich tradition of growing local, endemic wheat from agricultural fields. Also, the culture of millet and barley was developed, as well as the peas, later beans, etc. At present, a large part of the arable land is devoted to corn culture. Wheat crops are greatly reduced.

Wheat was cultivated in almost all areas of the Artvini region, including not only ethnic Georgians, but also the inhabitants of the coastal areas, although in much smaller quantities than in Imerkhevi, Devskheli, Murghuli, villages on the right and left banks of the Chorokhi River.

The geographical landscape favored the cultivation of wheat in this region. Wheat was grown on two types of arable land: 1. In a plowed field (which was often the result of breaking the plow). 2. On an artificially constructed terrace (Bakan-oroks). Terraces in this region were mostly made of stone, but there are also wooden terraces. Traces of terraces are still visible today. They are still used in many places.

The cultivation of cereal crops in the region has undergone major changes since the old endemic varieties (dika, doli) were replaced by new varieties. In this regard, attention is drawn to the toponym "Doliskana", the name of the village and the magnificent temple erected in this village, it is directly related to "Doli" wheat.

Plowing-sowing, reaping and weeding obviously required appropriate tools. Georgian plows were common here: Aruna, Jilghati, sometimes iron plows, other tools: kanji, partskhi, fochkhi, sickle, plowing tools - kevri, shoveli, fitsali, gob-saniavebeli, etc. Wheat was ground in a mill. The families had stone hand grinders.

Agriculture in the Artvin region was combined with cattle breeding and had a symbiotic character. Therefore, the pulling force here was the yoke of oxen.

Keywords: Artvin, wheat, tradition, endemic, Doliskana.

The Artvin region of the Republic of Turkey boasts a rich tradition of wheat cultivation, deeply embedded in its cultural and agricultural heritage. Situated in the northeastern part of Turkey, Artvin is characterized by its diverse topography, ranging from high mountains to deep valleys, which provide an ideal environment for wheat farming. The tradition of wheat cultivation in Artvin dates back centuries, with evidence suggesting that wheat has been grown in the region since ancient times. Historical records

and archaeological findings indicate that various civilizations, including the Greeks, Romans, and Byzantines, practiced agriculture in Artvin, with wheat being one of the staple crops.

Wheat holds immense cultural significance in Artvin, symbolizing prosperity, abundance, and sustenance. It is deeply ingrained in the local customs, rituals, and folklore, reflecting the importance of agriculture in the lives of the people. Festivals celebrating the harvest season often feature traditional dances, music, and culinary delights made from freshly harvested wheat.

Despite modernization and technological advancements in agriculture, many farmers in Artvin still adhere to traditional farming methods passed down through generations. The use of hand tools, oxen, and traditional irrigation systems remains prevalent in certain areas, preserving the authenticity of wheat cultivation practices.

Like many agricultural regions, Artvin faces challenges such as soil erosion, climate change, and fluctuating market prices. In response, farmers have implemented various adaptation strategies, including crop rotation, terracing on mountain slopes, and the use of organic farming practices to mitigate environmental impact.

Today, we introduce to you the indigenous wheat cultivated in Artvin. Artvin's distinctive natural conditions and agricultural traditions enable the cultivation of this particular wheat strain. Now, we will examine the distinctive attributes and cultural importance of the red drum wheat cultivated in Artvin.

Agriculture has been cultivated in the Artvin region of the Republic of Turkey since ancient times. The indigenous population in this region has historically been involved in the cultivation of crops, the cultivation of fruits, and the practice of horticulture.

Local, endemic wheat was cultivated in the agricultural areas, forming a prosperous heritage. Additionally, the cultivation of millet, barley, and legumes such as chickpeas, peas, and subsequently beans, was established. Currently, a significant portion of the cultivable area is allocated to the cultivation of corn. There is a significant decrease in wheat crops.

The cultivation of red drum wheat was widespread throughout the Artvini region, encompassing not just ethnic Georgians but also the coastal population. However, the quantities grown in these places were considerably lesser compared to the villages of Imerkhevi, Devskhel, Murghul, and those located on the right and left banks of the Chorokhi River.

The topography of the region was conducive to the growth and cultivation of wheat. Wheat was cultivated using two different tillage methods: 1. In a plowed field, which was frequently created by breaking up akhos.

2. On a man-made platform (Bakan-oroks). The predominant material used for constructing terraces in this area is stone, although there are also instances of wooden terraces. The remnants of terraces are still discernible in the present day. They continue to be utilized in numerous locations.

Red drum wheat is a significant component of the region's cultural heritage and a crucial element in local gastronomy. Artvin utilizes wheat in the preparation of a diverse range of classic culinary creations. Local breads, cakes, and pastries are some of the primary components of wheat. In addition, Red Drum wheat and wheat products are widely showcased during festivals and events in Artvin. These festivals offer a chance to commemorate the cultural legacy and agricultural abundance of the local community.

The cultivation of Red Drum wheat holds significant importance in the agricultural and cultural legacy of the region. The ancient cultivation of this unique strain of wheat in the region of Artvin holds great significance as a representation of both the abundant natural resources and rich cultural heritage of the area. Wheat in Artvin holds significance not just as a nourishment for the local community, but also as an integral component of the region's cultural heritage.

The cultivation of cereal crops in the region has experienced significant transformations since the ancient indigenous kinds (dika, doli) were substituted by new ones. Attention is directed to the toponym "Doliskana", which refers to the settlement and its impressive temple. The name is closely associated with the cultivation of "Doli" wheat.

Engaging in the tasks of plowing, sowing, reaping, and weeding necessitated the use of suitable instruments. Various types of plows were frequently used in this region, including the Aruna, Jilghati, and occasionally an iron plow. Other tools commonly employed for agricultural purposes included the kanji, partskhi, fochkhi, sickle/grill, kevri, shovel, fissali, and gob-saniavebeli. Wheat was milled. The

family possessed stone hand grinders and sanders. The agricultural practices in the Artvin region were integrated with cattle breeding, creating a mutually beneficial relationship. Thus, the exerted force in this scenario was the harnessing of oxen.

Red drum wheat is a premium wheat type, typically characterized by its medium grain size and pleasant sweetness. The topographical and precipitation-rich climate of Artvini exerts a beneficial influence on the flavor and nutritional composition of wheat. The wheat is cultivated using organic methods in the Artvini highlands and is enriched by the distinctive soil of the region.

Red drum wheat is a significant component of the region's cultural heritage and a crucial element in local gastronomy. Artvin utilizes wheat in the preparation of a diverse range of classic culinary creations. Local breads, cakes, and pastries are some of the primary components of wheat. In addition, Red Drum wheat and its derivatives are widely showcased during festivals and events in Artvin. These festivals offer a chance to commemorate the cultural legacy and agricultural abundance of the local community.

Red Drum wheat holds significant value in the agricultural and cultural legacy of the region. The ancient cultivation of this unique strain of wheat in Artvin for millennia has endowed it with significant cultural and ecological value, making it a prominent emblem of the region's natural and cultural abundance. Wheat in Artvin holds significance not only as sustenance for the local community, but also as an integral component of the region's cultural heritage.

Efforts are underway to preserve and promote the tradition of wheat cultivation in Artvin. Government initiatives, agricultural cooperatives, and non-profit organizations support local farmers through training programs, subsidies, and marketing assistance. Additionally, there is growing interest in organic and heritage wheat varieties, revitalizing traditional farming practices.

Despite the challenges, the tradition of wheat cultivation in Artvin remains resilient, deeply rooted in the cultural fabric of the region. With ongoing conservation efforts and sustainable farming practices, it is poised to thrive in the face of modernization and environmental changes, ensuring the preservation of this vital aspect of Artvin's heritage for generations to come.

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ქართული ხორბლის როლი მსოფლიო ხორბლის სელექციაში

სამადაშვილი ცოტნე - სოფლის მეურნეობის მეცნიერებათა დოქტორი, პროფესორი
ჩხუტიაშვილი გულნარი - სოფლის მეურნეობის აკადემიური დოქტორი
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აბსტრაქტი. ხორბლის კულტურას მსოფლიო მიწათმოქმედებაში წამყვანი როლი უჭირავს და პირველი ადგილი უჭირავს დაკავებული ფართობებით და მარცვლის წარმოების რაოდენობით. იგი ძირითადი სასურსათე კულტურაა, რომლისგანაც მზადდება პურფუნთუშეული, მაკარონი და საკონდიტრო ნაწარმი. ხორბლისგან მზადდება სპირტი. არსებობს ქართული ხორბლის სპეციალური ჯიშები, რომლებიც გამოიყენება სამკურნალოდ და სამშენებლო მასალად-ჩალა.

ხორბალი უძველესი კულტურაა, რომელიც ყოველთვის საქართველოს სტრატეგიულ კულტურად ითვლებოდა. მისი წარმოშობის ისტორია მჭიდროდაა დაკავშირებული ქართველი ხალხის ისტორიასთან. ხორბალი საქართველოში აღმოჩენილია ნეოლითის ხანაში და ითვლის 8000 წელიწადს. უკანასკნელი 30 წლის მანძილზე გამოქვეყნდა ხორბლის გვარის მრავალი სისტემატიკა. ყველაზე სრული სისტემატიკის მიხედვით ხორბლის გვარში გაერთიანებულია 27 სახეობა. ამ სისტემატიკის მიხედვით (13) საქართველოში აღმოჩენილი და აღწერილია 14 სახეობა, რაც შეადგენს ხორბლის გვარ Triticum-ში შემავალ სახეობათა 65%-ს. მათ შორის 5 ენდემური სახეობაა: - *T. timopheevii* Zhuk*, T.Karamyschevii* Nevski*, T. zhukovskyi* Men.*&* Eriz*, T. macha* Dekapr.*& Men, T. persicum* Vav. აქედან ოთხი სახეობა - ვიწრო ენდემურია, კილიანი, ძნელად გამოსალეწი და თავთავმტვრევადია. ეს სახეობები წარმოადგენენ დასვლეთ საქართველოს რელიქტიურ კულტურული ფლორის ნაშთებს. ენდემიზმის ასეთი დონე მსოფლიოს არცერთ ქვეყანაში არ გვხვდება. გარდა სახეობათა ენდემიზმისა საქართველოში აღწერილია 150-ზე მეტი სახესხვაობა. საქართველოს ტერიტორიაზე მცხოვრები ადამიანებისათვის, ჩვენს ერამდე 20 000 წლის წინათ სასურსათედ გამოყენებული იყო ხორბალი. ამ მიზნით შექმნა ქართველმა ხალხმა კილიანი ხორბლის ასაღებად, სპეციალური ხელსაწყო „შნაკვი“.

საკვანძო სიტყვები: ხორბალი, ენდემური სახეობა, ისტორია, ევოლუცია.

The Role of Georgian Wheat in World Wheat Breeding

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Wheat crop plays a leading role in world agriculture and ranks first in terms of occupied areas and grain production volumes. This is the main food crop from which bread, pasta and confectionery are produced. From wheat is also produced alcohol. There are special varieties of Georgian wheat that are used in medicine and in construction.

Wheat is an ancient culture that has always been considered a strategic culture of Georgia. The history of its origin is closely related to the history of the Georgian people. Wheat was discovered in

Georgia during the Neolithic era and dates from 8,000 years ago. Over the past 30 years, many taxonomies of wheat genera have been published. According to the most complete taxonomy, the genus of wheat includes 27 species. According to this taxonomy (13), 14 species were discovered and described in Georgia, which is 65% of the species included in the genus of wheat Triticum. Among them are 5 endemic species: - T. timopheevii Zhuk, T.Karamyschevii Nevski, T. zhukovskyi Men.& Eriz, T. macha Dekapr.& Men, T. persicum Vav.

Four of these species are narrow-endemic, spinous, hard to shatter, and brittle. These species are remnants of the relict cultural flora of western Georgia. There is no such level of endemism in any country in the world. In addition to species endemism, more than 150 varieties have been described in Georgia. People who lived on the territory of Georgia 20,000 years BC , used wheat for food. To harvest spinous wheat, they created a special tool called "shnakvi."

Keywords: Wheat, Endemic Species, History, Evolution**.**

Introduction. Wheat culture (Triticum) was investigated by: morphological, cytological, genetic, biochemical, electrophoretic, biotechnological and selection methods. According to these studies, species with 14 chromosomes are the oldest, and species of gymnosperms with 42 chromosomes are the youngest. Endemic species of Georgia played an important role in the evolution and selection improvement of the wheat genus. According to the concept of the Hungarian scientist G. Mandi, which is based on two centers of origin of species - Asia Minor and Transcaucasia, he believes that the level of evolution of tetraploid wheat was achieved in Asia Minor, and hexaploid species were conceived and developed further in Transcaucasia. The study of Georgian wheat species and native varieties gave world scientists the opportunity to discover and use their important positive qualities in breeding.

The role of Georgian wheat in the evolution of soft wheat. The achievement of world breeding in wheat culture is closely related to the creation of soft wheat. Soft wheat fully meets human needs and is one of the most complete foods. The origin of soft wheat is various. This species has originated in many places and many times. For now, four ways of origin of soft wheat have been experimentally established.

The first way of creation of soft wheat. The method of the Japanese triticologist Kihara, which received wheat form similar to soft wheat by crossing the white-grained form *T. carthlicum*, with the diploid form of wild wheat - *Ae. Tauschii* . *T. Carlicum* carries the Q gene, which confers resistance to the spike stem brittleness. *Aye. tauschii* can be found in the area of distribution of *T. carlicum*, so their spontaneous mating is easy.

The second way of creation was shown by the German triticologist Kukuki. By crossing Macha and Iranian spelta, he received a form very similar to soft wheat, resistant to self-pollinating and easy to harvest . This method of resynthesis was tested by L. Decaprelevich and the results confirmed Kukuki's experiments.

The third way of receiving of soft wheat was also shown by Kukuk. He received small successive mutations according to the following scheme: the form of Iranian polba-polby- soft wheat or keeled bristle - gymnosperm keeled bristle - non bristle gymnosperm. Such mutation could have occurred in the Macha species. The Macha species includes transitional forms resistant to fragility of the head stem. Macha's involvement in the receiving of soft wheat is also confirmed by Georgian triticologists (L. Decaprelevich, V.Menabde, P. Naskidashvili).

The fourth way. It is associated with a 42-chromosomal Macha interbreed with the *T. Cartlicum* octaploid. The latter carries the Q gene, which causes resistance to fragility of the stem.

According to research conducted to date, it is recognized in the world that endemic species of Georgia played a significant role in the evolution of the genus *Triticum*. Two species are important in this regard: *T. macha Dekapr. et Men u T. persicum Vav.*. This process of evolution took place in Georgia.

Role of endemic species in world breeding. Endemic species of Georgia play an important role in the creation of a new type of wheat of the modern era. They are distinguished by phenomenal complex

immunity to fungal diseases, resistance to pests and high biochemical indicators. They are the best genetic source for intensive-type varieties.

The endemic species Zanduri- *T. timopheevii Zhuk* (2n=28 - A^bA^bGG), has a genomic composition. It has been found that the G genome does not occur in any other species. Zanduri is separated from other species by a genetic mechanism. It carries a unique CMS gene that is important for creating hybrid wheat. It should be noted that the gene for recovery of cytoplasmic sterility Rf was also established in Georgian soft wheat – Dolis puri 35-4. Zanduri is a plastic wheat that develops well in both the humid zone of western Georgia and the moderately arid zone of eastern Georgia. The discovery of male cytoplasmic sterility genes CMS in Zanduri, which allows the creation of hybrid wheat, is considered the greatest achievement in wheat breeding in the United States over the past 60 years. Among all wheat, it has survived the longest in production crops. Tolerant to unfavorable conditions, resistant to withering due to a powerful root system. Straw is strong and does not burn.

The endemic species of Kolkhuri Asli - *T. georgicum Dekapr._ T. palaeo-colchicum Men._ T.Karamyschevii Nevski* (2n=28 genome, A^uA^u BB),, was widely distributed in the Racha-Lechkhumi region of Western Georgia. It was an admixture in the cenose of wheat Macha. L. Decaprelevich and V. Menabde, after a detailed study, singled it out as a separate species due to morphological features and geographical isolation. The Kolkhuri Asli specimen is characterized by plasticity, tolerates high humidity well, but is also resistant to drought. It is characterized by high latitude, rust resistance, high protein content (15.9-18.8%), lysine content in the protein is 2.7-2.91%. According to these indicators, Kolkhuri Asli is the best starting material.

The endemic species dika - *T. carthlicum Nevskyi T. persicum Vav.* (2n=28 A^uA^u BB) genome) is the oldest wheat in Georgia. Mentioned in the monuments of Georgian writing since the 5th century. It was a widespread species. Dika is the most cultivated gymnosperm tetraploid wheat. Morphologically resembles soft wheat. It is distinguished by a thin stem of the head and awns on the keels of the head. Its head is covered with double awns. Genetically, it belongs to the group of hard wheat and easily crosses with it, and also has factor Q, characteristic of soft wheat. In Georgia, Dika is represented by a large variety, but three varieties are most common: white Dika- *Var. Stramineum*, red Dika - *Var. Rubiginosum*, black Dika - *Var. Fuliginosum*. Dika is a valuable breeding material - it is plastic and frost-resistant. In mountainous areas, it matures at low temperatures. Easily tolerates mixed crops. Shows high resistance to fungal diseases. It is the best parent form in hybridization. When crossed with a susceptible variety, it gives practically immune forms. The grain contains 16.4-18.5% protein and 2.65-2.66% lysine.

The endemic species Macha - *T. macha Dekapr. et Men.*(2n=42 genome A^uA^u BB DD) - is a spinous - hexaploid wheat. The term Macha first appears in Georgian script in the Sulkhan-Saba Orbeliani dictionary, although it is an ancient primary species. Macha can be viewed as the "living ancestor" of cultural species. Macha is a bearer of signs of wild and cultivated wheat. Macha is an ecotype of the forest strip, the distribution range is 900-1200 m above sea level, represented by autumn and semi-autumn forms. Less resistant to rust. Different forms show different resistance to lodging. Tolerant of high humidity. Protein content 14.4%, lysine in protein 2.85%. When crossing with different species, a variety of breeding material is obtained.

The endemic species Zanduri hexaploids -*T. zhukovskyi Men. et Eriz. (2n=42, genome* A^b A^b A^bA^b *BB).* According to V. Menabde, this species is amphidiploid and evolved as a result of spontaneous hybridization at crossing Chelta Zanduri and Gvatsa Zanduri. Chelta, unlike Zanduri, is distinguished by a less dense and prolonged head, it is taller. The species adapts well to increased humidity, being more sensitive to drought than Zanduri. It is characterized by open flowering. It has a high protein content - 23.6%, lysine - 2.9%, has a good baking ability. It is also a carrier of the CMS gene, characterized by immunity to fungal diseases. By crossing this species with soft wheat, a very interesting initial selection material of soft wheat is obtained.

Soft wheat is the most common variety in Georgia. It is highly polymorphic in environmental diversity and species composition. The Georgian folk dictionary has many names for these forms and varieties. Many forms of Georgian soft wheat are of autochthonous origin. The Georgian soft wheat fund was created in a variety of natural-historical conditions for its cultivation. Spring and autumn, falling and non-falling, coarse-grained and fine-grained, powdery and horn consistency, early and late, winter-resistant and drought-resistant varieties and forms are known. The vertical border of soft wheat

cultivation in Georgia runs from 200 to 2300 meters above sea level. Autumn forms up to 1500 m, spring forms up to 2300 m. In Georgia, 9 ecotypes of wheat are distributed and more than 40 species of soft wheat are described. Soft wheat varieties created by the Georgian people fully met the needs of the Georgian people, and unique varieties are still in demand and are intensively used for food. This demand for older varieties is due to the following positive qualities: 1. Short and strong stem; 2. Disease resistance; 3. Rapid plant development; 4. Fertility recovery; 5. Resistance to grain falling during ripening; 6. Easy thrashing of grain from the spike; 7. Increased content of proteins and essential amino acids in the grain; 8. Coarse graininess; 9. High-quality bakery grinding; 10. Longevity; 11. Broad leaves of the plant; 12. Coarseness; 13. Early ripeness; 14. A gene that determines the ability to preserve baked bread for a long time.

Conclusion. Thanks to the ancient culture of the Georgian people and their great love for agriculture, following the diverse natural microzones of Georgia, by combining folk selection-natural and artificial selection, ecotypes and wheat varieties adapted to local conditions were created. The unique variety of wheat culture created in Georgia makes it possible for world breeders to use it to create modern varieties of an intensive type.

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აბსტრაქტი. საქართველო ხორბლის წარმოშობის ქვეყანაა, სადაც იგი ისტორიულად წარმოადგენდა ძირითად საკვებ კულტურას. ხორბლის გენეტიკური რესურსები განსაკუთრებული მნიშვნელობისაა როგორც ადგილობრივი, ასევე მთელი მსოფლიოს ხორბლის სელექციისათვის. დაბალი მოსავლიანობის ერთერთ მთავარ მიზეზს დაავადებების სტაბილური განვითარება წარმოადგენს. ხორბლის დაავადებათა შორის ყველაზე გავრცელებულ და მავნედ ხორბლის ჟანგები, თავთავის სეპტორიოზი და ყვითელი ლაქიანობა ითვლება. გამძლე ჯიშების წარმოება ხორბლის დაცვის საიმედო ეკოლოგიურ მიდგომაა, რისთვისაც ძალზე მნიშვნელოვანია პათოგენის ვირულენტობაში მიმდინარე ცვლილებების მუდმივი მონიტორინგი, ხოლო ახალი ვირულენტობის აღმოჩენის შემთხვევაში, სელექციონერების დროული ინფორმირება. ამ მიზნით, ფიტოპათოლოგიისა და ბიომრავალფეროვნების ინსტიტუტის მეცნიერები 30 წელია აკვირდებიან სოკოვანი დაავადებების მიმართ ხორბლის გამძლეობას. ხორბლის ოცდახუთი ნიმუშისაგან შემდგარი კოლექცია, რომელიც შედგებოდა ცამეტი ენდემური სახეობის /ქვესახეობისა და თორმეტი ძველი ჯიშისაგან, ძირითადი სოკოვანი დაავადებების (ღეროს ჟანგა, ფოთლის ჟანგა, ყვითელი ჟანგა, თავთავის სეპტორიოზი და ყვითელი ლაქიანობა) ხელოვნურ ინფექციურ ფონზე გამოიცადა საველე და სათბურის პირობებში. შეფასებისათვის გამოყენებული იქნა საერთაშორისოდ აღიარებული მეთოდოლოგია. როგორც აღმონაცენის, ასევე მოზრდილ ფაზაშიც, დაავადებათა მიმართ გამძლე და ზომიერად გამძლე აღმოჩნდა თითქმის ყველა გამოცდილი სახეობა: *Triticum monoccoccum* (*var.laetissimum*), *Triticum timopheevi(var. tipicum* Zhuk), *Triticum georgicum* (*var.chvamlicum* Supat), *Triticum dicoccum (var.farrum caucasicum*), *Triticum .ibericum* Men (*var. fuliginosum* Zhuk), *Triticum ibericum* Men (*var. stramineum* Zhuk), *Triticum macha* Dek et Men (*var. megrelicum* Men), *Triticum macha* Dek et Men (*var. colchicum*), *Triticum macha* Dek et Men (*var. palaeoimereticum*), *Triticum macha* Dek et Men (*var. sharashidze*) and *Triticum spelta (var. dekaprelevichi* Dorof.), *Triticum durum* Desf. და *Triticum compactum* Host *var.icterinum* Al. ძველი ადგილობრივი ჯიშების უმრავლესობა მიმღებიანი აღმოჩნდა ყველა დაავადების მიმართ. მხოლოდ ორმა მათგანმა (შავფხა, ჯავახეთის დიკა) გამოავლინა ზომიერი გამძლეობა. კვლევის შედეგები მეტად სასარგებლო იქნება ეროვნული და საერთაშორისო სასელექციო პროგრამებისთვის.

საკვანძო სიტყვები: ხორბალი, გამძლეობა, შეფასება, მთავარი დაავადებები

Resistance of Georgian Wheats to Major Diseases

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Georgia is a country of origin of wheat that has historically been a staple food crop in Georgia. Wheat genetic resources have particular importance, both for Georgia and world wheat breeding. One of the main reasons for low yield is stable development of diseases. The most common and harmful among wheat diseases are wheat rusts, septoria glume blotch and tan spot. The ecologically reliable way to protect the wheat plants is to develop resistant varieties. For this, it is extremely important to constantly monitor changes in the virulence of pathogens, since breeders must be informed in a timely manner. To this end, wheat's resistance to fungal diseases has been monitored for 30 years by researchers at the Institute of Phytopathology and Biodiversity. A collection of twenty-five wheat accessions including thirteen endemic wheat species/subspecies, twelve old varieties were evaluated under the artificial infection of major fungal diseases (stem rust, stripe rust, leaf rust, tan spot and septoria glum blotch) both in the field and in the greenhouse conditions according to the international methodology. High and moderate level of juvenile and adult disease resistance were detected in nearly all species: *Triticum monoccoccum*(*var.laetissimum*), *Triticum timopheevi (var. tipicum* Zhuk), *Triticum georgicum*(*var.chvamlicum* Supat), *Triticum dicoccum (var.farrum caucasicum*), *Triticum ibericum* Men(*var. fuliginosum* Zhuk), *Triticum ibericum* Men (*var. stramineum* Zhuk), *Triticum macha* Dek et Men (*var.megrelicum* Men), *Triticum macha* Dek et Men (*var. colchicum*), *Triticum macha* Dek et Men (*var.palaeoimereticum*), *Triticum macha* Dek et Men (*var. sharashidze*) and *Triticum spelta (var.dekaprelevichi* Dorof.), *Triticum durum* Desf. and *Triticum compactum* Host *var.icterinum* Al.. The most of old local varieties was susceptible to all diseases. Only two varieties (Shavpkha, Javakhetis dika) were moderately resistant. These research results could be useful for the national and international breeding programs in further using the resistant genotypes as parents in the crossing.

Key words: Wheat assessment, major diseases, resistance

Introduction

Wheat (*Triticum aestivum* L.) is a major food crop globally and the basis of global food security. It has historically been a staple food crop in Georgia. Georgia is a country of origin of wheat and presents an ancient center of agriculture. At the same time, it is distinguished by a diversity of a number of unique endemic species and old local varieties of different crops. Therefore, the genetic resources common in Georgia are significant not only from historic point of view, but also for selection of the valuable varieties for cultivation. The wheat is presented with very large diversity which is stipulated by diversity of soil and climate condition of Georgia. At different times, in Georgia 14 species of wheat are described, five out of which are local endemics. In overall, 144 subspecies and Georgian landraces of wheat are registered. The local wheat has many unique features such as high immunity, and high biochemical and technological quality of grain. They have particular importance, both for Georgia and world wheat breeding [1, 2]. The bread and other products made from this wheat were highly appreciated among local population and they were deeply connected with national traditions and custom. However, local varieties have been disappearing from agriculture. The new commercial varieties replaced land races. Most of these

varieties are susceptible to the local races of major diseases and produce low yield. The low yield of wheat in region can be explained by stable development of diseases, low-yielding and poorly-adapted varieties etc. Naturally, the development of different types of wheat pathogens, including the wheat rusts, has the same length history and they are known for their wide spreading and harm [3]. Georgia is an area of the permanent spread of cereal diseases because of its climate conditions, diversity of infection reserving plants and existence of alternate host-plants [4]. The major and ecologically reliable way to confront this problem is development and release of resistant varieties. To achieve success, it is crucial to permanently monitor the changes in virulence of pathogens and in case if new virulence is occurred, the breeders need to be informed in timely manner about the ineffectiveness of the complementary resistance gene of this virulence. With this target, during 30 years wheat resistance to fungal diseases was monitored by researchers of the Institute of Phytopathology and Biodiversity. The most common and harmful among wheat diseases are wheat rust, which causes losses of an average of 30%, the rate of which can increase to 80% in case of severe epiphytotia [5]. The yield reductions were also related to the high occurrence of Septoria glume blotch and tan spot [6,7]. Other leaf diseases such as, powdery mildew, spot blotch and head scab were of little importance).

The goal of this study was to determine levels of resistance in wheat species and old Georgian varieties. The research was based primarily on plot trials and should allow subsequent selection of the most promising genotypes.

Materials and Methods

Wheat germplasm. A collection of twenty-five wheat accessions including thirteen endemic wheat species and subspecies, twelve old varieties were evaluated under the artificial infection of major fungal diseases (stem rust, stripe rust, leaf rust, tan spot and Septoria glum blotch) both in the field and in the greenhouse conditions. Experimental material has been received from Agriculture SR Center of Georgia (former Lomouri Institute of Crop Science of Georgia).

Trial design and data collection. The wheat field trials were conducted at experimental area of Institute of Phytopathology and Biodiversity during 2013-2019. Tested entries were sown in the fall. Each entry was planted in 3 rows with 1-meter length spaced 20 cm apart at a rate 130 seeds per meter. The trial was hand-planted to reduce the experimental error. 2 rows of standard varieties (Bezostaya 1 and Lomtagora 126) and universal susceptible varieties were planted within the screening material after every 20th entry to enhance inoculum pressure. The plants were inoculated at the flag leaf stage with the mixture of Georgian races of pathogens (*Puccinia f. sp. striiformis*, *Puccinia f. sp. graminis*, *Puccinia f. sp. triticina*, *Stagonospora nodorum* and *Pyrenophora tritic-repentis*) by spraying the spore-water suspension. Inoculated plants were covered by polyethylene film for a moist chamber. Disease scoring was done 20-25 days after inoculation in three times with 7-8 days intervals. Measurement of disease incidence and severity in wheat varieties during each of the six growing seasons was conducted according to methods described by Roelfs et al (1992). and Eyal et al. (1987). Two types of scoring were combined: a) the host response to infection (RT) in the field was scored using 'R' (resistance) or 'MR' (moderate resistance); "MS' to indicate moderate susceptible, and "S' to indicate full susceptibility, b) the disease severity. Wheat disease severity was recorded at the milk ripening stage during experimentation time using the scales specified for rusts [8, 10] and spot diseases [11] For description of the wheat growth stages the Zadok's (1975) scale were used. Seedlings consisted of eight to ten plants per wheat entries were tested under the greenhouse conditions. Seven-day-old seedlings were inoculated in the second leaf stage with the water-spores mixture (approximately 3-5mg of freshly collected spores per 1ml of distilled water suspension) and incubated during 24 hours in a dew chamber in dark condition at 20-22^{0}C and 100% humidity. After that plant were transferred to a glasshouse where the temperature varied between 22-25^{0}C and relative humidity 60-70%. For each seedling, infection types (IT) were recorded 12-14 days after inoculation, based on a 0-4 and 0-9 specific scales for rust species [13, 14] and for blotches [11], respectively.

Results and Discussion

High and moderate level (R, MR) of juvenile and adult resistance to the rusts, tan spot and Septoria glum blotch were found in nearly all tested species: *Triticum monoccoccum* (*var.laetissimum* Korn),

Triticum timopheevi (var. tipicum Zhuk-*var.viticulosum* Zhuk), *Triticum georgicum* (*var.chvamlicum* Supat), *Triticum dicoccum (var.farrum caucasicum*), *Triticum .ibericum* Men (*var. fuliginosum* Zhuk), *Triticum .ibericum* Men (*var. stramineum* Zhuk), *Triticum macha* Dek et Men (*var. megrelicum* Men), *Triticum macha* Dek et Men (*var. colchicum*), *Triticum macha* Dek et Men (*var. palaeoimereticum*), *Triticum macha* Dek et Men (*var. sharashidze*) and *Triticum spelta (var. dekaprelevichi* Dorof.), *Triticum durum* Desf. and *Triticum compactum* Host *Var.icterinum* Al.. Exception was three variation of *Triticum macha* which showed the moderate susceptibility. Different responses of old Georgian varieties to the diseases were recorded. The most of old local varieties tested under artificial infection was susceptible to rusts and spot diseases. Only two varieties (Shavpkha and Javakhetis dika) out of twelve under study were moderately resistant to the diseases in both stages. (Table 1). These findings are in agreement with the results obtained in previous years [15, 16, 17].

Table 1. Resistance of wheat species and local varieties to major diseases

Speciee/ subspecies /Georgian name	**Incidence and Reaction type in adult/ seedling stages**				
	Stem rust	**Stripe rust**	**Leaf rust**	**Septoria Glume blotch**	**Tan spot**
Tr.monoccoccum/ Var.laetissimum Korn Gvatsa Zanduri	R/ R	R	R	10MR	20MR
Tr.timopheevi/ Var.tipicum Shuk-var.viticulosum Shuk Chelta Zanduri	R/ MR	R	R	10MR	20MR
Tr. Dicoccum, Var. farrum caucasicum/ Asli	R/ MR	10MR	10MR	20MR	25MR
Triticum macha Dek et Men (Var.megrelicum Men) Makha	5MR/ MR	5MR	5MR-MS	20MR	20MR
Triticum macha Dek et Men (Var. palaeocolchicum Dek et Men) Makha	5MR/ MR	5MR	10MR	10MR -MS	5MS
Triticum macha Dek et Men (Var.colchicum Dek et Men) Makha	MR	R	R	10MR -MS	5MS
Triticum macha Dek et Men (*var. sharashidze*)	MR	5MR	20MR	5MR -MS	5MS
T. *georgicum* Dekapr/ Kolkhuri Asli	MR/ MR	5MR	10MR	20MR	10MR
Tr.ibericum Men Var. fuliginosum Zhuk/ Dika	R/ MR	10MR	20MR	20MR	20MR
Tr.ibericum Men Var .stramineum Zhu/k Dika	R/ MR	30MR	20MR	40MR	10MR
Tr.ibericum Men Var.fuliginosum Zhuk	20MR	R	20MR	30MR	10MR
Tr.compactum Host Var.icterinum Al.	20MR/ MR	30MR	30MR	20MR	20MR

Tr. Spelta Dek et Men Var.dekaprelevichi Dorof	50MR/MR	5MR	5MR	20MR	20MR
Shavpkha *(Triticum durum)*	5MR-MS	R	5MR-MS	60MR	50MR
Adgilobrivi Dolis Puri *Tr.aestivum*	5MR- MS	60MR	5MS	5MR- MS	10MS
Korboulis dolis puri	20MS	5MR-MS	20MS	20MS	30MS
Akhaltsikhis tsiteli dolis puri	30MS	MR-1MS	30MS	50MS	50MS
Moklegeroiani tsiteli Dolis Puri	*20MS*	5MS	30MS	30MS	30MS
Dolura	30MS	5MS	20MS	20MS	30MS
Tetri dika	30MS	5S	10MS	10MS	20MS
Javakhetis dika	5MR	10MR	10MR	10MR	5MR
Tsiteli dika	30MS	40MS	50MS-S	50MS	60MS
Shavi dika	R	1MR	R	50MS	50MS
Tetri Ipkli *Tr.m*	10MS	5MR	5MS	50MS	40MS
Tetri tavtukhi	10MS	20MS	10MS	25MS	30MS

As it is known, the Ug99 group of races was recognized as a major threat to wheat production. Twelve races belonging to the Ug99 lineage are now known and have spread to various wheat-growing countries in the eastern African highlands, South Africa, Sudan, Yemen, Egypt, Iran etc. Identification and transfer of new sources of race-specific resistance from various wheat relatives are very important to enhance the diversity of resistance [18].

The collaborative work with the Cereal Diseases Laboratory (Minnesota University, USA) to determine the resistance of nine endemic wheat subspecies and four Georgian landraces to four variants of stem rust race Ug99 was conducted in 2014. The genotypes were tested in seedling stage against three isolates: 04KEN156/04 (race TTKSK), 06KEN19V3 (race TTKST), 07KEN24-4 (race TTTSK) of Ug99 variants from Kenya and one isolate 06YEM34-1 (race TRTTF) from Yemen. Six endemic subspecies:*T.monoccoccum* var.*laetissimum, T.timopheevii* var.*typicum, T. ibericum* var. *fuliginosum, T. ibericum* var. *stramineum, T. macha* var *.megrelicum,* and *T. macha* var *.palaeo-imereticum* were highly resistant (R) to Kenyan races: TTKSK, TTKST and TTTSK. Two species *T. macha var.* colchicum and *T. macha var. megrelicum* showed moderately resistance (MR) to these races. Only two accessions *T. macha var.stramineum* and *T. georgicum* Dekapr showed moderate susceptibility to all races [19].

The Georgian wheat landraces have been widely used in breeding of wheat as they represent rich sources of genes conferring resistance to diseases. Over the years, breeding for rust resistance has been based on Georgian endemic wheat species: *Triticum timopheevi*, *Triticum zhukovski*, *Triticum carthlicum* in the world. Much experience has been gained using wild wheat relatives for identification of new resistance sources [20, 21, 22, 23]. These research results could be useful for the national and international breeding programs in further using the resistant genotypes as parents in the crossing.

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საქართველოს სოფლის მეურნეობის სამეცნიერო კვლევითი ცენტრი, საქართველო, თბილისი.
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აბსტრაქტი. საქართველო მიწათმოქმედების და აგრარული ცივილიზაციის უძველესი ქვეყანაა. აქ მცხოვრებმა უძველესმა ტომებმა, პირველ საცხოვრისის შექმნასთან ერთად, მის სიახლოვეს ხორბლის და ვაზის კულტურის მოშინაურება და კულტივირება, ჯერ კიდევ 8000 წლის წინ დაიწყო. დღემდე უდიდესია ამ კულტურებისადმი ინტერესი: ქართული ვაზი და ღვინო, ხორბალი და პური ქვეყნის მატერიალურ-კულტურული საგანძური და ეროვნული ღირებულებების მატარებელია.

ხორბლის მნიშვნელობიდან გამომდინარე მთელი მსოფლიოს ხალხი მუშაობდა მისი, როგორც კულტურის გაუმჯობესებაზე. ათასწლიანი მუშაობა მიმდინარეობდა ცალკეულ ქვეყნებში და შეიქმნა ხორბლის 22 სახეობის 40 ათასამდე ჯიში. დღეს მსოფლიოში გავრცელებული ხორბლის 27 სახეობიდან 14 საქართველოში მოყავდათ, მათგან საქართველოს სხვადასხვა ეთნოგრაფიულ კუთხეებში 5 ენდემური სახეობაა (ზანდური-*T. timopheevii* Zhuk, კოლხური ასლი-*T.Karamyschevii* Nevski, დიკა-*T. persicum* Vav., ჰექსაპლოიდური ზანდური-*T. zhukovskyi* Men.& Eriz, მახა-*T. macha* Dekapr.&Men.) გავრცელებული. საქართველოს ტერიტორიაზე ხორბლის წარმოშობასა და ევოლუციაზე მიუთითებენ გამოჩენილი ტრიტიკოლოგი მკვლევარები: ნ. ვავილოვი, მაკ-კეი, პ. ჟუკოვსკი, მ. იაკუბცნერი, ვ. დოროფეევი, ლ. დეკაპრელევიჩი, ვ. მენაბდე, პ. ნასყიდაშვილი.

ხორბლის კულტურის წარმოშობის ძირითადი კერა დასავლეთ საქართველოა, კერძოდ, კოლხეთის დაბლობი, რაჭა-ლეჩხუმი. ისტორიამ დაგვიდასტურა, რომ საქართველოს დამოუკიდებლობაში ხორბლის კულტურას განსაკუთრებული ადგილი ეჭირა. ქართველი ხალხი ქმნიდა ადგილობრივი პირობებისადმი შეგუებულ ფორმებს, რაც გარანტირებული მოსავლის მიღების საშუალება იყო. სწორედ ამიტომ საქართველოს მოსახლეობამ შექმნა ხორბლის ისეთი ბიომრავალფეროვნება, რომელიც უნიკალურია

მთელ მსოფლიოში. ქართული ენდემური სახეობები ხასიათდება უნიკალური თვისებებით, რის გამოც ითვლებიან საუკეთესო გენეტიკურ წყაროდ მსოფლიო სელექციაში.

განსაკუთრებით მსოფლიოს ტრიტიკოლოგთა ყურადღების ცენტრშია: ჩელტა ზანდური, დიკა და ჰექსაპლოიდური ზანდური (ჟუკოვსკი), რომელიც ხასიათდება სოკოვანი დაავადების მიმართ ფენომენალური კომპლექსური იმუნიტეტით; ჩელტა ზანდური გამოირჩევა მარცვალში მაღალცილიანობით და პურცხობის მაღალი ხარისხით; ენდემური სახეობა კოლხური ასლი ხასიათდება ნაცრის სხვადასხვა რასისადმი გამძლეობით; ხორბალი მახა ხასიათდება მცენარეზე ფოთლების დიდი მასის განვითარებით და ღეროს სიმტკიცით, კარგად იტანს ჭარბ ტენიანობას.

საქართველოს რბილი ხორბლის აბორიგენული ჯიშ-პოპულაციები გამოირჩევა დიდი მრავალფეროვნებით, რომლებიც წარმოდგენილია ეკოლოგიურ ჯგუფებად და ხასიათდებიან შედარებით დაბალი, მაგრამ გარანტირებული მყარი მოსავალით. კარგად ეგუებიან მკვეთრად ჭრელ ნიადაგურ და კლიმატურ პირობებს. მათი ჩანასახოვანი პლაზმა ატარებს თანამედროვე ინტენსიური ტიპის ჯიშებისათვის საჭირო აუცილებელ ნიშან-თვისებებს. ხორბლის ტრადიციები საქართველოში შემორჩენილია ნეოლითის პერიოდიდან დღემდე. ქართველი ხალხის ისტორიული გამოცდილება ხორბლის წარმოებაზე ერთ-ერთი უძველესია მსოფლიოში. მე-19 საუკუნის ბოლოს საქართველოს, ჯერ კიდევ, გაჰქონდა ხორბალი საზღვარგარეთ.

საკვანძო სიტყვები: ხორბალი, ტრადიციები, ენდემური სახეობები, ისტორია, ევოლუცია.

Traditions of Georgian Wheat and its Use - Past, Present and Future

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Abstract. Georgia is an ancient country of agriculture and agrarian civilization. The ancient tribes who lived here 8000 years ago, along with the creation of the first dwellings, began to domesticate and cultivate wheat and grape cultures . Georgian vine and wheat still attract great interest: Georgian vine and wine, wheat and bread are the treasures of the country and carriers of national values.

Owing to the importance of wheat, people around the world have worked on the improvement of this crop for thousands of years. As a result, up to 40,000 varieties of 22 types of wheat have been created. Today, 14 of the 27 wheat species distributed in the world are grown in Georgia, of which 5 endemic species are widespread in different ethnographic parts of Georgia (Zanduri - *T. timopheevii* Zhuk, Kolkhuri Asli - *T.Karamyschevii* Nevski, Dika - *T. persicum* Vav.,Hexaploid Zanduri - *T. zhukovskyi* Men.& Eriz, Macha-*T. macha* Dekapr.&Men.). Prominent triticologists confirm the origin and evolution of wheat in Georgia: N. Vavilov, M.Mackay, P. Zhukovsky, M. Yakubtsiner, V. Dorofeev, L. Decaprelevich, V. Menabde, P. Naskidashvili.

The center of wheat culture origin is Western Georgia, namely the Kolkhida Plain, Racha-Lechkhumi. History has confirmed that wheat culture played an important role in Georgia's independence. The Georgian people created forms adapted to local conditions, which guaranteed the steady production of crops. That is why the population of Georgia has created such wheat biodiversity,

which is unique around the world. Georgian endemic species are characterized by unique properties, therefore they are considered the best genetic source in world breeding.

The attention of triticologists of the world is especially attracted by: Chelta Zanduri, Dika and Hexaploid Zanduri (Zhukovsky), characterized by phenomenal complex immunity to fungal diseases; Chelta Zanduri is characterized by high protein content in the grain and high degree of baking ability; the endemic species Kolkhuri Asli is resistant to various types of rust; Macha wheat is characterized by an abundance of leaf mass on the plant and the strength of the stem, well tolerates excess moisture.

The native varieties of soft wheat of Georgia are very diverse, which are represented in ecological groups and are characterized by a relatively low, but guaranteed solid yield. They adapt well to dramatically changing soil-climate conditions. Their germplasm carries the necessary characteristics for modern varieties of the intensive type. Wheat traditions in Georgia have survived from the Neolithic period to the present day. The historical experience of the Georgian people in the production of wheat is one of the oldest in the world. At the end of the 19th century, Georgia still produced wheat for export.

Keywords: Wheat, Traditions, Endemic Species, History, Evolution.

Introduction. The attitude of the Georgian people to the wheat culture is exceptional. Historically, Georgia was in a constant war with neighboring countries. From ancient times, the Georgian people were considered permanently residing people and who did not leave their home even in war times. None of the conquerors - Macedonians, Mongols, Iranians, Turks and Russians - were able to destroy Georgia. The high level of agriculture, the love of wheat and viticulture played a large role in the survival of Georgia. The writer Xenophon the First gives us information that "the Hellenic army, passing through the land of the Muscovites of the Kartvel tribe, robbed houses where they came across a large supply of bread, which, according to the Muscovites, were distributed last year by the will of their ancestors. The freshly cut wheat was bound in sheaves. Especially a lot was "Asli" (Berdzenishvili, 1956; Mikeladze, 1967)

According to ethnographic studies, wheat cultivation in Georgia has been at high level since the ancient times. Endemic elements of material culture have survived to this day, such as "shnakvi" a simple tool for collecting keeled wheat, and a threshing tool "kevri".

Historical data on wheat in ancient times. In the works of ancient Greek historians Herodotus and Xenophon, we come across the information about the distribution of many types of wheat in ancient Georgia. The first monuments of the wheat civilization belong to the Mesolithic period, which is confirmed by archaeological excavations. Several types of wheat have been found in Neolithic settlements - Arukhlo, Khramis Gora, Shulaveris Gora. Among them are hard and soft wheat, whose age dates from 6,000 years BC (Rusishvili et al., 2019). As a result of similar archaeological excavations in a settlement in the village of Digomi, carbonized grains of Zanduri of the late Bronze age were discovered (Maisaia et al., 2005).

Archaeological research in the Mtkvari-Araksi Valley revealed the remains of Tavtukhi, dating from the 4th and 3rd millennium BC (Dzidziguri, 2000). According to these materials, the primary wheat species existing in Georgia revealed phylogenesis of the wheat genus and confirmed the diversity of wheat species. Georgian farmers in ancient times gave corresponding names to all this great variety of wheat species. Georgian names for wheat by biological group were "dzveltesli" or autumn, and "akhaltesli" or spring. By species and varieties - Zanduri, Asli, Dika, Tavtukhi, Ipkli, Doli Puri, Khulugo, Khozo, Khotora. By place of origin - Chveneburi, Rachuli, Akhaltsikhe, Kolkhuri, Corbouli. These names give a peculiar folk classification of a wide variety of Georgian wheat varieties. Ecotope is a mesophyte. The distribution area - Racha, Lechkhumi, Chiatura, Sachkhere, Kvemo Svaneti. Varieties: Khulugo, Khotora, Khozo. Later Korboulis Dolis Puri and Ipkli. According to morphological characteristics - Shavtavtava, Shavtavela, Shavpkha, Tsiteli doli, Shavi dika, Tetri dika. These names are a kind of folk classification of a wide variety of of Georgian wheat varieties. According to Ivane Javakhishvili, this is not only the result of observations of farmers, in ancient Georgia there were such writers - agronomists and naturalists as Katon, Varon, Columbella and Plinus. The first information about the biodiversity of Georgian wheat belongs to Sulkhan-Saba Orbeliani (XVII century) and Vakhushti

Batonishvili (XVIII century). Foreign naturalists also traveled to Georgia - Guldstadt, Georg and Klaport (18th-19th centuries). In Georgia, even today, it is possible to detect sub-contoured forms resulting from the natural interbreeding of wild and cultural forms. Such forms were discovered in the village Eredvi of Kartli area.

Of all the richness of varieties that have been created in Georgia for centuries, autumn varieties of soft wheat with red grains called "Dolis Puri" are especially valuable. These varieties had the most important properties, such as high nutritional value, baking ability, and long-term storage of the baked bread. Based on its meaning, the people called it mother's bread. Thanks to these qualities, wheat played the role of a mother in the history of the Georgian people. Over the centuries, the wheat variety developed following the conditions of historical development. Georgian warriors could take bread with them to the war, which did not got staled or change its taste for two weeks.

Thanks to the love of wheat culture, in the highlands of Georgia (Racha-Lechkhumi, Meskhet-Javakheti, Mtatusheti) keeled wheat is still grown today and use old Georgian terms: "Jejili" is a newly sprouted field, "Namja is what is left after harvesting, "Kalo" is a place for threshing ears, "Kevri" is a board for threshing ears, "ulo" means strong binding of wheat stems, "shnakvi" is a tool for collecting wheat.

Traditions of use of wheat in Georgia. Wheat has many uses in Georgia. By the church, it is considered as a holy culture. In the Georgian Orthodox Church from ancient times, flatbreads were made from wheat flour in honor of the holy fathers. In Tusheti, small loaves were baked, which were called “kveri”. In every corner of Georgia, church holidays are celebrated with food made of wheat grains or flour. During the holiday Barbaloba, it is customary to bake “lobiani” (a pie with beans). On Christmas in Guria they bake pies with cheese and boiled eggs. In Kartli-Kakheti, Ertso-Tianeti and Gudamakari is prepared “korkoti” (boiled wheat grains). Church rituals are celebrated in each corner in different way.

Wheat was widely used in folk medicine: pus was squeezed out of a suppurated place with the help of "khavitsi." Stomatitis was treated with roasted wheat grain, into the broth of which alum was added and was prepared infusion for rinsing. Wheat starch is used to treat cough and gastrointestinal diseases. Various ointments are made from wheat flour. Wheat flour porridge is used for gastrointestinal diseases and to eliminate hemorrhoids (wheat grains should be soaked for two days, when it germinates, dried, ground, boiled and mixed with butter and salt). Wheat malt is also used as a laxative for animals. Zanduri is used in Samegrelo to stimulate sweating in patients with fever, and patientswithneurosis are given a boiledgrain broth with honey. Macha seed broth is used to improve vision. In folk medicine, the boiled wheat grains brothis used as a refreshing drink.

Modern achievements of Georgian wheat. The multi-species biodiversity of Georgian wheat has not gone unnoticed by world scientists. Scientists in Japan, Russia, Germany, England, the United States and France are intensively working on Georgian wheat.

It is important that on the basis of endemic species of Georgia, 8 new varieties of wheat were obtained: *Tr. milinae 2n = 28*, a naked analogue of *Tr. Timopheevii*; *Tr. Miguschovii 2n = 42*, an immune analogue of hexaploid wheat; *Tr. kiharae 2n = 42*, wheat spelt homolog; *Tr. Timonovum 2n = 28* obtained by Zanduri autopolyploidy; *Tr. fungicidum* 2n=56, obtained by Zhukovsky by crossing Dika and Zanduri;

With the participation of Chelta Zanduri in the USA, Australia, Kenya, Japan, England, many new forms and varieties of wheat were obtained: Melanopus 5, Melanopus 6, Melanopus 7, Steinwedel, Timstein, Mengavi, Lepard, SRPC 67;

The future of the Georgian wheat. The diversity of wheat created by the Georgian people over 8,000 years of activity will allow geneticists and breeders of the world to create new varieties of intensive type of wheat using modern methods. The immunity of Georgian species to fungal diseases is especially important for the future. Chelta Zanduri also has cytoplasmic sterility genes that allow the creation of hybrid wheat.Also a gene, found in Georgian soft wheat Dolis Puri 35-4 allows the restoraton of fertility. The positive characteristics of Georgian wheatspecies and soft wheat varieties are the best source for creating promising varieties and forms using gene modification and nanotechnology. This is confirmed by data from the Institute of Molecular Genetics in Liverpool. According to German researchers, in the future, humanity should consume Zanduri.

Conclusion. The Georgian people are the ancient nation, thanks to their traditions and development, have created a huge biodiversity of the wheat culture over the centuries. These traditions continue today and create new opportunities to provide the world's population with new promising source material for wheat.

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ქართული ხორბალი და მისი მოხმარების სოციალურ-კულტურული ასპექტები

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აბსტრაქტი. საქართველო უძველესი სამიწათმოქმედო ცენტრია. ველური ხორბლის გაკულტურების ერთ-ერთი კერა წინა აზიასთან ერთად კავკასია და საქართველოა. საქართველოში არსებულმა პირველადმა სახეობებმა ახსნა ხორბლის გვარის ფილოგენეზი და დაამტკიცა ის ფაქტი, რომ ხორბლის სახეობათა მრავალფეროვნებით ხასიათდება მხოლოდ საქართველო.

საქართველოს პრიორიტეტს კულტურული ხორბლის გაჩენაში, ადასტურებს როგორც არქეოლოგიური მონაპოვარი, ისე აგრიკულტურის ეთნოგრაფიული და სხვა მონაცემები და კვლევები. ამასვე ადასტურებს ის გარემოება, რომ ათასწლეულების განმავლობაში ქართველი ხალხის სამეურნეო ყოფაში უკანასკნელ დრომდე ფუნქციონირებდა როგორც ხელით სამუშაო სამიწათმოქმედო სამეურნეო იარაღების, ისე სახვნელი საშუალებების დიდი მრავალფეროვნება, განვითარების დინამიკაში უმარტივესიდან რთულისაკენ.

ქვემო ქართლში წარმოებული არქეოლოგიური გათხრების შედეგად ე. წ. „გადაჭრილ გორაზე“ აღმოჩნდა ძვ. წ. VI ათასწლეულის კარბონირებული ხორბლის მარცვლები, ასე რომ, რვა ათასი წლის წინ ჩვენი ქვეყნის ტერიტორიაზე დაწყებული ქართული ხორბლის თესვა-მოყვანა უწყვეტად გრძელდებოდა და ამ საქმიანობას აქააური მოსახლეობა დღესაც გულმოდგინედ ეწევა.

საქართველოში ხორბლის კულტურის გავრცელების და ტრადიციების გაგრძელებასთან დაკავშირებით განხორციელებულ ეთნოგრაფიულ ექსპედიციებში დაფიქსირებული მასალა ცხადყოფს, - მიუხედავად იმისა რომ გასული საუკუნის სამოციანი წლებიდან საქართველოში ინტენსიურად შემოდის უხვმოსავლიანი ე. წ. ინდუსტრიული ხორბალი, ენდემური და ტრადიციული ქართული ხორბლის თესვა-მოყვანის ტრადიცია თუმცა შესუსტდა, მაგრამ არასოდეს შეწყვეტილა და დღესაც მისდევენ მის მოყვანას. არათუ მისდევენ, რიგი თვისებრივი უპირატესობის გამო, მათზე და მათ ნამზადზე მოთხოვნილება საზოგადოებაში უფროდაუფრო იზრდება. აღნიშნული მოთხოვნილება იწვევს მათი ფართობების და გავრცელების მიკროზონების არეალის ზრდას.

ხორბალთან დაკავშირებულმა სპეციალურმა ექსპედიციებმა დაადასტურა, რომ ენდემური და ტრადიციული ჯიშები ითესება საქართველოს თითქმის ყველა კუთხეში. მათ შორის ყველაზე ერთგულად ჩვენი ქვეყნის აღმოსავლეთის მთასთან ერთად რიტუალური და საწესო ხორბლის ნაწარმი, ტრადიციული წეს-ჩვეულებების დაყენება-ჩატარება და მათში მონაწილეობა განსაკუთრებიღ საქართველოს მთიანმა კუთხეებმა, გამორჩეულად სვანეთმა შემოინახა.

ქართული ხორბლის ტრადიციების გაგრძელებასა და აღორძინებაში დიდი წვლილი შეაქვს საეკლესიო-სამონასტრო სფეროს წარმომადგენლებს. მემკვიდრეობითობის თვალსაზრისით არანაკლებ მნიშვნელოვანია აღნიშნული დიდი ტრადიციების ტრანსმისია, მოზარდი თაობის ჩართვა ამ კეთილშობლურ საქმეში და ამ გზით ტრადიციების შენარჩუნება და გადაცემა.

სასიამოვნოა ის ტენდენცია, რომ ჯერ ერთი, წინაპართაგან გადმოცემული ტრადიციები გრძელდება და მეორეც ის, რომ საზოგადოების განწყობა და სურვილია, რიტუალური ნამზადის ცხობისას გამოიყენონ ქართული ხორბალი. კერძოდ, ენდემურიც, ტრადიციულიც და სულაც რამდენიმე ათწლეულის წინ საქართველოში სელექციის გზით მიღებულიც. დაბოლოს, ჩვენს თვალწინ, ყოველდღიურ ყოფაში ხდება ამ ტრადიციათა გადაცემა, ტრანსმისია მოზარდი თაობისადმი ინტერაქტივით, პრაქტიკული და მენტალური ჩვევების გათავისებით.

საკვანძო სიტყვები: ხორბალი, გავრცელება, ნამზადი, ტრადიცია.

Georgian Wheat and Socio-Cultural Aspects of its Consumption

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Abstract. Georgia is the oldest agricultural country. Along with Anterior Asia, the Caucasus and Georgia are one of the centers for the domestication of wild wheat. The primary species existing in Georgia explained the phylogenesis of the wheat genus and proved the fact that such huge variety of wheat species is characteristic only for Georgia.

Georgia's priority in the developing of cultural wheat is confirmed by both archaeological finds and ethnographic and other agricultural data and research. This is also confirmed by the fact that for millennia in the agricultural life of the Georgian people until recently, a wide variety of manual agricultural and arable tools were used, in the dynamics of development from the simplest to the most complex.

As a result of archaeological excavations carried out in Kvemo Kartli, on the so-called "cut hill," were found carbonized wheat grains dating from the 6th millennium BC, so that, the sowing and cultivation of Georgian wheat, which began eight thousand years ago in our country, went on continuously, and the local population is still diligently engaged in this activity today.

The material found in ethnographic expeditions carried out in connection with the spread of wheat culture and the continuation of the traditions in Georgia shows that - despite the fact that since the 60s of the last century were intensively imported high-yielding so-called industrial varieties of wheat, the tradition of sowing and growing, endemic and traditional Georgian wheat, although weakened, has never stopped and is still cultivated. Moreover, not only did it not stop, thanks to a number of qualitative advantages, the demand for them and their products in society is constantly increasing. Such demand leads to an increase in their sowing areas and the areas of distribution in micro zones.

Special expeditions related to wheat have confirmed that endemic and traditional varieties are sown in almost every corner of Georgia. In the mountainous corners in eastern Georgia, especially in Svaneti, the most devotedly preserved are ritual household wheat products, staging and conducting traditional rituals and participating in them.

Representatives of the church and monasteries make a great contribution to the continuation and revival of traditions related to Georgian wheat. From the point of view of heredity, the transmission of the mentioned traditions, the involvement of the younger generation in this noble cause and, thus, the preservation and transition of traditions are equally important.

It is good to see that, first, the ancient traditions received from ancestors are continued, and second, society is in the mood of using Georgian wheat both endemic, traditional varieties and obtained by selection several decades ago in the cooking of food for rituals. Finally, before our eyes, in our daily lives, these traditions are transmitted to the younger generation in an interactive mode, through the acquiring of practical and mental skills.

Keywords: Wheat, Spread, Preparation, Tradition

The scientific community agrees that Georgia is the oldest agricultural center. Along with Anterior Asia, the Caucasus and Georgia are one of the centers for the domestication of wild wheat (Vavilov 1932; Bernal 1956; Menabde 1950; Chitaia 1997; Jalabadze 1986; Sadunishvili 2021).

The priority of Georgia and its neighboring countries in the emergence of cultural wheat is confirmed by both archaeological finds and ethnographic and other agricultural data and research. This is also confirmed by the fact that for millennia, in the economic life of the Georgian people until recently,

a great number of both manual agricultural and arable tools have been used, in the dynamics of development - from the simplest to the most complex ones (Chitaia 1997; Jalabadze 1960; Bregadze 2004).

Academician Iv. Javakhishvili was the first to conclude, that Georgia is a living museum of arable tools (Javakhishvili, 1986), and the other researchers in subsequent years, as a result of careful conclusions, have confirmed this opinion (Chitaia, 1986).

As a result of archaeological excavations carried out in Kvemo Kartli, on the so-called "cut hill," were found carbonized wheat grains dating from the 6th millennium BC, which are currently stored in the National Museum of Georgia. So that, the sowing and growing of Georgian wheat, which began eight thousand years ago in our country, went on continuously, and today the local population is still diligently engaged in this activity.

Today, the agricultural scientists share the opinion, that five of cultural wheat species described in the world are endemic to Georgia: Zanduri - T. timopheevii Zhuk, Kolkhuri asli - T. Karamyschevii Nevski, Dika - T. persicum Vav., Hexaploid Zanduri - T. zhukovskyi Men. & amp; Eriz, Macha - T. macha Dekapr. & Men (NaskidashviliP. 1983).

One of the indicators of the process of domestication of wild wheat in Georgia are the species Macha and Zanduri, semi-wild wheat species preserved in Racha-Lechkhumi. Academician G. Chitaia drew attention to the fact that the species Zanduri was harvested not with a sickle, like the other cereal crops, but with the agricultural tool preserved from time immemorial - "shnakvi."

Over the centuries, local (indigenous) wheat varieties and variety -populations, obtained by folk breeding, have been added to endemic wheat species. First of all, different variants of the variety Dolis Puri. In particular, Akhaltsikhis Tsiteli Dolis Puri, Kartlis Tetri Dolis Puri, Korboulis Dolis Puri, Lagodekhis Grdzeltavtava, Khulugo, Ipkli, Shavpkha and many others.

The material found in ethnographic expeditions carried out in connection with the spread of wheat culture and its traditions in Georgia shows that, despite the fact that since the 60s of the last century were intensively imported high-yielding so-called industrial varieties of wheat, the tradition of sowing and growing, endemic and traditional Georgian wheat, although weakened, has never stopped and is still cultivated. Moreover, thanks to a number of qualitative advantages, the demand for endemic wheat varieties and goods produced from them is constantly increasing in society. Such demand leads to the growth of their sowing and the distribution areas in microzones and is of interest to specific enterprising farmers.

The reason for the current trend the understanding of the merits of Georgian wheat in terms of human health, taste and aroma.

Indeed, the researcher N. Bregadze, describing the advantages of Georgian wheat, notes - "adaptation of the rich species diversity of wheat to the local natural conditions of the microzones of Georgia (frost resistance and winter resistance), immunity to diseases and pests, high yield, vascularization, elastic dough. Excellent taste and aroma "(Bregadze,2004). The proof of the sacred attitude towards bread is that in many places the term "holy" is used as a synonym for wheat (Kartli, Khevsureti, Pshavi, Khevi).

Given the merits of traditional Georgian wheat, the mentioned field has found a new life in the last quarter of a century. Interest from community groups, families, and individual wheat farmers has been recognized. The revival of this trend was supported by brunch associations of farmers, governmental and non-governmental organizations.

Special expeditions related to wheat have confirmed that endemic and traditional varieties are sown in almost all parts of Georgia. We list some of them: the first is Shiraki, called the "bread barn" of Georgia - Dedoplistskaro, Signagi; Kakheti (Telavi, Sagarejo, Akhmeta); Kvemo Kartli (Marneuli, Tetritskaro); Shida Kartli (Mtskheta, Gori, Khashuri); Tusheti communities carry on this work with great enthusiasm both in the mountains (Omalo, Shenako, Diklo) and in plain (Zemo Alvani); In Southern Georgia, Samtskhe-Javakheti (Akhaltsikhe, Adigeni, Aspindza, Akhalkalaki); In Western Georgia, the great traditions of Georgian wheat are preserved and carried on in Racha-Lechkhumi and Kvemo Svaneti (Ambrolauri, Tsageri, Lentekhi); It is worth noting the great desire of the population to expand crops in Zemo Svaneti (Mestia) and other regions.

The Academy of Agricultural of Georgia and the Scientific-Research Center of Agriculture, the Association "Elkana" , the Lomtagora seed company, and the Association of Georgian Wheat Producers make a great contribution to this noble cause. Of course, the craft bakeries "Mzetamze-Puri Gemovani" ("Tavtukhi" in Kutaisi, "Jean-Jacques Bread," "Graminea," etc.)

Representatives of the church and monastic sphere make a great contribution to the preservation and revival of the traditions of Georgian wheat. They sow and grow traditional Georgian wheat, the products of which are used both in monastic life and in the church-ritual sphere. From the flour of varieties Dolis Puri and Dika sown in Shiraki, lean bread and artos are baked in the New Shuamta convent, which fully satisfies the needs of the Alaverdi diocese. True, in Guria, despite the lack of traditions of Georgian wheat, the diocese of Shemokmedi has wheat fields in Kakheti, the products of which they use. From this point of view, the Natakhtari nunnery should also be distinguished. The convent of St. Nino in Ude, the monastery of Baraleti, and other monasteries.

It is worth mentioning the diocese of Nikortsminda. Church and public holidays are held with ritual bread baked from wheat grown here and the unique red wine "Khvanchkara" made in the same diocese. This case is the best example of the socio-cultural unity of the population, heredity, and the best indicator of one of the formulas of Georgian identity "Grace of bread and wine."

From the point of view of heredity, the transfer of the mentioned great traditions, the involvement of the younger generation in this noble cause and, thus, the transfer and preservation of traditions are no less important. The best example is the Lagazidze family in Zemo Alwani, where all family members participate in the whole process, from growing Georgian wheat to harvesting it.

The best example of the participation of the teenage generation is the involvement of schoolchildren in sowing and growing Georgian wheat in Lechkhumi, the village of Gvirishi and Nasperi. A small school of this mountain village with a staff of outstanding teachers, has a large area where students are directly involved in all processes, starting with manual sowing according to the traditions of the ancestors, accompanied by all rituals.

Namely, in the village Nasperi, where the wheat growing farmer Muradi Khvadagiani has a field of wheat Zanduri,where he and his sons harvest with the help of the ancient agricultural tool mentioned above. "Shnakvi" is at first glance a simple cutting tool, but perfectly suitable for harvesting. It consists of two polished sticks up to half a meter long, movably connected with a collar, which widens at the end. A farmer collects a certain number of ears with sticks and with a precise movement breaks them into a basket. This method prevents grains in Zanduri keel from crumbling into the soil, (Chitaia, 1997).

The most important stages of the agricultural cycle associated with the cultivation of wheat are plowing-sowing, harvesting and thrashing-storing. All stages are very laborious and traditionally require significant social support and cooperation. In plowing, such cooperation was necessary, especially when cultivating the land with a large Georgian plow, into which 8-9 oxen and buffaloes were drawn. Such cooperation, which included combining arable resources and traction and was led by Gutnis deda,which was called the Modgami. Modgami meant the distribution of arable days, determined by shared participation between peasants.

Wheat was usually harvested with a sickle in July. That is why the old Georgian name of this month is Mkatatve. Harvesting a ripe crop was very responsible, so everyone gathered to help. This form of labor organization was called mamitadi. In addition to the family's men, it also featured mostly cousins, namesakes and neighbors. Such assistance was mutual, all family members, in turn, helped in return during the harvest. An experienced and skillful harvester was respected and at the beginning of the harvest he was named "Mesveuri," the first to start harvesting.

The collected sheaves of wheat were spread on the ground prepared for threshing, and threshed with the help of "kevri" drawn by bulls. Currently, all these processes are mechanized, if rails and field area allow it.

In Western Georgia, threshed grain was stored in a special place –“begeli” (barn) and in Eastern and Southern Georgia –also in –“begeli”, as well as in moats and pits in the ground. The harvested crop was ground using the hand mills (especially for the preparation of ritual bread porridge) and at the water mills (Shilakadze, 1985; Bedukadze, 1960).

The format of the article does not allow us to discuss in more detail a very diverse range of products from Georgian wheat. Therefore, we will briefly consider and note that the product primarily means a

variety of bread. "Our daily bread," along with other products is baked in a vertical bakery (tone) and a horizontal bakery (purne). They bake it in a hearth and fireplace on clay and stone ketsi (Ketseuli); It was also baked on stone slabs placed in a hearth (ka).

At the beginning, unleavened bread was baked –"khmiadi". After that, the preparation of yeast products prepared with traditional 'khashi', began. The round bread or "Gurgvali" is the earliest one (Gotsiridze, 2007). It is spread throughout Georgia. In Kartli-Kakheti, week's supply of bread was baked and stored in a special storage place –"kidobani". Such a long storing was explained by a small amount of weed plant makhobeli seeds which were mixed with wheat and gave bread a bluish color, it also caused elasticity and aroma. At the end of the week "bread chowder" -a liquid dish was prepared from the old bread.

They also bake "shoti" bread (Kakheti, Kartli), "lavashi" (for a ritual table), small "shoti "called Likani (Gotsiridze, 2007 , p.135-137). Other kinds of bread were Meskhuri bread "somini" and bread (cocora) with a hole in the middle. It was also baked ritual sweet bread, nazuki, etc.

A variety of ritual breads are prepared for the New Year: breads of luck and prosperity, "Basil's bread" in the form of man, small breads: depicting a bull, cow, sheep, sickle, and etc.; New Year's ritual bread, along with other New Year's snacks, necessarily with a boiled pork head in the middle, is laid out on a wooden dish or "gobi". In Kartli, it is named "Abramiani", and the head of the family, who was at the same time Jalabobi, congratulates family members on the New Year, and wishes them health, well-being, and prosperity. In Khevsureti and Pshavi was baked the New Year's bread "Goga Puri," in Svaneti,was baked large bread with a cross for communal ritual celebrations.

Nourishing kada-khachapuri is a wonderful tradition and a variety of baking wheat products. Khachapuri with a cheese filling is one of the outstanding dishes of Georgian cuisine, which has taken a worthy place in the treasury of world folk cooking. There are many of its species: Imeruli, Megruli, Meskhuri (leaf puff), Tushuri (kotori), Guruli (with the addition of a boiled egg), Ajaruli and others.

Racha is distinguished by its variety of baked goods with filling, which, like in other parts of Georgia, were prepared for both sacred holidays and rituals. These are cheese-filled bachuli/bohchuans, which unlike other khachapuri were not round but square; bread with nut filling, layered lobiani//with beans. The latter, like many other dishes, went beyond specific corners and established itself in general Georgian cuisine, especially on the Barbaloba holiday. Before the advent of beans in Georgia, it was made from other legumes, the number of types of which reaches twenty. A legume plant sweet pea was especially used.

Meskheti is a unique corner where puff pastry kada-khachapuri, is baked in a traditional oven on pork fat, the baking process is a whole ritual. The shape is also characteristic - it is square-shaped, like the bachuli in Racha.

In all corners of Georgia, they bake kada with fillings. They are a necessary preparation for religious holidays.In all cases,the filling fornkada isnwhole grain flour, mixed with salt and melted butter (sometimes pork fat). If desired, it is sweetened during baking.

Among the corners of Georgia, ritual wheat pastries and traditional rites and customs were best preserved by the inhabitants of mountainous Svaneti, as well as participation in them. The two most important bread products are Lescari and Lemziri. Lescari is a large bread with a cross, which is baked for a public holiday, for example, on the feast of Peter and Paul, on the feast of "Parpulashi." As ethnologist, Rosetta Gujejiani notes, "Lescari, Lemziri, and other ritual breads are baked with two purposes - as offering to God and commemorating the souls of the dead (usually is baked as many Lemziri as members in the family) (Gujejiani 2014, 8-14)

In conclusion, it is a pleasure to see the tendency, first, the ancient traditions received from ancestors are continued, and second, society is in the mood of using Georgian wheat both endemic, traditional varieties and obtained by selection several decades ago in the cooking of food for rituals. Finally, before our eyes, in our daily lives, these traditions are transmitted to the younger generation in an interactive mode, through the acquiring of practical and mental skills.

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ხორბლის ადგილობრივი ჯიშების ბიომრავალფეროვნება და თესლის სერტიფიცირება

ჩოხელი მირიან, ჯინჯიხაძე თამარ, დევიძე ანა, კოშაძე თინა, თვაური ირინა
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აბსტრაქტი. სხვადასხვა გარემო პირობებთან ადაპტირებული აგრარული ბიომრავალფეროვნების, მათ შორის ადგილობრივი ჯიშების გენეტიკური რესურსების დაცვა და შენარჩუნება მნიშვნელოვანი ფაქტორია სასურსათო უსაფრთხოებისათვის. ხორბალი ერთ-ერთი ფართოდ გავრცელებული კულტურაა საქართველოში. ამ კულტურის ადგილობრივი ჯიშების პოპულაციების კონკრეტულ გარემო პირობებთან ადაპტაციისა და გენეტიკური რესურსების შენარჩუნებისათვის მნიშვნელოვანია, რომ ისინი ითესებოდეს მისი ისტორიული ჩამოყალიბების და გავრცელების გარემო პირობებში, ტრადიციულ ფერმერულ მეურნეობებში. ბაზარზე მოხვედრილი სათესლე მასალა კი წარმოადგენს საკანონმდებლო რეგულირების სფეროს. ევროპული კანონმდებლობით, რომლის დაახლოებაც მიმდინარეობს ჩვენს კანონმდებლობასთან, ადგილობრივი ჯიშების გასავრცელებლად დაშვება და თესლის სერტიფიცირება უნდა ემსახურებოდეს ამ ჯიშების გენეტიკური რესურსების შენარჩუნებას, რაც თავის მხრივ სახელმწიფოს ზრუნვის საგანია. საქართველოს სოფლის მეურნეობის სამეცნიერო კვლევითი ცენტრი მუშაობს როგორც ადგილობრივი ჯიშების გენეტიკური რესურსების მოძიება, შესწავლა და კონსერვაციაზე,

ასევე მონაწილეობს ევროპული გამოცდილების გათვალისწინებით მათ კატალოგიზაციასა და ადგილობრივ პირობებზე მორგებული წესებისა და ნორმების მომზადებაზე.

საკვანძო სიტყვები: ხორბალი, ჯიში, ბიომრავალფეროვნება, თესლი, სერტიფიცირება.

Biodiversity of Local Wheat Varieties and Seed Certification

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Abstract. The maintenance of Agrarian biodiversity including genetic resources of local varieties, that are adapted well to various environmental conditions is the key factor for sustainable food security. Wheat is one of the most widely grown and consumed grain crops in Georgia. In order to adapt the populations of local varieties of the agricultural crops to specific environmental conditions and maintain their genetic resources, it is necessary that they are cultivated and maintained by the traditional farmers in the environmental conditions of its historical formation and distribution. Seed material of agricultural crops, placed on the market is the subject of seed marketing legislation. According to the European legislation, which is being approximated to our legislation, permission for the distribution of local varieties and seed certification should serve their genetic resources preservation. The Scientific-Research Center of Agricultural of Georgia works both on the search, study and conservation of genetic resources of local varieties and their include in the catalogue and preparation of rules and regulations adapted to local conditions, taking into account European experience. Keywords: wheat, variety, biodiversity, seed, certification.

Keywords: Wheat, Variety, Biodiversity, Seed, Certification.

Wheat is historically important crop in Western as well as in Eastern Georgia. The ethnographic material delivered in botanic literature and archeological researches confirms existence of sufficiently large diversity of wheat which was widely spread in Georgia. This was conditioned by diversity of natural soil and climate conditions and long history of wheat cultivation. They were well adapted to the local environmental conditions and were closely related to Georgian people's traditions and culture.

In Georgia, local varieties are not only populations, but in some cases even they are cenoses. For example, local wheat variety – Makha (*Triticum macha*) was represented by 14 different botanical varieties in crops. Kolkhik asli (*Triticum palaeo-colchicum*) was presented as an admixture in it. Zanduri was a cenosis consisting of three different species - Chelta, Gwatsa and hexaploid Zanduri (*Triticum timopheevii, Tr. monococcum , Tr. zhukovskyi*). Javakheti dika was represented by a mixture of two different species, common wheat and dika. Durum wheat crops contained turgidum as an impurity. In addition to botanical diversity, we can say that ecotypes were characterized by even more genetic diversity and consisted of various biotypes.

One of the methods of maintaining of the biodiversity of local varieties is genetic resources *in situ (on farm*) conservation, which implies the continuous reproduction and maintenance of local varieties in the area of their origin and spreading, under the traditional farming sistem. In this case, the populations maintain their genetic structure and are involved in the process of adaptation to changes in climatic conditions.

Cultivation of local varieties in farms is related to the seed marketing, which is the area of legislation. European legislation establishes certain exceptional rules for local varieties in difference from bred variaties. For allowing that a variety to be spread and its seed be placed on the market, it is necessary that a variety were introduced in the national catalogue with varietal description composed by corresponding rule. Also it should be indicated the natural area of its spreading. In difference from the bred varieties, it is not necessary that a variety pass official examination as an exceptional rule.

In Georgia the information about seed accessions existing in various seed collections is very insignificant. In most cases, the names of the varieties are indicated in a wrong way, the origin of accessions are undefined, as well as its collection sites and other. Detailed descriptions of varieties, their etalons (herbaria, detailed photos, original patterns and other) didn't come to us. Therefore, to introduce varieties in the national catalogue, identification of the existing accessions are very complicated issue. For this we study accessions of the corresponding varieties, from collections received from foreign genebanks and local sources, information given in scientific and other kind of literature. We study compare them with each other and at the basis of researces we make varietal identification of the targeted accessions. Then we prepare varietal description of a variety taking into consideration their population diversity described in scientific literature. During field inspections, composing components envisaged by varietal description are not regarded as varietal impurities. On the contrary, the existence of such components facilitates maintenance of variety biodiversity and elaboration of adaptation ability towards environmental factors change. The several years' experience of local varieties seed certification showed that in Georgia there is a growing interest towards local varieties. Today, in the national catalogue allowed for spreading 10 varieties of georgian wheat with different components, among them 5 are of endemic species.

Because of the fact that local varieties are sown on a small areas in comparison with bred varieties and yield is harvested by big combines of which cleaning is not done properly, For farmers are difficult to maintain variety purity in the subsequent generations. Also bred varieties are characterized by higher productivity than local varieties, In the case of varietal deterioration they restrict local varieties and because of this in one or two generations their population composition changes quickly in favour of bred varieties.

Sometimes it is not managed to multiply in suitable soil and climatic conditions to maintain a variety, which also causes certain changes in populations. At present, for placement of seed of local varieties on market it is established the same quality standards like those for bred varieties, which causes discontent of farmers and non-governmental organizations involved in maintenance of genetic resources. In 2026 in the country, it will come into force the legislation about derogations for acceptance of agricultural landraces and varieties which are naturally adapted to the local and regional conditions and threatened by genetic erosion and for marketing of seed based on European legislation (The Commission Directive 2008/62/CE of 20 June 2008). It is needed to be envisaged such conditions which provide protection of local varieties diversity as well as farmers' demands.

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❖ სარედაქციო კოლეგია პასუხისმგებელია კონფერენციის მასალების თემატიკაზე, ხოლო სტატიების შინაარსზე, მათში მოყვანილ შედეგებსა და დასკვნებზე პასუხისმგებლობა ეკისრებათ ავტორებს.

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