Macroremains of edible plants from the Cenozoic of Bulgaria*

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Abstract. On the basis of fossil macroremains 48 taxa of edible plants are established on the territory of Bulgaria. The fossil material originates from Cenozoic sediments. The transition from paleotropical to arctotertiary characteristics of the flora happened on the territory of Europe during the Cenozoic (65.5 Ma). The results of the present research are in accordance with this process. Edible plants growing at present on Bulgarian territory, or their fossil forms, were registered mainly at the Miocene/Pliocene boundary interval. And, conversely, the fossil species, having edible nearest living relatives distributed now in the tropical and subtropical area had totally disappeared at the Late Pliocene.

Key words: Bulgaria, Cenozoic, edible plants, macroremains

Introduction

Plants are the beginning of the food chain, so they are the most important part of the biosphere. They provide energy and nourishing substances to various representatives of the Earth fauna. Also, the human race in its historical development has always been connected to plants. The progress of man has depended on them. He mainly supplied food from plants, but they have also been source of materials for the varied human activities, as well as for the production of medicines. In the course of time, man has tried to strengthen the qualities he preferred in plants. Today we witness great achievements in this field, but recent edible plants or their ancestors could be found even before the appearance of man. They were a decisive factor in the paleocoenose in the same way as they are now. They limited the spread of definite animal species and set the structure of the food chain.

Nearly 900 taxa have been registered in the Bulgarian Cenozoic flora established so far by macroremains. Carbonized leaves, fruits and seeds or their imprints included in the sedimentary rocks are the most frequently found macroremains (Palamarev & al. 2005; Bozukov & Tsenov 2012).

Attention in this article is directed at recent edible plants or their ancestors existing even before the appearance of man and, more precisely, the existence of these plants on the Bulgarian territory during the Cenozoic. The dynamics of their composition caused by the paleoclimatic and paleogeographic changes happening in this part of Europe during that period of time will be followed.

Results

In spite of certain fluctuations during the Cenozoic, the main tendency in the climate change on the territory of Europe during that era was transition from warm and humid climate typical of the tropics, to temperate climate. According to Jimenez-Moreno & al. (2007), a progressive reduction had occurred in the most thermophilous and high-water requirement plants typical

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of broad-leaved evergreen forests and, in contrast, an increase in seasonal-adapted plants coming from higher altitude belts, including mesothermic (mainly deciduous) elements, altitudinal trees and herbs, during the Middle–Late Miocene and Pliocene. This has been interpreted as response of the vegetation to global climate cooling, accentuated by regional uplift of the surrounding mountains during the Alpine tectonics. This process may also had been favoured by the progressive movement of Eurasia towards northern latitudes.

The results of the present research are in accordance with this process. Data about edible plants growing presently on Bulgarian territory, their fossil forms, or their ancestors can be seen in Table 1. They clearly show that these plants were registered mainly at the end of Neogene. And, conversely, the fossil species, whose nearest living relatives (NLR) are distributed now in the tropical and subtropical area, had totally disappeared at the Late Pliocene.

The edible plants mentioned in Table 1 can be divided into four groups: 1. Recent plants registered on the territory of Bulgaria and their fossil forms, or their ancestors; 2. Fossil species whose NLR exist in climatic conditions similar to those in Bulgaria at present, but cannot be found in Europe nowadays; 3. Fossil species whose NLR inhabit tropical and subtropical areas; 4. Fossil species which do not have NLR.

To the first group can be added such taxa like *Cornus mas* foss., *Corylus avelana* foss., *Crataegus pentagyna* foss., *Cydonia oblonga, Juglans regia*, *Malus* aff. *orientalis*, *Mespilus germanica*, *Morus tertiaria, Prunus fruticosa* foss., and *Pyracanta coccinea* foss.; two species of genus *Pyrus, Ribes uva-crispa, Rubus mucronatus, Sorbus* aff. *aria* and *Swida sanguinea* foss.; four species of genus *Vaccinium;* and two species of genus *Vitis*. What they have in common is that they were registered in Late Miocene, when paleogeographic and climatic conditions were relatively close to the present (Hristova & Ivanov 2014).

Special attention should be paid to the species *Castanea sativa.* It is the only edible plant whose fossil form is registered on the Bulgarian territory at mid-Miocene (~15.0 Ma) (Palamarev & Petkova 1987; Bozukov 1999a), and which continues to form natural forests in Bulgaria to the present day.

Fossil species, whose NLR exist in areas with climatic conditions similar to those in Europe nowadays, but outside its borders, belong to the second group. These are species found during the Oligocene and Miocene. The reason for their existence on the territory of Europe is probably connected to paleogeographic changes on the mainland. The presence of fossil species like *Cornus distans*, *Crataegus integrifolia,* and species of genus *Vitis* (Table 1), which have NLR in N America, can be explained with the existence of terrestrial connection between Europe and N America. The extinction of these species could be explained by rivalry of authochtonous species. The extinction of several species of the genera *Cornus*, *Rubus,* and *Prunus* (Table 1), which have NLR in E Asia, could be explained by the same reason.

It is a fact that the fossil taxa *Rubus* aff. *phoenicolasius* and *R. laticostatus* have the same NLR, but established in a different way. In the first case, the leaf morphology was used, and in the second – that of the seed. It probably refers to the same fossil species, but first established by leaf and then by seed.

The relationship between the taxa *Vitis sylvestris* foss. and *V. parasylvestris,* belonging to the first defined group, can be interpreted in the same way.

Species of the genera *Actinidia, Ficus, Olea, Persea,* and *Phoenicites* are referred to the third group (Table 1). These are species whose NLR inhabit tropical and subtropical areas. The upper border of their stratigraphic distribution is the Upper Miocene–Lower Pliocene. The spread of some of the third-group representatives there was possible due to the warmer and more humid climate, as compared to the present day (Hristova & al. 2015).

The species that has the most extensive stratigraphic distribution of all taxa mentioned here belongs to this group. This is *Persea braunii* (Lower Eocene to Lower Pliocene), whose NLR is *P. americana* known as avocado.

The species *Cornus orbifera, Prunus langsdorfii* and *Pyrus theobroma,* without any established NLR, are referred to the fourth group (Table 1). Most probably, they had become extinct without giving origin to a recent species.

Conclusions

According to paleobotanical data based on macroremains, it is evident that 48 taxa of edible plants are known on Bulgarian territory. Most of them are established at the Late Miocene – Early Pliocene boundary interval. Thanks to the favorable conditions, along with the recent species or their ancestors, representatives of subtropical taxa have also spread out. During the Late Pliocene, only authochtonous arctotertyary species were found, due

to the fact that climatic and paleogeographic conditions were becoming closer to the present day.

This updating of the list of edible plants has led to updating of local fauna. The diversity of the edible plants provides various nourishing substances, as well as different time of fruit ripeness, which ensure food for the most part of the vegetation period. In this way, favorable conditions emerged for migration of the animal species. The same applies to the genus *Homo* that had reached Eurasia and settled down on Bulgarian territory in the end of the Pliocene and the beginning of Pleistocene (Spassov 2001).

Table 1. Alphabetical list of edible plants species or their fossil ancestors known by macroremains in Bulgarian Cenozoic flora, the common name of the NLR and its area, the type of the fossil material, stratigraphical range of them and references.

Species / Nearest living relative (NLR) of a fossil species	Common name of the NLR / Areal	Fossil type	Paleogene					Neogene					Reference
			Eocene			Oligocene		Miocene			Pliocene		
			L	M	U	L	U	L	M	U	L	U	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Actinidia faveolata C. & E. Reid. / *A. melanandra* Franch.	Red kiwi / China	Cd								Tr	Tr		Palamarev 1970, 1982
Actinidia cf. *superba* Negru / *A. eriantha* Benth.	No common name / SE China	Cd							Tr	Tr			Palamarev 1994a,b
Castanea sativa Mill. foss. / *C. sativa*	Chestnut / Europe	Lf							Eu	Eu	Eu	Eu	Konjaroff 1932; Kitanov & Nikolova 1956; Kitanov 1984; Palamarev & Petkova 1987; Bozukov 1999a
Cornus distans Boulay. / *C. amomum* L.	Sylky dogwood / N America	Lf				Al			Al				Palamarev 1963, 1964; Bozukov 1999b
Cornus mas L. foss. / *C. mas*	Cornel-tree / Europe, SW Asia	Lf								Eu	Eu		Kitanov 1982
Cornus megaphylla Hu & Chaney / *C. macrophylla* Wall.	Large-leaf dogwood / Himalayas, E Asia	Lf							Al				Palamarev 1964
Cornus orbifera Heer / no NLR	Dogwood	Lf							No				Palamarev & Petkova 1987
Corylus avelana L. foss. / *Corylus avelana*	Hazelnut / Europe, W Asia	Cd								Eu	Eu	Eu	Kitanov 1960; Kitanov 1984
Crataegus integrifolia Palam. / *C. crus-galli* L.	Cockspur hawthorn / N America	Lf				Al							Palamarev & Petkova 1966
Crataegus pentagyna Waldst. & Kit. foss. / *C. pentagyna*	Black hawthorn / Europe	Cd										Eu	Palamarev 2004
Cydonia oblonga Mill.	Quince-tree / SW Asia	Lf								Eu	Eu	Eu	Stefanoff & Jordanoff 1935; Kitanov & Nikolova 1956
Diospyros lotoides Unger / *D. lotus* L.	Caucasian persimmon / Caucasus	Lf			Tr								Baikovskaja 1956
Diospyros lotus L.	Caucasian persimmon / Caucasus	Lf								Tr	Tr		Stefanoff & Jordanoff 1934, 1935
Ficus palamarevii Boz., Ivan. & Utesh. / *F. gasparriniana* Miq.	Christmas fig / SW China	Lf				Tr							Bozukov & al. 2013
Juglans acuminata A. Braun / *J. regia* L.	Walnut-tree / Balkans, Himalayas, SW China	Lf							Eu				Palamarev & Petkova 1987; Bozukov 1999b
Juglans regia L.	Walnut-tree / Balkans, Himalayas, SW China	Lf										Eu	Kitanov & Nikolova 1956
Malus aff. *orientalis* Uglitzk.	Caucasian apple / Caucasus	Cd								Eu			Palamarev 1970
Mespilus germanica L.	Common medlar / SE Europe, SW Asia	Lf								Eu	Eu		Stefanoff & Jordanoff 1935
Morus tertiaria Dorof. / *M. nigra* L.	Black mulberry / SW Asia	Cd								Eu	Eu		Palamarev 1982
Olea europaea L. var. *oleaster* DC.	Olive / Mediterranean	Lf								Tr	Tr		Stojanoff & Stefanoff 1929; Stefanoff & Jordanoff 1935
Persea braunii Heer / *P. americana* Mill.	Avocado / C America	Lf	Tr			Tr			Tr	Tr	Tr		Stefanoff & Jordanoff 1935; Palamarev & Petkova 1987; Palamarev & al. 1999

Table 1. Continuation.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Phoenicites spectabilis Unger / *Phoenix dactylifera* L.	Date palm / Iraq	Lf			Tr	Tr							Palamarev & al. 1992, 1999
Prunus attenuatifolia Palam. & Petk. / *P. cornuta* (Wall.) Steud.	Himalayan Bird Cherry / E Asia	Lf							Al				Palamarev & Petkova 1987
Prunus fruticosa Pallas foss. / *P. fruticosa*	European dwarf cherry / E Europe, W Asia	Cd										Eu	Palamarev 2004
Prunus langsdorfii Kirchh. / no NLR	Plum	Cd				No							Palamarev 1967
Prunus cf. *scharfii* Gregor. / *P. napaulensis* Steud.	Aru pate /E Asia	Cd							Al				Palamarev 1994b
Punica palaeogranatum Kut. / *P. granatum* L.	Pomegranate / Iran	Lf			Tr	Tr							Černjavska & al. 1988
Pyracantha coccinea Roem. foss. / *P. coccinea*	Scarlet firethorn / S Europe, W Asia	Cd										Eu	Palamarev 2004
Pyrus aff. *communis* L. / *P. communis*	Common pear / Europe, SW Asia	Lf								Eu	Eu	Eu	Stefanoff & Jordanoff 1934; Kitanov & Nikolova 1956
Pyrus theobroma Unger / no NLR	Pear	Lf		No	No								Palamarev 1967; Černjavska & al. 1988
Pyrus aff. *amigdaliformis* Vill. / *P. amigdaliformis*	Almond-leaved pear / Europe, W Asia	Lf								Eu	Eu		Stefanoff & Jordanoff 1934; Stefanoff & Jordanoff 1935
Ribes uva-crispa L.	European gooseberry / Europe, W Asia	Lf								Eu	Eu		Stojanoff & Stefanoff 1929
Rubus laticostatus Kirsch. / *R. phoenicolasius* Maxim.	Japanese wineberry / E Asia	Cd								Al	Al		Palamarev 1970
Rubus microspermus C. & E. Reid / *R. illecebrosus* Focke	Baloon berry / Japan	Cd							Al	Al	Al		Palamarev 1970, 1971, 1982, 1989
Rubus merianii (Heer) Kolak. / *R. malifolius* Focke	Chinese common name / E Asia	Lf				Al	Al		Al				Palamarev & al. 2005
Rubus mucronatus Palam. / *R. ulmifolius* Schott	Elmleaf blackberry / Europe	Cd							Eu	Eu			Palamarev & Petkova 1987
Rubus aff. *phoenicolasius* Maxim. / *R. phoenicolasius*	Japanese wineberry / E Asia	Lf								Al			Bozukov & Ivanova 2014
Sorbus aff. *aria* (L.) Crantz / *S. aria*	Common whitebeam / Europe, Near East	Lf								Eu	Eu	Eu	Stojanoff & Stefanoff 1929; Kitanov & Nikolova 1956
Swida sanguinea (L.) Opiz foss. / *S. sanguinea*	Common dogwood / Europe, W Asia	Cd										Eu	Palamarev 2004
Vaccinium arctostaphylos L.	Caucasian whortlberry / SE Europe, W Asia	Lf								Eu	Eu		Stefanoff & Jordanoff 1934; Stefanoff & Jordanoff 1935
Vaccinium myrtillus L.	European blueberry / Europe, N Asia	Lf								Eu	Eu		Stefanoff & Jordanoff 1935
Vaccinium uliginosum L.	Bog bilberry / Northern Hemisphere	Lf								Eu	Eu		Stojanoff & Stefanoff 1929
Vaccinium vitis-idaea L.	Lingonberry / Northern Hemisphere	Lf								Eu	Eu		Stojanoff & Stefanoff 1929; Stefanoff & Jordanoff 1934
Vitis parasylvestris Kirchh. / *V. vinifera* L. subsp. *sylvestris* Hegi	Common grape vine / Europe, Mediterranean	Cd								Eu	Eu		Palamarev 1982, 1994a
Vitis stricta (Goep.) Knobl. / *V. vulpina*. L.	Frost grape / N America	Lf							Al				Palamarev & Petkova 1987
Vitis teutonica A. Braun / *V. palmata* Vahl.	Catbird grape / N America	Cd								Al			Palamarev & Petkova 1987
Vitis sylvestris Gmel. foss. / *V. vinifera* subsp. *sylvestris*	Common grape vine / Europe, Mediterranean	Lf								Eu	Eu	Eu	Kitanov & Nikolova 1956; Kitanov 1984
Vitis vitifolia (A. Braun) Proch. & Bužek / *V. labrusca*. L.	Fox grape / N America	Lf							Al				Palamarev & Petkova 1987

Legend: **Cd** – carpoid; **Lf** – leaf; **L** – Lower; **M** – Middle; **U** – Upper; **Al** – allohthonous arctotertiary NLR; **Eu** – european arctotertiary NLR; **Tr** – tropical or subtropical NLR; **No** – no NLR.

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