



## SCALE INSECTS (COCCOMORPHA) ASSOCIATED WITH FOREST TREES IN BULGARIA

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### ABSTRACT

Scale insects associated with forest trees recorded to date in Bulgaria is presented. The data provided here are based on literature records and on the collections made by the authors and include the latest taxonomic and nomenclatural changes and updates on Coccoomorpha reported in Bulgaria. A total of 56 species belonging to 26 genera and 8 families are included in the list. The paper provides information about scale insects associated with forest trees in Bulgaria in last 84 years, since the first list in 1938 was published.

**Key words:** Coccoomorpha, scale insects, checklist, forest trees, Bulgaria, species, genera, families, checklist, taxonomy, nomenclatural changes, diversity, host plants

Climate change is expected to have many biotic and abiotic effects on forest ecosystems (Dale et al., 2001; Allen et al., 2010; Frank, 2021). Scale insects (Hemiptera: Coccoomorpha) infest many tree species and are among the most important arthropod pests of trees in urban and rural forests, plantations and other forest systems (Drooz, 1985; Gill and Kosztarab, 1997; Frank, 2019; Frank, 2021). Scale insects can kill or sicken trees across vast geographic areas (Preisser et al., 2008; Schulz et al., 2018; Frank, 2021), thereby changing the structure and functions of forest ecosystems (McGee, 2000; Ellison et al., 2005; Morin and Liebhold, 2015; Frank, 2021). In addition, scale insects are easily transported around the world and are among the most commonly introduced arthropod taxa (Debach and Rosen, 1976; Miller et al., 2005; Mazzeo et al., 2014; Brockerhoff and Liebhold, 2017; Frank, 2021). The scale insects of Bulgaria are a comparatively well-studied group. According to García Morales et al. (2016) the number of species found in Bulgaria are 150 in 13 families and 77 genera. Fifty-six of these are associated with forest trees. The number of species now known in Bulgaria in each family is as follows (García Morales et al., 2016): Diaspididae 49 species in 21 genera; Pseudococcidae 33 species in 18 genera; Coccidae 34 species in 18 genera; Eriococcidae 12 species in 6 genera; Asterolecaniidae 6 species in 2 genera; Kermesidae 4 species in 1 genus, Ortheziidae 3 species in 3 genera, Cryptococcidae 2 species in 2 genera; Rhizoecidae 2 species in 2 genera; and Matsucoccidae 2 species in 1 genus; Cerococcidae, Monophlebidae and Putoidae each have only 1 species in 1 genus. The article provides information about the

scale insects associated with forest trees in Bulgaria in last 84 years, since the first list in 1938 was published.

### MATERIALS AND METHODS

This list is based on bibliographic sources and on collections made by the authors and provides information about scale insects associated with forest trees recorded to date in Bulgaria. The nomenclature used here for the Coccoomorpha follows the ScaleNet database (García Morales et al., 2016). This study presents the results of an intensive literature search and some recent surveys of Coccoomorpha in Bulgaria. Few previous studies on this group in Bulgaria are also summarised. Families and species as concluded in this study are listed in alphabetical order (Table 1).

### RESULTS AND DISCUSSION

The scale insects of Bulgaria are a comparatively well-studied group are the first list of Coccoomorpha was published by Chorbadzhiev in 1938, he included 23 species on 24 host plants. Later studies are those of Lazarov (1940); Buresh and Lazarov (1956); Tsalev (1968); Kozar et al. (1979); Grigorov (1976); Trenchev (1987); Staneva (1992, 2003); Pencheva (1995, 2007); Hodgson and Trencheva (2008); Trencheva et al. (2009); Gavrilo (2010) and Trencheva et al. (2010). The most substantial contribution was made by Tsalev (1968), who listed 89 species belonging to 8 families, 55 new to Bulgaria. According to ScaleNet database (García Morales et al., 2016), Bulgaria currently has some 150 species, of which 56 associated with forest

Table 1. Checklist of species of Cocomorpha associated with forest trees in Bulgaria

Family/ Species	Validation source and host plants
<b>Asterolecaniidae</b>	
<i>Asterodiaspis bella</i> (Russell)	<i>Quercus pubescens</i> (Kozar et al., 1979)
<i>Asterodiaspis quercicola</i> (Bouche)	<i>Quercus pubescens f. polymorpha</i> , <i>Quercus</i> sp. (Kozar et al., 1979)
<i>Asterodiaspis repugnans</i> (Russell)	<i>Quercus</i> sp. (Trencheva et al., 2009)
<i>Asterodiaspis roboris</i> (Russell)	<i>Quercus pubescens f. polymorpha</i> (Kozar et al., 1979)
<i>Asterodiaspis variolosa</i> (Ratzeburg)	<i>Quercus frainetto</i> , <i>Quercus pubescens</i> , <i>Quercus cerris</i> (Tsalev and Vulcheva, 1963); <i>Quercus</i> sp. (Tsalev, 1968)
<b>Coccidae</b>	
<i>Eulecanium ciliatum</i> (Douglas)	<i>Quercus</i> sp. (Tsalev, 1968; Trencheva et al., 2009)
<i>Eulecanium sericeum</i> (Lindinger)	<i>Abies pinsapo</i> (Ruskov, 1928; Buresh and Lazarov, 1956)
<i>Eulecanium tiliae</i> (L)	<i>Acacia</i> sp., <i>Cornus</i> sp., <i>Corylus</i> sp., <i>Acer</i> sp. (Buresh and Lazarov, 1956); <i>Tilia cordata</i> , <i>Tilia</i> sp., <i>Aesculus hippocastanum</i> (Tsalev, 1968); <i>Quercus</i> sp., <i>Quercus polycarpa</i> (Trencheva et al., 2009)
<i>Parthenolecanium corni corni</i> (Bouche)	<i>Fraxinus</i> sp., <i>Acacia</i> sp., (Chorbadjiev, 1938); <i>Acacia</i> sp., <i>Aesculus hippocastanum</i> , <i>Fraxinus</i> sp., <i>Carpinus</i> sp., (Buresh and Lazarov, 1956); <i>Gleditschia triacanthos</i> , <i>Robinia pseudoacacia</i> , <i>Sorbus</i> sp., <i>Platanus orientalis</i> , <i>Crataegus</i> sp., <i>Tilia</i> sp., <i>Acer</i> sp., <i>Aesculus hippocastanum</i> , <i>Cornus</i> sp., <i>Corylus avellana</i> , <i>Betula</i> sp., <i>Alnus glutinosa</i> , <i>Quercus</i> sp. <i>Fraxinus</i> sp., <i>Salix</i> sp., <i>Ulmus</i> sp., <i>Populus</i> sp., <i>Caragana</i> sp. (Tsalev, 1968); <i>Corylus</i> sp., <i>Robinia pseudoacacia</i> (Grigorov, 1976); <i>Fraxinus excelsior</i> , <i>Caragana arborescens</i> (Kozar et al., 1979)
<i>Parthenolecanium persicae</i> (F)	<i>Fraxinus excelsior</i> (Tsalev, 1968)
<i>Parthenolecanium rufulum</i> (Cockerell)	<i>Quercus robur</i> (Chorbadjiev, 1938); <i>Quercus</i> sp. (Buresh and Lazarov, 1956); <i>Quercus</i> sp., <i>Ulmus</i> sp., <i>Carpinus</i> sp., <i>Castanea vesca</i> , <i>Corylus avellana</i> , <i>Acer</i> sp. (Tsalev and Vulcheva, 1965); <i>Quercus</i> sp., <i>Castanea vesca</i> , <i>Corylus avellana</i> , <i>Ulmus</i> sp., (Tsalev, 1968); <i>Quercus</i> sp., <i>Quercus polycarpa</i> , <i>Quercus frainetto</i> , <i>Quercus pubescens</i> (Trencheva et al., 2009)
<i>Phyllostroma myrtilli</i> (Kaltenbach)	<i>Picea abies</i> (Gavrilov, 2010)
<i>Physokermes hemicyphus</i> (Dalman)	<i>Picea abies</i> (Kozar et al., 1979; Gavrilov, 2010)
<i>Physokermes piceae</i> (Schrank)	<i>Picea excelsa</i> (Tsalev, 1968)
<i>Pulvinaria vitis</i> (L)	<i>Betula pendula</i> , <i>Betula verrucosa</i> , <i>Betula pubescens</i> , <i>Salix babilonica</i> , <i>Salix</i> sp., <i>Populus pyramidalis</i> , <i>Populus canadensis</i> , <i>Populus</i> sp., (Tsalev, 1968); <i>Crataegus</i> sp., <i>Ulmus</i> sp., <i>Populus</i> sp., <i>Salix</i> sp., <i>Alnus</i> sp., (Grigorov, 1976)
<i>Pulvinaria kuwacola</i> Kuwana	<i>Tilia</i> sp., <i>Cornus mas</i> , <i>Crataegus</i> sp. (Trencheva and Tomov, 2014)
<b>Cryptococcidae</b>	
<i>Cryptococcus fagisuga</i> Lindinger	<i>Fagus</i> sp. (Tsalev, 1968)
<i>Pseudochermes fraxini</i> (Kaltenbach)	<i>Fraxinus</i> sp. (Chorbadjiev, 1938); <i>Fraxinus excelsior</i> (Tsalev, 1968; Kozar et al., 1979)
<b>Diaspididae</b>	
<i>Aulacaspis rosae</i> (Bouche)	<i>Fagus</i> sp., <i>Quercus</i> sp. (Buresh and Lazarov, 1956)
<i>Chionaspis salicis</i> (L)	<i>Populus</i> sp., (Chorbadjiev, 1938); <i>Acacia</i> sp., <i>Salix</i> sp., <i>Populus</i> sp., <i>Ulmus</i> sp., <i>Tilia</i> sp., <i>Fraxinus</i> sp. (Buresh and Lazarov, 1956); <i>Salix</i> sp. (Kozar et al., 1979); <i>Populus</i> sp., <i>Alnus glutinosa</i> , <i>Alnus</i> sp. (Tsalev, 1968)
<i>Comstockaspis perniciososa</i> (Comstock)	<i>Crataegus</i> sp., <i>Sorbus aucuparia</i> , <i>Salix</i> sp., <i>Salix purpurea</i> , <i>Salix caprea</i> , <i>Populus</i> sp., <i>Tilia</i> sp., <i>Ulmus campestris</i> (Stanev, 1963); <i>Sorbus</i> sp., <i>Ulmus campestris</i> , <i>Crataegus</i> sp., <i>Syringa vulgaris</i> , <i>Tilia</i> sp., <i>Salix caprea</i> , <i>Salix</i> sp., (Tsalev, 1968); <i>Crataegus</i> sp. (Trencheva et al., 2010; Trencheva et al., 2012)
<i>Diaspidiotus gigas</i> (Thiem & Gerneck)	<i>Populus alba</i> , <i>Populus nigra</i> , <i>Populus tremula</i> , <i>Populus pyramidalis</i> , <i>Populus</i> sp., <i>Salix</i> sp. (Tsalev, 1968); <i>Populus pyramidalis</i> , <i>Salix alba</i> (Kozar et al., 1979)
<i>Diaspidiotus lenticularis</i> (Lindinger)	<i>Fraxinus excelsior</i> (Kozar et al., 1979; Staneva, 2003)

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<i>Diaspidiotus marani</i> (Zahradnik)	<i>Crataegus monogyna</i> , <i>Fraxinus</i> sp. (Stanev, 1964); <i>Crataegus</i> sp., <i>Fraxinus</i> sp., <i>Fraxinus excelsior</i> (Tsalev, 1968); <i>Crataegus monogyna</i> , <i>Fraxinus</i> sp. (Staneva, 2003)
<i>Diaspidiotus osborni</i> (Newell & Cockerell)	<i>Platanus orientalis</i> (Kozar et al., 1979)
<i>Diaspidiotus ostreaeformis</i> (Curtis)	<i>Ulmus</i> sp., <i>Fraxinus</i> sp., <i>Quercus</i> sp., <i>Fagus</i> sp., <i>Tilia</i> sp., (Chorbadjiev, 1938); <i>Ulmus</i> sp., <i>Fagus</i> sp., <i>Quercus</i> sp., <i>Tilia</i> sp., <i>Fraxinus</i> sp. (Buresh and Lazarov, 1956); <i>Crataegus</i> sp., <i>Fraxinus excelsior</i> , <i>Acacia</i> sp., <i>Betula verrucosa</i> ( <i>Betula pendula</i> ), <i>Betula</i> sp., <i>Tilia cordata</i> , <i>Tilia</i> sp., <i>Caragana</i> sp., <i>Sorbus</i> sp., <i>Cornus</i> sp., <i>Salix</i> sp., <i>Aesculus</i> sp., <i>Populus</i> sp. (Tsalev, 1968); <i>Crataegus monogyna</i> , <i>Salix</i> sp., <i>Betula</i> sp., <i>Populus</i> sp., <i>Tilia</i> sp., <i>Quercus</i> sp. (Grigorov, 1976)
<i>Diaspidiotus pyri</i> (Lichtenstein)	<i>Crataegus monogyna</i> , <i>Fraxinus</i> sp., (Lazarov, 1940); <i>Sorbus</i> sp., <i>Fraxinus excelsior</i> ; <i>Platanus orientalis</i> , <i>Betula</i> sp., <i>Crataegus</i> sp., <i>Cornus</i> sp. (Tsalev, 1968); <i>Crataegus monogyna</i> , <i>Fraxinus</i> sp. <i>Plantanus orientalis</i> , <i>Betula</i> sp. <i>Sorbus</i> sp., <i>Cornus</i> sp. (Grigorov, 1976)
<i>Diaspidiotus wuenni</i> (Lindinger)	<i>Quercus</i> sp. (Stanev, 1964; Tsalev, 1968)
<i>Diaspidiotus zonatus</i> (Frauenfeld)	<i>Quercus</i> sp., <i>Quercus robur</i> (Stanev, 1964; Tsalev, 1968)
<i>Dynaspidiotus abietis</i> (Schrank)	<i>Pinus sylvestris</i> , <i>Picea excelsa</i> (Tsalev, 1968)
<i>Epidiaspis leperii</i> (Signoret)	<i>Aesculus hippocastanum</i> (Tsalev, 1968, Grigorov, 1976)
<i>Epidiaspis gennadii</i> (Leonardi)	<i>Pistacia terebinthus</i> (Gorgiev et al., 2012)
<i>Lepidosaphes malicola</i> Borchsenius	<i>Aesculus hippocastanum</i> (Trenchev, 1987)
<i>Lepidosaphes newsteadi</i> (Sulc)	<i>Pinus sylvestris</i> (Tsalev, 1968)
<i>Lepidosaphes conchiformis</i> (Gmelin)	<i>Ulmus campestris</i> , <i>Ulmus</i> sp. (Tsalev, 1968)
<i>Lepidosaphes ulmi</i> (L)	<i>Fraxinus</i> sp., <i>Salix</i> sp., <i>Populus</i> sp., <i>Ulmus</i> sp., <i>Quercus</i> sp., <i>Fagus</i> sp., (Chorbadjiev, 1938); <i>Salix</i> sp., <i>Crataegus</i> sp., <i>Betula</i> sp., <i>Quercus</i> sp., <i>Populus</i> sp., <i>Fraxinus</i> sp. (Buresh and Lazarov, 1956); <i>Fraxinus excelsior</i> , <i>Fraxinus</i> sp., <i>Celtis</i> sp., <i>Crataegus</i> sp., <i>Sorbus</i> sp., <i>Cornus</i> sp., <i>Quercus</i> sp., <i>Betula pendula</i> , <i>Betula</i> sp., <i>Alnus</i> sp., <i>Crataegus</i> sp., <i>Populus alba</i> , <i>Populus nigra</i> , <i>Populus tremula</i> , <i>Populus pyramidalis</i> , <i>Populus</i> sp., <i>Salix alba</i> , <i>Salix caprea</i> , <i>Salix</i> sp., <i>Fraxinus</i> sp. (Tsalev, 1968); <i>Fraxinus</i> sp., <i>Betula</i> sp., <i>Crataegus monogyna</i> , <i>Salix</i> sp., <i>Quercus</i> sp., <i>Alnus</i> sp., <i>Sorbus</i> sp., <i>Cornus</i> sp. (Grigorov, 1976); <i>Quercus pubescens</i> (Trencheva et al., 2009)
<i>Leucaspis lowi</i> Colvee	<i>Pinus</i> sp. (Chorbadjiev, 1938); <i>Pinus sylvestris</i> , <i>Pinus nigra</i> (Tsalev, 1968); <i>Pinus nigra</i> (Kozar et al., 1979); <i>Pinus nigra</i> , <i>Pinus excelsa</i> , <i>Pinus strobus</i> , <i>Pinus maritima</i> , <i>Pinus sylvestris</i> , <i>Pinus peuce</i> , <i>Pinus ponderosa</i> , <i>Pinus montana</i> , <i>Pinus jeffreyi</i> (Pencheva, 2000)
<i>Leucaspis pini</i> (Hartig)	<i>Pinus</i> sp., <i>Pinus sylvestris</i> , <i>Pinus nigra</i> (Buresh and Lazarov, 1956); <i>Pinus sylvestris</i> , <i>Pinus nigra</i> (Tsalev, 1968); <i>Pinus maritima</i> , <i>Pinus nigra</i> (Pencheva, 2000)
<i>Leucaspis pusilla</i> Low	<i>Pinus sylvestris</i> , <i>Pinus nigra</i> , <i>Pinus</i> sp. (Tsalev, 1968); <i>Pinus nigra</i> , <i>Pinus excelsa</i> , <i>Pinus strobus</i> , <i>Pinus halepensis</i> , <i>Pinus pinea</i> , <i>Pinus maritima</i> , <i>Pinus sylvestris</i> (Pencheva, 2000)
<i>Parlatoria oleae</i> (Colvee)*	<i>Fraxinus excelsior</i> , <i>Cornus</i> sp., (Lazarov, 1940); <i>Fraxinus excelsior</i> , <i>Cornus</i> sp., (Tsalev, 1968); <i>Fraxinus</i> sp., <i>Fraxinus excelsior</i> , <i>Cornus</i> sp., (Grigorov, 1976)
<i>Parlatoria parlatoriae</i> (Sulc)	<i>Picea</i> sp. (Tsalev, 1968)
<i>Pseudaulacaspis pentagona</i> (Targioni Tozzetti)	<i>Salix</i> sp., <i>Cornus</i> sp., <i>Syringa vulgaris</i> , <i>Acacia</i> sp., (Tsalev, 1968)
<i>Targionia vitis</i> (Signoret)	<i>Quercus pedunculata</i> (Stanev, 1964; Tsalev, 1968); <i>Quercus pubescens</i> (Kozar et al., 1979 ; <i>Quercus</i> sp. (Trencheva et al., 2009)
Eriococcidae <i>Acanthococcus aceris</i> Signoret	<i>Acer</i> sp. (Tsalev, 1968); <i>Quercus</i> sp. (Gavrilov, 2010)

(contd.)

(contd. Table 1)

<i>Acantococcus melnikensis</i> (Hodgson & Trencheva)	<i>Quercus pubescens</i> (Hodgson and Trencheva, 2008)
<i>Gossyparia spuria</i> (Modeer)	<i>Ulmus</i> sp. (Chorbadjiev, 1938; Tsalev, 1968; Kozar et al., 1979)
Kermesidae	
<i>Kermes gibbosus</i> Signoret	<i>Quercus</i> sp. (Tsalev, 1968; Trencheva et al., 2009; Gavrilov, 2010)
<i>Kermes quercus</i> (L)	<i>Quercus</i> sp. (Tsalev, 1968)
<i>Kermes nakagawae</i> Kuwana	<i>Quercus</i> sp. (Tsalev, 1968)
<i>Kermes roboris</i> (Fourcroy)	<i>Quercus</i> sp. (Tsalev, 1968; Trencheva et al., 2009; Gavrilov, 2010)
Matsucoccidae	
<i>Matsucoccus feytaudi</i> Ducasse	<i>Pinus nigra</i> (Kozar et al., 1979)
<i>Matsucoccus pini</i> Green	<i>Pinus</i> sp. (Foldi, 2005)
Pseudococcidae	
<i>Phenacoccus aceris</i> (Signoret)	<i>Acer saccharinum</i> , <i>Fraxinus angustifolia</i> (Lazarov & Grigorov, 1960); <i>Fraxinus excelsior</i> , <i>Fraxinus</i> sp., <i>Crataegus</i> sp., <i>Acer</i> sp., <i>Caragana</i> sp. (Tsalev, 1968); <i>Fraxinus</i> sp., <i>Crataegus</i> sp., <i>Tilia</i> sp., <i>Quercus</i> sp., <i>Ulmus</i> sp., <i>Aesculus hippocastanum</i> , <i>Acer campestre</i> (Grigorov, 1976)
<i>Phenacoccus piceae</i> (Loew)	<i>Picea abies</i> (Tsalev, 1968)
<i>Planococcus vovae</i> (Nasonov)	<i>Juniperus communis</i> , <i>Juniperus</i> sp. (Tsalev, 1968)
<i>Pseudococcus viburni</i> (Signoret)	<i>Taxus baccata</i> (Kozar et al., 1979; Pencheva, 1995)

trees. Some of these families are poorly represented in forests, such as the Cryptococcidae 2 species, Matsucoccidae 2 species, Eriococcidae with 3 species. Based on literature review we present comprehensive checklist of the scale insects associated with forest trees in Bulgaria. The list presented below comprises a total of 56 species from 26 genera and 8 families, namely Diaspididae (25), Coccidae (11), Asterolecaniidae (5), Pseudococcidae (4), Kermesidae (4), Eriococcidae (3), Matsucoccidae (2), Cryptococcidae (2) (Table 1). In the discussion below all species associated with forest trees till 2021 are given.

**Diaspididae:** 25 species belonging to 11 genera. The largest genera are *Diaspidiotus* 8 species, and *Lepidosaphes* and *Leucaspis* with 4 and 3 species respectively. Some *Leucaspis* species notably *Leucaspis lowi*, *Leucaspis pini* and *Leucaspis pusilla*, are mainly restricted to *Pinus* spp., whilst *Diaspidiotus wuenni*, *Diaspidiotus zonatus* and *Targionia vitis* are restricted to *Quercus* spp.

**Coccidae:** 11 species belonging to 5 genera. *Parthenolecanium* with 3 species, *Eulecanium* 3 and *Pulvinaria* and *Physokermes* with 2 species. *Phyllostroma* with 1 species associated with *Picea abies*. Species, such as *Parthenolecanium rufulum*, develop only on *Quercus* and *Ulmus* species.

**Asterolecaniidae:** 5 species in the genus *Asterodiaspis* - *Asterodiaspis bella*, *Asterodiaspis quercicola*, *Asterodiaspis roboris*, *Asterodiaspis*

*variolosa* and *Asterodiaspis repugnans* appear to be restricted to oaks (*Quercus* spp).

**Pseudococcidae:** 4 species in 3 genera. The number of species in each genus is *Phenacoccus* 2 species, *Pseudococcus* and *Planococcus* all with 1 species. *Phenacoccus* is represented by *Phenacoccus aceris* on *Acer*, *Fraxinus*, *Crataegus*, *Caragana*, *Tilia*, *Quercus* and *Aesculus*, while *Phenacoccus piceae* is restricted to *Picea abies*. Other species such as *Planococcus vovae* and *Pseudococcus viburni* develop only on *Juniperus* and *Taxus* respectively.

**Kermesidae:** 4 species, all in genus *Kermes* - *Kermes gibbosus*, *Kermes. quercus*, *Kermes nakagawae* and *Kermes roboris*, all only known on the genus *Quercus*.

**Eriococcidae:** 3 species belonging to 2 genera, of which 2 species are in the genus *Acanthococcus*. Of the other genera, *Gossyparia* only has *Gossyparia spuria* found on *Ulmus* sp. (Chorbadjiev, 1938; Tsalev, 1968; Kozar et al., 1979). Species are found on forestry trees, such as species of *Acer*, *Quercus* and *Ulmus*.

**Cryptococcidae:** 2 species belonging to 2 genera. *Cryptococcus* is only represented by *Cryptococcus fagisuga* on *Fagus* sp. (Tsalev, 1968) and the only recorded species of *Pseudochermes*, *P. fraxini*, is only known off *Fraxinus* sp. (Chorbadjiev, 1938) and *Fraxinus excelsior* (Tsalev, 1968; Kozar et al., 1979).

**Matsucoccidae:** 2 species in genus *Matsucoccus* -

*Matsucoccus feytaudi* and *Matsucoccus pini*, both on *Pinus nigra*.

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#### AUTHOR CONTRIBUTION STATEMENT

Trencheva K conceptualized and framed the research proposal, Grozeva S corrected draft. All authors read and approved the manuscript.

#### CONFLICT OF INTEREST

No conflict of interest.

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