Tomostethus nigritus F. (HYMENOPTERA, TENTHREDINIDAE) – A NEW PEST SPECIES OF ASH TREE IN THE REPUBLIC OF MOLDOVA

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Abstract. In the Republic of Moldova, the ash tree is a common forest species, used in the reforestation and afforestation of woods and territories, and widely used as an ornamental tree in cities and along roads. For more than ten years, our ash tree woods have been severely defoliated by the ash weevil *Stereonychusfraxini* (De Geer, 1775) from Curculionidae family. *In the vegetation period of 2018 and 2019, defoliation was seen on ash trees, caused by unknown* sawfly *larvae species from the Tenthredinidae* family. *The analyses showed that these pests belong to the* Hymenoptera order – the privet sawfly – *Macrophya punctumalbum* (Linnaeus, 1767), and *Tomostethus* nigritus (Fabricius, 1804), the last one being a new species for the fauna of the Republic of Moldova. The biggest ash defoliations caused by the *Tomostethus* nigritus larvae were recorded in the centre of the country, especially in the Nisporeni and Tighina Forest Enterprises and in the "Plaiul Fagului" Scientific Reserve, as well as in the urban space.

Keywords: Ash Black sawfly, Tenthredinidae, ash tree, outbreaks, defoliations, Republic of Moldova.

Rezumat. *Tomostethus nigritus* F. (Hymenoptera, Tenthredinidae) – specie nouă de dăunător al frasinului în Republica Moldova. În Republica Moldova, frasinul este o specie obișnuită, folosită nu numai în reîmpădurire și împădurire dar utilizat pe scară largă ca arbore ornamental în parcurile din orașe și de-a lungul drumurilor. Mai bine de zece ani, pădurile de frasin sunt defoliate anual de către trombarul frunzelor de frasin *Stereonychus fraxini* (De Geer, 1775) din familia Curculionidae. În perioada de vegetație din 2018 și 2019 au fost observate defolieri cauzate de larvele viespilor *Macrophya punctumalbum* (Linnaeus, 1767) și Viespea Neagră a frasinului *Tomostethus nigritus* (Fabricius, 1804) din familia Tenthredinidae, ultima fiind specie nouă pentru fauna Republicii Moldova. Cele mai mari defolieri ale frasinului cauzate de către larvele de *Tomostethus nigritus* au fost înregistrate în centrul țării, în special în Întreprinderile Forestiere Nisporeni și Tighina; Rezervația „Plaiul Fagului", de asemenea și în spațiul urban.

Cuvinte cheie: Viespea Neagră a frasinului, Tenthredinidae, frasin, focare, defolieri, Republica Moldova.

INTRODUCTION

The genus *Fraxinus* (ash) belongs to the olive (Oleaceae) family, tribe Oleeae, subtribe Fraxininae and was described by Linnaeus in 1753. According to The Plant List (*** TPL, 2010), since description to our days, 456 scientific names of species were provided for this genus, that are nowadays mostly seen as synonyms. At present, just 63 names from 456 have been fully accepted. As a tree species, the ash trees have two statuses: invasive – in some parts of its natural range ash can become invasive; and as a vulnerable species (DOBROWOLSKA et al., 2011). The *Fraxinus* usually represents medium to large trees, most being deciduous species. Ash species occur in temperate and subtropical regions of the northern hemisphere, with two main distribution areas in eastern Asia and North America with 20 species each (WALLANDER & ALBERT, 2000).

The composition of Moldovan forests is dominated by deciduous species with 97.8%, including oaks – 143.8 thousand ha (39.6%), acacias – 131.0 thousand ha (36.1%), ashes – 16.6 thousand ha (4.6%), etc. (*** AM[1]). In the Republic of Moldova the types of ash are not as varied: *Fraxinus excelsior* – European ash or common ash, *F. ornus* – Manna ash or Flowering ash, *F. pennsylvanica* – Red ash and *F. pallisae* – Pallis' Ash. In the Republic of Moldova, *F. excelsior* is the most common species of this genus, growing in forests and urban stands, shelterbelts, arboretums and urban spaces. The ash is not demanding to soil fertility, being one of the most tolerant to drought and frost, growing fast, tolerating frost but not late spring frosts. The largest areas of ash forests are found in the centre of the country, especially in the Forest Enterprises Nisporeni and Tighina and Reserve „Plaiul Fagului".

Although, until recently, the ash was considered in Europe as a species that is resistant to abiotic and biotic factors (GRZYWACZ, 1995), this situation has changed in the last decade of the twentieth century. In many countries of Europe, the ash is dying due to a fungal disease – *Hymenoscyphus fraxineus*, whose pathogenesis is poorly understood. At the same time, in the Republic of Moldova, ash stands are dying due to insect pests, especially the defoliating ones, and the first place is held by *Stereonychus fraxini* (Coleoptera, Curculionidae) (DERJANSCHI et al., 2012; RODIDEAL et al., 2014, 2015, BULGARI et al., 2016; STAHI et al., 2016). Thereby, the results of actions of these factors led to the beginning of ash decline in all environments, whether in woods or parks, alleys or squares.

MATERIALS AND METHODS

The studies were conducted during 2013-2019, with the main objective of identifying the impact of natural risks on ash ecosystems. All subsequent observations were made in the ash woods near Chisinau city (Forest Enterprise Chișinău), also Tighina, Rezeni, Telenești, Orhei, Nisporeni Forest Enterprises, the "Codrii" Reserve and certainly from the "Plaiul Fagului" Reserve, where ash is one of the dominant species (*** AM[1]). For a better understanding of the

biology and ecology of *Tomostethus nigritus*, we visited the ash stands of the Chisinau Forest Enterprise and the "Plaiul Fagului" Reserve three times in 2019, on April, May and June.

For the identification of sawflies, the following books and papers were consulted: BENSON (1952), MOL (2002), MRKVA (1965) and LORENZ & KRAUS (1957).

For the discussion on the distribution of sawflies, we consulted the Compendium of European Sawflies (LISTON, 1955), Sawflies of the Carpathian Basin, History and Current Research (ROLLER & HARIS, 2008) and the most recent European checklist of species (TAEGER et al., 2006). The higher classification of sawflies applied follows the Hymenoptera part of Fauna Europaea (*** FE).

RESULTS AND DISCUSSIONS

In spite of a big distribution area of *Fraxinus* spp. on the territory of the Republic of Moldova, the pathological situation of ash forests, especially those from the centre of country is very bad (RODIDEAL et al., 2014, 2015; BULGARI et al., 2016; STAHI et al., 2016). This pathological situation is caused mainly by the defoliator insects, which during of last years produced massive ash defoliations. Therefore, this paper was stimulated by the occurrence of new outbreaks of insect pests in pure and mixed ash woods and urban areas.

Even though the diversity of harmful insects on *Fraxinus* spp., in the conditions of the Republic of Moldova is not great, their damages are felt year after year. Therefore, to the Lepidoptera order belong the lilac leaf miner or privet leaf miner – *Gracillaria syringella* (Fabricius, 1794), the Ash Pug – *Eupithecia innotata* form *fraxinata* Crewe, 1863, the Winter Moth – *Operophtera brumata* (Linnaeus, 1758). To the Coleoptera order belong the following: Ash Weevil *Stereonychus fraxini* (De Geer, 1775), the Spanish Fly *Lytta vesicatoria* Linnaeus, 1758, and the Birch Sapwood Borer *Scolytus kirsch* and *Hylesinus fraxini* (Panzer, 1779). Only one species was mentioned from the Hymenoptera order: the Privet sawfly *Macrophya punctumalbum* (Linnaeus, 1767). From the Hemiptera order: the Red cicada *Tibicina haematodes* (Scopoli, 1763) and the New Forest cicada *Cicadetta montana* (Scopoli, 1763); *Psyllopsis fraxini* (Linnaeus, 1767), and from the Diptera order:the gall midge *Dasineura fraxini* Bremi, 1847.

The most dangerous ash insect pests in the Republic of Moldova are *O. brumata*, *S. fraxini* and *S. kirsch* (STAHI et al., 2016; APOSTOLOV, 1970). The main mode of attack caused by the larvae of winter moth consists in defoliations of the young ash and of branches from the lower part of the trees. Generally, they affect the plots located on tops of hills, with a consistency not exceeding 0.6-0.7. In addition, APOSTOLOV (1970) draws attention to the zonal change of habitats by *O. brumata* in the conditions of our republic, which was described for the first time by BEI-BIENKO (1930).

Across the times, throughout the country *S. fraxini* caused massively and repeatedly defoliations of the ash trees, which led to a greatly reducing crown stem quality and height growth. Also, in the affected parcels it was observed that the decrease of the shading percentage led to the appearance of a rich vegetal carpet, which represents a very favourable environment for the development of secondary pests such as as Red cicada *T. haematodes*, *S. kirsch* and *H. fraxini* and sawflies. Therefore, for the first time in the "Plaiul Fagului" Reserve, parcels were observed that were affected by *S. fraxini* in combination with Red cicada and sawfly species. As it is known, as an ash pest for the Republic of Moldova from the Hymenoptera order, only the privet sawfly *M. punctumalbum* (APOSTOLOV, 1970) was mentioned. Knowing the morphology and biology of *M. punctumalbum*, and as a result of the determination of larvae and sawfly adults of new pest, we established that this is a new sawfly species for the fauna of the Republic of Moldova – *Tomostethus nigritus* (Fabricius, 1804).

T. nigritus belongs to the Hymenoptera order, Symphyta suborder, Tenthredinidae family and Blennocampinae subfamily.

Synonyms: *Tenthredo* (*Selandria*) *fraxini* Audinet-Serville, 1823; *T. fraxini* Serville, 1823; *T. fraxini* Lepeletier, 1823; *T.* (*Allantus*) *brevicornis* Klug, 1816; *T.* (*A.*) *nigerrima* Klug, 1816 *Monophadnus latus* (Costa, 1894)

Distribution: a Siberian-European element spread in Turkey, Caucasus, Transcaucasia, China, Korean Peninsula, North Africa (MEDVEDEV, 1994; LISTON, 1995; LACOURT, 1999), Iran (TAVAKOLI et al., 2019), Japan (ABE, 1989), Russia (BELOVA, 1987; ZHELOCHOVTSEV & ZINOVJEV, 1996). In Europe, the Ash Black sawfly is spread in Bulgaria, Germany, Denmark, Estonia, Spain, Finland, France, Great Britain, Luxembourg, Latvia, Poland, Sweden, Ukraine (LISTON 1955, TAEGER et al., 2010). Also, this species causes severe defoliations of *F. excelsior* in Austria (FRANZ, 1982), Belgium and the Netherlands (BEQUAERT, 1912), Croatia (PEROVIČ & LEINER, 1996), Czech Republic (GREGOR & BAŤA, 1942), Hungary (MOCSÁRY, 1900), Italy (MITALI, 2012), Norway (AUSTARÄ, 1991), Serbia (GLAVENDEKIĆ & MIRIĆ, 2011), Slovakia (ROLLER, 1993), Romania (MOCSÁRY, 1900), etc.

The morphology and biology of *T. nigritus* in conditions of the Republic of Moldova. *T. nigritus* is a monophagous pest of ash preferring *F. excelsior* L., and, to a lesser extent, *F. angustifolia* (Figs. 1-3). This sawfly has a generation per year (univoltine), wintering in the stage of eonymph or pronymph (MRKVA, 1965) inside of a cocoon in the soil at 5-15 cm around the base of previously infested ash trees. The pupation of *T. nigritus* take place in early spring.

The adult body is black with the abdomen and thorax a little bit wider and the fore tibia brownish. The female body is quite rugged from 8 to 10 mm long, with the head behind slightly widened eyes. The male body is 5.5 - 8 mm long, having a slightly narrowed head behind the eyes. The antennae are shorts and thick, composed of 11 segments, the

eyes almost reach to the base of the upper jaws (VERHEYDE & SIOEN, 2019). The forewings are black and the hind wings are greyish.

The date of emergence of Ash Black sawfly is prolonged due to the hibernation place, the depth and the illumination percentage of the soil. Of course, a huge role in this process is also played by the weather that in our republic is very unstable, with mild winters but cold springs.

The appearance of adults, egg and larval stage is staggered too, depending on the abiotic factors. Thus, in the study period, the emergence started in the first and second decades of April but the period of massive swarming took place on 15 April of 2018 and on 20 April 2019. The flight period of adults of *T. nigritus* lasts about 3 weeks, again depending on the forecast. Males appear first and, in a few days, the females (MKRVA, 1965). In addition, for a good monitoring we must pay attention to the fact that recently appeared sawfly adults fly badly, so they move on the ground. The adults feed on nectar and flower pollen (VERHEYDE & SIOEN, 2019). During sunny days and without wind, clouds and rain the adults can be seen flying around the budding buds of ash trees as they mate and lay eggs. When the mass appearance of adults takes place (over 5-6 days after the appearance of the first specimens) swarms of flying wasps can be seen.

The female lays eggs inserting her lightly sclerotized ovipositor into the tissue of the lower epidermis of newly emerged foliage, mainly near the central vein; therefore, the leaves are slightly distorted. The eggs of ash Black sawfly are light green colour, curved, sharpened at the ends for about 0.1 x 0.4 mm, being almost transparent yellow-green. According to our data, the maximum number of eggs per one leaflet was 0.5-1 pcs in Chisinau and Nisporeni Forest Enterprise, while in the others enterprises the maximum was a larva at the leaf. We did not determine the fertility of females of this species, but according to the literature, the maximum fertility is 320 eggs (GLAVENDEKIĆ, 2011) and 46.3 ± 4, 9 eggs (BELOVA, 1987; ZINCHENKO & KUKINA, 2015). The embryonic period last 10-15 days (the development is in full accordance with the ambient temperatures).

During our observations done in 2018-2019 the larvae of *T. nigritus* appeared in the last days of April and first decade of May. The body colour and size of the larva differs depending on instars that are five (male –four and female – five). Their larval exuvium can be easily observed on the underside of the leaves (Figs. 4, 5).

The first larval instars of Ash Black sawfly have a cylindrical body, a greenish had with black yeas, while the abdomen is yellow-green and on the back can be seen a dark-rayed dorsal vessel. The larva of last instars has an olive-green colour, with whitish bands (fat bodies) clearly showing through dorsally folds above the abdominal legs without warts. Young larvae perforate the leaves (Fig. 3), and then eat around the edges, so that only the area between the veins remains. Adult caterpillars eat leaves completely, leaving only the main vein (Figs. 1, 2).

The complete feeding of Ash Black sawfly larvae took place at the third decade of May (22-28 May); they become full-grown as mentioned by colleagues ZINCHENKO & KUKINA (2015) from Ukraine. The larvae descend the trunk (Figs. 5-7) and enters the soil, usually near of the root collars and form shiny, black parchment-like cocoons covered on the outside with earth (MRKVA, 1965). The pupa is free, first bright green, then dark, almost black. The cocoon is dark, relatively fragile. In this cocoon the Ash Black sawfly can hibernate as a pronymph and eonymph. In the eonymph stage *T. nigritus* falls into diapause, which lasts up to 2-3 years (MRKVA, 1965; BELOVA, 1987) with the proportion of such individuals not exceeding 7% (GLAVENDEKIĆ, 2011).

Figure 1. *F. excelsior* defoliation caused by larvae of *T. nigritus* in the Chisinau Forest Enterprise (original).

Figure 2. *F. excelsior* defoliation caused by larvae of *T. nigritus* in the „Plaiul Fagului" Forest Enterprise (original).

Figure 3. *F. excelsior* defoliation caused by larvae of *T. nigritus* in the Chișinău Forest Enterprise (original).

The first damages of *T. nigritus* in the Republic of Moldova were recorded in the ash stands of the Forest Enterprise Tighina in 2013. A year later, the pest entered in the diapause and was not found in the ash woods' trees since 2018. In 2016, the larvae and signs of defoliation of this pest were found in the ashes within the Forest Enterprises Rezeni, Telenesti and other forest enterprises. Because the damage was not significant, no special attention was paid to the given species. Already, in the spring of years of 2018 and 2019 in the Republic of Moldova the first outbreaks with severe damages caused by larvae of this species were fixed. The outbreaks were observed during of our investigations

performed throughout in springs of 2018 and 2019 in the Chișinău, Nisporeni, Tighina, Telenești, Orhei, Hîncești Forest Enterprises, also in the "Plaiul Fagului" and "Codrii" Reserves. Most affected were the pure and mixed illuminated ash forest stands, shelterbelts especially regardless of any age in the various ash groves from these enterprises. In addition, severe defoliations were recorded in urban stands and solitary trees.

At the end of 2018, the surface of the outbreaks of Ash Black sawfly in the country was 419 ha. At the end of 2019, the outbreak surface of *T. nigritus* constituted 257 ha and 162 ha of outbreaks extinguished under the action of various natural factors. In the third decade of May, the first decade of June of 2019, the ash trees defoliation degree caused by larvae of *T. nigritus* oscillated from 25 percent to 80 percent (Figs. 1, 2). According to the larvae behaviour of different ages in the ash forest outbreaks within the Chisinau Forestry Enterprise a big part of the larvae were infested by viral infection (nuclear polyhedrosis), which proves that the outbreak is already in the decline phase.

Figure 4. Adult of *T. nigritus* (original).

Figures 5-6. Larvae of *T. nigritus* of last instar (original).

Figure 7. Larvae of last of *T. nigritus* instar going on hibernation (original).

The outbreaks of Ash Black sawfly from the monitored forests were in accordance with the defoliations caused by adults and larvae of *S. fraxini*. After these repeatedly year-by-year defoliations caused by these two pests – *S. fraxini* and *T. nigritus* and in complex with high temperatures and a maximum lack of humidity the ash trees present many dead branches in the crowns, occasional shoot necrosis, and discoloration of wood and premature leaves shedding.

CONCLUSIONS

1. The ash black sawfly *T. nigritus* is a new ash pest in the Republic of Moldova.
2. The ash weevil *S. fraxini* and Ash Black sawfly *T. nigritus* in complex with high temperatures and a maximum lack of humidity bring ash in a phytosanitary condition of degree 3-4, with dead branches in the crowns, occasional shoot necrosis, and discoloration of wood and premature leaves shedding.
3. Phenology is one of the key factors influencing the intensity and evolution of outbreaks of evolution of *T. nigritus*. Thus, an early form of *F. excelsior* is attacked in the Republic of Moldova, but the late form and other specimens that had fully developed leaves or that had only buds on their branches are not attacked or are moderately attacked (the leaves are not in the ideal developmental phase for egg laying).
4. *T. nigritus* is a monophagous pest, preferring the leaves of *F. excelsior* L.
5. The Ash Black sawfly has a generation per year, wintering in an eonymph or pronymph stage inside of a cocoon in the soil at 5-15 cm. Mainly the cocoons can be observed in the soil, around the base of previously infested ash tree.
6. Most affected are pure and mixed illuminated ash forest stands, shelterbelts, regardless of any age in the various ash groves from the studied enterprises.
7. In the third decade of May – first decade of June of 2019 the ash trees defoliation degree caused by larvae of *T. nigritus* oscillated from 25 to 80 percent.
8. According the investigations during of 2013 and 2019 outbreaks were observed in the Chișinău, Nisporeni, Tighina, Telenești, Orhei, Hîncești Forest Enterprises, also in the "Plaiul Fagului" and "Codrii" Reserves.
9. At the end of 2018, the surface of the outbreaks of Ash Black sawfly in the republic was 419 ha, but at the end of 2019 just 257 ha, because 162 ha of outbreaks extinguished under the action of various natural factors.

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