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Paranthrene diaphana: a new clearwing moth (Lepidoptera: Sesiidae) species in Romania and its preliminary response to sex attractants

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Summary: The genus *Paranthrene* includes diurnal clearwing moths mimicking Hymenoptera and known for their impact in forestry. In Europe, it comprises three species: *Paranthrene tabaniformis*, *P. diaphana*, and *P. insolitus*, which are morphologically similar but distinct in host plant preferences and distribution. *P. tabaniformis* is widespread and a pest of *Populus*, while *P. diaphana* occurs patchily in southeastern Europe and feeds on *Salix*. This study reports the first records of *P. diaphana* in Romania, expanding the known distribution of this species in Europe. Field surveys in Romania recorded this species in the regions of Banat, Oltenia, and Muntenia, while surveys conducted in Buzău County with sex attractant lures between 2013 and 2024 revealed the presence of *P. diaphana* alongside *P. tabaniformis*, a common species in the country. *P. diaphana* shows an apparent distribution primarily in southern Romania. In all the habitats where *P. diaphana* was recorded the habitat includes willows, poplars, and agricultural fields. The findings contribute to the understanding of *Paranthrene* species and confirms presence of *P. diaphana* in Romania, expanding its known range and highlighting the need for further research, particularly into *P. insolitus*. Thanks to citizen science contributions the species is recorded also in Dobrodja region.

Key words: *Paranthrene diaphana*, new records, Sesiidae, pheromons, citizen science, Romania.

Introduction

The genus *Paranthrene* Hübner, [1819], part of the family Sesiidae (clearwing moths), consists of diurnally active species. Sesiidae (clearwing moths) are renowned for their striking mimicry of aculeate Hymenoptera and their potential as pests of various food crops globally. In Europe, the genus *Paranthrene* is represented by three species: *Paranthrene tabaniformis* (Rottemburg, 1775), *P. diaphana* Dalla Torre & Strand, 1925 and *P. insolitus* Le Cerf, 1914. These species form a complex of morphologically similar taxa that can be easily misidentified in the field at a first look and without collecting.

P. tabaniformis and *P. diaphana* utilize members of the Salicaceae family as host plants, whereas *P. insolitus* relies on oak species (*Quercus robur*, *Q. petraea* and *Q. pubescens*) during its larval stage. *P. diaphana* appears to prefer species of the genus *Salix*, such as *Salix alba* and *S. caprea*, in Bulgaria (Georgiev 2015), while *P. tabaniformis* predominantly feeds on *Populus* species (Mifsud *et al.* 2003).

Distribution

The species *P. tabaniformis* is by far the most widespread of the three European *Paranthrene* species. It is a transcontinental species, being found in North America, Europe and Asia, with a strong presence in nearly all European countries (Laštůvka and Laštůvka 2001, Ulrich *et al.* 2011).

The species *P. diaphana* exhibits a patchy distribution, primarily concentrated in southeastern Europe (Špatenka *et al.* 1999). The species was confirmed relatively recently in Bulgaria (Georgiev 2015) and in Italy (Sicily) (Bella *et al.* 2017). European populations appear scattered and occur at low densities. However, beyond Europe, the species is widespread in countries such as Turkey and Iran (Georgiev 2015, Bąkowski and Askarianzadeh 2023).

The distributions of *P. tabaniformis* and *P. diaphana* widely overlap in southern Europe, with both species confirmed in countries such as Serbia, Italy and Bulgaria.

The species *P. insolitus* occurs in scattered localities across western, central, and southern Europe, as well as in Turkey, Iraq, Syria, and Israel (Špatenka and Laštůvka 1997, Bąkowski *et al.* 2009, Garrevoet 2022) and was not yet found in Romania.

Romania ranks as the fourth most Sesiidae-rich country in Europe, following Greece, Bulgaria, and Italy, likely due to its southeastern geographical position (Bąkowski *et al.* 2010). Currently, 53 Sesiidae species have been recorded in Romania (Rákosy and Goia 2021). Despite this richness, according to Rákosy *et al.* (2003), Rákosy and Goia (2021) only *P. tabaniformis* has been previously reported from Romania.

In this study, we provide the first record of *P. diaphana* (Fig. 1) in the Romanian Sesiidae fauna.

Materials and methods

Traps with chemical lures and direct observations followed by collecting were methods used to identify this species in Romania. Pheromone traps consisting of green Unitraps™ with yellow funnels were positioned at a height of 1.5-2 m under tree canopies and spaced at least 20 m apart (Bossert and Wilson 1963, Greenfield and Karandinos 1979). All traps were baited with 1 mg custom-made lures acquired from PheroBank (https://www.pherobank.com/). Lures consisted of red rubber septa impregnated with 1 mg active compounds known to be attractive to various sesiids including *Paranthrene* species: (Z,Z)- or (E,Z)- 3,13 ODDA and the alcohol analogues (Z,Z)- or (E,Z)- 3,13 ODDOH (Greenfield and Karandinos 1979, Cowles *et al.* 1996, Garrevoet *et al.* 2005, Mozūraitis and Karalius 2007).

In 2013, a preliminary survey of the Sesiidae fauna was conducted near Măgura, Buzău County using chemical lures traps. Traps were deployed for 15 days, from July 1 to July 15. In 2023 and 2024, an additional survey was conducted near Potoceni, Buzău County, spanning June 11 to August 4 in both years.

Using QGIS software (version 3.34) a map, with points where the species was identified, was generated (Fig. 2).

Results and discussions

In 2013, near Măgura, Buzău County (N 45.2439°, E 26.5593°) (Fig.2), a male *P. diaphana*, along with several specimens of *P. tabaniformis* (nominate form) and *P. tabaniformis* f. *rhyngiaeformis*, were collected. Additional specimens of both species were collected in 2023 and 2024 from Potoceni, Buzău County (N 45.1991°, E 26.7717°) (Fig.2), including 3 *P. diaphana*, 20 *P. tabaniformis*, and 7 *P. tabaniformis* f. r*hyngiaeformis*. The lures were attractive to both species: *P. diaphana* and *P. tabaniformis,* but both species came in small numbers of specimens.

Despite that Mozūraitis and Karalius (2007) identified the pheromone of *P. tabaniformis* as a blend predominantly composed of (E,Z)-3,13-ODDOH and (Z,Z)-3,13-ODDOH (3:1), along with minor compounds, for *P. diaphana*, the exact pheromone remains unknown. Garrevoet *et al.* (2005) noted weak male attraction to blends of: (Z,Z)-3,13- ODDA and (E,Z)-2,13- ODDA (95:5) and (E,Z)-3,13- ODDOH and (Z,Z)-3,13- ODDOH (97:3). Previous studies suggest that males of both species exhibit peak activity in the afternoon (Pühringer and Ryrholm 2000).

On June 19, 2022, a female *P. diaphana* was collected after being observed and photographed when resting (Fig. 1.) on a small bush of *Salix* x *fragilis* around hour 11:00 near Potelu, Olt County (N 43.7041°, E 24.1953°), in the vicinity of the Danube River. A second female *P. diaphana* was collected when resting on leaves of *Salix cinerea* at about 1 m height around 13:00 on 15 May 2024 near Sânandrei, Timiș County (N 45.8793°, E 21.2109°) (Fig. 3). All this data suggest that the species may be widespread, at least in the southern part of the country. The collected specimens are preserved in the authors' collections.

Additional records of *P. diaphana* have been reported by members of the Facebook group "Insects of Romania and Europe". On June 29, 2018, a female specimen was photographed in Sulina, Tulcea County (N 44.4733°, E 26.1222°) by Cornel Alexandru. On June 24, 2024, Marius Iana captured an image of a male in Bucharest - Pajiștea Petricani (N 44.4733°, E 26.1222°) while it was feeding on *Sambucus ebulus*. Additionally, on June 24, 2021, Florin Prunar photographed a pair in copula in Timișoara, Timiș County (N 45.7212°, E 21.2355°).

These additional observations highlight the importance of citizen involvement in biodiversity mapping. Citizen science has become a crucial tool for improving data collection efficiency in wildlife monitoring (Sun *et al*. 2021). The enhancement of distributional maps for wildlife is supported by the increased availability of data provided by citizens (Dickinson *et al.* 2010, McKinley *et al.* 2017, Mautini *et al.* 2021).

Therefore, the presence of *P. diaphana* aligns with previous observations regarding sesiid richness in Europe, particularly in Southern Europe. As noted by Ulrich *et al.* (2011), the two major post-glacial radiation centers for European clearwings are located in Southern and Eastern Europe. Consequently, we strongly suspect that the third European *Paranthrene* species, *P. insolitus*, may also be present in Romania, and is likely to be discovered.

A probable reason for the apparent absence of this third species in the Romanian fauna is most likely the low number of entomologists in the country, coupled with certain methodological constraints, such as the lack of sexual pheromones.

On the other hand, in recent decades, we have witnessed an expansion in the range of several non-native lepidopteran species that are establishing populations outside their native range (Hordley *et al.* 2024), which may be the result of climate changes. Some of these non-native species may become invasive, posing a threat to biodiversity or leading to economic losses (Cuthbert *et al.* 2021, Early *et al.* 2016). *P. tabaniformis* is known as a serious pest of poplars in the Holarctic region (Fibiger and Kristensen 1974, Solomon 1979, Du *et al.* 1985, Georgiev 2000). While *P. diaphana* is not recognized as a pest in Europe, the increased culturing of energetic willow may change attention in this regard, thereby making further studies on its biology and sex attractant optimization is a worthwhile research direction.

Fig. 1. Female of *Paranthrene diaphana* in situ, Potelu (Olt County) - 19 June 2022 (Photo: Cosmin-Ovidiu Manci).

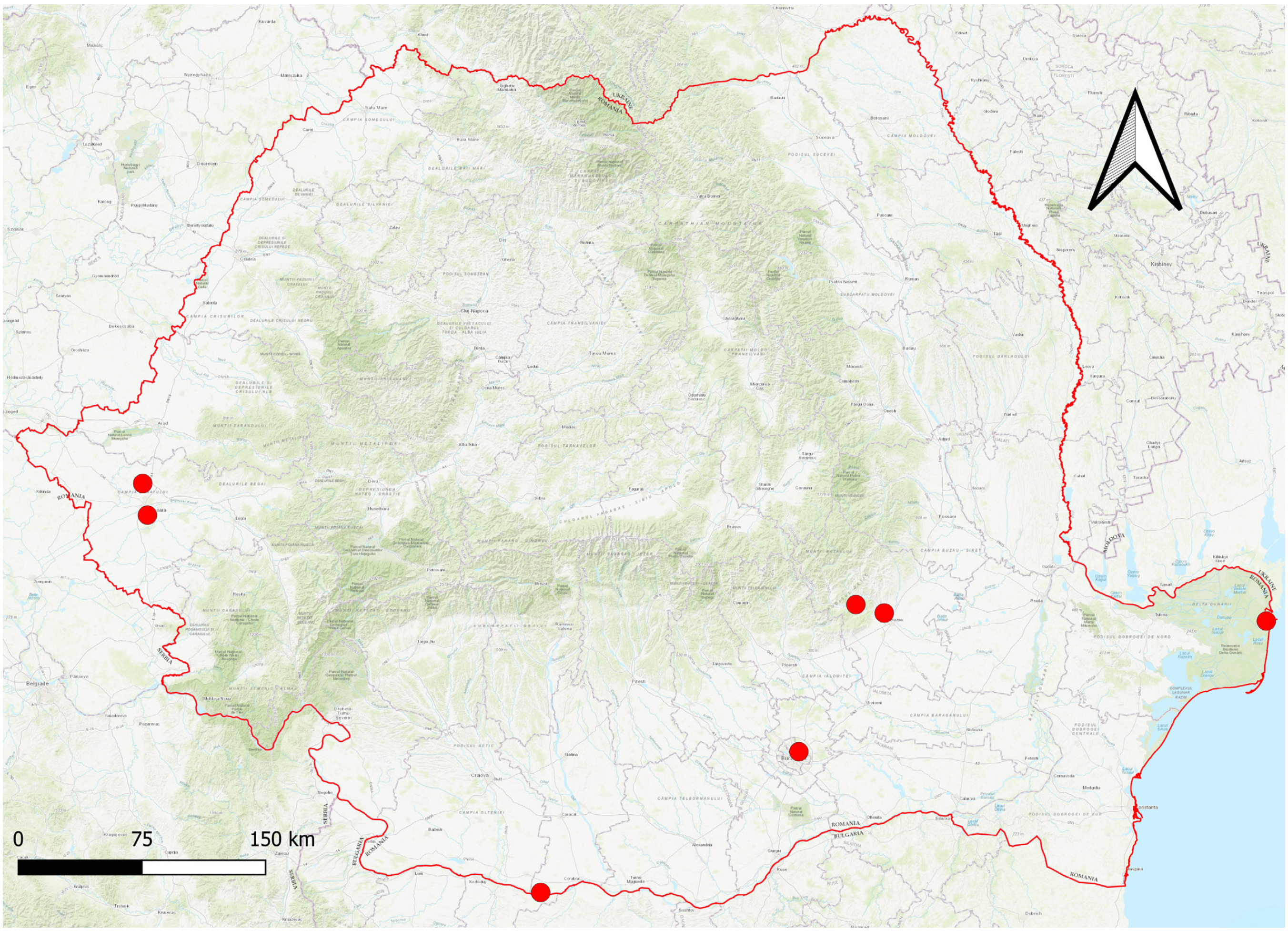

Fig. 2. Map with locations where *Paranthrene diaphana* was identified.

Habitat description

For now, the species *P. diaphana* in confirmed in all southern regions of the country: Banat, Oltenia, Muntenia and Dobrodja.

In Banat the habitat near Sânandrei (Timiş County) is a mosaic of agricultural field along the Lacului valley with a main wet area along the valley and ditches used to limit floods (Fig. 3). This valley has a good number of willows. At the location stands of stands *of Salix alba* (white willow), *Salix × fragilis* (crack willow) and *Salix cinerea* (common sallow) where found.

In Oltenia the habitat near Potelu (Olt County) is a mosaic of sandunes, more or less wet area and agricultural field in floodplain of Danube. In part this sandunes are covered with more or less scatered willows and poplars. At the location stands *of Salix alba* (white willow) and *Salix × fragilis* (crack willow) were identified.

In Muntenia the species was found in two localities, Măgura and Potoceni. The habitat near Măgura (Buzău County) is characterized by willows and poplars, situated around a naturally formed, permanent pond. In contrast, the habitat near Potoceni (Buzău County) is dominated by orchards and agricultural fields, located approximately 500 to 1000 meters from several large, young poplar stands, scattered young weeping willows, abandoned irrigation ditches, and the northern bank of the Buzău River.

Diagnosis

All specimens were identified based on external morphology using the identification key provided by Laštůvka and Laštůvka (2001).

The two *Paranthrene* species collected are superficially similar to one another and compared in Table 1. Both species are examples of Batesian mimics, exhibiting the characteristic black and yellow abdominal rings and completely transparent hindwings. However, while the forewings of *P. tabaniformis* are mostly opaque, those of *P. diaphana* are predominantly transparent (Fig. 4A). Nominotypical *P. tabaniformis* (Fig. 4B) specimens have a black abdomen with yellow rings on tergites 2, 4, and 6 in females, and tergites 2, 4, 6, and 7 in males. This species is highly polymorphic and includes several distinct forms: *synagriformis*, which has all-yellow abdominal rings and is found only in France, the Iberian Peninsula, and North Africa; *P. tabaniformis rhyngiaeformis* (Fig. 4C), which has yellow rings on all abdominal segments; and *kungessana*, characterized by whitish scaling, known only from Central Asia (Špatenka *et al.* 1999). In contrast, *P. diaphana* appears to have a relatively stable phenotype throughout its range, with a black abdomen and yellow scales on all abdominal segments.

Conclusions

This study provides the first confirmed record of *P. diaphana* in the Romanian Sesiidae fauna, marking a significant addition to the country's known clearwing moth diversity. This finding supports previous suggestions that *P. diaphana* may be more widely distributed in southeastern Europe than previously documented.

The suspected presence of *P. insolitus* in Romania, along with the newly recorded *P. diaphana*, suggests that further investigations into the diversity of *Paranthrene* species in Romania are warranted. A reliable sex attractant for *P. insolitus* is likely to be crucial for confirming its presence in the country. Additionally, the

Fig. 3. Habitat of *Paranthrene diaphana*, near Sânandrei (Timiş County) - 11 May 2024 (Photo: Cosmin-Ovidiu Manci).

Table 1. Differential diagnosis between the two species: *P. diaphana* and *P. tabaniformis* (and *P. tabaniformis* f. *rhingiaeformis*) that are found in Romania (PTA - posterior transparent area, ATA - anterior transparent area and ETA - external transparent area).

	P. diaphana (Fig. 4A)	*P. tabaniformis* (Fig. 4B)	*P. t.* f. *rhingiaeformis* (Fig. 4C)
Head			
- antenna	orange-brown	black	black, orange-brown apically
- frons	light brown	black	black
- vertex	black	black	black
- labial palpi	brown, yellow dorsally	black, yellow ventrally	black, yellow ventrally
Thorax	**black**	**black**	**black**
- tegula	black	black	black
- hind tibia	yellow, black proximally	yellow, black proximally	yellow, black proximally
Wings			
- forewings	light brown with orange scales	dark brown with light brown scales	light brown, some orange scales
- PTA	2/3 transparent	2/3 transparent	2/3 transparent
- ATA	2/3 transparent	1/3 transparent	1/3 transparent
- ETA	transparent	opaque	opaque
- discal spot	orange	dark brown	dark brown
- apical area	light brown with orange scales	dark brown	dark brown
- hindwings	transparent	transparent	transparent
-discal spot	light brown	light brown	light brown
Abdomen	**black**	**black**	**black**
- tergites	2 – 7 posterior margins yellow	2, 4, 6, 7 posterior margins yellow	2 – 7 posterior margins yellow
- sternites	posterior margins yellow	posterior margins yellow	posterior margins yellow
- anal tuft	black medially, yellow laterally	mostly black	mostly black

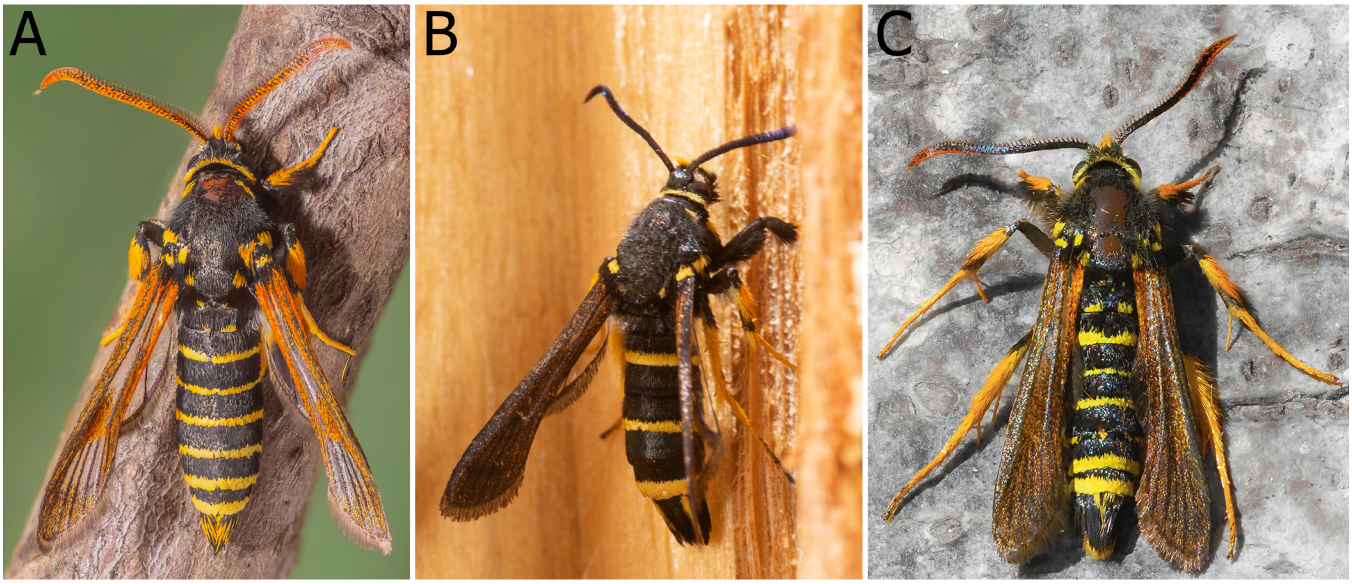

Fig. 4. A - male of *P. diaphana* (A), near Potoceni (Buzău County) - 11 June 2023 (Photo: Virgiliu Marius Aurelian), B - female of *P. tabaniformis*, near Agigea (Constanța County) - 10 June 2020 (Photo: Cosmin-Ovidiu Manci) and C - male of *P. tabaniformis* f. *rhyngiaeformis*, near Măgura (Buzău County) - 7 July 2013 (Photo: Virgiliu Marius Aurelian).

potential for discovering further cryptic species within this genus remains high, emphasizing the need for continued research in the region.

The expansion of *P. tabaniformis* and other non-native lepidopteran species in response to global warming highlights the need for monitoring shifts in the distribution of these species. Some of these species may become invasive, posing potential threats to native biodiversity and agricultural systems. *P. tabaniformis*, in particular, is known to be a significant pest of poplars, which underscores the importance of tracking its range and impact in Romania.

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