

CONTRIBUTION TO THE KNOWLEDGE OF APHROPHORID SPITTLEBUGS (HEMIPTERA: APHROPHORIDAE) FROM MOROCCO

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Abstract

This paper lists the current fauna of Aphrophoridae family in Morocco. Distribution data of their occurrence in the country are provided. Nine species of aphrophorid spittlebugs found in Morocco are listed, five of them identified and described for the first time in the country and four other species reported in the literature. An identification key of aphrophorid genera and species is given. The Mediterranean spittlebug *Philaenus tessellatus* Melichar, 1899 (Moroccan specimen) is described and differentiated from the European meadow spittlebug *Philaenus spumarius* Linnaeus, 1758 (Italian specimen). The newly reported *Philaenus* sp. specimen found in Morocco is described.

KEY WORDS: Aphrophoridae, *Philaenus tessellatus*, *Neophilaenus*, taxonomy, Morocco

Introduction

The plant pathogenic *Xylella fastidiosa* (Xanthomonadaceae, Gammaproteobacteria), is a xylem-restricted pathogenic, gram-negative bacterium. In the European and Mediterranean Plant Protection Organization (EPPO) region it has been reported since 2013 in Apulia, Southern Italy (Saponari *et al.*, 2013), and since then the damage caused by this bacterium has been observed on a wide range of host plants in Europe (EPPO, 2019). This bacterium has become a serious threat to Moroccan plant heritage (ONSSA, 2016;

Afechtal *et al.*, 2018a). It is transmitted to plants by several xylem-sap feeding insects belonging to the Auchenorrhyncha suborder, mainly the Aphrophoridae family and causes diseases such as Olive quick decline syndrome (Saponari *et al.* 2019). Dietrich (2009) described how to distinguish characters in the Auchenorrhyncha suborder from other Hemiptera species. Hemipteran species belonging to the suborder Auchenorrhyncha are insects of varied sizes, which may reduce crop yield by feeding on plant fluid and weakening the terminal young branches (Mozaffarian, 2018). The Cercopoidea superfamily belongs to the suborder Auchenorrhyncha and includes around 3000 described species within 340 genera worldwide and consists of five taxa; Aphrophoridae, Cercopidae, Epipygidae, Clastopteridae and Machaerotidae (Cryan & Svenson, 2010). Research on aphrophorid spittlebugs was focused first on the taxonomy of species and polymorphism, mainly the meadow spittlebug *Philaenus spumarius* (Linnaeus, 1758) (Halkka & Lallukka, 1969; Drosopoulos & Asche, 1991). Recently, an overview of Aphrophoridae, mainly in Europe, North and South America, was given (Cornara *et al.*, 2019). Most relevant information on aphrophorids from Morocco came from early studies performed in Southern Europe. *Philaenus spumarius* (reported as *Philaenus spumarius* sp. *tesselatus*), *Philaenus signatus* Melichar, 1896 and *Philaenus tessellatus* Melichar, 1899 (reported as *Philaenus spumarius* sp. *tesselatus*) were the first *Philaenus* species reported from the country (Halkka & Lallukka, 1969). *Philaenus maghresignus* Drosopoulos & Remane, 2000, was recorded from North Africa, including Morocco (Drosopoulos, 2003). The other spittlebug species recorded were *Neophilaenus campestris* Fallén, 1805, *Aphrophora alni* Fallén, 1805 and *Aphrophora salicina* Goeze, 1778 (Lodos & Kalkandelen, 1981). There is little information about aphrophorid spittlebug in Morocco (Afechtal *et al.*, 2018b; Smaili & Afechtal, 2018). Current surveys carried out on the suborder Auchenorrhyncha in Morocco were reported but without description (Haddad *et al.*, 2021). In addition, the morphological characteristics and identification keys used for all *Philaenus* and *Neophilaenus* species recorded in Morocco need to be clarified. Three genera (*Philaenus*, *Neophilaenus* and *Aphrophora*) and nine species are listed in this study, with five of them being described for the first time in the country.

Materials and Methods

Available information on aphrophorid adults in Morocco was gathered using published data, followed by large scale surveys during 2019 and 2020 to determine the current composition list of Aphrophoridae species. A total of 368 Aphrophoridae specimens were collected and studied from different provinces across the country: northern province (Tanger), north-central province (Chefchaouen), eastern province (Guercif), central province (Ifrane), north western provinces (Larache, Kenitra), south central province (Settat, Marrakech) (Fig. 1). Insect-collecting surveys covered low altitudes (Larache) and high altitudes (Ifrane) and included different crop ecosystems (e.g. olive), mountain forest, lowland forest and natural ecosystems (e.g. coastal areas) (Fig. 2). Using an entomological sweep net, many long transects were performed to collect aphrophorid adults on the ground vegetation. Adult insects were collected in small plastic bags and carefully placed into the microtubes containing 70% ethanol for conservation. All samples were referenced and conserved for identification. Taxonomic identification of aphrophorid adult specimens was performed based on morphological characters (e.g. rear leg morphology and apical spines on tibia and tarsus I) using a stereomicroscope (Olympus SZ61, France). Species identification was performed by dissecting male genitalia according to available identification keys and illustrations (Remane & Drosopoulos, 2001; Drosopoulos & Quartau, 2002; Mozaffarian & Wilson, 2015; Mozaffarian, 2018; EPPO, 2020). After clearing in KOH (10%), insects were rinsed with distilled water and dissected in glycerin. Male genitalia were mounted and preserved in glycerin. Then, measurements of the aedeagus appendage were carried out using a micrometer slide using the stereomicroscope (Olympus SZ61, France). Description of the morphological characters of all male genitalia, including the aedeagus, anal tube and stylus, were also

made using the stereomicroscope (Optika vision Lite 2.1, B-150 Series, Optika microscopes, Italy). Adult insect measurements were made using the stereomicroscope (Olympus SZ61, France). Photos were taken using a digital camera (Sony digital camera, USA) connected to the stereomicroscope. An identification key was made on the basis of all the examined aphrophorid specimens collected from the surveyed areas. To enhance our identification key, we also used previously published articles (Remane & Drosopoulos, 2001; Drosopoulos & Quartau, 2002; Dietrich, 2005; Mozaffarian & Wilson 2015; Mozaffarian, 2018, EPPO, 2020). Materials examined are presented in the following order: province, locality, habitat, number of males and females examined, coordinates, altitude, name of collector. For differential diagnostics we also compared the male aedeagus of Moroccan *P. tessellatus* specimens with those of *P. spumarius* specimens from Italy. The gathered information data on Aphrophoridae were summarized taking into consideration: 1) literature that gives the reported distribution of these species in Morocco; 2) the current list of aphrophorid species and their occurrence in Morocco; 3) general worldwide distribution and 4) description of the observed species.

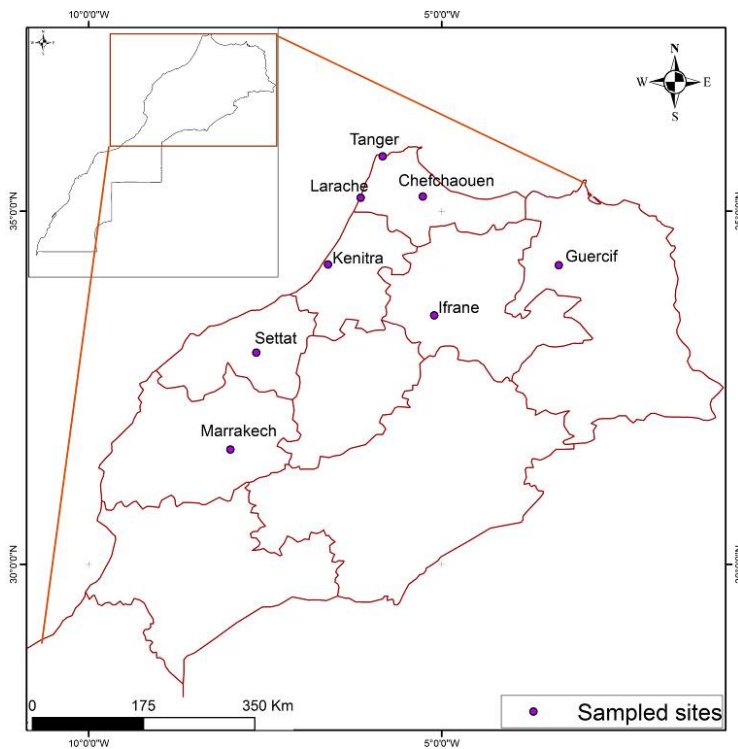


Figure 1. A detailed map showing provinces where Aphrophoridae specimens were collected in Morocco between 2019 and 2020.

Abbreviation: LMAF/LMAA – total length of male adult, (from apex of vertex to tip of forewings /length from apex of vertex to apex of abdomen); LFAF/LFAA – total length of female adult, (from apex of vertex to tip of forewings /length from apex of vertex to apex of ovipositor); WMAA/WMA – width of male adult with forewings (line of insertion of second pair of legs in mesothorax)/width of male adult without forewing;

WFAA/WFA – width of female adult with forewings (line of insertion of second pair of legs in mesothorax)/width of female adult without forewing; LA – length of aedeagus and WA – width of aedeagus; MCS and MA – Moulay Chrif Smaili and Mohamed Afechtal, INRA-CRRA, Kenitra, Morocco (National Institute for Agricultural Research, Regional Center for Agricultural Research of Kenitra, Morocco); NH – Najat Haddad, INRA-CRRA-Kenitra/University Ibn Toufail, Faculty of Sciences, Kenitra, Morocco; YO – Yamna Ougass INRA-CRRA-Marrakech, Morocco.

Examined specimens, mainly *P. tessellatus*, *N. campestris* and *N. lineatus* were deposited in the following collection: – Coll. INRA-CRRA, Kenitra.

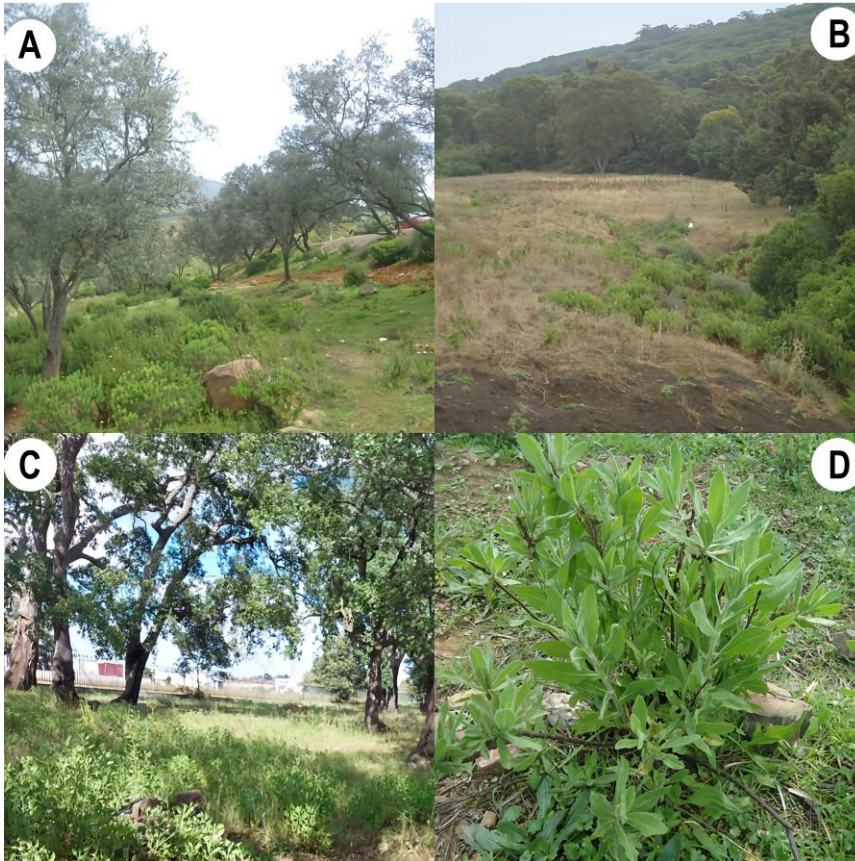


Figure 2. Habitat of *Philaenus* and *Neophilaenus* species. A – high altitude mixed olive forest and ground cover in Chefchaoun; B – mixed low mountainous forest and ground cover in Tanger; C – low altitude mixed forest and ground cover in Kenitra; D – habitat: plant infested by *P. tessellatus* nymphs in Kenitra.

Key to genera and species of Aphrophoridae in Morocco

1. Hind tibia: without row of setae but with two visible thick spines. Pronotum as wide as head, eye globular, forewings without red coloring..... 2
2. Pronotum and vertex with a median line keel located along the center line on the front half..... *Aphrophora*
- 2a. Pronotum and vertex without a median line keel located along the center line on the front half. (Fig. 3 A & E; Fig. 5A; Fig. 6 A-C)..... 3
3. Hind tibia rounded with eight spines, front wings with basal costal convex but not in line and not parallel to rear margin. Fronto-clypeus with length of upper margin smaller than the distance between it and eye in the front margin of the vertex. Plate of vertex longer than large..... *Philaenus* 4
- 3a. Hind tibia rounded with more than eight spines, often 12–14 spines. Front wings with basal costal in line form and almost parallel to rear margin. Fronto-clypeus with length of upper margin higher than the distance between it and eye in the front margin of the vertex. Plate of vertex larger than longer..... *Neophilaenus* 7
4. Male genitalia including aedeagus, anal tube and stylus (Fig. 3 B-D & F-G; Fig. 5 B-E). Aedeagus ventro-caudal morphological forms with three pairs of aedeagal appendages (Fig. 3 B, F-G)..... 5
- 4a. Male genitalia including aedeagus, anal tube and stylus (Fig. 4 A-D; Fig. 5 A-E). Aedeagus ventro-caudal morphological forms with only two pairs of aedeagal appendages (Fig. 4 A; Fig. 5 B)..... 6
5. Length of body is around 6.5 to 7.00 mm (from apex of vertex to tip of forewings) (Fig. 3 A). LA is around of 225 μ m and WA is often larger around of 161 μ m; lengths of posterior III pairs from upper of aedeagal appendages are higher; lengths of posterior I pairs from lower of aedeagal appendages are higher (Fig. 3 B)..... *Philaenus tessellatus*
- 5a. Length of body is around 5.8 mm, not exceeding 6.2 mm (Fig. 3 E). LA doesn't exceed more than 100 μ m and most of the time WA is often not large; lengths of posterior III pairs from upper aedeagal appendages are lower and rounded; lengths of posterior I pairs from lower aedeagal appendages are very short (Fig. 3 F-G)..... *Philaenus spumarius*
6. First upper pair of appendages with medium shorter than the second pair, not curved both with regular thickness and little curved at the end (Fig 3 A), anal tube anterior is elongate, presence of several spiniform not curved located in the ventro lateral from anal tube, four among those located at the tip of the tube are very long (Fig. 4 A-D)..... *Philaenus maghresignus*
- 6a. First pair of appendages with medium length, narrower, but becomes wider and curves to a semi-circle thickness, in caudal view, anal tube anterior is elongate and wider than from *P. maghresignus*, presence of several very long and fine spiniform not curved located ventro lateral from anal tube (Fig. 5 B-E)..... *Philaenus* sp.

7. Body is elongate approximately 5.1 to 6.8 mm, either brownish-white, or brownish-white slightly dark (Fig. 6 A-C). Male genitalia including elongate aedeagus, anal tube and stylus (Fig. 6 D-G)..... 8
8. Body is approximately 5.1 to 6.8 mm, brownish-white (exception for a few darker specimens) (Fig. 6 B). Scutellum color is brownish-white darker without black spot (most specimens) (Fig. 6 A; C left). Forewing with characteristic white band located in the outside edge of the forewing parallel to costa. Aedeagus elongate and width is greater (Fig. 6 D)..... *Neophilaenus lineatus*
- 8a. Body size approximately 6.5 mm, with color brown slightly darker. Scutellum color is darker brown with irregular black spot in the upper. Forewing without any band running down the edge of forewing (Fig. 6 C right). Aedeagus very elongate and width is shorter (Fig. 6 G)..... *Neophilaenus campestris*

Results

Superfamily Cercopoidea Leach, 1815

Family Aphrophoridae Amyot & Serville, 1843

Subfamily Aphrophorinae Licent, 1912

Genus *Philaenus* Stål, 1864

***Philaenus tessellatus* Melichar, 1899 (Fig. 3 A-D)**

Material examined: Morocco: Larache, INRA station, ground cover of forest agroecosystem, 35.151944/-6.150278, alt. 38m, 28.03.2019, 18 ♂♂, 8 ♀♀, leg NH, MCS & MA; 35.177222/-6.147222, alt. 38m, 24.04.2019, 10 ♂♂, 6 ♀♀, leg NH and MCS; 35.136667/-6.139722, alt. 38m, 21.05.2020, 22 ♂♂, 7 ♀♀, leg NH & MA. Kenitra, downtown, ground cover of forest agroecosystem, 34.2505282/-6.572728, alt. 13 m, 04.04.2019, 9 ♂♂, 2 ♀♀, NH leg; 34.009270/-6.849900, alt. 13 m, 05.05.2019, 5 ♂♂, 3 ♀♀, leg MCS and MA; 34.006320 /-6.911110, alt. 13 m, 28.05.2020, 3 ♂♂ 2 ♀♀, leg MA, NH and MCS. Kenitra, El Menzeh, ground cover, 34.295335 /-6.482414, alt. 33.8 m, 26.03.2019; 8 ♂♂ 5 ♀♀, leg MCS, NH and MA; 34.250628/-6.572620, alt. 33.8 m, 19.04.2019; 5 ♂♂ 3 ♀♀, leg NH, MCS & MA; 34.262530 /-6.553471, alt. 33.8 m, 26.05.2020; 6 ♂♂, 2 ♀♀, leg NH, MCS & MA. Chefchaouen, 1km from downtown, ground cover of olive orchards, 35.135124 /-5.274691, 600 m, 02.04.2019, 11 ♂♂, 7 ♀♀, leg MCS, NH & MA; 35.193240 /-5.215420, 560 m, 26.06.2019, 9 ♂♂, 7 ♀♀, leg NH & MA; 35.231420 /-5.194320, 600 m, 18.06.2020, 8 ♂♂, 5 ♀♀, leg NH & MCS. Tanger, forest reserve, ground cover of mountainous forest, 35.784183/-5.894834, 110 m, 25.06.2000, 15 ♂♂, 11 ♀♀. Port Med, 35.895706/-5.479601, 800 m, 25.06.2020, 25 ♂♂, 3 ♀♀, leg NH, MCS & MA. Ifrane, 1k from downtown, ground cover of forest agroecosystem, 33.519782 /-5.115166, 1664 m, 02.06.2000, 6 ♂♂, 2 ♀♀. Marrakech, Ourika Valley, 31.2115 /-7.4541, alt. 906m, 27.07.2020, 2 ♂♂, 1 ♀, leg YO.

Literature about Morocco: As western Mediterranean *Philaenus spumarius tessellatus* (Halkka & Lallukka, 1969); 6 ♂♂, 13 ♀♀, as *P. spumarius* sp. *tessellatus* (Drosopoulos & Remane, 2000); 4 ♂♂, 2 ♀♀, Bab Taza 800, 1 ♂♂, 2 ♀♀, Haut Atlas, St Gorges De Reraie, 3 ♀♀, Moyen Atlas, Ravel Mt, 2 ♂♂, 5 ♀♀,

High Atlas (Drosopoulos & Quartau, 2002). 12 ♂♂, 17 ♀♀, Spain+North Africa, including Morocco (Drosopoulos, 2003). Spain + Morocco (Drosopoulos *et al.*, 2010), as *P. tessellatus* (Haddad *et al.*, 2021).

Current distribution in Morocco. Ground cover of forest agrosystem in Larache, Kenitra, Chefchaouen, Ifrane, Tanger and Marrakech.

General distribution: Mediterranean as *P. spumarius* sp. *tessellatus* (Drosopoulos & Remane 2000); Holarctic (Drosopoulos & Quartau, 2002); Portugal, Morocco (Haddad *et al.*, 2021; Seabra *et al.*, 2021).

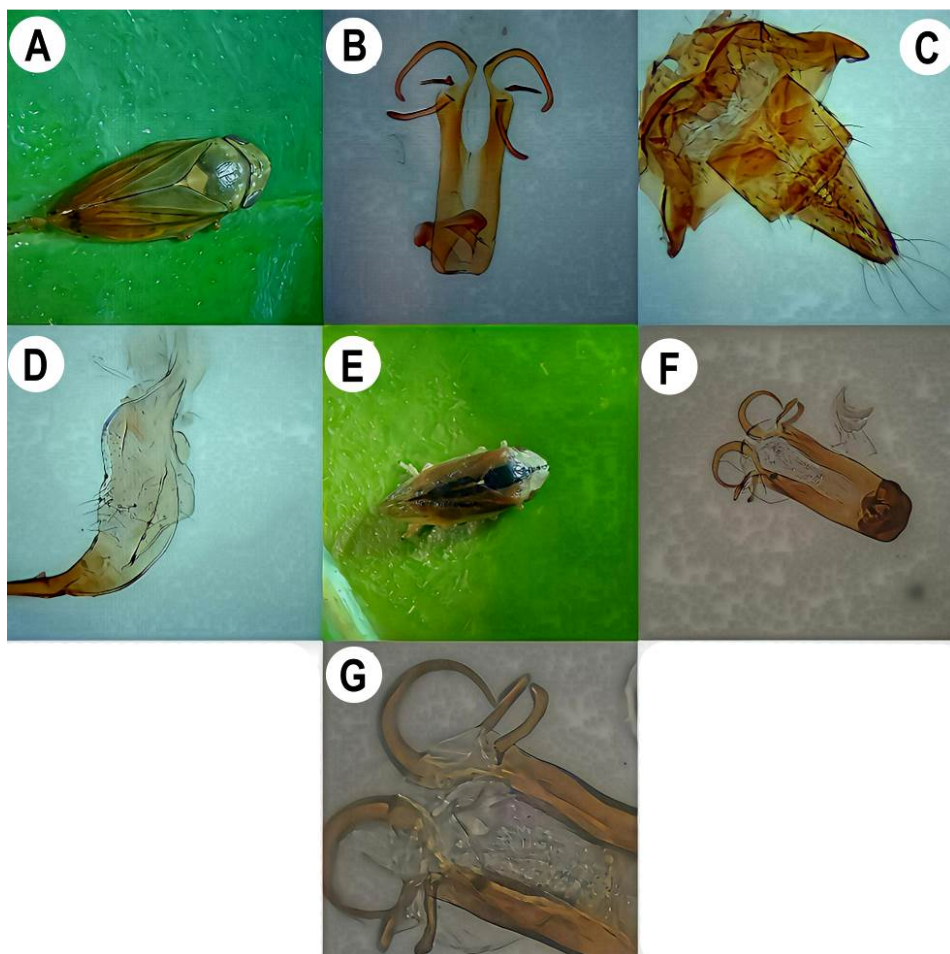


Figure 3. A-D – *P. tessulatus*, A – habitus, B – male aedeagus, C – anal tube, D – stylus. E-G – *P. spumarius* (specimen from Italy), E – habitus, F – male aedeagus, G – detail of male aedeagus.

Description:

Body: Dorsal habitus elongated in shape, lateral habitus view margin of head is less rounded, polymorphism for dorsal color; whitish-brown, there is lighter and darker (melanic form) specimen dorsum. LMAF/LMAA: 6.3-

6.6/5.9-6.1 mm; LFAF/LFAA: 6.5-7.0/6.0-7.0 mm; WMAA/WMA: 2.5-3.5/2.0-2.1 mm; WFAA/WFA: 2.4-2.5/2.0-2.2 mm. Usually adult without (specimen of North) or with (specimen of center-south) brown fine setae.

Head: Postclypeus located in central of face, frontoclypus enlarged, two ocelli located on dorsal side, eye not reaching forewing upper base.

Pronotum: As wide as head, more extended to suture of scutellum, whitish-brown.

Hind tibia: round appearance without row of setae, with two visible thick spines.

Elytra: Polymorphism for dorsal color of forewing; whitish-brown upper base slightly reddish, clear in lower part. Forewings with visible veins.

Male genitalia: Male genitalia, aedeagus ventro-caudal morphological forms are similar with three pairs of aedeagal appendages. LA is higher in *P. tesselatus* (around of 225 μm) than in *P. spumarius* (European specimens); WA is a little larger in *P. tesselatus* (around of 161.2 μm) than in *P. spumarius*. LP III is at least twice as long for *P. tesselatus* than *P. spumarius*; LPI is 1.5 higher for *P. tesselatus* than *P. spumarius*.

Differential diagnostic: *Philaenus tesselatus* morphology is similar to *P. spumarius*, widely distributed in Europe (specimens examined here). In dorsal view, size and shape of male and female from the two species are similar. Regarding male genitalia, aedeagus ventro-caudal morphological forms are similar with three pairs of aedeagal appendages. However, specific parameters were different: 1) *P. tesselatus* body length, from apex of vertex to tip of forewings, is higher (around 6.5 to 7.00 mm) than *P. spumarius* body (around 5.8 mm and not exceeding 6.2 mm); 2) length of aedeagus is higher in *P. tesselatus* than *P. spumarius*; 3) width of aedeagus is often larger in *P. tesselatus* than *P. spumarius*; 4) length of posterior III pairs from upper aedeagal appendages is greater in *P. tesselatus* than *P. spumarius*, which are also rounded; 5) length of posterior I pairs from lower aedeagal appendages is greater for *P. tesselatus* than *P. spumarius*.

***Philaenus spumarius* Linnaeus, 1758** (Fig. 3 E-G)

Material examined (from Morocco). None.

Material examined: Italy: Lecce, Olive trees, 40.152217, 18.226063, alt. 75 m, 25.06.2019, 10 ♂♂, 7 ♀♀, leg YO.

Literature about Morocco: as *Philaenus spumarius* (Lodos & Kalkandelen, 1981); as *P. spumarius* sp. *tesselatus* (Halkka & Lallukka 1969; Rodrigues *et al.*, 2014).

Current distribution in Morocco: None (this paper).

General distribution: Hawaii (Davis & Mitchell, 1946); Holarctic as *P. spumarius* sp. *spumarius* (Halkka & Lallukka, 1969); Finland, China (Kansu); North America (Thompson & Halkka, 1973); Turkey, former USSR, former Yugoslavia, Nearctic region, Iraq and North Africa (Lodos & Kalkandelen, 1981); New Zealand (Thompson, 1984); Southern and northern Europe and Iran (Drosopoulos & Asche, 1991; Mozaffarian & Wilson, 2015; Mozaffarian, 2018; Cornara *et al.*, 2019; Santoiemma *et al.*, 2019); Japan (Cornara *et al.*, 2018); Europe (Kapantaidak *et al.*, 2021; Seabra *et al.*, 2021).

***Philaenus maghresignus* Drosopoulos & Remane, 2000** (Fig. 4 A-D)

Material examined: Morocco: Chefchaouen, 1km from downtown, ground cover of olive orchards, 35.135124 /-5.274691, 600 m, 02.04.2019, 1 ♂, leg NH, MCS & MA.

Literature about Morocco: Spain+Portugal+North Africa, including Morocco, 34 ♀♀ and 20 ♀♀ (Drosopoulos, 2003). Southern Iberian peninsula (Spain) + Morocco (Drosopoulos *et al.*, 2008, 2010). Morocco: Dayet Aoua, Holotype 1 ♂, mountain range, Moyen Atlas, leg. Remane R.; Azrou, Paratypes, 2

♂♂, , Moyen Atlas (1400-1600 m) South Est Azrou; around Azrou, 1 ♂, 1 ♀; Ras-El-Ma east supra Azrou; Ain Leuh, 2 ♂♂, 1 ♀, (1500 m); EL Ksiba, 7 ♂♂, 2 ♀♀, (1100 m); W. Oulms-Harcha Massif, 5 ♂♂, 7 ♀♀, (1000-1200 m); Coastal plains, Souk-Khemis du Sahel near Larache, 2 ♀♀; North of Larache, 1 ♀, leg Remane R.; Azrou, 1 ♂, 3 ♀♀; Coastal plain on the way to Kenitra Maamora, 1 ♂, 4 ♀♀ (Coll. Lindberg H.), (British Museum); Middle Atlas, 2 ♂♂, 3 ♀♀, (Coll. Lawrence P.N.), (British Museum) (Drosopoulos & Remane, 2000), Morocco (Haddad *et al.*, 2021).

Current distribution in Morocco: Ground cover of olive grove, Chefchaouen.

General distribution: North west Africa and southern part of the Iberian peninsula (Drosopoulos & Remane, 2000; Drosopoulos *et al.*, 2010); Spain (Kapantaidak *et al.*, 2021).

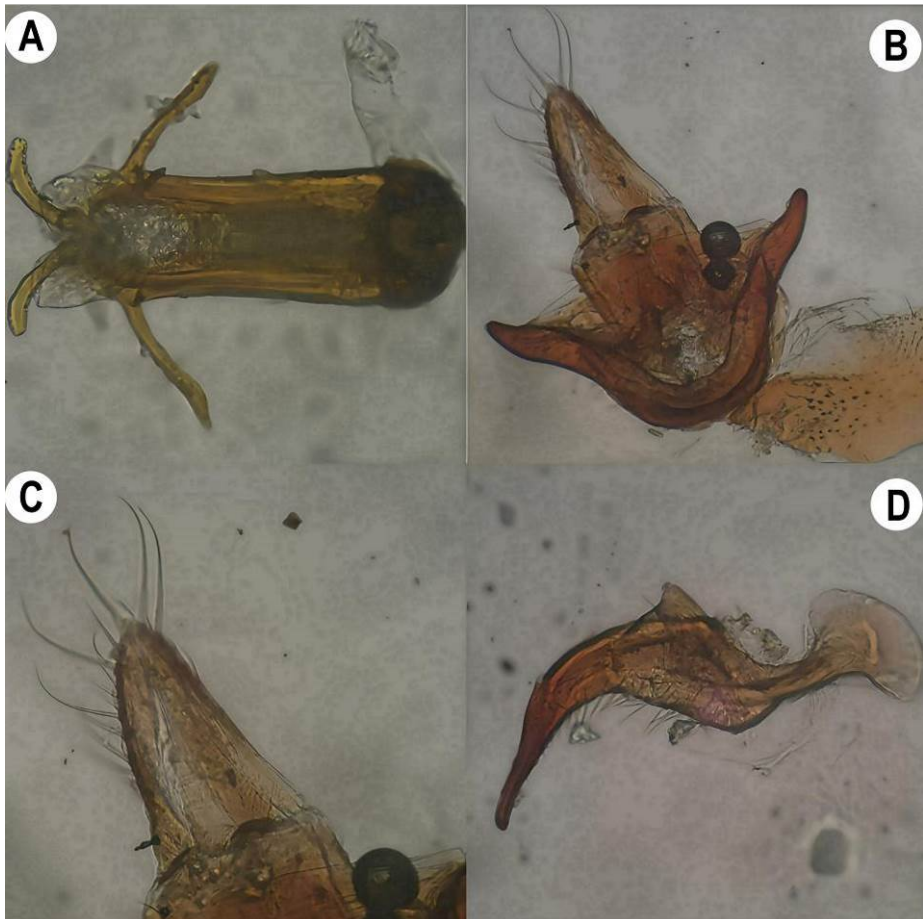


Figure 4. A-D – *P. maghresignus*, A – male aedeagus, B – anal tube, C – detail of anal tube, D – stylus.

***Philaenus* sp.** (Fig. 5 A-E)

Material examined: Morocco: Tanger, Port Med II, ground cover of mountainous forest, 35.895706/-5.479601, alt. 800 m, 25.06.2020, 1 ♂, leg NH, MCS and MA. The right posterior II pairs from upper aedeagal appendages are missing.

Literature about Morocco: Haddad *et al.* (2021).

Current distribution in Morocco: Tanger, Port Med II, ground cover of mountainous forest, 35.895706/-5.479601.

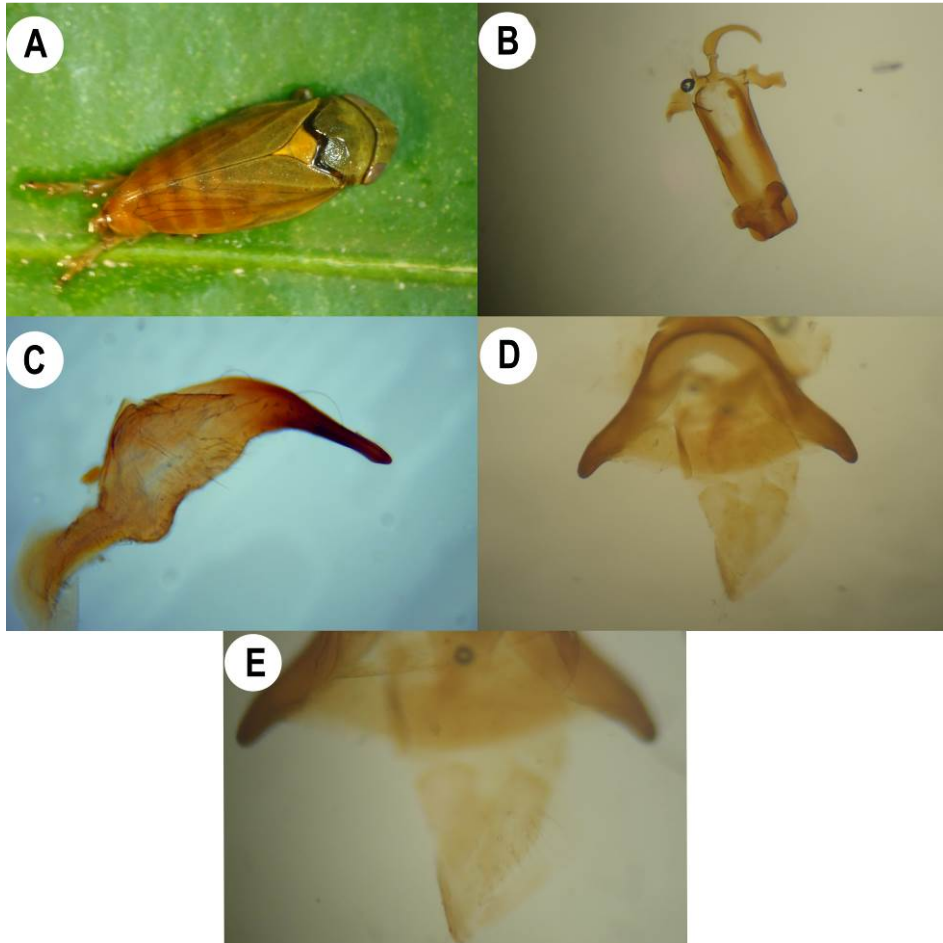


Figure 5. A-E – *Philaenus* sp., A – habitus, B – male aedeagus, C – stylus, D – anal tube, E – detail of anal tube.

Description:

Body: Dorsal habitus more elongated in shape than other *Philaenus* species, lateral habitus view margin of head is less rounded, yellowish-brown, LMAF/LMAA: 7.45/7.1 mm; WMAA/WMA: 3.5/2.0 mm. Dorsal view body with a few fine setae.

Head: Postclypeus located in central of face; frontoclypus enlarged, presence of two ocelli and located on dorsal side. In dorsal view, WE shorter than those of other *Philaenus* species, eye not reaching forewing upper base.

Pronotum: brown darker, as wide as head, separated with black suture from forewing upper base. Scutellum brownish-yellow.

Hind tibia: round appearance without row of setae, with two visible thick spines.

Elytra: Fore wing brown. Forewings with visible veins. Front wings with basal costal little in line form but not like other *Neophilaenus* species.

Male genitalia: Aedeagal appendages with two pairs of appendices.

Differential diagnostic: The morphological characters of this *Philaenus* sp. are similar to those of *P. tessellatus* and *P. maghresignus*. In dorsal view, the shape of males and females of these three species are very similar. However, length body of the male adult of this *Philaenus* is greater than those of the other two species. Regarding male genitalia, aedeagus ventro-caudal morphological forms of this *Philaenus* sp. are similar to *P. maghresignus* with two pairs of aedeagal appendages. However, specific parameters were different: 1) posterior III pairs from upper aedeagal appendages of medium length (as in *P. maghresignus*), but narrower in the first, becoming wider and curving to a semicircle thickness. 2) medium thickness of posterior I pairs from lower aedeagal appendages (as in *P. maghresignus*). 3) in caudal view, anal tube anterior is very elongate; 4) presence of several long spiniform not curved located ventro lateral from anal tube.

***Philaenus signatus* Melichar, 1896**

Material examined: None.

Literature about Morocco: (Lodos & Kalkandelen, 1981); (Halkka & Lallukka, 1969; 5 ♂♂, 4 ♀♀, (Drosopoulos & Remane, 2000).

Current distribution in Morocco: None (this paper).

General distribution: Souther of Europe, Turkey, former Yugoslavia, Iraq and Morocco (Lodos & Kalkandelen, 1981); Mediterranean (Drosopoulos & Asche, 1991; Drosopoulos & Remane, 2000; Drosopoulos & Quartau, 2002); Greece (Kapantaidak *et al.*, 2021).

Genus *Neophilaenus* Haupt, 1935

***Neophilaenus lineatus* Linnaeus, 1758** (Fig. 6 A-B; C left; D-F)

Material examined: Morocco: Larache, INRA station, ground cover of forest agroecosystem, 35.151944/-6.150278, alt. 38m, 28.03.2019, 1 ♂, 1 ♀, leg NH, MCS & MA; 35.177222/-6.147222, alt. 38m, 24.04.2019, 1 ♂, leg NH & MCS. Kenitra, El Menzeh, ground cover, 34.295335/-6.482414, alt. 33.8 m, 26.03.2019; 2 ♂♂, 1 ♀, leg MCS, NH & MA; 34.250628/-6.572620, alt. 33.8 m, 19.04.2019; 2 ♂♂, leg NH, MCS & MA; 34.262530/6.553471, alt. 33.8 m, 26.05. 2020; 3 ♂♂, 2 ♀♀, leg NH, MC & MA. Ifrane, between Ifrane and Azrou, ground cover of forest agroecosystem, 33.578907/-5.092339, 1 664 m, 02.07.2000, 1 ♂, 2 ♀♀, leg NH & MCS. Tanger, forest reserve, ground cover of mountainous forest, 35.784183/-5.894834, 110 m, 25.06.2000, 1 ♂, 2 ♀♀. Port Med II, 35.895706/-5.479601, 800 m, 25.06.2000, 1 ♀, leg MA, NH & MCS. Guercif, 1km from downtown, ground cover of olive grove, 34.299514/-3.123773, 362 m, 25.07.2019, 2 ♀♀;

34.240775/-3.315459, 378 m, 25.06.2000, 1 ♀, leg MCS & MA. Settât, 20 km from downtown, ground cover, 32.952855/-7.626754, 290 m, 12.07.2018, 1 ♀, leg MCS.

Literature about Morocco: Haddad *et al.* (2021).

Current distribution in Morocco: Ground cover of forest agroecosystem in Larache, Menzeh (Kenitra), Ifrane, Tanger, Guercif and Settât.

General distribution. Europe, Turkey, former USSR, former Yugoslavia, Nearctic region, North Africa (Algeria, Tunisia), Iran (Lodos & Kalkandelen, 1981; Mozaffarian & Wilson, 2015), Morocco Haddad *et al.* (2021).

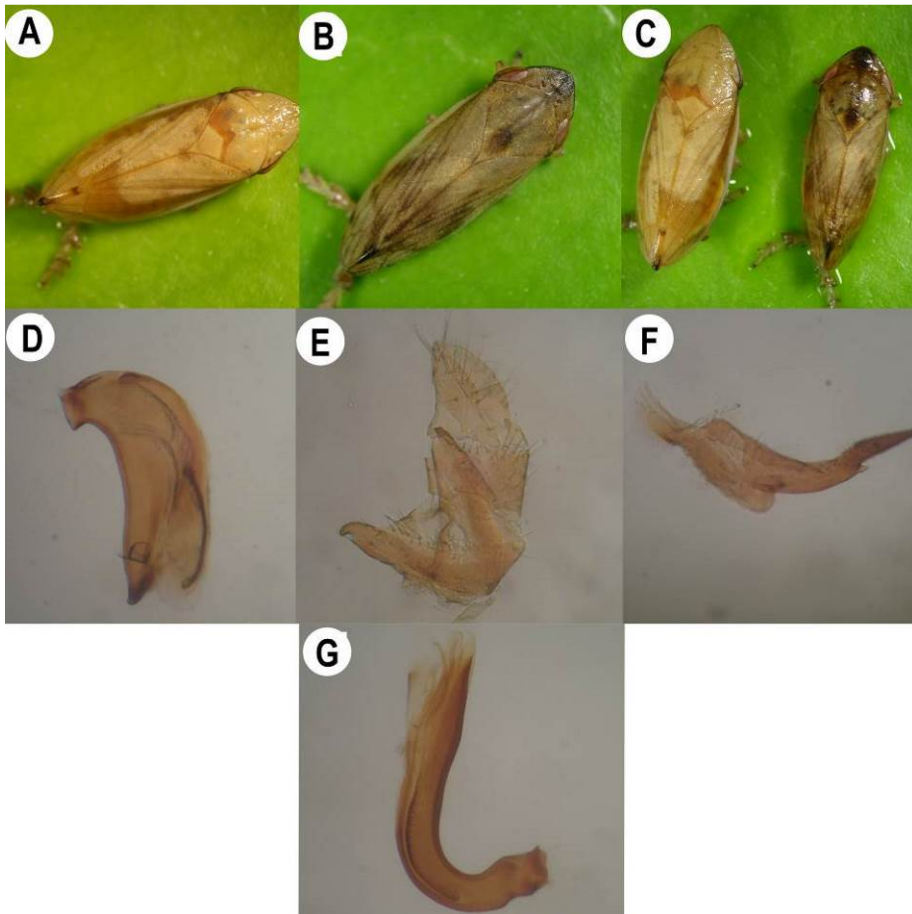


Figure 6. A-C – *N. lineatus*, A – habitus of common specimen, B – habitus of darker specimen, C – habitus comparison between *N. lineatus* (left) and *N. campestris* (right). D-G *N. lineatus*: D – male aedeagus, E – anal tube, F – stylus. *N. campestris* G – stylus.

Description:

Body: Body is approximately 5 to 6.8 mm, dorsal habitus elongated in shape, lateral habitus view margin of head is less rounded, Body color brownish-white, LMAF/LMAA: 5.1-6.4/5.1-5.4 mm; LFAF/LFAA: 6.5-6.8/6.0-6.1 mm; WMAA/WMA: 1.8-2.0/1.7-1.8 mm; WFAA/ WFA: 2.3-2.5/2.1 mm. Usually adult with brown setae.

Head: Postclypeus located in central of face; frontoclypeus enlarged. Presence of two ocelli located on dorsal side. The face is darker brown transverse line between ocelli. Part anterior of vertex is wider than long. Eye not reaching forewing upper base.

Pronotum: Wide as head, more extended to suture, with brownish-white color (most specimens), but few specimens have darker color.

Scutellum: Most specimens, color is brownish-white light without any spot, but on some species a black irregular spot is located on the apex of the scutellum.

Hind tibia: Round appearance without row of setae, with two visible thick spines, with more than eight spines, often 12-14 spines.

Elytra: Dorsal color of forewing is in general whitish-yellow color with visible veins. In addition, a white band running down and located in the outside edge of the forewing. A small black spot located at the tip of the rear margin

Differential diagnostic: *Neophilaenus lineatus* morphology found is similar to *N. campestris*. In dorsal view, size and shape of male and female from the two species are similar. However, specific parameters were different: 1) *N. lineatus* body color is brownish-white with small black spot located at the tip of the rear margin, while *N. campestris* is darker brown; 2) scutellum color for *N. lineatus* is brownish-white without black spot (most brownish-white specimens), while for *N. campestris* scutellum the color is darker brown with irregular black spot on the upper of the scutellum; 3) width forewing is larger in *N. lineatus* than in *N. campestris*; 4) in *N. lineatus* a white band running down and located on the outside edge of the forewing parallel to costa, while *N. campestris* does not have this band. In addition a small black spot located at the tip of the rear margin; 5) male genitalia, aedeagus ventro-caudal morphological forms are not similar; in *N. lineatus* aedeagus elongate and width is larger while it is more elongate and shorter in *N. campestris*.

***Neophilaenus campestris* Fallén, 1805 (Fig. 6 C right; G)**

Material examined: Morocco: Larache, INRA station, ground cover of forest agroecosystem, 35.151944/-6.150278, alt. 38m, 28.03.2019, 12 ♂♂, 7 ♀♀, leg NH, MCS & MA; 35.177222/-6.147222, alt. 38m, 24.04.2019, 6 ♂♂, 5 ♀♀, leg NH and MCS; 35.136667/-6.139722, alt. 38m, 21.5. 2020, 4 ♂♂, 3 ♀♀, leg NH and MA. Kenitra, downtown, ground cover of forest agroecosystem, 34.2505282/-6.572728, alt. 13 m, 04.04.2019, 6 ♂♂, 7 ♀♀, leg NH; 34.009270/-6.849900, alt. 13 m, 05.05.2019, 2 ♂♂, 1 ♀, leg MCS and MA; 34.006320 /-6.911110, alt. 13 m, 28.05.2020, 1 ♂, 1 ♀, leg MA, NH and MCS. Kenitra, El Menzeh, ground cover, 34.295335 /-6.482414, alt. 33.8 m, 26.03. 2019; 5 ♂♂, 4 ♀♀, leg MCS, NH & MA; 34.250628/-6.572620, alt. 33.8 m, 19.04.2019, 3 ♂♂, 4 ♀♀, leg NH, MCS & MA; 34.262530 /-6.553471, alt. 33.8 m, 26.5. 2020, 5 ♂♂, 4 ♀♀, leg NH, MCS & MA. Chefchaouen, 1km from downtown, ground cover of olive orchards, 35.135124 /-5.274691, 600 m, 02.04.2019, 4 ♂♂, 2 ♀♀, leg MCS, NH & MA; 35.193240 /-5.215420, 560 m, 26.06.2019, 3 ♂♂, 3 ♀♀, leg NH & MA; 35.231420 /-5.194320, 600 m, 18.06.200, 5 ♂♂, 4 ♀♀, leg NH & MCS. Tanger, forest reserve, ground cover of mountainous forest, 35.784183/-5.894834, 110 m, 25.6.2020, 3 ♂♂, 2 ♀♀. Port Med II, 35.895706/-5.479601, 800 m, 25.06.2020, 5 ♂♂, 4 ♀♀, leg NH, MCS & MA.

Literature about Morocco: (Lodos & Kalkandelen, 1981; Haddad *et al.*, 2021).

Current distribution in Morocco: Ground cover of forest agroecosystem in Larache, Kenitra, Chefchaouen and Tanger.

General distribution: Europe, former USSR, Middle East Turkey, West of Asia, Iran, North of Africa (Lodos & Kalkandelen, 1981; Mozaffarian & Wilson, 2015; Cavalieri *et al.*, 2019; Cornara *et al.*, 2019).

Genus *Aphrophora* Germar, 1821

***Aphrophora alni* Fallén, 1805**

Material examined: None.

Literature about Morocco: (Lodos & Kalkandelen, 1981).

Current distribution in Morocco: None.

General distribution: Europe, former USSR, Turkey, China, former Yugoslavia, Japan, Iran and North Africa (Lodos & Kalkandelen, 1981; Mozaffarian & Wilson, 2015; Mozaffarian, 2018).

***Aphrophora salicina* Goeze, 1778**

Material examined: None

Literature about Morocco: (Lodos & Kalkandelen, 1981; Liang, 2006).

Current distribution in Morocco: None.

General distribution: Europe, former USSR, Turkey, former Yugoslavia, Iran, North Africa (Lodos & Kalkandelen, 1981; Liang, 2006; Mozaffarian & Wilson, 2015). China, Korea, Japan, United States and Canada (Liang, 2006).

Discussion and Conclusion

This study provides a current annotated check list of Aphrophorid spittlebugs in Morocco. Aphrophoridae species are widely present in Morocco, mainly in coastal areas in the north west of the country. The spittlebugs were collected mainly on the ground cover in forest areas (low altitudes (Larache, Kenitra) and high altitudes (Ifrane and Marrakech)), and in olive groves (Chefchaoun). Nine species of aphrophorid spittlebugs were found in Morocco; five identified and described species (*P. tesselatus*, *P. maghresignus*, *Philaenus* sp., *N. lineatus*, *N. campestris*) and four others reported in the literature (*P. spumarius*, *P. signatus*, *A. alni*, *A. salicina*). A key to Aphrophoridae species in Morocco was also given. Previous studies reported the presence of *P. spumarius* in Morocco (Halkka & Lallukka, 1969; Lodos & Kalkandelen, 1981; Rodrigues *et al.*, 2014); however, *P. spumarius* was not identified in the specimens collected in the surveyed provinces. Differential diagnostics from male genitalia showed a clear differentiation between *P. tesselatus* (Moroccan specimen) and *P. spumarius* (Italian specimen). The spittlebug *P. tesselatus* was the only abundant aphrophorid recorded on a wide variety of host ground-cover plants (dicotyledonous and monocotyledonous). Our observations were similar to previous studies which noted that *P. spumarius* is now absent or very limited in Morocco (Drosopoulos & Quartau, 2002; Drosopoulos *et al.*, 2010). The remaining question is whether previous reports of *P. spumarius* from Morocco were accurate. Based on our results, it appears possible that these old reports were misidentifications of *P. tesselatus*. A recent study showed that morphological and genomic analysis allowed a more detailed view of the differences between *P. spumarius* and *P. tesselatus* (Seabra *et al.*, 2021). This could be true for the occurrence of *P. signatus* as another misidentification. Description of the male genitalia character of the newly recorded *Philaenus* sp. specimen found in ground cover of a mountainous forest on the coastal area of Tanger differs from others *Philaenus*

species reported. The site is the nearest point of Morocco from Tarifa area (Spain). According to Remane & Drosopoulos (2001), *Philaenus tarifa* Remane & Drosopoulos, 2001, was the only *Philaenus* species found in the low vegetation of the mixed *Quercus* forest of mountain ranges in the region under Atlantic influence in southern Spain. *Philaenus maghresignus* should be considered as “rare”, since only one adult was found in this present study. For the first time, the morphological traits of adult habitus and male genitalia of *N. lineatus* were described in Morocco and compared with *N. campestris*. These two last aphrophorid species were found on monocotyledonous weeds.

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ДОПРИНОС ПОЗНАВАЊУ ПЕНУША (HEMIPTERA: ARHRORHORIDAE) МАРОКА

МУЛАЈ ШРИФ СМАИЛИ, НАЈАТ ХАДАД, МОХАМЕД АФЕШТАЛ,
ЖАН-КЛОД СТРЕИТО, ЈАМНА УГАС и РАШИД БЕНКИРАНЕ

Извод

У овом раду је представљена фауна породице Arhrophoridae у Мароку. Наведени су подаци о распрострањењу врста. Представљено је девет врста пенуша породице Arhrophoridae пронађених у Мароку, од којих је пет идентификовано и описано по први пут у земљи, а четири друге врсте из литературних података. У раду је дат идентификациони кључ за родове и врсте. Медитеранска пенуша *Philaenus tessellatus* Melichar, 1899 (примерак из Марока) је описана и истакнуте су разлике у односу на европску ливадску пенушу *Philaenus spumarius* Linnaeus, 1758 (примерак из Италије). Описан је новорегистровани примерак пронађен у Мароку *Philaenus* sp.

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