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Hemiptera pest species identified on woody ornamental crops in Galicia northwest Spain

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ABSTRACT. The precise identification of dominant woody ornamental plant species is crucial for the development of sustainable plant protection programs within the Galician region of northwestern Spain. In the present paper, a total number of 49 new different *Hemiptera* species were identified, 24 Aphidoidea, 2 Phylloxeroidea, 6 Coccidae, 6 Diaspididae, 1 Pseudococcidae, 1 Rhizoecidae, 1 Pentatomidae, 1 Triozidae, 2 Aphrophoridae, 3 Tingidae, 3 Aleyrodidae and 1 Coreidae, in woody ornamental crops of Galicia, as part of author independent consultancy service, carried out from 1999 to 2022. Considering only crop pests, 33 from 49 were new references for woody ornamental crops in Galicia and 23 of them were new references for Spain. With the information obtained by the author, this paper also describes the following new worldwide references: *Aphis fabae* on *Peltaria* sp., *Myzocallis boernerii* on *Quercus robur, Tetraneura ulmi* on *Ulmus minor, Protopulvinaria pyryformis* on *Gardenia japonica*, *Saissetia oleae* on *Cyca revoluta, Rhizoecus falcifer* on *Phyllostachys aurea, Phyllostachys nigra* and *Leucothoe fontenesiana, Balanococus diminutus* on *Viburnum tinus* and *Nandina domestica, Graphosoma lineatum* on *Phyllostachys aurea* and *Phyllostachys nigra*, *Aphrophora salicina* on *Grevillea robusta*, *Grevillea rosmarifolia* and *Azalea*, *Corythucha ciliata* on *Rosa canina, Sambucus nigra* as well as on *Lavandula angustifolia* and *Trialeurodes vaporariorum* on *Ceanothus repens, Metrosideros robusta Polygala myrtifolia* and *Azalea*. A total number of 49 *Hemiptera* species will be described in the paper.

Keywords: aphids; armoured scales; froghoppers; mealybugs; woody ornamental crops

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INTRODUCTION

Hemiptera are one of the most important ornamental pest group due to their biological characters, they are easily dispersed large distances, are difficult to manage with conventional chemical methods, are great transmitters of virus and bacteria and are easily resistant to conventional insecticides. These are the main reasons of the importance of their quick detection before they stablish on new countries. (Andrés & International Plant Quarantine Work Group, 2021). Hemiptera insects are one of the arthropod groups most dispersed between countries because of the international trade being one of the most successful groups invading new geographical areas (O´ Connor *et al*., 2013).

There are no literature references about crop ornamental aphids or phylloxeras, neither in Galicia nor in Spain, with the exception of the scarce references of *Camellia japonica* pests (Salinero & Vela, 2004; Mansilla *et al*., 2005; Andrés, 2017), of garden pests (Villalva, 1996), as well as of the different pest species of bamboo (Andrés, 2016). All the information that a specialist can afford is based on faunistic studies carried out by a specific group of researchers not located in Galicia (Mier *et al*., 1988; Mier & Nieto, 1997). There is a great lack of information about armored scales, soft scales or mealybugs species, on woody ornamental crops, in Galicia, except for the valuable references on *Camellia japonica, Hemiberlesia rapax, Pulvinaria floccifera, Coccus hesperidium*, *Planococcus citri* and *Cerosplastes sinensis* (Salinero & Vela, 2004).

The number of species belonging to the families *Pentatomidae, Triozidae, Aphrophoridae, Tingidae, Aleyrodidae & Coreidae* and referenced on woody ornamental crops in Galicia (NW Spain) is even shorter: *Corythucha ciliata, Monosteira unicostata, Stephanytis pyri, Leptoglossus occidentallis*, only photographic records (Rodríguez Gracia *et al*., 2016; Pérez Valcárcel & Prieto Piloña, 2010). This type of ornamental pests, has recently increased in importance due to a specific matter: the presence of the quarantine pathogen *Xylella fastidiosa* in Europe. Some of these species

are considered current and potential vectors of the pathogen *Xylella fastidiosa*: *Aphrophora alni, Aphrophora salicina, Philaenus spumarius, Cercopis vulnerata, Neophilaenus campestris*. (Cavalieri & Porcelli, 2017).

The identification of the main key species of woody ornamental crops is especially useful for the design of sustainable plant protection programs due to the problem of resistance to insecticides referenced on different Hemiptera pest species, *Aonidiella aurantii* to carbamate insecticides in California (Grafton-Cardwell, 1995), soft scales, *Phenacoccus solenopsis* to deltametrin in Pakistan (Saddiq *et al*., 2015), *Pseudococcus affinis* to chloropyrifos in New Zealand (Charles *et al*., 1993) and mealybugs. *Bemisia tabaci* has been referenced as resistant to carbamates, organophosphates, pyretroids, neonicotinoids, pymnetrozine, pyriproxyfen, ciclodien organochlorines and phenylpyrazones (IRAC, 2020a). *Trialeurodes vaporariorum* has also been referenced to have resistant populations to Neonicotinoids, pyrethroids and ketoenols. (IRAC, 2020 b). This resistance to such group of pesticides produces an increase in the number of insecticide applications necessary for the management of such insect pests (IRAC, 2020a; IRAC, 2020b). The objective of the present paper, is to detail information about the Hemiptera species considered pest on woody ornamental crops of this part of the Spain.

MATERIALS AND METHODS

The study was carried out only in woody ornamental production centres of Galicia, from 1999 to 2022. The samples were obtained from 21 nurseries belonging to the following Galician provinces: 14 in Pontevedra, 6 in A Coruña and 1 in Lugo. The entomological monitoring of the pests was carried out every 15 or 30 days, sampling periodically in order to identify the Hemiptera species by means of classical entomological determination methods described later in this epigraph. The author used specific entomological methods that differed depending on the group of Hemiptera species, in order to carry out a precise entomological determination of species. The infested plant material samples were analyzed in the entomological laboratory of the firm Consultorías Noroeste S.C.

Aphidoidea & Phylloxeroidea. The species determinations, carried out by the author, were performed based on Blackman & Eastop methods (Blackman & Eastop 1994; Blackman & Eastop, 2000; Blackman & Eastop, 2006) as well as based on Alford species descriptions (Alford, 1995).

Coccidae, Diaspididae, Pseudococcidae & Rhizoecidae: The mounting methods were based on the studies of Williams and Granara de Willink (1992). The species determinations, carried out by the author, were performed based on the following taxonomical keys: Williams and Watson (1990) and Pellizari & Germain (2010) for *Coccidae* species; Miller & Davidson (2005) for *Diaspididae* species; Williams and Granara de Willink (1992) and Kaydan & Gullan (2012) for *Pseudococcidae* species and Ramos-Portilla (2015) for *Rhizoecidae* species.

Pentatomidae, Triozidae, Aphrophoridae, Tingidae, Aleyrodidae and Coreidae. The species determinations, carried out by the author, were performed based on the following taxonomical keys: *Aphrophoridae*, Hamilton, 1982; *Coreidae*, Mc Pherson *et al*., 1990; *Pentatomidae*: Pericart 2010; *Tinguidae* : Pericart, 1983; *Triozidae*: Hodkinson & White, 1979; *Aleyrodidae*, Hodges & Evans, 2005 .

***Stephanitis* species**. several leaves with lace bugs were collected and sited in plastic bags with airtight sealing. The lace bugs were collected and introduced in an 70 % ethanol solution by means of a thin painting brush. They rested in this solution for a period of 24 h. After this period, they were mounted on microscope slides with the aid of a 85 % lactic acid solution. The genus and species determinations were carried out following conventional entomological keys (Dioli *et al.*, 2015).

***Aleurocanthus* species**. Several leaves with whiteflies were collected and sited in plastic bags with airtight sealing. The whiteflies were collected and introduced in an 10 % KOH solution by means of a thin painting brush. They rested in this solution for a period of 24 h. After this period the puparia were introduced on a 70 % ethanol solution for a period of 10 min, then to a glacial acetic acid for 15 min and finally to a clove oil other 15 min. Then they were mounted on microscope slides with the

aid of a 85 % lactic acid solution. The genus and species determinations were carried out following conventional entomological keys (Jansen & Porcelli, 2018).

RESULTS AND DISCUSSION

List of identified species

Superfamily Aphidoidea

Family: Aphididae

1. *Aphis arbuti* (Ferrari, 1872)
   Host: *Arbutus unedo*
   Type of crop: container
   Province: Pontevedra
2. *Aphis fabae* (Scopoli, 1763)
   Host: *Peltaria* spp.
   Type of crop: soil
   Province: Pontevedra
3. *Aphis nerii* (Boyer de Fonscolombe ,1841)
   Host: *Nerium oleander*
   Type of crop: container
   Province: Pontevedra
4. *Aphis pomi* (de Geer, 1773)
   Host: *Photinia x fraseri*
   Type of crop: container
   Province: A Coruña, Pontevedra
5. *Cavariella aegopodii* (Scopoli, 1763)
   Host: *Salix alba*
   Type of crop: soil
   Province: Pontevedra
6. *Dysaphis anthrisci* (Borner, 1950)
   Host: *Malus domestica*
   Type of crop: soil
   Province: Pontevedra
7. *Eriosoma lanigerum* (Hausman, 1802)
   Host: *Malus domestica*
   Type of crop: soil
   Province: Pontevedra
8. *Illinoia liriodendri* (Monell, 1879)
   Host: *Liriodendron* spp.
   Type of crop: container
   Province: Pontevedra
9. *Euceraphis betulae* (Koch, 1855)
   Host: *Betula pendula*
   Type of crop: soil
   Province: Pontevedra
10. *Illinoia lambersii* (Mac Gillivrag, 1960)
    Host: *Rhododendron* spp.
    Type of crop: container
    Province: A Coruña
11. *Macrosiphon rosae* (Linnaeus, 1758)
    Host: *Rosa canina*
    Type of crop: soil

Province: Pontevedra

12. *Macrosiphoniella sambornii* (Gillette, 1908)
    Host: *Argyranthemum*
    Type of crop: container
    Province: Pontevedra
13. *Myzocallis castanicola* (Baker, 1917)
    Host: *Castanea sativa*
    Type of crop: container
    Province: Lugo
14. *Myzocallis boernerii* (Stroyan, 1957)
    Host: *Quercus robur*
    Type of crop: soil
    Province: Lugo
15. *Myzus persicae* (Sulzer, 1779)
    Hosts: *Prunus* spp., *Sasa tsuboiana, Phyllostachys rubromarginatta, Phyllostachys aureosulcatta, Phyllostachys bissetti, Phyllostachys humilis, Phyllostachys aurea, Phyllostachys nigra, Phyllostachys atrovaginatta, Pseudosasa japonica*
    Type of crop: soil and container
    Province: A Coruña, Pontevedra
16. *Peryphillus lyropictus* (Kessler, 1886)
    Host: *Acer platanoides*
    Type of crop: soil
    Province: Pontevedra
17. *Mindarius abietinus* (Koch, 1857)
    Host: *Abies pinsapo*
    Type of crop: soil
    Province: Pontevedra
18. *Pterocallis alni* (de Geer, 1773)
    Host: *Alnus glutinosa*
    Type of crop: soil
    Province: Pontevedra
19. *Takecallis arundicolens* (Matsumura, 1917)
    Hostes*: Sasa tsuboiana, Phyllostachys rubromarginatta, Phyllostachys aureosulcatta, Phyllostachys bissetti, Phyllostachys humilis, Phyllostachys aurea, Phyllostachys nigra, Phyllostachys atrovaginatta, Pseudosasa japonica, Fargesia scabrida*
    Type of crop: containe
    Province: A Coruña, Pontevedra
20. *Tetraneura ulmi* (Linnaeus, 1758)
    Host: *Ulmus minor*
    Type of crop: soil
    Province: Pontevedra
21. *Toxoptera aurantii* (Boyer de Fonscolombe, 1841)
    Host: *Camellia japonica, Ilex aqufolium, Pittosporum tobira, Sasa tsuboiana, Phyllostachys rubromarginatta, Phyllostachys aureosulcatta, Phyllostachys bissetti, Phyllostachys humilis, Phyllostachys aurea, Phyllostachys nigra, Phyllostachys atrovaginatta, Pseudosasa japonica.*
    Type of crop: container
    Province: A Coruña, Pontevedra
22. *Tuberculachnus salignus* (Gmelin, 1790)
    Host: *Salix alba*
    Type of crop: soil

Province: Pontevedra

23. *Aphis gossypii* (Glover, 1877)
    Host: *Camellia japonica*
    Type of crop: container
    Province: Pontevedra
24. *Paracolopha morrisoni* (Baker, 1919)
    Host: *Phyllostachys nigra, Phyllostachys bissetti, Phyllostachys aurea, Phyllostachys aureosulcata spectabilis, Phyllostachys decora.*
    Type of crop: container
    Province: Pontevedra, A Coruña

Superfamily Phylloxeroidea

Family: Adelguidae

25. *Pineus pini* (Macquart, 1819)
    Host: *Pinus sylvestris*
    Type of crop: soil
    Province: Lugo

Family: Phylloxeridae

26. *Phylloxera quercus* (Boyer de Fonscolombe, 1834)
    Host: *Quercus robur*
    Type of crop: soil
    Province: Lugo

Family: Coccidae

27. *Coccus hesperidium* (Linnaeus, 1758)
    Hosts: *Nerium oleander, Laurus nobilis*
    Type of crop: soil
    Province: Pontevedra
28. *Protopulvinaria pyriformis* (Cockerell, 1894)
    Hosts: *Gardenia japonica, Laurus nobilis*
    Type of crop: container
    Province: Pontevedra
29. *Pulvinaria floccifera* (Westwood, 1870)
    Host: *Ilex aquifolium, Camellia japonica*
    Type of crop: container
    Province: Pontevedra
30. *Eriococcus leptospermi* (Maskell, 1891)
    Host: Leptospermum scoparium
    Type of crop: container
    Province: A Coruña
31. *Ceroplastes sinensis* (Del Guercio, 1900)
    Host: *Ilex aquifolium*
    Type of crop: soil and container
    Province: Pontevedra

Family: Diaspididae

32. *Aspidiotus nerii* (Bouche, 1833)
    Hosts: *Cyca revolute, Laurus nobilis*
    Type of crop: container
    Province: Pontevedra
33. *Nuculaspis regnieri* (Balachowski, 1928)
    Hosts: *Cedrus atlantica*

Type of crop: container
Province: Pontevedra

34. *Saissetia oleae* (Olivier, 1791)
Host: *Cyca revoluta*
Type of crop: container
Province: Pontevedra
35. *Unaspis euonymi* (Comstock, 1881)
Host: *Euonymus japonicus*
Type of crop: soil
Province: Pontevedra
36. *Hemiberlesia rapax* (Comstock, 1881)
Host: *Camellia japonica*
Type of crop: container
Province: Pontevedra

Family: Pseudococcidae

37. *Balanococcus diminutus* (Leonardi, 1918)
Hosts: *Phormium tenax, Viburnum tinus, Nandina domestica*
Type of crop: container
Province: Pontevedra
Type of crop: container
Province: A Coruña, Pontevedra

Family: Rhizoecidae

38. *Rhizoecus falcifer* (Kunckel d´Herculais, 1878)
Hosts: *Phyllostachys aurea, Phyllostachys nigra, Leucothoe fontanesiana, Buxus sempervirens, Camellia japonica*
Type of crop: container
Province: A Coruña, Pontevedra

Family: Pentatomidae

39. *Graphosoma lineatum* (Linnaeus, 1758)
Hosts: *Phyllostachys nigra, P. aurea*
Type of crop: container
Province: A Coruña

Family: Triozidae

40. *Trioza alacris* (Flor, 1861)
Hosts: *Clematis* sp., *Laurus nobilis*
Type of crop: soil
Province: Pontevedra

Family: Aphrophoridae

41. *Aphrophora salicina* (Goeze, 1778)
Hosts: *Grevillea robusta*, *Hebe* spp., *Pyracantha* sp., *Grevillea rosmarifolia*, *Azalea*
Type of crop: container
Province: Pontevedra
42. *Aphrophora cribata* (Walker, 1851)
Hosts: *Pinus pinaster*
Type of crop: container
Province: Pontevedra

Family: Tinguidae

43. *Stephanitis pyri* (Fabricius, 1775)
Hosts: *Pyrus domestica*
Type of crop: soil

Province: Pontevedra

44. *Corythucha ciliate* (Say, 1832)
Hosts: *Platanus hispanica, Rosa canina, Sambucus nigra, Lavandula angustifolia*
Type of crop: soil
Province: Pontevedra
45. *Stephanitis pyrioides* (Scott, 1874)
Host: Rhododendron (*Azalea*)
Type of crop: container and soil
Province: Pontevedra

Family: Aleyrodidae

46. *Traleurodes vaporariorum* (Westwood, 1856)
Hosts: *Ceanothus repens, Stevia, Metrosideros robusta, Polygala myrtifolia, Azalea*
Type of crop: container
Province: Pontevedra, A Coruña
47. *Bemisia tabaci* (Gennadius, 1889)
Hosts: *Ruta graveolens, Hibiscus* sp.
Type of crop: container
Province: Pontevedra
48. *Aleurocanthus camelliae* (Kanmya & Kasai, 2011)
Host: *Camellia japonica*
Type of crop: container
Province: Pontevedra

Family: Coreidae

49. *Leptoglossus occidentallis* (Heidemann, 1810)
Hosts: *Cedrus atlantica*
Type of crop: soil
Province: Pontevedra

It is important to mention the presence of *Aphis fabae* on cultivated *Peltaria* spp., not referenced on this crop before neither in Galicia (Mier & Nieto, 1982; 1983; Mier *et al*., 1988; García Prieto, 2004), nor in Spain (Gosh *et al*., 1994; García Prieto *et al*., 2004; Pérez Hidalgo *et al*. 2009; Mier & Nafría, 1997; Muñoz *et al*., 2003). It is also remarkable to mention the presence of *Illinoia liriodendra* on *Liriodendron* sp., of *Euceraphis betulae* on *Betula pendulae* and of *Illinoia lambersi* on *Rhododendron* spp., being all of them cultivated hosts, and representing this the first report of them both in Galicia (Mier & Nieto, 1982; 1983; Mier *et al*., 1988; García Prieto, 2004) and in Spain (Gosh *et al*., 1994; García Prieto *et al*., 2004; Pérez Hidalgo *et al*. 2009; Mier & Nafría, 1997; Muñoz *et al*., 2003).

Considering the total number of 26 species of aphids and phylloxeras presented in this study 21 of them had not been referenced before on such type of crops in Galicia (Mier & Nieto, 1982; 1983; Mier *et al*., 1988; García Prieto, 2004) and 19 of them had not been cited before in Spain (Villalva, 1996; Gosh *et al*., 1994; García Prieto *et al*., 2004; Pérez Hidalgo *et al*. 2009; Mier & Nafría, 1997; Muñoz *et al*., 2003).

It is important to mention the new worldwide references of *Aphis fabae* on *Peltaria*, of *Myzocallis boernerii* on *Quercus robur* as well as of *Tetraneura ulmi* on *Ulmus minor* (Blackman & Eastop, 2006). The references of *Takecallis arundicolens*, *Toxoptera aurantii* and *Paracolopha morrosoni* on different species of *Phyllostachys, Sasa* and *Fargesia* had been described before by the author that signs this paper on a previous study (Andrés, 2016).

It is important to mention that 7 out of the total number of scale and mealybug species, presented in this work, were first references of their presence in Galicia, *Protopulvinaria pyryformis, Eriococcus leptospermi, Aspidiotus nerii, Nuculaspis regnieri, Saisetia oleae, Unaspis euonymi, and*

Balanococcus diminutus, and two of them *Eriococcus leptospermi, and Balanococcus diminutus* were first references on any crop in Spain (García Marí *et al*., 1994; Villalva, 1996; De Liñán, 1998; Pellizari & Germain, 2010). If we consider only ornamental crops there were four new references for our country with this study: *Protopulvinaria pyriformis, Eriococcus leptospermi, Hemiberlesia rapax and Balanococcus diminutus.* (De Liñán, 1998; García Marí *et al*., 1994; Villalva, 1996; Pellizari & Germain, 2010). The hosts where the different species were identified are also important to mention, since there were 7 new registers that were not previously referenced worldwide, these are the following: *Protopulvinaria pyryformis* on *Gardenia japonica*, *Saissetia oleae* on *Cyca revoluta*, *Rhizoecus falcifer* on *Phyllostachys aurea, Phyllostachys nigra* and *Leucothoe fontenesiana* as well as *Balanococus diminutus on Viburnum tinus and Nandina domestica* (Alford, 1995; Granara de Willink & Claps, 2003; Pellizari & Germain, 2010; Malumphy & Badmin, 2012).

The author could confirm, as part of his entomological consultancy services on 21 nurseries where the species were collected, that all the identified scale and mealybug species were clearly phytophagous in the conditions of Galicia, and considered as important pests for all their respective crops. This is not in concordance with the results described by certain authors that point out that certain species are not injurious to ornamental crops in their climatic conditions: *Aspidiotus nerri* and *Hemiberlesia rapax* on several ornamental species in Argentina (Granara de Willink & Claps, 2003).

Graphosoma lineatum was not referenced before on woody ornamental crops either in Galicia or in Spain, having been reported before not as key pest, only as part of a faunistic catalogue (Vivas & López-Gallego, 2013). A similar situation takes place with *Aphrophora cribata* being cited in Galicia and in Spain for the first time. These are the first references of these two species injuring woody ornamental crops in Galicia.

Three of the 9 species of whiteflies, froghoppers, bugs and suckers, presented in this work, were recorded in woody ornamental hosts of Galicia for the first time, these are *Trioza alacris*, *Aphrophora salicina* as well as *Bemisia tabaci*. We must mention *Leptoglossus occidentallis* which was referenced before in Galicia bur only as photographic records (Pérez Valcárcel & Prieto Piloña, 2010). If we considered the hosts where these species were recorded, we must mention new world references: *Graphosoma lineatum* on *Phyllostachys aurea* and *Phyllostachys nigra*; *Aphrophora salicina* on *Grevillea robusta, Grevillea rosmarifolia* and azalea; *Corythucha ciliata* on *Rosa canina, Sambucus nigra* as well as on *Lavandula angustifolia* and *Trialeurodes vaporariorum* on *Ceanothus repens, Metrosideros robusta, Polygala myrtifolia* and *Azalea* (De Liñán, 1998). None of these species are considered potential vectors of the quarantine disease *Xylella fastidiosa* apart from the Aphrophoridae *Aphrophora salicina* (Cavalieri, 2017).

Stephanitis pyrioides (Scott 1874) was first reported in Europe in Italy (Bene & Pluot-Sigwalt 2005, Jucker *et al*., 2008), France (Streito, 2006) and Greece (Kment 2007). Certain authors suggest an increased trend of introductions from North America to Europe, mainly due to the transport of ornamental plants (Rabitsch, 2008; Rabitsch, 2010). This is, with the information obtained by the author, the first reference of *Stephanitis pyrioides* Scott in Spain (EPPO, 2022).

Aleurocanthus camelliae Kanmiya & Kasai is an invasive pest of tea crops *Camellia sinensis* as well as of camellia productions *Camellia japonica*, probably native to Taiwan or China and introduced into Japan where it has been spreading throughout tea plantations ever since 2004. On 2017 it was detected for the first time in the EU on *Camellia japonica* plants in Holland sent from Japan (Jansen & Porcelli, 2018). This is, with the information obtained by the author, the first reference of *Aleurocanthus camelliae* in Spain (EPPO, 2022). This situation of polyphagy is well documented on ornamental pests in the United Kingdom (Alford, 1995).

CONCLUSION

Out from de 49 Hemiptera species identified and presented in this paper, 33 were new references for woody ornamental crops in Galicia and 23 of them were new references for Spain. *Stephanitis pyrioides (*Scott, 1874) and *Aleurocanthus camelliae* Kanmiya & Kasai are new references in any

crop for Spain. The paper also describes 22 new world references, pest species, and host species. The identification of the main key species of woody ornamental crops is especially useful for the design of sustainable and efficient plant protection programs due to the problem of resistance to insecticides, as well as for the future set point of alternative, not chemical, pest management methods.

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