



Armored scale insects (Hemiptera: Diaspididae) associated with avocados (*Persea americana*) in México's main production areas, with keys for identification and natural enemies

CARLOS LÁZARO-CASTELLANOS^{1,2}, HÉCTOR GONZÁLEZ-HERNÁNDEZ^{1,3,*}, JESÚS ROMERO-NÁPOLES^{1,4}, LAURA D. ORTEGA-ARENAS^{1,5}, ARMANDO EQUIHUA-MARTÍNEZ^{1,6} & SALVADOR OCHOA-ASCENCIO^{7,8}

¹ Fitosanidad-Entomología y Acarología, Colegio de Postgraduados. Km 36.5 Carretera Federal México-Texcoco. C.P. 56230. Montecillo, Texcoco, Edo. de México, México

² ✉ lazaro.carlos@colpos.mx; <https://orcid.org/0000-0003-0840-984X>

³ ✉ hgzzhdz@colpos.mx; <https://orcid.org/0000-0001-5025-3370>

⁴ ✉ jnapoles@colpos.mx; <https://orcid.org/0000-0001-5376-2605>

⁵ ✉ ladeorar@colpos.mx; <https://orcid.org/0000-0002-1154-4359>

⁶ ✉ equihuaa@colpos.mx; <https://orcid.org/0000-0003-4392-3924>

⁷ Facultad de Agrobiología, Universidad Michoacana de San Nicolás de Hidalgo. Paseo Lázaro Cárdenas Esquina Berlín s/n. C.P. 60170. Colonia Viveros, Uruapan, Michoacán, México

⁸ ✉ sochoa@umich.mx; <https://orcid.org/0000-0001-9019-4141>

*Corresponding author

Abstract

Avocado orchards in eight avocado-producing states of México were sampled to collect and identify the armored scale insect species (Hemiptera: Diaspididae) that attack the crop and their natural enemies. Sixteen species of armored scales were identified, 12 from the subfamily Aspidiotinae and four from Diaspidinae. A dichotomous key is provided for the identification of the 18 armored scale species associated with avocado in central México. Forty species of associated natural enemies were also recorded, the most important belonging to Hymenoptera: Aphelinidae, Encyrtidae, Eulophidae, and Signiphoridae, and to Coleoptera: Coccinellidae. For each species of armored scale, brief general information on its distribution, host varietal preferences and natural enemies is given.

Key words: Sternorrhyncha, Coccoomorpha, Aspidiotinae, Diaspidinae, host varietal preferences, Aphelinidae, Encyrtidae, Signiphoridae, Eulophidae, Coccinellidae

Introduction

In México, few studies of armored scale insect species (Hemiptera: Diaspididae) associated with avocado cultivation have been done. González Hernández & Atkinson (1984) conducted a study of scale insects on several hosts in the states of central México, in which they reported nine diaspidid species infesting avocado. Subsequently, González Hernández *et al.* (2008) listed nine species collected in commercial avocado orchards in Michoacán, México. However, Morse *et al.* (2009) considered that some of the armored scale species found on avocado in México cited by Teliz & Mora (2007) might have been incorrectly identified because they had only been recorded previously on non-avocado hosts. In addition, the species that had been identified in the literature as *Diaspidiotus perniciosus* (Comstock) (= *Comstockaspis perniciosus*) had subsequently been shown to be new to science: *Davidsonaspis aguacatae* (Evans, Watson & Miller, 2009). Morse *et al.* (2009) also pointed out that at that time, United States Department of Agriculture—Animal and Plant Health Inspection Service (USDA-APHIS) were using an unpublished key that identified nine species of Diaspididae found on avocado fruits imported from México. There are some taxonomic and ecological inconsistencies, however, that raise doubts as to the identity of some of them.

Studies in México have been conducted mainly in commercial Hass avocado orchards in the state of Michoacán

(González-Hernández, pers. comm., 2019), but less frequently in backyard orchards growing other avocado varieties in other states in the center of the country (González Hernández & Atkinson 1984). These studies identified armored scales found feeding on branches, leaves and fruits, whereas the specimens studied by USDA-APHIS and Morse *et al.* (2009) were all obtained from imported Hass avocado fruits originating from Michoacán. Consequently, the number of species determined by USDA-APHIS may not fully reflect the diversity of armored scale species associated with avocado trees in México. Further studies were therefore considered necessary to augment knowledge of the armored scale species associated with cultivated avocados in México.

The aims of this work were: (i) to identify the armored scale insect species found in commercial and backyard avocado orchards in eight important avocado-producing Mexican states, not including Michoacán; (ii) to develop an identification key to these species; and (iii) to identify and list the species of natural enemies associated with the armored scale species on avocado in the seven central Mexican states studied.

Materials and methods

In commercial and urban avocado orchards in municipalities of the central Mexican states of Colima, Guanajuato, Jalisco, México, Morelos, Nayarit, Puebla and Querétaro, we collected avocado branches, leaves and fruits infested with armored scales between March 2017 and June 2019. In each state we made two- to four-day visits to the main areas of avocado production, usually with the support of technical staff of the State Committees of Plant Health, as well as staff of the Salvador Sánchez Colin CICTAMEX S.C. Foundation (State of México), and faculty of the Autonomous University of Nayarit (School of Agronomy). In each orchard, several randomly selected infested trees were checked, and samples of infested plant material were collected and placed in number 16 paper bags; each bag was marked with a code indicating the state in which it was collected, sample number, avocado variety and plant part, geo-reference points and altitude, name of the orchard, locality, and municipality (Table 1). The collected material was transferred to the Fruit Pests laboratory of the Colegio de Postgraduados, Campus Montecillo, Texcoco, State of México, for examination with a stereoscopic dissection microscope. The samples contained adult female armored scales for slide mounting and identification.

TABLE 1. Distribution and location of avocado orchards sampled in seven states in central México between 2017 and 2019.

State	Orchard name	Locality and municipality	Geographic coordinates	Altitude (m a.s.l.)	Type of production	Avocado variety
México	La Pitaya	Porfirio Díaz, Villa Guerrero	N 18° 56' 15.7" W 99° 43' 10.2"	2,361	Commercial	Mexicano 1
México	Papalote 1	Porfirio Díaz, Villa Guerrero	N 18° 56' 18.5" W 99° 43' 22.7"	2,320	Commercial	Hass
México	La Cruz	Porfirio Díaz, Villa Guerrero	N 18° 56' 13" W 99° 43' 39.3"	2,308	Backyard	Mexicano 1
México	La Cabaña	Porfirio Díaz, Villa Guerrero	N 18° 55' 42.8" W 99° 43' 17.6"	2,418	Commercial	Hass
México	Cochisquila 1	Cochisquila, Coatepec Harinas	N 18° 54' 38.3" W 99° 45' 07.5"	2,144	Commercial	Hass
México	Cochisquila 2	Cochisquila, Coatepec Harinas	N 18° 55' 01.3" W 99° 45' 08.2"	2,220	Commercial	Hass
México	Bordo 2	CICTAMEX, Coatepec Harinas	N 18° 55' 02.9" W 99° 45' 33.5"	2,244	Research	Hass-Jiménez
México	Chirimoyo	CICTAMEX, Coatepec Harinas	N 18° 55' 02.9" W 99° 45' 33.5"	2,244	Research	Hass

.....continued on the next page

TABLE 1 (Continued)

State	Orchard name	Locality and municipality	Geographic coordinates	Altitude (m a.s.l.)	Type of production	Avocado variety
México	La Colonia	Colonia Guadalupe, Coatepec Harinas	N 18° 53' 54" W 99° 46' 4.8"	2,260	Commercial	Hass
México	Ixtlahuaca 1	Ixtlahuaca de Villada, Coatepec Harinas	N 18° 55' 24.1" W 99° 48' 44"	2,204	Commercial	Hass
México	La Casita	Ixtlahuaca de Villada, Coatepec Harinas	N 18° 45' 40" W 99° 48' 47.7"	2,230	Commercial	Hass
México	Ixtlahuaca 2	Ixtlahuaca de Villada, Coatepec Harinas	N 18° 55' 42.7" W 99° 48' 42.7"	2,259	Commercial	Hass
México	Ixtlahuaca 3	Ixtlahuaca de Villada, Coatepec Harinas	N 18° 56' 04.5" W 99° 48' 46.5"	2,302	Commercial (urban)	Hass
México	Santa Ana	Santa Ana, Coatepec Harinas	N 18° 56' 12.4" W 99° 46' 14.2"	2,326	Backyard	Mexicano 1
México	Lindero	San José, Coatepec Harinas	N 18° 57' 03.4" W 99° 47' 11.2"	2,435	Backyard	Hass
México	San José 2	San José, Coatepec Harinas	N 18° 55' 26" W 99° 46' 56.8"	2,256	Commercial	Fuerte
México	Potrero	Potrero, Coatepec Harinas	N 18° 55' 12" W 99° 47' 45.6"	2,259	Commercial	Hass
México	M1Texcoco	Tequexquinahuac, Texcoco	N 19° 28' 38" W 98° 49' 48"	2,429	Backyard	Mexicano 1
México	M2Texcoco	Tequexquinahuac, Texcoco	N 19° 28' 38" W 98° 28' 38"	2,430	Backyard	Mexicano 1
México	M3Texcoco	Tequexquinahuac, Texcoco	N 19° 28' 36" W 98° 49' 37"	2,447	Backyard	Mexicano 1
México	M4Texcoco	Tequexquinahuac, Texcoco	N 19° 28' 36" W 98° 49' 37"	2,448	Backyard	Mexicano 1
México	M5Texcoco	Tequexquinahuac, Texcoco	N 19° 28' 57" W 98° 49' 47"	2,381	Backyard	Mexicano 1
México	M6Texcoco	La Purificación, Texcoco	N 19° 31' 25" W 98° 48' 59"	2,380	Commercial	Mexicano 1
Morelos	Metepec 1	Metepec, Ocuituco	N 18° 52' 39.6" W 98° 44' 43.4"	1,954	Commercial	Hass
Morelos	Xolosuchitl 1	Tlacotepec, Zacualpan de Amilpas	N 18° 49' 43.2" W 98° 45' 53.7"	1,810	Commercial	Fuerte
Morelos	Xolosuchitl 2	Tlacotepec, Zacualpan de Amilpas	N 18° 49' 41.4" W 98° 45' 54.7"	1,834	Commercial	Hass
Morelos	Xolosuchitl 3	Tlacotepec, Zacualpan de Amilpas	N 18° 49' 39.8" W 98° 45' 55.5"	1,834	Commercial	Hass
Morelos	San Miguel	Tlacotepec, Zacualpan de Amilpas	N 18° 49' 24.9" W 98° 45' 22.1"	1,802	Commercial	Hass
Morelos	Isla Chica 1	San Nicolás, Ocuituco	N 18° 53' 05" W 98° 46' 48"	1,861	Commercial	Hass, Mexicano 1
Morelos	Isla Chica 2	San Nicolás, Ocuituco	N 18° 53' 06" W 98° 46' 47.7"	1,863	Commercial	Hass, Mexicano 1
Morelos	Paraíso	Paraíso de las Flores, Yecapixtla	N 18° 51' 30.9" W 98° 50' 12.6"	1,650	Backyard	Hass
Morelos	Tezantetelco	Xochitlan, Yecapixtla	N 18° 53' 34.2" W 98° 48' 36.7"	1,769	Commercial	Hass

.....continued on the next page

TABLE 1 (Continued)

State	Orchard name	Locality and municipality	Geographic coordinates	Altitude (m a.s.l.)	Type of production	Avocado variety
Morelos	M10Mor	Near to CBTa, Tetela del Volcán	N 18° 54' 07.1" W 98° 42' 39.1"	2,223	Commercial	Hass, Fuerte
Morelos	Santa Cruz Axopilco	Hueyapan, Tetela del Volcán	N 18° 52' 40.9" W 98° 41' 50.1"	2,215	Commercial	Hass
Morelos	Santo Domingo	Santo Domingo, Tetela del Volcán	N 18° 51' 22.8" W 98° 42' 33.3"	2,068	Commercial	Hass
Morelos	Paluca 1	Paluca, Tetela del Volcán	N 18° 53' 06.4" W 98° 42' 44"	2,162	Commercial	Fuerte
Morelos	Paluca 2	Paluca, Tetela del Volcán	N 18° 53' 00.9" W 98° 42' 43.5"	2,152	Commercial	Fuerte
Morelos	Tlalnepantla 1	Tlalnepantla, Tlalnepantla	N 18° 59' 14.1" W 98° 59' 17.4"	1,778	Backyard	Hass
Puebla	La Aguacatera	Xalpatlaco, Atlixco	N 18° 56' 13.7" W 98° 26' 04.5"	1,807	Commercial	Fuerte, Granón, Hass, Padua, Vitacalli, Mexicano 1
Puebla	Acapulco	San Diego, Atlixco	N 18° 52' 44.2" W 98° 26' 44.1"	1,782	Commercial	Fuerte, Padua, Kila, Mexicano 1
Puebla	Tochimilco 1	Tochimilco, Tochimilco	N 18° 52' 58.4" W 98° 33' 56.8"	1,988	Commercial	Hass
Puebla	Amexatl 1	Amexatl, Tochimilco	N 18° 53' 42.2" W 98° 34' 04.3"	2,066	Commercial	Fuerte
Puebla	Amexatl 2	Amexatl, Tochimilco	N 18° 53' 41.1" W 98° 34' 02.7"	2,067	Commercial	Hass
Puebla	El Arco	Tochimilco, Tochimilco	N 18° 53' 41.1" W 98° 34' 02.7"	2,067	Commercial	Fuerte
Puebla	El Carmen	Tochimilco, Tochimilco	N 18° 53' 48.1" W 98° 34' 10.3"	2,093	Commercial	Hass
Puebla	La Cuesta	Tochimilco, Tochimilco	N 18° 53' 21.8" W 98° 33' 56"	2,026	Backyard	Mexicano 1
Colima	Piedra Rajada	Agosto, Comala	N 19° 24' 50" W 103° 44' 08"	1,199	Commercial	Hass
Colima	Agosto	Agosto, Comala	N 19° 23' 47" W 103° 43' 55"	1,102	Commercial	Hass
Colima	Rancho Alto	Cofradía de Suchitlán, Comala	N 19° 25' 08" W 103° 42' 19"	1,338	Commercial	Hass
Colima	La Calma	Quesería, Cuauhtemoc	N 19° 25' 28" W 103° 35' 42"	1,523	Commercial	Hass
Nayarit	UAN	Xalisco, Xalisco	N 21° 25' 32" W 104° 53' 29"	971	Research	Booth, Hass, Mexicano 1
Nayarit	Camino Cerro San Juan	Xalisco, Xalisco	N 21° 27' 06" W 104° 55' 06"	1,113	Commercial	Hass
Nayarit	Crucero La Curva	Emiliano Zapata, Xalisco	N 21° 22' 12" W 104° 53' 37"	1,028	Commercial	Hass
Nayarit	Crucero Carrizal	Emiliano Zapata, Xalisco	N 21° 21' 59" W 104° 55' 18"	1,105	Commercial	Hass
Nayarit	Camino a Cofradía	El Carrizal, Xalisco	N 21° 22' 09" W 104° 55' 50"	1,136	Commercial	Hass
Nayarit	Los Terreros	El Carrizal, Xalisco	N 21° 21' 39" W 104° 56' 23"	1,073	Commercial	Hass
Nayarit	Camichin 1	Camichin de Jauja, Tepic	N 21° 29' 15" W 104° 46' 16"	1,128	Commercial	Hass
Nayarit	Camichin 2	Camichin de Jauja, Tepic	N 21° 29' 13" W 104° 45' 29"	1,183	Commercial	Fuerte
Nayarit	El Aguacate	Tepic, Tepic	N 21° 31' 03" W 104° 56' 26"	954	Commercial	Hass

.....continued on the next page

TABLE 1 (Continued)

State	Orchard name	Locality and municipality	Geographic coordinates	Altitude (m a.s.l.)	Type of production	Avocado variety
Nayarit	Entrada El Cuarenteño	Fortuna, Tepic	N 21° 30' 54" W 104° 58' 15"	1,123	Commercial	Hass
Nayarit	La Fortuna	Fortuna, Tepic	N 21° 30' 32" W 104° 58' 53"	1,437	Commercial	Hass
Nayarit	La Hierba	Tepic, Tepic	N 21° 31' 28" W 105° 02' 39"	891	Commercial	Hass
Jalisco	La Quinta	Rancho la Quinta, Sayula	N 19° 51' 34.5" W 103° 36' 03"	1,407	Commercial	Hass-Méndez
Jalisco	La Providencia	Rancho La Providencia, Gómez Farías	N 19° 47' 48" W 103° 26' 2.4"	2,096	Commercial	Hass-Méndez
Jalisco	Los Depósitos	Zapotlán El Grande	N 19° 38' 20" W 103° 34' 43"	2,089	Commercial	Hass-Méndez
Jalisco	El Fresnito	Zapotlán El Grande	N 19° 36' 33" W 103° 32' 01"	1,908	Commercial	Hass-Méndez
Jalisco	Frutícola GMI-3 Marías	Canoas, Zapoltitic	N 19° 36' 38" W 103° 28' 06"	1,499	Commercial	Hass-Méndez
Jalisco	Agro Leal	Zapotiltic, Zapoltitic	N 19° 36' 29" W 103° 25' 11"	1,297	Commercial	Hass
Jalisco	Loma Delgada 1	Copala, Tolimán	N 19° 36' 46" W 103° 45' 46"	1,486	Commercial	Hass
Jalisco	Loma Delgada 2	Copala, Tolimán	N 19° 36' 45.6" W 103° 45' 47"	1,476	Commercial	Hass-Méndez
Jalisco	Jazmín 1	El Jazmín, San Gabriel	N 19° 39' 12" W 103° 42' 52"	1,685	Commercial (urban)	Hass
Jalisco	Jazmín 2	El Jazmín, San Gabriel	N 19° 39' 18" W 103° 42' 17"	1,725	Commercial	Hass
Jalisco	La Loma	El Jazmín, San Gabriel	N 19° 38' 34" W 103° 41' 27"	1,826	Commercial	Hass
Jalisco	Hacienda El Colomo	Colomo, Concepción de Buenos Aires	N 19° 58' 29.8" W 103° 11' 24.4"	2,133	Commercial	Hass-Méndez
Jalisco	El Cerezo	Cruz de Tierra, Concepción de Buenos Aires	N 19° 58' 26.8" W 103° 12' 44.7"	2,160	Commercial	Hass
Querétaro	M1Qro	Adjuntas de Rancho Quemado, Cadereyta	N 20° 59' 05" W 99° 40' 52"	1,011	Commercial (urban)	Mexicano 2
Querétaro	M2Qro	Rancho Quemado, Cadereyta	N 20° 58' 36" W 99° 40' 19"	1,139	Commercial	Hass
Querétaro	Adjuntas de Higueras	Adjuntas de Higueras, Peñamiller	N 20° 59' 46" W 99° 42' 11"	1,171	Commercial	Fuerte
Querétaro	San Miguel	San Miguel, Tolimán	N 20° 52' 10" W 99° 57' 57"	1,620	Commercial (urban)	Mexicano 2
Querétaro	La Estancia	Tolimán, Tolimán	N 20° 52' 34" W 100° 01' 25"	1,705	Backyard	Mexicano 2
Guanajuato	M1Gto	Near to INIFAP, Celaya	N 20° 34' 42" W 100° 49' 6"	1,767	Backyard	Mexicano 1

Armored scale insect specimens showing signs of parasitism were isolated individually in transparent size "0" gelatin capsules, to await emergence of the adult parasitoid for identification. In addition, part of the plant material infested with armored scales was placed in Petri dishes, lined with absorbent paper to prevent excess condensation, to obtain more adult parasitoids. The specimens of armored scales and natural enemies obtained were preserved in 80% alcohol.

Slide mounts of adult armored scales and parasitoids were prepared for identification in permanent mounts in Canada balsam, using the method for Diaspididae proposed by Kosztarab (1963) and that for parasitic micro-wasps proposed by Noyes (1982). The identification keys in Ferris (1942) and Evans *et al.* (2009) were used to identify the diaspidid species, while the keys of Myartseva & Ruiz-Cancino (2001), Myartseva & Evans (2008), Myartseva *et al.* (2010, 2012, 2016), Ramírez-Ahuja *et al.* (2015), Woolley & Dal Molin (2017), Noyes (1980), Noyes *et al.*

(1997), and Schauff *et al.* (1997) were used to identify the parasitoid species. The key in Gordon (1985) was used to identify Coleoptera: Coccinellidae. The collected and identified material was deposited in the insect collection of the Colegio de Postgraduados, Montecillo, Texcoco, Estado de México (CEAM).

The inventory of 16 diaspidid species on avocado in México compiled during the study was supplemented with two additional species from the scale insect slide collection of Dr Héctor González Hernández (Graduate Program in Plant Health-Entomology and Acarology, Colegio de Postgraduados, Montecillo, Texcoco, Edo. de México). The identification key to 18 Mexican armored scale species found on avocado, presented below, was based on this expanded inventory of species.

For some of the diaspidid species, some of the information on taxonomy, distribution and hosts was obtained from Watson (2002) and García Morales *et al.* (2016). The morphological terminology used for the description of armored scale species was after Watson (2002) and Miller & Davidson (2005). In slide-mounted adult females, the distance between the anal opening and the base of the median lobes was measured from the posterior margin of the anal opening to the midpoint between the bases of the median lobes. The pygidial lobes are referred to using abbreviations, as follows: L1 for the median lobes, L2 for the second pair of lobes, and L3 and L4 for pairs three and four, respectively, with the numbers starting from the mid-line and counting laterally.

The lists of synonyms provided do not include mis-spellings or misidentifications; for exhaustive lists of synonyms, see ScaleNet online (García Morales *et al.* 2016).

Information on natural enemies was obtained from García Morales *et al.* (2016) and Noyes (2019). When labeling the samples of natural enemies, a number was placed within parentheses to indicate the number of individuals, followed by the letter F for female or M for male.

Results and discussion

Ninety samples of plant material were obtained from 77 orchards in the eight states visited (Table 1), and four additional samples were delivered to the laboratory from Coatepec Harinas, State of México (Potrero); Tlalnepantla, Morelos (Tlalnepantla 1); Celaya, Guanajuato (M1Gto); and Gómez Farias, Jalisco (La Providencia). It is noted that the orchard “La Colonia” Coatepec Harinas, State of México, was in transition from an avocado plantation to a peach (*Prunus persica* L.) orchard (Table 1).

The varieties of avocado sampled in the different sites visited were Hass, Hass-Jiménez, Hass-Méndez, Fuerte, Booth, Granón, Kila, Padua, Vitacalli, Mexicano 1 and Mexicano 2 (Table 1). The difference between the two varieties of Mexicano avocado is that, when ripening, the peel of Mexicano 1 becomes dark, while that of Mexicano 2 remains green; both these varieties have thin peel and a small seed.

Summary of the diaspidid scale insects recorded: During this study, 16 armored scale insect species were identified from the samples collected: *Acutaspis albopicta* (Cockerell), *Ac. scutiformis* (Cockerell), *Aonidiella aurantii* (Maskell), *Aspidiotus nerii* (Bouché), *Chrysomphalus dictyospermi* (Morgan), *Clavaspis herculeana* (Cockerell & Hadden), *Davidsonaspis aguacatae*, *Diaspis* near *coccois* (Lichtenstein), *Hemiberlesia crescentiae* (Ferris), *H. cyanophylli* (Signoret), *H. diffinis* (Newstead), *H. lataniae* (Signoret), *H. rapax* (Comstock), *Howardia biclavis* (Comstock), *Lepidosaphes pinnaeformis* (Bouché), and *Pseudoparlatoria parlatorioides* (Comstock). Two additional diaspidid species were recorded previously but not collected during the present study: *Mycetaspis personata* Comstock (México, Allende, Nuevo León, coll. J. Fernando Solís A., 4.vii.1986) and *Oceanaspidotus spinosus* Comstock (México, Tingambato, Michoacán, coll. Héctor González H., 29.xi.2007). This brings the number of diaspidid species found on avocado in central México to a total of 18 species.

Summary of the natural enemies of diaspidid scales recorded: one predator species and 39 parasitoid species were identified during this study, although seven of them were determined only to generic level. The natural enemies belonged to the following species and families: Hymenoptera: *Aphytis diaspidis* (Howard), *Aph. holoxanthus* (DeBach), *Aph. lepidosaphes* (Compere), *Aph. lingnanensis* (Compere), *Aph. melinus* (DeBach), *Aph. pinnaeformis* (DeBach & Rosen), *Aph. proclia* (Walker), *Coccobius averini* (Myartseva), *Cocc. juliae* (Myartseva), *Cocc. mexicanus* (Myartseva), *Encarsia aurantii* (Howard), *E. citrina* (Craw), *E. escama* (Myartseva), *E. gaonae* (Myartseva & Evans), *E. juanae* (Myartseva & Evans), *E. lounsburyi* (Berlese & Paoli), *E. perniciosi* (Tower), *E. tarsalis* (Myartseva), *E. titillata* (Girault), *Marietta mexicana* (Howard), *M. montana* (Myartseva & Ruiz-Cancino) (Aphelinidae); *Chartocerus* sp., *Signiphora benneti* (Woolley & Dal Molin), *S. dozieri* (Woolley & Dal Molin), *S. falcata* (Woolley & Dal Molin), *S. fax* (Girault), *S. flavella* (Girault), *S. merceti* (Malenotti), *S. mexicana* (Ashmead),

S. perpauca (Girault), *S. tumida* (De Santis) (Signiphoridae); *Archinus* sp., *Emersonella* sp., *Metaphycus* sp. 1, *Metaphycus* sp. 2, *Metaphycus* sp. 3, *Metaphycus* sp. 4, *Plagiomerus diaspidis* (Crawford), *Pseudhomalopoda prima* (Girault) (Encyrtidae); and *Emersonella* sp. (Eulophidae). In Coleoptera: Coccinellidae, the predator *Coccidophilus atronitens* (Casey) was determined.

Key to armored scale insect species found on avocado in central México (adult females), partly based on Evans, Watson & Miller (2009)

- 1 Pygidium with 1-barred macroducts. L2 and L3 not divided. Plates present between pygidial lobes, usually fringed but sometimes fleshy and blunt. Anterior spiracles usually not associated with disc pores. Each antenna usually with only 1 obvious seta (Aspidiotinae) 2
- Pygidium with 2-barred macroducts. L2 and L3 usually divided, bilobate. Pointed gland spines often present between pygidial lobes. Anterior spiracles usually associated with disc pores. Each antenna usually with 2 or more setae (Diaspidinae) 15
- 2(1) Pygidial paraphyses present 3
- Pygidial paraphyses absent. 14
- 3(2) Paraphyses originating only from basal angles of lobes, never present in interlobular spaces. All paraphyses shorter than L1 (except for 1 pair of very long outer L1 paraphyses in *Clavaspis*) 4
- With at least a few paraphyses originating within interlobular spaces. All paraphyses longer than L1, except in *Aonidiella* 10
- 4(3) Perivulvar pores present. 5
- Perivulvar pores absent. 7
- 5(4) L2 reduced to a single sclerosed point, L3 absent. Each L1 outer paraphysis conspicuously long, with a globular inner end. Each side with 2 or 3 perivulvar pores distributed singly *Clavaspis herculeana* Cockerell & Hadden
- L2 developed or reduced; L3 present but reduced. Each L1 outer paraphysis lacking a globular inner end. Perivulvar pores present or absent, when present distributed in groups 6
- 6(5) Anal opening large (longer and wider than L1), separated from bases of L1 by no more than twice L1 length. L1 without basal sclerosis. Prosomal margin opposite anterior spiracle without sclerotized spur. L1 slightly convergent, each with lateral margin notched distally and slightly longer than inner margin *Hemiberlesia lataniae* Signoret
- Anal opening small (smaller than L1 or same size), separated from bases of L1 by more than twice L1 length. L1 with well-developed basal sclerosis. Prosomal margin opposite anterior spiracle with sclerotised spur. L1 parallel, each with a distal notch on either side. *Hemiberlesia cyanophylli* Signoret
- 7(4) Anal opening large (longer and wider than L1), separated from base of L1 by no more than twice L1 length 8
- Anal opening small (shorter and narrower than L1), separated from base of L1 by more than twice L1 length 9
- 8(7) L2 and L3 each reduced to a sclerotized point, never toothed. Anal opening large, located no more than 1x length of L1 from L1 bases. Plates anterior to L3 not branched *Hemiberlesia rapax* Comstock
- L2 well developed, with slightly toothed lateral margin (with 1 or 2 teeth). Anal opening smaller, located at 1–2x its diameter from L1 bases. Plates anterior to L3 branched. *Hemiberlesia diffinis* Newstead
- 9(7) L2 and L3 absent. Pygidium wider than long, with relatively wide margins. Plates in first interlobular space short; other plates long, flattened, bifurcate or only slightly fringed. *Hemiberlesia crescentiae* (Ferris)
- L2 and L3 present. Pygidium longer than wide, with narrow margins. Plates in first interlobular space longer than adjacent lobes; long plates between other lobes with apices fringed, but plates lateral to L3 usually more-or-less bifurcate. *Davidsonaspis aguacatae* (Evans, Watson & Miller)
- 10(3) Mature adult females with prosoma expanded and sclerotized, kidney-shaped. Perivulvar pores absent. Venter of pygidium with 2 pairs of linear prevulvar scleroses and 1 pair of apophyses *Aonidiella aurantii* Maskell
- Mature adult female with prosoma usually membranous or only slightly sclerotised, not kidney-shaped. Perivulvar pores present or absent. Venter of pygidium with linear prevulvar scleroses and apophyses absent or poorly developed 11
- 11(10) Body circular except for front part of head protruding and sclerotized, like a cap. Pygidium very short, wide, and rounded, with L4 well developed. Perivulvar pores absent. *Mycetaspis personata* Comstock
- Body pyriform or oval, front of head not protruding and usually membranous. Pygidium long, narrow, and more angular, with L4 not well developed. Perivulvar pores present or absent 12
- 12(11) Pygidial base wide, with sides straight and apex more-or-less rounded; apical angle usually greater than 90°. Pygidial plates between L3 and L4 longer than lobes; with 2 plates lateral to L3 each with a fleshy filament. Prepygidial segments without any dorsal groups of 4 or more ducts; second and third pygidial furrows each with macroducts in a single row *Chrysomphalus dictyospermi* Morgan
- Pygidium long, with base wide and sides often concave, tapering to a point; apical angle less than 90°. Details of plates and distributions and numbers of macroducts different from above. 13
- 13(12) L2 with paraphysis arising at external angle about 2x as long as paraphysis arising from inner angle. Anal opening elongate oval. Pygidium with macroducts in the third sclerotized area close to anal opening. *Acutaspis albopicta* Cockerell
- L2 with paraphysis arising at external angle shorter, only 1.0–1.6x longer than paraphysis arising from inner angle. Anal opening subcircular. Pygidium lacks macroducts in the third sclerotized area close to anal opening. *Acutaspis scutiformis* Cockerell

- 14(2) Anal opening obviously smaller than L1, located at about first basal fifth of pygidium. Pygidial macroducts relatively long and narrow (approximately 15x longer than wide). L3 developed, with apex rounded. Dorsal setae associated with L2 and L3 thickened, swollen basally *Oceanaspidiotus spinosus* Comstock
- Anal opening same size or larger than L1, located at about first apical third of pygidium. Pygidial macroducts short and wide (approximately 5x longer than wide). L3 reduced to a sclerotised point. Dorsal setae associated with L2 and L3 not thickened or swollen basally *Aspidiotus nerii* Bouché
- 15(1) Body elongate, at least 2x longer than wide, with lateral margins divergent posteriorly. L1 clearly separate. Each pre-pygidial segment with a sclerotized secondary lobe at the anterior lateral angle. Perivulvar pores present. Dorsal bosses absent
 *Lepidosaphes pinnaeformis* (Bouché)
- Body oval, turbinate or almost circular, less than 2x longer than wide. Perivulvar pores present or absent. L1 separated by a narrow or wide space 16
- 16(15) L1 widely separated, by at least 1x width of L1. Plates between L1 together fishtail-shaped; gland spines absent. Perivulvar pores present. *Pseudoparlatoria parlatorioides* Comstock
- L1 separated by only a narrow space, narrower than width of L1. Plates between L1 together not fishtail-shaped; slender gland spines may be present. Perivulvar pores present or absent 17
- 17(16) Apex of pygidium with L1 asymmetrical, each lobe with inner margin longer than outer margin, forming a deep notch between lobes. Perivulvar pores present. L1 without any basal sclerosis. Gland spines between lobes present singly
 *Diaspis* near *coccolis* Lichtenstein
- Apex of pygidium with L1 more-or-less symmetrical, not forming a deep notch. Perivulvar pores absent. Inner basal corner of L1 with an elongate, club-shaped basal sclerosis. Gland spines between lobes present in groups of 4 or more.
 *Howardia biclavis* (Comstock)

Notes on Diaspididae species recorded on avocado in central México

Acutaspis albopicta (Cockerell)

Aspidiotus (*Chrysomphalus*) *albopictus* Cockerell 1898a: 433.
Aspidiotus albopictus leonis Townsend & Cockerell 1898: 179.
Aspidiotus koebelei Townsend & Cockerell 1898: 179.
Chrysomphalus albopictus (Cockerell); Cockerell 1899a: 396.
Aspidiotus albopictus (Cockerell); Cockerell 1905a: 46.
Aspidiotus leonis (Townsend & Cockerell); McKenzie 1939: 53.
Acutaspis albopicta (Cockerell); Ferris 1941a: 329.

Field diagnosis. Adult female scale cover circular to slightly oval, flat, or slightly convex, and rigid, 1.2–1.5 mm in diameter, with subcentral exuviae; cover usually dark brown but sometimes gray or grayish white, mainly in immatures. Adult female body pyriform with acute posterior end, white to creamy white in life, about 1.2 mm long.

Discussion. *Acutaspis albopicta* can be confused with *Ac. scutiformis* because of the similar color and shape of the scale cover; morphologically, in slide mounts, these species can be differentiated by the relative sizes of the paraphyses on L2. In *Ac. albopicta*, the paraphysis on the external angle of L2 is almost twice the size of that on the internal angle, whereas in *Ac. scutiformis* these two paraphyses are almost the same size or the external paraphysis is only slightly larger than the internal one.

Habits on the hosts. During sampling, *Ac. albopicta* was found on branches, leaves and fruits; it was observed forming large colonies on fruits and leaf upper and lower surfaces, as well as small colonies or isolated individuals on the different substrates. It was found alone or sharing space with other diaspidid species such as *H. cyanophylli*, *H. diffinis*, *H. lataniae* and *D. near coccolis*.

Hosts. *Acutaspis albopicta* is polyphagous; it has been recorded attacking members of 14 plant genera belonging to 13 families worldwide. Some of these plants are economically important, such as coconut, avocado and citrus (García Morales *et al.* 2016). In this study, the scale was found on the avocado varieties Fuerte, Hass and Hass-Méndez.

Distribution. The species is reported to be present in nine countries in the Americas, from USA to Brazil. In México it has been recorded in the states of Colima, Guerrero, Morelos, Nuevo León, Oaxaca, Quintana Roo, Sinaloa, and Tamaulipas (García Morales *et al.* 2016). González Hernández & Atkinson (1984) collected *Ac. albopicta* on avocado in Tetela de Ocampo, Puebla, México. In our study it was found in the following states and orchards: **Morelos:** Xolosuchitl 1 and Tlalnepantla 1; and **Jalisco:** La Quinta, Fruticola GMI-3 Marias, Agro Leal, and Loma Delgada 1.

Natural enemies. The following hymenopteran parasitoids have been reported attacking *Ac. albopicta*: *Paraphytis acutaspidis* Rosen & DeBach (Aphelinidae), and *Signiphora* sp. (Signiphoridae) (García Morales *et al.* 2016; Noyes 2019). In the present study, the following species were found parasitizing it: *Aphytis holoxanthus* (6F), *Aph. lepidosaphes* (18F, 4M), *Aph. lingnanensis* (13F, 5M), *Aph. melinus* (3F, 6M), *Signiphora flavella* (1F) and *Pseudhomalopoda prima* (1F).

***Acutaspis scutiformis* (Cockerell)**

Aspidiotus scutiformis Cockerell 1893a: 48.
Aspidiotus (Chrysomphalus) scutiformis (Cockerell); Cockerell 1897a: 25.
Chrysomphalus scutiformis (Cockerell); Berlese & Leonardi 1898: 116.
Acutaspis scutiformis (Cockerell); Ferris 1941a: 207.
Insaspidotus scutiformis (Cockerell); Costa Lima 1942: 289.
Acutaspis scutiformis (Cockerell); Borchsenius 1966: 355.

Field diagnosis. Adult female scale cover circular, flat to slightly convex and rigid, dark brown, about 1.5 mm in diameter (although García Morales *et al.* (2016) indicate that it can reach 3.0 mm), with subcentral yellow exuviae. Body of live adult female pyriform, with acute pygidium, whitish, usually about 1.2 mm long.

Discussion. *Acutaspis scutiformis* can be mistaken for *Ac. albopicta*, although these species can be differentiated by some morphological characteristics, such as the relative sizes of the external paraphyses on L2, as discussed above.

Habits on the hosts. Individuals of *Ac. scutiformis* were obtained from branches, fruits and leaves. On branches and fruits, it was observed in small groups or individually, while on the leaves, the scales were mainly found on the abaxial surface. The scale was generally found associated with other diaspidid species like *C. dictyospermi*, *H. cyanophylli*, *H. diffinis* and *H. lataniae*.

Hosts. *Acutaspis scutiformis* has been reported attacking members of 10 plant genera belonging to seven families, causing damage to some economically important species such as citrus and avocado (García Morales *et al.* 2016). In this study it was found associated with the avocado varieties Fuerte, Hass and Hass-Jiménez.

Distribution. The species that has been reported in six countries in the Americas; in México it has been recorded in Guerrero, Nuevo León, Tamaulipas, and Veracruz states (García Morales *et al.* 2016). In this study it was found in the following states and orchards: **State of México:** Bordo 2 and San Jose 2; **Puebla:** El Arco; **Colima:** Piedra Rajada, Agosto and Rancho Alto; and **Nayarit:** Los Terreros.

Natural enemies. Two species of hymenopteran parasitoid have been reported attacking *Ac. scutiformis*: *Aphytis hispanicus* (Aphelinidae) and *Signiphora perpauca* (Signiphoridae) (García Morales *et al.* 2016; Noyes 2019). In the present study, the following species were found parasitizing it: *Aph. holoxanthus* (4F), *Coccobius juliae* (2F, 1M), *Encarsia citrina* (1F), *E. gaonae* (5F, 1M), *E. juanae* (2F), *E. titillata* (1F), *S. bennetti* (7F) and *S. falcata* (3F, 1M).

***Aonidiella aurantii* (Maskell)**

Aspidiotus aurantii Maskell 1879: 199.
Aonidia gennadii Targioni Tozzetti 1881: 151.
Aspidiotus citri Comstock 1881a: 8.
Aspidiotus coccineus Gennadius 1881: 189.
Aonidiella aurantii (Maskell); Berlese 1895: 125.
Chrysomphalus (Aonidiella) aurantii (Maskell); Cockerell 1899a: 396.
Chrysomphalus citri (Comstock); Lindinger 1935: 132.
Aonidiella coccineus (Gennadius); McKenzie 1939: 54.
Aonidiella gennadi (Targioni Tozzetti); McKenzie 1939: 54.
Chrysomphalus coccineus (Gennadius); Lindinger 1949: 211.

Field diagnosis. Adult female scale cover flattened and circular, reddish brown or reddish gray, about 1.5 mm in diameter (but according to Watson (2002) it can reach 2.0 mm), with dark central exuviae. Mature adult female

kidney-shaped and sclerotized, white to slightly amber, about 0.8 mm in diameter (although according to Watson (2002) it can vary from 0.7 to 1.2 mm).

Discussion. *Aonidiella aurantii* usually can be differentiated from *Ao. citrina* (Coquillett) by the color of the scale cover, which is reddish-brown in *Ao. aurantii*, while *Ao. citrina* has a white to yellow scale cover. Morphologically, in slide mounts, *Ao. aurantii* has prevulvar scleroses and apophyses, whereas *Ao. citrina* lacks prevulvar scleroses, although it has prevulvar apophyses. Separation of these species can be difficult; according to Miller & Davidson (2005), additional characters that can be used are (characteristics of *Ao. citrina* in parenthesis): *Ao. aurantii* with plates with the fringing not very pronounced (fringing on posterior plates deeply pronounced); macroducts slightly shorter (macroducts slightly longer); and submarginal cluster of microducts on each side of segment IV numbering 8–19, usually about 12 (numbering 4–11, usually about 8).

Habits on the hosts. *Aonidiella aurantii* can be found on branches, also on leaves and fruits of citrus (González Hernández & Atkinson 1984). In this study it was found individually on avocado branches, where there were few live individuals; it was also found associated with other diaspidid scale species such as *A. nerii*, *H. lataniae*, *H. rapax* and *D. near coccois*.

Hosts. The scale is polyphagous, attacking members of 178 plant genera belonging to 77 families, many of which are economically important, such as mango, fig, blackberries, coconut, date palm, oil palm, banana, guava, agave, asparagus, cassava, papaya, peach, citrus, walnut, avocado, pomegranate, and grape, among others (Watson 2002; García Morales *et al.* 2016). In this study, *Ao. aurantii* was found associated with the avocado variety Mexicano 1.

Distribution. *Aonidiella aurantii* is present in 88 countries in Africa, America, Asia, Europe, and Oceania (Watson 2002; García Morales *et al.* 2016); in México it has been found associated with citrus fruits in the Tamaulipas (García Morales *et al.* 2016), State of México, Morelos and Sonora (González Hernández & Atkinson 1984). In our study it was recorded only in **State of México**: La Purificación orchard.

Natural enemies. Natural enemies reported for *Ao. aurantii* include members of 39 genera belonging to 14 families. Among the genera outstanding for the high number of species that attack the scale are those of parasitic wasps such as *Aphytis* and *Encarsia* (Aphelinidae), and *Signiphora* (Signiphoridae). Other important parasitoid wasp genera attacking *Ao. aurantii* scales include: *Coccobius*, *Coccophagoides*, *Coccophagus*, *Marietta* and *Pteroptrix* (Aphelinidae); and *Adelencyrtus*, *Aphycus*, *Comperiella*, *Habrolepis*, *Pseudhomalopoda* (Encyrtidae).

An important predatory genus outstanding for the high number of species that attack *Ao. aurantii* is *Chilocorus* (Coleoptera: Coccinellidae); other important predatory genera include: *Coccidophilus*, *Cryptolaemus*, *Exochomus*, *Halmus*, *Microweisea*, *Nephus*, *Orcus*, *Pentilia*, *Pharosecymnus*, *Rhizophobius*, *Scymnus* and *Telsimia* (Coccinellidae); mites in *Cocphylobius* and *Neophyllobius* (Camerobiidae), *Hemisarcoptes* (Hemisarcoptidae), and *Amblyseius* and *Euseius* (Phytoseiidae); gall midges in *Cecidomyia* and *Lestodiplosis* (Cecidomyiidae); lacewings in *Chrysoperla* (Chrysopidae); dustywings in *Conwentzia* and *Heteroconis* (Coniopterygidae); thrips in *Aleurodothrips* (Phlaeothripidae); and entomophagous fungi in *Clonostachys* (Hypocreales), *Microcera* (Nectriaceae) and *Podonectria* (Tubeufiaceae) (García Morales *et al.* 2016; Noyes 2019). In the present study, because of the low number of specimens collected, no natural enemies were obtained from *Ao. aurantii*.

Aspidiotus nerii (Bouché)

Diaspis obliquum Costa 1829: 2.

Aspidiotus nerii Bouché 1833: 52.

Aspidiotus genistae Westwood 1840: 118.

Diaspis bouchei Targioni Tozzetti 1867: 13.

Chermes aloes Boisduval 1867: 327.

Chermes cycadicola Boisduval 1867: 345.

Chermes ericae Boisduval 1867: 330.

Chermes nerii (Bouché); Boisduval 1868: 281.

Aspidiotus affinis Targioni Tozzetti 1868: 736.

Aspidiotus caldesii Targioni Tozzetti 1868: 736.

Aspidiotus denticulatus Targioni Tozzetti 1868: 736.

Aspidiotus villosus Targioni Tozzetti 1868: 736.

Aspidiotus bouchei Targioni Tozzetti 1868: 13.

Aspidiotus aloes (Boisduval); Signoret 1869a: 843.

Aspidiotus cycadicola (Boisduval) Signoret 1869b: 119.

Aspidiotus ericae (Boisduval) Signoret 1869b: 121.
Aspidiotus budleiae Signoret 1869b: 115.
Aspidiotus capparis Signoret 1869b: 129.
Aspidiotus ceratoniae Signoret 1869b: 118.
Aspidiotus epidendri Signoret 1869b: 121.
Aspidiotus genistae Signoret 1869b: 122.
Aspidiotus gnidii Signoret 1869b: 122.
Aspidiotus ilicis Signoret 1869b: 123.
Aspidiotus limonii Signoret 1869b: 125.
Aspidiotus myricinae Signoret 1869b: 125.
Aspidiotus ulicis Signoret 1869b: 132.
Aspidiotus vriesciae Signoret 1869b: 134.
Aspidiotus budleiae Signoret 1869a: 845.
Aspidiotus limonii Signoret 1869a: 860.
Aspidiotus vriesciae Signoret 1869a: 876.
Coccus limonii (Signoret); Murray 1871: 342.
Aspidiotus lentisci Signoret 1877: 601.
Aspidiotus? osmanthi Signoret 1877: 621.
Aspidiotus atherospermae Maskell 1879: 198.
Aspidiotus dysoxylis Maskell 1879: 198.
Aspidiotus oleae Colvée 1880: 39.
Aspidiotus corynocarpi Colvée 1881: 39.
Aspidiotus oleastri Colvée 1882: 12.
Aspidiotus sophorae Maskell 1884: 121.
Aspidiotus carpodeti Maskell 1885: 21.
Aspidiotus nerii limonii (Bouché); Cockerell 1896: 334.
Aspidiotus epidendri Cockerell 1896: 334.
Aspidiotus nerii (Bouche); Cockerell 1897a: 18.
Aspidiotus osmanthi Cockerell 1897a: 30.
Aspidiotus (Evaspidiotus) hederæ (Signoret); Leonardi 1898: 76.
Aspidiotus hederæ nerii (Bouché); Hunter 1899: 11.
Aspidiotus hederæ carpodeti (Maskell); Cockerell & Parrott 1899: 276.
Aspidiotus hederæ limonii (Signoret); Cockerell 1900: 350.
Aspidiotus transparens rectangulatus Lindiger 1913: 97.
Aspidiotus confusus Froggatt 1914: 136.
Aspidiotus transvaalensis Leonardi 1914: 198.
Aspidiotus tasmaniae Green 1915: 50.
Octaspidotus atherospermae (Maskell); MacGillivray 1921: 395.
Aspidiotus hederæ urenae Hall 1923: 19.
Aspidiotus hederæ unipectinata Carimini 1930: 121.
Aspidiotus (Dynaspidotus) hederæ (Signoret); Thiem & Gerneck 1934:131.
Chermes hederæ (Signoret); Ferris 1937: 62.
Chermes genistae (Westwood); Ferris 1941b: 43.
Chermes osmanthi (Signoret); Ferris 1941b: 46.
Aspidiotus rectangulatus (Lindinger); Ferris 1941b: 47.
Aspidiotus unipectinatus (Carimini); Ferris 1941b: 49.
Aspidiotus urenae (Hall); Ferris 1941b: 49.
Aspidiotus fonsecai Giannotti 1942: 214.
Octaspidotus athospermae (Maskell); Balachowsky 1948: 272.
Aspidiotus hederæ hederæ (Signoret); Schmutterer 1952: 566.
Aspidiotus hederæ unisexualis Schmutterer 1952: 566.
Aspidiotus nerii Borchsenius 1966: 261.

Field diagnosis. Adult female scale cover white, semicircular, flat to convex, with yellow subcentral exuviae. According to Watson (2002), the scale cover can measure 1.5 to 2.0 mm in diameter and is semi-translucent yellowish white to slightly tan. Body of live adult female unsclerotised, whitish and slightly oval or pyriform.

Discussion. Based on the color of the scale-cover and body shape, *Asp. nerii* can be easily mistaken for *H. cyanophylli*; however, it can be differentiated morphologically, in slide mounts, because *H. cyanophylli* has dorsal pygidial macroducts approximately 15 times longer than wide, whereas in *Asp. nerii* these macroducts are only five times longer than wide.

Habits on the hosts. In this study, *Asp. nerii* was found mainly on leaves but also on branches, displacing other scale species such as *D. near coccois*. On both substrates it was found associated with other diaspidid species such as *Ao. aurantii*, *D. near coccois*, *H. lataniae* and *H. rapax*.

Hosts. *Aspidiotus nerii* is a polyphagous species that attacks members of 239 plant genera belonging to 120 families, some of which are economically important such as mango, walnut, coconut, agave, asparagus, avocado, pomegranate, fig, banana, apple, lemon, tomato, potato and grape, among others (Watson 2002; García Morales *et al.* 2016). In México it has been found on walnut, plum, peach, pear and apple (González Hernández & Atkinson 1984). In this study it was collected on the avocado variety Mexicano 1.

Distribution. *Aspidiotus nerii* is cosmopolitan, present in 74 countries in Africa, America, Asia, Europe, and Australia (Watson 2002; García Morales *et al.* 2016). In this study it was recorded only in the **State of México**: Tequexquahuac, Texcoco, and La Purificación, Texcoco orchards.

Natural enemies. The natural enemies attacking *Asp. nerii* belong to 23 genera from 10 families, among which are the following parasitoid wasp genera: *Aphytis*, *Coccophagus*, *Encarsia* (Aphelinidae); *Adelencyrtus*, *Aphycus*, *Habrolepis*, *Metaphycus*, *Zelaphycus* (Encyrtidae); and *Signiphora* (Signiphoridae). Predators of *Asp. nerii* include members of the beetle genera *Myzomorpha* (Cerambycidae), *Chilocorus*, *Coccidophilus*, *Exochomus*, *Nephus*, *Paroscyrnus*, *Rhyzobius* (Coccinellidae) and *Miloceris* (Curculionidae); also, lacewings in *Chrysoperla* (Chrysopidae); thrips in *Aleurodothrips* and *Karnyothrips* (Phlaeothripidae); mites in *Hemisarcoptes* (Hemisarcoptidae); and fungi in *Microcera* (Nectriaceae) (Watson 2002; García-Morales *et al.* 2016). In the present study, two species attacking the scale were obtained: *Coccobius juliae* (1F, 1M) and *Encarsia titillata* (1F).

***Chrysomphalus dictyospermi* (Morgan)**

Aspidiotus dictyospermi Morgan 1889: 352.

Aspidiotus dictyospermi arecae Newstead 1893a: 185.

Aspidiotus mangiferae Cockerell 1893b: 255.

Aspidiotus dictyospermi jamaicensis Cockerell 1894: 129.

Chrysomphalus dictyospermi (Morgan); Maskell 1895: 44.

Aspidiotus minor Cockerell 1896: 334.

Chrysomphalus minor Berlese in Berlese & Leonardi 1896: 346.

Chrysomphalus mangiferae (Cockerell); Leonardi 1899: 199.

Chrysomphalus dictyospermi minor (Berlese in Berlese & Leonardi); Marchal 1904: 246.

Aspidiotus agrumicola De Gregorio 1915: 125, 164.

Chrysomphalus castigatus Mamet 1936: 94.

Chrysomphalus dictyospermi (Morgan); Ferris 1938: 200.

Field diagnosis. Adult female scale cover circular and flat, about 1.7 mm in diameter, gray to brown or dark brown; according to Watson (2002), it can have a diameter of 1.5 to 2.0 mm and be greyish to reddish brown with yellow central exuviae. Body of live adult female pyriform, white to yellow, membranous, with a diameter of about 1.1 mm.

Discussion. *Chrysomphalus dictyospermi* is easily distinguishable from other *Chrysomphalus* species by having clavate processes on two plates lateral to each L3, and by lacking clusters of dorsal prepygidial ducts (Miller & Davidson 2005).

Habits on the hosts. The scale was found on branches, leaves, and fruits, but was most common on branches. It was detected in groups or individually on the different substrates; on leaves it was observed on both adaxial and abaxial surfaces. Generally, *Chr. dictyospermi* was found associated with other species of armored scales such as *Ac. scutiformis*, *D. near coccois*, *H. crescentiae*, *H. diffinis*, *H. lataniae*, *H. rapax*, *Ho. biclavis* and *Cl. herculeana*.

Hosts. *Chrysomphalus dictyospermi* is a highly polyphagous species that attacks members of 188 plant genera belonging to 80 families, several of which are economically important, such as citrus, mango, annona, coconut, banana, papaya, date palm and avocado, as well as other tropical and subtropical plants (Watson 2002; Smith-Pardo *et al.* 2012; García Morales *et al.* 2016). In this work, the scale was found associated with the avocado varieties Fuerte, Hass, Mexicano 1 and Padua.

Distribution. The species is cosmopolitan but is found mainly in tropical and subtropical regions (Smith-Pardo *et al.* 2012). *Chrysomphalus dictyospermi* has been recorded in 102 countries on five continents worldwide (Watson

2002, García Morales *et al.* 2016). In México it has been reported in the state of Veracruz (García Morales *et al.* 2016) and the central region of México on mango, pear, and citrus (González Hernández & Atkinson 1984). In the present study, it was recorded in the following states and orchards: **Puebla**: Acapulco and La Cuesta; **Colima**: Rancho Alto and La Calma; and **Nayarit**: UAN, Crucero la Curva, Los Terreros, Camichin1, Camichin 2, and La Fortuna.

Natural enemies. Among the natural enemies reported to be associated with *Chr. dictyospermi* are listed 21 genera belonging to eight families, particularly the hymenopteran parasitoids: *Aphelinus*, *Aphytis*, *Coccophagus*, *Encarsia*, *Marietta* and *Pteroptrix* (Aphelinidae); *Comperiella*, *Metaphycus* (Encyrtidae); *Arrenophagus*, *Coccidencyrthus*, *Habrolepis* (Encyrtidae); *Tetrastichus* (Eulophidae); *Theocolax* (Pteromalidae); and *Signiphora*, also *Thysanus* (Signiphoridae). Predators of the scale particularly include beetles in *Chilocorus*, but also in *Exochomus*, *Halmus*, *Rhyzobius* (Coccinellidae), and predatory mites in *Hemisarcoptes* (Hemisarcoptidae) (García Morales *et al.*, 2016; Noyes 2019). In the present study, 20 parasitoid specimens were obtained from *Chr. dictyospermi*: *Aphytis holoxanthus* (9F, 2M), *Aph. lepidosaphes* (1F), *Aph. melinus* (1H, 2M), *Encarsia juanae* (1F), *E. perniciosi* (1F), *Signiphora dozieri* (1F) and *S. falcata* (1F, 1M).

***Clavaspis herculeana* (Cockerell & Hadden)**

Aspidiotus herculeanus Cockerell & Hadden in Doane & Hadden 1909: 298.

Aspidiotus subsimilis anonae Houser 1918: 163.

Aspidiotus anonae (Houser); Ferris 1921: 94.

Clavaspis anona (Houser); MacGillivray 1921: 441.

Aspidiotus symbioticus Hempel 1932: 334.

Chrysomphalus alluaudi Mamet 1936: 93.

Clavaspis alluaudi (Mamet); McKenzie 1939:

Clavaspis symbioticus (Hempel); Vernalha 1953: 169.

Aspidiotus (Clavaspis) herculeanus (Cockerell & Hadden); Merrill 1953: 21.

Clavaspis herculeana (Cockerell & Hadden); Borchsenius 1966: 318.

Diagnosis. Adult female scale cover circular, about 1.0 mm diameter, brown, with subcentral exuviae. Body of live adult female subcircular or slightly oval with an acute pygidium, yellowish white, about 0.75 mm long and 0.68 mm wide. When slide mounted, pygidium of adult female with well-developed and prominent median lobes; L2 reduced to almost a point; L3 and L4 absent; and plates simple. Pygidium with 3 pairs of well-developed paraphyses; L1 with inner paraphyses medium sized and external paraphyses conspicuously long, each ending in a globular apical club.

Discussion. *Clavaspis herculeana* could be confused with *Melanaspis deklei* (Deitz & Davidson, 1986) because of the similar shape and size of the external paraphyses on L1. However, *Cl. herculeana* has only two obvious pairs of pygidial lobes, while *M. deklei* has four.

Habits on the hosts. The scale was found on branches, in low abundance and solitary, but sometimes associated with other diaspidid scales like *Chr. dictyospermi* and *H. lataniae*.

Hosts. *Clavaspis herculeana* is reported to be associated with members of 43 genera belonging to 25 plant families, several of which are of economic importance such as mango, soursop, papaya, fig and pear (García Morales *et al.* 2016). In this study it was found associated only with Hass avocado.

Distribution. *Clavaspis herculeana* has been recorded in 31 countries in Africa, America, Asia, and Australia; according to García Morales *et al.* (2016); in México it has been reported in the states of Guerrero, San Luís Potosí, and Veracruz, although those reports did not specify the hosts. Our study recorded it in **Nayarit**: UAN, Crucero La Curva, and La Hierba orchards.

Natural enemies. In the literature there are no records of natural enemies of *Cl. herculeana*. No natural enemies of this armored scale were detected in this study.

***Davidsonaspis aguacatae* (Evans, Watson & Miller)**

Abgrallaspis aguacatae Evans, Watson & Miller 2009: 58.

Field diagnosis. Adult female scale cover subcircular to broadly oval and flat, flimsy, about 1.2 mm in diameter, brown to dark brown, with subcentral exuviae. Body of live adult female pyriform, with rather sharp pygidial apex, whitish yellow, about 0.9 mm in diameter. According to Evans *et al.* (2009), the pygidium is yellow brown with a darker apex, and the slide-mounted body of the adult female is 0.84–1.37 mm long and 0.64–1.07 mm wide.

Discussion. *Davidsonaspis aguacatae* can be confused with *H. diffinis* because the latter's scale cover sometimes turns dark when honeydew from other sucking insects falls on it. The slide-mounted adult females can be separated by the following characteristics: *Da. aguacatae* has three well-developed pygidial lobes and L2 and L3 each have two or more lateral teeth, while *H. diffinis* has only two well-developed lobes, and L2 has one or two lateral teeth; L3 is only small and lacks lateral teeth.

Habits on the hosts. The scale was collected from leaves, branches, and fruits, where it was observed grouped in small to large colonies, with intermingled females and males. On leaves it was detected on the adaxial and/or abaxial surfaces. In addition, *Da. aguacatae* was found associated with other armored scales such as *Diaspis* near *coccois*, *H. diffinis*, *H. lataniae* and *H. rapax*.

Hosts. The scale has only been found attacking *Persea americana* (Evans *et al.* 2009; García Morales *et al.* 2016); the present study found it on the varieties Fuerte, Hass, Mexican 1, Granón and Padua.

Distribution. Although *Da. aguacatae* has been recorded only from the state of Michoacán (Evans *et al.* 2009; García Morales *et al.* 2016), previously González Hernández & Atkinson (1984) had detected it on avocado in Zacatlán, Puebla, where it was initially identified as *Quadraspiditous perniciosus* (*Comstockaspis perniciosus*) (Comstock). The present study recorded it in the following states and orchards: **State of México:** La Cabaña, Cochisquila 1, Cochisquila 2, La Colonia, Ixtlahuaca 1, La Casita, Ixtlahuaca 2, and Ixtlahuaca 3; and **Puebla:** La Aguacatera.

Natural enemies. Among the natural enemies of *Da. aguacatae* reported are the hymenopteran parasitoids *Aphytis* sp., *Encarsia citrina*, *E. juanae* (Lázaro-Castellanos *et al.* 2012), *E. lounsburyi* (Stocks & Evans 2017) (Aphelinidae), and *Signiphora flavella* (mistakenly identified as *Signiphora* near *borinquensis*) (Signiphoridae); and the predatory beetle *Chilocorus cacti* (Coccinellidae) (Lázaro-Castellanos *et al.* 2012). In the present study, we obtained 19 specimens, of which 14 were hymenopteran parasitoids and five were coccinellid predators. The species identified were the parasitoids *Aph. lepidosaphes* (1F), *Encarsia citrina* (2F), *E. aurantii* (1F), *E. juanae* (1F), *E. gaonae*, *E. lounsburyi* (4F) (Aphelinidae) and *Signifora flavella* (2F, 2M) (Signiphoridae); and the coccinellid predator *Coccidophilus atronitens* (5).

***Diaspis* near *coccois* (Lichtenstein)**

Field diagnosis. On avocado fruits, adult female scale cover opaque white to slightly brown, whereas on leaves it is transparent or semi-transparent; in both cases it is circular and flat or slightly convex, about 1.5 mm in diameter, with yellow subcentral exuviae. In life, adult female body creamy white or yellow, membranous, slightly rounded, about 1.0 mm long, with an obvious notch between median lobes. In immature males the waxy cover is cottony white; males are found in large groups or individually, usually close to females.

Discussion. This apparently undescribed species is very close to *D. coccois* because the slide-mounted adult female lacks lateral prothoracic protrusions and submedial dorsal micropores on segments VI and VII of the pygidium. It has perivulvar pores clustered in 5 groups; the anterior group contains 0–12 (usually 8) pores; the anterolateral pore groups each contain 8–19 pores, and the posterolateral groups each contain 7–15 pores. According to Soria *et al.* (2000), *D. coccois* in Spain has perivulvar pores numbering 10, 20, and 15 in each of the respective groups, while Boratynski (1968) gives numbers of 0–12 in the anterior group, 9–12 in each anterolateral group, and 9–17 in each posterolateral group. Boratynski's (1968) description seems to resemble our material; however, it is still doubtful that it is *D. coccois*, since both the above study descriptions were of specimens obtained from coconut palms. For this reason, we decided to determine this species as *Diaspis* near *coccois*, pending authoritative identification by expert taxonomists.

Habits on the hosts. *Diaspis* near *coccois* was collected on leaves, branches, and fruits; however, it was observed to be predominant on leaves, where it occurs singly or in groups covering large areas of the adaxial and/or

abaxial surfaces. It can also coexist with other species of armored scales such as *Ac. albopicta*, *Ac. scutiformis*, *Chr. dictyospermi*, *Da. aguacatae*, *H. diffinis*, *H. lataniae*, *H. rapax*, *L. pinnaeformis* and *P. parlatorioides*.

Hosts. The scale has been collected previously on Mexican and Hass avocados in México (González Hernández & Atkinson 1984). In our study it was found associated with the following varieties of avocado: Fuerte, Hass, Granón, Vitacalli, Padua, Kila, Mexicano 1 and Mexicano 2.

Distribution. In México, *Diaspis* near *coccois* has been found associated with avocado in Texcoco, State of México; Tianguismanalco, Puebla, and several municipalities of Michoacán (González Hernández & Atkinson 1984, González-Hernández, pers. comm., 2019). In the present work, it was recorded in the following states and orchards: **State of México:** Cochisquila 2, La Casita, Santa Ana, Lindero, San José, M1Texcoco, M2Texcoco, M3Texcoco, M4Texcoco, M5Texcoco and M6Texcoco; **Morelos:** Metepec 1, Xolosuchitl 1, Xolosuchitl 3, San Miguel, Isla Chica 1, M10Mor, Santa Cruz Axopilco, Paluca 1 and Tlalnepantla 1; **Puebla:** La Aguacatera, Acapulco, Amexatl 1, El Arco, El Carmen and La Cuesta; **Guanajuato:** M1Gto; **Jalisco:** La Loma; and **Querétaro:** La Estancia.

Natural enemies. In previous works, no natural enemies of this species were recorded. In the present study we obtained a total of 66 parasitoid individuals, belonging to the following families: Aphelinidae: *Aphytis holoxanthus* (5F, 5M), *Aph. lepidosaphes* (11F, 5M), *Aph. proclia* (1F), *Coccobius juliae* (4F, 2M), *Cocc. mexicanus* (1F), and *Encarsia titillata* (1F, 4M); Eulophidae: *Emersonella* sp. (18F, 5M); Encyrtidae: *Metaphycus* sp. 3 (1F); Signiphoridae: *Signiphora fax* (1M), *S. flavella* (1F) and *S. merceti* (1F).

***Hemiberlesia crescentiae* (Ferris)**

Diaspidiotus crescentiae Ferris 1938: 219.

Hemiberlesia crescentiae (Ferris); Wei *et al.* 2021: 8.

Field diagnosis. Adult female scale cover white to grey, circular, convex, approximately 1.0 mm in diameter, with central exuviae. Body of live adult female yellowish white, pyriform, membranous, about 0.8 mm long. The slide-mounted adult female lacks perivulvar pores.

Discussion. *Hemiberlesia crescentiae* could be confused with *Comstockaspis pernicioso*; however, these species are easy to differentiate in slide mounts by the number of well-developed pygidial lobes. *Hemiberlesia crescentiae* only has L1 developed, whereas *Co. pernicioso* has both L1 and L2 visible.

Habits on the hosts. The scale was collected on branches, where it occurred singly. The number of individuals present was lower than those of the other diaspidid species with which it was associated, such as *H. diffinis* and *H. lataniae*.

Hosts. *Hemiberlesia crescentiae* has been recorded on *Crescentia alata* (Bignoniaceae) and *Alibertia* sp. (Rubiaceae) (García Morales *et al.* 2016). We found it on the avocado varieties Fuerte, Kila and Mexicano 1 (New host records).

Distribution. The presence of *H. crescentiae* has been recorded in México and Panama. The type material was collected in Mazatlán, Sinaloa, México (Ferris 1942, García Morales *et al.* 2016). In the present study, it was found in **Puebla:** Acapulco orchard.

Natural enemies. In the literature no natural enemies are recorded for this species. In the present study we obtained the parasitoids *Signiphora flavella* (1M) (Signiphoridae) and *Plagiomerus diaspidis* (1M) (Encyrtidae) from this scale, new records for *H. crescentiae*.

***Hemiberlesia cyanophylli* (Signoret)**

Aspidiotus cyanophylli Signoret 1869b: 119.

Aspidiotus (Evaspidiotus) cyanophylli (Signoret); Leonardi 1898: 53.

Furcaspis cyanophylli (Signoret); MacGillivray 1921: 407.

Hemiberlesia cyanophylli (Signoret); Ferris 1938: SII-237.

Abgrallaspis cyanophylli (Signoret); Balachowsky 1948: 308.

Diaspidiotus cyanophylli /Signoret); Bodenheimer 1952: 337.

Aspidiotus (Hemiberlesia) cyanophylli (Signoret); Merrill 1953: 18.

Hemiberlesia (Abgrallaspis) cyanophylli (Signoret); Takagi & Yamamoto 1974: 39.

Field diagnosis. Adult female scale cover circular or slightly oval, flat, 1.5 to 2.0 mm in diameter, white to grey white, with subcentral exuviae yellow or light brown; on avocado fruits the cover becomes slightly brown. Body of adult female membranous, pyriform to subcircular, yellow, pygidium slightly acute.

Discussion. *Hemiberlesia cyanophylli* can be confused with *Oceanaspidiotus spinosus* and *Asp. nerii*. Both *H. cyanophylli* and *O. spinosus* have large dorsal macroducts approximately 15 times longer than wide, but in *H. cyanophylli* the anal opening is larger than L1 (smaller than L1 in *O. spinosus*); and *O. spinosus* lacks paraphyses on the pygidial lobes (present in *H. cyanophylli*). The separation of *Asp. nerii* from *H. cyanophylli* has been discussed above.

Habits on the hosts. The scale was found associated with leaves, branches, and fruits and was observed singly or grouped, mainly on the fruits; on leaves it was found on both the adaxial and abaxial surfaces. *Hemiberlesia cyanophylli* was found alone or associated with other species such as *Ac. scutiformis*, *Chr. dictyospermi*, *D. near coccois*, *H. diffinis*, *H. lataniae*, *H. rapax*, *Ho. biclavis* and *P. parlatorioides*.

Hosts. This is a polyphagous species that attacks members of 141 plant genera belonging to 73 families, including several economically important species such as coconut, mango, cocoa, grape, avocado and other fruit and ornamental species (Watson 2002; García Morales *et al.* 2016). In the present study it was found attacking the avocado varieties Hass, Hass-Jiménez, Hass-Méndez and Fuerte.

Distribution. *Hemiberlesia cyanophylli* has a wide distribution in tropical and subtropical parts of the world, and even in temperate regions; it has been recorded in 70 countries on five continents (Watson 2002; García Morales *et al.* 2016). In México it has been collected as a pest of Hass avocado in the state of Michoacán in the municipalities of Tancítaro, Zitácuaro, Cherangueran, and Uruapan (González Hernández, pers. comm., 2019). In the present study it was found in the following states and orchards: **Colima:** Agosto; **Jalisco:** Loma Delgada; **State of México:** Papalote 1, Bordo 2, Chirimoyo, and Lindero; **Morelos:** Tezantetelco; **Nayarit:** Camino Cerro San Juan and Los Terreros; and **Querétaro:** Rancho Quemado and Adjuntas de Higueras.

Natural enemies. For *H. cyanophylli*, 16 species of natural enemies have been reported belonging to the following genera: *Aphytis* (4), *Encarsia* (3) (Aphelinidae); *Signiphora* (4) (Signiphoridae); *Chilocorus* (1), *Rhyzobius* (2) and *Telsimia* (1) (Coccinellidae); and the fungus *Fusarium* (1) (Nectriaceae) (Watson 2002; García-Morales *et al.* 2016). In the present work, 30 individuals from the following families and species were obtained: Aphelinidae: *Aphytis holoxanthus* (1F), *Aph. melinus* (2F, 2M), *Coccobius averini* (3F), *Cocc. juliae* (6F, 1M), *Encarsia aurantii* (2F), *E. citrina* (5F), *E. juanae* (2F), *E. titillata* (3F); and Encyrtidae: *Metaphycus* sp. 4 (2F), and *Plagiomerus diaspidis* (1M).

***Hemiberlesia diffinis* (Newstead)**

Aspidiotus affinis Newstead, 1893a: 186.

Aspidiotus diffinis Newstead 1893b: 281.

Aspidiotus (Diaspidiotus) diffinis (Newstead); Cockerell, 1897a: 23.

Hemiberlesia diffinis (Newstead); Leonardi, 1897a: 133.

Aspidiotus jatrophae Townsend & Cockerell, 1898: 178.

Aspidiotus jatrophae parrotti Newell 1899: 23.

Hemiberlesia jatrophae (Townsend & Cockerell); Leonardi 1900: 339.

Aspidiotus diffinis parrotti (Newell); Fernald 1903: 258.

Hemiberlesia diffinis parrotti (Newell); MacGillivray 1921: 438.

Abgrallaspis diffinis (Newstead); Komosinska 1969: 60.

Hemiberlesia diffinis (Newstead); Miller & Davidson 1998: 197.

Field diagnosis. Adult female cover waxy to creamy white, circular or slightly oval, 1.5 to 2.0 mm in diameter, with subcentral exuviae yellow to slightly brown. Body of live adult female membranous, pale yellow, pyriform with slightly acute pygidium, 0.7–0.9 mm long.

Discussion. According to Miller & Davidson (1998), *H. diffinis* can be confused with *H. neodiffinis* Miller & Davidson, because both species have the same characteristics of waxy cover, size, and morphology. However, in slide mounts they differ in the following morphological characters: *H. diffinis* has a macroduct between L1 on the

pygidium (absent in *H. neodiffinis*), and the plates before L3 each contain more than one microduct (each contain only one microduct in *H. neodiffinis*).

Habits on the hosts. The scale was found primarily associated with branches but leaves and fruits are also affected. *Hemiberlesia diffinis* was observed individually or in groups, in many cases associated with other armored scale species such as *Ac. albopicta*, *Ac. scutiformis*, *Chr. dictyospermi*, *Da. aguacatae*, *D. near coccois*, *H. crescentiae*, *H. cyanophylli*, *H. lataniae*, *H. rapax*, *Ho. biclavis*, *L. pinnaeformis* and *P. parlatorioides*.

Hosts. The scale has been reported to attack members of 35 genera belonging to 27 plant families, including several species of economic importance, including avocado (García Morales *et al.* 2016). In our study, *H. diffinis* was found attacking the avocado varieties Hass, Hass-Méndez, Fuerte, Mexicano 1, Mexicano 2, Vitacalli, Padua and Kila.

Distribution. *Hemiberlesia diffinis* has been recorded in 16 countries in the Americas. In México, it has been reported in Baja California and Tabasco (García Morales *et al.* 2016). In the present study, it was found in the following states and orchards: **Morelos:** Xolosuchitl 3, San Miguel, Isla Chica 1, Paraíso, Tezantetelco and Tlalnepantla 1; **Puebla:** La Aguacatera, Acapulco, Amexatl 1, Amexatl 2, El Arco and La Cuesta; **Colima:** Piedra Rajada, Agosto and La Calma; **Nayarit:** Camino Cerro San Juan, Crucero Carrizal, Los Terreros, Camichin 1, El Aguacate, Entrada El Cuarenteño and La Fortuna; **Jalisco:** Frutícola GMI-3 Marías, Agro Leal, Loma Delgada 1, Loma Delgada 2, Jasmín 1 and Jasmín 2; and **Querétaro:** Adjuntas de Rancho Quemado, Rancho Quemado and Adjuntas de Higueras.

Natural enemies. No natural enemies have been registered for this armored scale. However, our study obtained 201 individuals parasitizing this scale, belonging to the families Aphelinidae: *Aphytis holoxanthus* (14F, 6M), *A. lepidosaphes* (5F, 1M), *A. lingnanensis* (3M), *A. melinus* (2F, 8M), *Coccobius juliae* (1M), *Encarsia citrina* (3F), *E. juanae* (11F), *E. lounsburyi* (11F), *E. subelongata* (1F), *E. tarsalis* (1F); Encyrtidae: *Archinus* sp. (1F), *Metaphycus* sp. 2 (1F), *Metaphycus* sp. 4 (1M), *Plagiomerus diaspidis* (3F, 3M); Signiphoridae: *Chartocerus* sp. (1F), *Signiphora dozieri* (1F), *S. falcata* (1F, 1M), *S. fax* (8F, 3M), *S. flavella* (34F, 44M), *S. merceti* (2F), *S. mexicana* (1F, 1M), *S. perpauca* (23F, 3M), and *S. tumida* (1M).

Hemiberlesia lataniae (Signoret)

- Aspidiotus lataniae* Signoret 1869b: 124.
Aspidiotus cydoniae Comstock 1881b: 295.
Aspidiotus punicae Cockerell 1893b: 255.
Aspidiotus diffinis lateralis Cockerell 1894: 130.
Aspidiotus (Hemiberlesia) cydoniae (Comstock); Cockerell 1897a: 21.
Aspidiotus (Aspidiotus) lataniae (Signoret); Cockerell 1897a: 29.
Aspidiotus (Diaspidiotus) punicae (Cockerell); Cockerell 1897a: 24.
Aspidiotus (Hemiberlesia) crawii Cockerell 1897a: 23.
Aspidiotus cydoniae tecta Maskell 1897: 240.
Aspidiotus (Diaspidiotus) greenii Cockerell 1897a: 27.
Aspidiotus implicatus Maskell 1897: 241.
Hemiberlesia lataniae (Signoret); Cockerell 1905b: 202.
Diaspidiotus lataniae (Signoret); MacGillivray 1921: 412.
Aspidiotus aspleniae Sasaki 1935: 864.
Hemiberlesia lataniae (Signoret); Borchsenius 1966: 306.

Field diagnosis. Adult female cover subcircular, convex, 1.5–2.0 mm in diameter, white and waxy, with orange to yellow subcentral exuviae. Live adult female body membranous, yellow, subcircular to pyriform, 0.7–0.9 mm long.

Discussion. *Hemiberlesia lataniae* is close to *H. rapax*, but *H. lataniae* has perivulvar pores which *H. rapax* lacks, and the distance between the anal opening and the rear edge of the pygidium is greater than the diameter of the anal opening in *H. lataniae* (shorter than the diameter of the anal opening in *H. rapax*).

Habits on the hosts. *Hemiberlesia lataniae* is found on leaves, branches and fruits, individually or in groups, in high or low or densities on different substrates; on leaves it was found on the adaxial and/or abaxial surfaces, alone or associated with other species of armored scale such as *Ac. albopicta*, *Ac. scutiformis*, *Ao. aurantii*, *Asp. nerii*, *Chr. dictyospermi*, *Cl. herculeana*, *Da. aguacatae*, *D. near coccois*, *H. crescentiae*, *H. cyanophylli*, *H. diffinis*,

H. rapax, *Ho. biclavis*, *L. pinnaeformis* and *P. parlatorioides*. Generally, *H. lataniae* had the highest number of individuals in the samples, and in some orchards, it was the only species present.

Hosts. The scale is highly polyphagous, attacking members of 321 genera belonging to 114 plant families, among which are several economically important species such as avocado, coffee, citrus, macadamia, mango, pear and grape, among others (Watson 2002; García Morales *et al.* 2016). In this study we collected it on the avocado varieties Booth, Hass, Hass-Jiménez, Hass-Méndez, Fuerte, Mexicano 1 and Mexicano 2.

Distribution. *Hemiberlesia lataniae* is a cosmopolitan species, widely distributed in almost all zoogeographic areas of the world; it has been identified in 111 countries on five continents (Watson 2002; García Morales *et al.*, 2016). In México it was recorded in Baja California, without the host being specified (García Morales *et al.* 2016), and in the State of México, Tlaxcala, Hidalgo, Morelos, and Puebla as an avocado pest (González Hernández & Atkinson 1984) as well as in Michoacán (Lázaro-Castellanos *et al.* 2012). In the present study it was collected in the following states and orchards: **State of México:** La Pitaya, Papalote 1, Bordo 2, Chirimoyo, La Colonia, Potrero and M6Texcoco; **Morelos:** Metepec 1, Xolosuchitl 1, Isla Chica 1, Isla Chica 2, M10Mor, Santa Cruz Axopilco, Santo Domingo, Paluca 1 and Paluca 2; **Puebla:** La Aguacatera, Acapulco, Tochimilco 1, Amexatl 1, Amexatl 2 and El Carmen; **Colima:** Rancho Alto and La Calma; **Guanajuato:** M1Gto; **Nayarit:** UAN, Crucero La Curva, Camichin 2, El Aguacate, Entrada El Cuarenteño and La Fortuna; **Jalisco:** La Providencia, Los Depósitos, El Fresnito, Frutícola GMI-3 Marías, Agro Leal, Loma Delgada 1, Loma Delgada 2, Jasmín 2, La Loma, Hacienda El Colomo and El Cerezo; and **Querétaro:** M1Qro, M2Qro, Adjuntas de Higueras, San Miguel and La Estancia.

Natural enemies. *Hemiberlesia lataniae* has a long list of natural enemies worldwide. The list of parasitoid wasps includes 34 species of Aphelinidae in the genera *Aphytis* (19), *Coccobius* (1), *Coccophagus* (1), *Encarsia* (6), *Marietta* (4), *Paraphytis* (1), *Prophycus* (1), and *Pteroptrix* (1); 12 species of Encyrtidae in *Adelencyrtus* (2), *Comperiella* (2), *Habrolepis* (2), *Metaphycus* (1), *Plagiomerus* (3) and *Thomsonisca* (2); and 10 species of Signiphoridae in *Signiphora* (Watson 2002; García Morales *et al.* 2016; Noyes 2019). Predators include one species of Cecidomyiidae in *Dentifibula*; 1 species of Chrysopidae in *Chrysoperla*; 8 species of Coccinellidae in *Chilocorus* (3), *Coccidophilus* (1), *Cycloneda* (1), *Rhyzobius* (2) and *Scymnus* (1); 1 species of Forficulidae in *Forficula*; 1 species of Phlaeothripidae in *Karnyothrips* (= *Watsoniella*); two species of Hemisarcoptidae in *Hemisarcoptes*; 1 species of Cheyletidae in *Cheletomimus*, and 1 pathogenic fungus (Nectriaceae) in *Nectria* (Watson 2002; García Morales *et al.* 2016). In the present study, 278 individuals were obtained parasitizing *H. lataniae*: Aphelinidae: *Aphytis diaspidis* (15F, 1M), *Aph. holoxanthus* (3F, 2M), *Aph. lepidosaphes* (7F, 6M), *Aph. lignanensis* (1F), *Aph. melinus* (1M), *Aph. proclia* (12F, 1M), *Coccobius averini* (2F), *Cocc. juliae* (1F), *Encarsia aurantii* (1F), *E. citrina* (40F), *E. juanae* (57F), *E. lounsburyi* (3F), and *Marietta montana* (2M); Encyrtidae: *Metaphycus* sp. 4 (1M), *Plagiomerus diaspidis* (2F, 4M); and Signiphoridae: *Signiphora falcata* (1F), *S. fax* (2F, 2M), *S. flavella* (48F, 42M), and *S. perpauca* (19F, 2M).

***Hemiberlesia rapax* (Comstock)**

- Aspidiotus rapax* Comstock 1881b: 307.
Aspidiotus acuminatus Targioni Tozzetti 1881: 151.
Diaspis santali Maskell 1884: 122.
Aspidiotus evonymi Targioni Tozzetti 1888: 420.
Aspidiotus flavescens Green 1890: 21.
Diaspis circulata Green 1896: 4.
Aspidiotus (Hemiberlesia) rapax (Comstock); Cockerell, 1897a: 30.
Aspidiotus tricolor (Green); Townsend 1897: 185.
Hemiberlesia camelliae (Signoret, 1869c); Leonardi 1897a: 124.
Aspidiotus rapax evonymi (Targioni Tozzetti); Cockerell 1899a: 396.
Aspidiotus lucumae Cockerell 1899b: 22.
Aspidiotus (Hemiberlesia) camelliae (Signoret); Hempel 1900: 501.
Hemiberlesia argentina Leonardi 1911: 237.
Aspidiotus santali (Maskell); Lindinger 1937: 180.
Aspidiotus argentina (Leonardi); Chou 1985: 301.
Hemiberlesia rapax (Comstock); Ferris, 1938: 244.

Field diagnosis. Adult female scale cover semicircular or slightly oval, convex, 1.0–2.0 mm in diameter, white with

yellow to brown subcentral exuviae. Body of live adult female membranous, yellow, pyriform, 0.7–1.0 mm long; according to Watson (2002) it can vary from 1.0–1.5 mm long.

Discussion. *Hemiberlesia rapax* is very similar to *H. lataniae* in terms of the color and shape of the waxy cover, as well as shape of the adult female body; however, they can be differentiated by morphological traits already discussed above and indicated in the key.

Habits on the hosts. The scale was collected from leaves, branches, and fruits, and was found isolated or in groups. It formed small or large colonies on leaves on both adaxial and abaxial surfaces, but on branches the colonies were less abundant. *Hemiberlesia rapax* was also found in small or medium infestations. The species was found alone or associated with other diaspidid scales, such as *Asp. nerii*, *Ao. aurantii*, *Ac. scutiformis*, *Chr. dictyospermi*, *Da. aguacatae*, *Diaspis* near *coccois*, *H. cyanophylli*, *H. diffinis* and *H. lataniae*.

Hosts. *Hemiberlesia rapax* is a highly polyphagous species that affects a wide variety of plants grown in tropical and subtropical regions of the world, attacking members of 188 genera belonging to 79 economically important plant families, including avocado, citrus, eucalyptus, guava, peach, pear and pomegranate, among others (Watson 2002; García Morales *et al.* 2016). In this study we found it attacking the avocado varieties Fuerte, Granón, Hass and Mexicano 1.

Distribution. The scale has a cosmopolitan distribution; it is known in 71 countries on five continents (Watson 2002; García Morales *et al.* 2016). In México, it has been reported in the states of Baja California, Michoacán, and Oaxaca (García Morales *et al.* 2016). We found it in the following states and orchards: **State of México:** La Cruz, La Cabaña, Cochisquila 1, Cochisquila 2, Ixtlahuaca 2, Santa Ana, Lindero, San José 2, M1Texcoco, M2Texcoco, M3Texcoco, M4Texcoco, M5Texcoco and M6Texcoco; and **Puebla:** La Aguacatera and La Cuesta.

Natural enemies. Among the species of natural enemies that regulate *H. rapax* worldwide are reported species belonging to 17 genera in seven families of hymenopteran parasitoids, including: Aphelinidae: *Ablerus* (3), *Aphytis* (8), *Coccophagus* (3), *Encarsia* (6), *Marietta* (2), *Pteroptrix* (1); Encyrtidae: *Coccidencyrtus* (1), *Comperiella* (1), *Gahaniella* (1), *Habrolepis* (1), *Neococcidencyrtus* (1), *Pseudectroma* (1); Eulophidae: *Tetrastichus* (1); Eupelmidae: *Eupelmus* (1); Pteromalidae: *Scutellista* (1); Signiphoridae: *Signiphora* (7); also a predatory mite in Hemisarcoptidae: *Hemisarcoptes* (1) (García Morales *et al.*, 2016; Noyes 2019). In the present work, we obtained 39 individuals parasitizing *H. rapax*; Aphelinidae: *Aphytis pinnae* (1F), *Aph. proclia* (1F, 1M), *Coccobius averini* (1F), *Cocc. juliae* (1F, 1M), *Encarsia aurantii* (1F), *E. citrina* (1F), *E. gaonae* (4F), *E. lounsburyi* (2F), *Marietta mexicana* (1F, 1M); Encyrtidae: *Metaphycus* sp. 1 (1F); and Signiphoridae: *Signiphora dozieri* 1M), *S. falcata* (3F, 1M), *S. fax* (4F, 1M), *S. flavella* (6M) and *S. merceti* (6F).

***Howardia biclavis* (Comstock)**

Chionaspis? biclavis Comstock 1883: 98–100.

Chionaspis biclavis detecta Maskell 1895: 49.

Howardia biclavis (Comstock); Berlese & Leonardi 1896: 348.

Chionaspis (Howardia) biclavis (Comstock); Maxwell-Lefroy 1902: 250.

Howardia biclavis detecta (Maskell); Fernald, 1903: 227.

Megalodiaspis biclavis (Comstock); Paoli 1915: 256.

Howardia (Chionaspis) biclavis (Comstock); Ramakrishna Ayyar 1921; 353.

Field diagnosis. Adult female scale cover circular and convex, 2.5–3.0 mm in diameter, yellowish white to brown, with fibrous appearance, exuviae subcentral. Body of live adult female membranous, slightly brown, or gray, 2.4–2.9 mm long, occupying almost the entire diameter of the waxy cover.

Discussion. Several studies record that adult female *Ho. biclavis* can penetrate the epidermal tissue of its hosts although judging by their morphology, the crawlers seem not to have this capacity; on the other hand, still little is known about the biology of this species (García Morales *et al.* 2016).

Habits on the hosts. *Howardia biclavis* was found on branches individually or in small groups of no more than three individuals; it was found associated with other species of diaspidid scales such as *Chr. dictyospermi*, *H. diffinis*, *H. lataniae* and *P. parlatoroides*.

Hosts. The scale is a polyphagous species that attacks members of 196 genera belonging to 69 plant families, including several hosts of economic importance such as mango, soursop, papaya, lemon, avocado, eggplant, and

tea, among others (Watson 2002; García Morales *et al.* 2016). In this study it was found associated only with Hass avocado.

Distribution. *Howardia biclavis* is widely distributed; its presence is known in 72 countries on five continents (Watson 2002; García Morales *et al.* 2016). In México, it has been collected on Hass avocado in the municipality of Los Reyes, Michoacán (González Hernández, pers. comm., 2019). In the present study it was found in the following states and orchards: **Colima:** La Calma; and **Nayarit:** Camino Cerro San Juan, Camino a Cofradía and El Aguacate.

Natural enemies. Among the natural enemies that regulate *Ho. biclavis* are the following: Aphelinidae: *Aphytis diaspidis*, *Aph. proclia*, *Aph. theae*, *Marietta busckii*, *Pteroptrix albifemur*; Encyrtidae: *Plagiomerus* sp., *Zaomma* sp.; and Signiphoridae: *Signiphora dozieri*; also, Phlaeothripidae: *Haplothrips* sp. (García Morales *et al.* 2016; Noyes 2019). In the present study, the parasitoids *Aph. holoxanthus* (1M) and *S. perpauca* (1F) were reared from *Ho. biclavis*.

***Lepidosaphes pinnaeformis* (Bouché)**

- Aspidiotus pinnaeformis* Bouché 1851: 111.
Mytilaspis pinnaeformis (Bouché); Signoret 1870: 97.
Mytilaspis machili Maskell 1898: 230–231.
Lepidosaphes machili (Maskell); Fernald 1903: 311.
Lepidosaphes pinnaeformis (Bouché); Green 1905: 28.
Lepidosaphes tuberculata Malenotti 1916: 183–185.
Scrupulaspis machili (Maskell); MacGillivray 1921: 288.
Parlatoria pinnaeformis (Bouché); Bodkin 1922: 60.
Lepidosaphes cymbidicola Kuwana 1925: 48–50.
Lepidosaphes ezokihadae Kuwana, 1932: 147.
Lepidosaphes cinnamomi Takahashi 1933: 48–50.
Lepidosaphes pinniformis (Bouché); Schmutterer 1952: 578.
Eucornuaspis pinnaeformis (Bouché); Wise 1977: 108.
Mytilococcus machili (Maskell); Zahradnik 1977: 120.

Field diagnosis. Adult female scale cover elongated, often with caudal region widened, giving it an oyster- or mussel-like appearance; slightly convex, narrow, or curved, 2.5–3.5 mm long, brown with terminal exuviae yellow or slightly orange. Body of live adult female membranous, elongate, with rounded head, creamy white or pearly.

Discussion. In the field, *L. pinnaeformis* could be confused with *L. beckii* because the adult female scale covers are usually very similar in shape and color; however, in *L. pinnaeformis* they remain brown throughout development, whereas according to Watson (2002), those of *L. beckii* are dark brown but occasionally have light tan edges, and the posterior end of each exuviae often has a red spot. Morphologically, in slide mounts, the adult females do not show much similarity characteristics of *L. beckii* according to Watson (2002) given in parenthesis; *L. pinnaeformis* has each eye developed into a sclerotized spur (not developed into a spur), lateral marginal spurs present on margins of prepygidial segments II, III and IV (lateral marginal spurs absent); and pygidium with five or six marginal macroducts on each side (six marginal macroducts on each side). In the present study, in samples from the state of Morelos where this species was collected, empty purplish scale covers were found but female specimens could not be obtained to confirm whether *L. beckii* was present.

Habits on the hosts. The scale was found on branches in small groups or individually, associated with other armored scales such as *Da. aguacatae*, *Diaspis* near *coccois*, *H. diffinis* and *H. lataniae*.

Hosts. *Lepidosaphes pinnaeformis* is a polyphagous species that attacks members of 34 genera belonging to 21 plant families, some of which are of economic importance such as lemon, peach, tea and avocado, among others (Watson 2002; García Morales *et al.* 2016). In this study it was found associated with the avocado varieties Fuerte, Mexicano 1 and Vitacalli.

Distribution. The scale is known to be present in 35 countries on five continents (Watson 2002; García Morales *et al.* 2016). In the present study it was recorded in the following states and orchards: **Morelos:** Isla Chica 1 and Paluca 2; and **Puebla:** La Aguacatera.

Natural enemies. Among the natural enemies associated with *L. pinnaeformis* are species in 12 genera

belonging to seven families: Hymenoptera: Aphelinidae, Encyrtidae, Mymaridae and Signiphoridae; Coleoptera: Coccinellidae; Lepidoptera: Noctuidae; and Thysanoptera: Phlaeothripidae. Some of the genera notable for the number of their species that attack *L. pinnaeformis* are the parasitoid wasps, Aphelinidae: *Aphytis* (4) and *Encarsia* (6); and other genera each represented by only one species: *Marietta* and *Pteroptrix*; Encyrtidae: *Metaphycus*; Mymaridae: *Arescon*; and Signiphoridae: *Signiphora*. The predators include the Coccinellidae: *Chilocorus*, *Coccidophilus*, *Exochomus*; Lepidoptera: *Prospalta*; and Phlaeothripidae: *Karnyothrips* (Watson 2002; García Morales *et al.* 2016; Noyes 2019). However, no natural enemies were obtained from *L. pinnaeformis* in the present study.

***Mycetaspis personata* (Comstock)**

Aspidiotus personatus Comstock 1883: 66.
Aspidiotus (Mycetaspis) personatus (Comstock); Cockerell 1897a: 24.
Aonidiella personata (Comstock); Leonardi 1897b: 286.
Chrysomphalus personatus (Comstock); Fernald 1903: 292.
Melanaspis personata (Comstock); Lindinger 1921: 427.
Mycetaspis personata (Comstock); MacGillivray 1921: 442.
Pseudaonidia personata (Comstock); Gómez-Menor Ortega 1941: 139.
Chrysomphalus (Mycetaspis) personata (Comstock); Merrill 1953: 40.
Mycetaspis personata (Comstock); Borchsenius 1966: 357.

Field diagnosis. Adult female scale cover 0.5–1.0 mm long, almost hemispherical, often taller than wide, black, brittle, with central exuviae (Watson 2002).

Discussion. According to Watson (2002), *M. personata* can be confused with *M. apicata*, but differs as follows (characteristics of *M. apicata* given in parenthesis): *M. personata* has the sclerotized area on the head forming a somewhat flattened bulge (forming a rounded cone); eyes each represented by an unsclerotized boss (each modified into a pointed spur); and ventral microducts absent from around the mouthparts and anterior spiracles (microducts numerous near the mouthparts and anterior spiracles).

Habits on the hosts. *Mycetaspis personata* was found on leaves and branches; it was abundant on the upper surfaces of leaves and less frequent on terminal branches (Solis *et al.* 1992).

Hosts. The scale is polyphagous, attacking members of 30 genera belonging to 19 plant families, some of which are of economic importance such as mango, coconut, guava, and avocado (Watson 2002; García Morales *et al.* 2016).

Distribution. *Mycetaspis personata* is known to be present in 44 countries in Africa, America, Asia, and Europe (Watson 2002; García Morales *et al.* 2016). In México it has been collected on avocado in the municipality of Allende in Nuevo León (Solis *et al.* 1992).

Natural enemies. Among the natural enemies that regulate *M. personata* are the following parasitoid wasps: Aphelinidae: *Aphytis chrysomphali*, *Aph. equatorialis*; and Signiphoridae: *Signiphora falcata* and *S. fax* (García Morales *et al.* 2016).

***Oceanaspidiotus spinosus* (Comstock)**

Aspidiotus spinosus Comstock 1883: 70.
Aspidiotus spinosus (Comstock); Cockerell 1895: 17.
Aspidiotus (Evaspidiotus) spinosus (Cockerell) Leonardi 1898: 56
Aspidiotus persearum Cockerell 1898b: 240.
Aspidiotus (Evaspidiotus) persearum (Cockerell); Leonardi 1900: 341.
Acanthaspidiotus borchsenii Takagi & Kawai 1966: 116.
Oceanaspidiotus spinosus (Cockerell); Takagi 1984: 18.
Acanthaspidiotus spinosa (Comstock); Kawai 1987: 18.
Oceanaspidiotus spinosus (Cockerell); Takagi & Moghaddam 2005: 52.

Diagnosis. Scale cover of live adult female flat and white, with subcentral exuviae. Body of live adult female

membranous, yellow, pyriform. Slide-mounted adult female with three well-developed pygidial lobes; L1 largest, each with lateral and medium notches and a well-defined basal sclerosis; L2 smaller than L1 but the same shape; L3 simple, each smaller than L2, with a lateral notch. Perivulvar pores present, paraphyses absent.

Discussion. *Oceanaspidiotus spinosus* could be confused with *H. cyanophylli*; their separation has been discussed above.

Habits on the hosts. *Oceanaspidiotus spinosus* was found attacking avocado fruits, alone or associated with other species of armored scale such as *H. lataniae*, *Ac. albopicta* and *Da. aguacatae* (González *et al.* 2008).

Hosts. The scale is polyphagous, attacking members of 79 genera belonging to 48 plant families, some of which are of economic importance including kiwi, mango, fig, grape vines and avocado, among others (González & Atkinson 1984; Watson 2002; García Morales *et al.* 2016).

Distribution. *Oceanaspidiotus spinosus* is known to be present in 48 countries in Africa, America, Asia and Europe (Watson 2002; García Morales *et al.* 2016). In México, it has been recorded in the states of Baja California, Colima, Michoacán, Morelos and Veracruz (González & Atkinson 1984; González *et al.* 2008; García Morales *et al.* 2016).

Natural enemies. Among the natural enemies that regulate *O. spinosus* are the coccinellid beetles: *Chilocorus bipustulatus*, *Rhyzobius chrysomeloides* and *Rhy. lophanthae*; and the parasitoid wasps, Signiphoridae: *Signiphora flava* and *S. flavella* (Watson 2002; García Morales *et al.* 2016).

***Pseudoparlatoria parlatorioides* (Comstock)**

Aspidiotus parlatorioides Comstock 1883: 64–65.

Pseudoparlatoria parlatorioides (Comstock); Cockerell 1897b: 383.

Pseudoparlatoria pusilla Green, 1922: 1010–1011.

Field diagnosis. Adult female scale cover circular or slightly oval, flat to slightly convex, about 1.0 mm in diameter, semi-transparent and thin, white, with marginal exuviae yellow or slightly brown. According to Watson (2002), the exuviae can be sub-marginal and the scale cover measures 0.75–1.5 mm in diameter. Body of live adult female membranous, pyriform, white, about 0.7 mm long.

Discussion. In field or laboratory, the color and shape of the scale cover of *P. parlatorioides* may vary; to the naked eye, it could be confused with *D. near coccois*, although when the scale cover is lifted, absence of the typical *Diaspis* apical pygidial notch can be seen.

Habits on the hosts. *Pseudoparlatoria parlatorioides* was found mainly on leaves, also on branches, in large groups or individually; on leaves it was observed on both adaxial and/or abaxial surfaces, and on some occasions, it was the most abundant species on such substrates. It was observed associated with other diaspidid scales such as *D. near coccois*, *H. cyanophylli*, *H. diffinis*, *H. lataniae* and *Ho. biclavis*.

Hosts. The scale is a polyphagous species that attacks members of 142 genera belonging to 54 plant families, among which there are several economically important species such as cocoa, coconut, papaya, avocado, peach, and vanilla, among others (Watson 2002; García Morales *et al.* 2016). In this study, it was found associated with the varieties of avocado Hass, Mexicano 1 and Mexicano 2.

Distribution. *Pseudoparlatoria parlatorioides* has been recorded from 31 countries, mainly in the Americas and Europe, but it is also found in Africa and Oceania (Watson 2002; García Morales *et al.* 2016). In México it has been reported for Baja California Sur, Coahuila, Guanajuato, Guerrero, Jalisco, Nayarit, and Sonora (García Morales *et al.* 2016), as well as on Hass avocado in Tingambato, Michoacán (González Hernández, pers. comm., 2019). In the present study it was recorded in the following states and orchards: **Nayarit:** Camino Cerro San Juan and El Aguacate; **Querétaro:** La Estancia; and **Guanajuato:** M1Gto.

Natural enemies. Reported natural enemies of *P. parlatorioides* are: Aphelinidae: *Encarsia citrina* (Watson 2002; García Morales *et al.* 2016) and Encyrtidae: *Cheiloneurus* sp. (Noyes 2019). In the present study, four parasitoids were found parasitizing the scale, identified as: Aphelinidae: *Aphytis lepidosaphes* (2F), *Aph. lingnanensis* (1F) and *Aph. melinus* (1F).

Conclusions

From collections made in the eight main avocado-producing states in México, on different avocado varieties, 16 species of armored scale were detected and two other species previously reported are described above: nine of these species attack leaves and branches in addition to the fruits, and a dichotomous key has been provided to facilitate their identification.

Of these armored scale species, those with the widest geographical distribution in México were *Diaspis* near *coccois*, *Hemiberlesia cyanophylli*, *H. diffinis* and *H. lataniae*, the latter having been found in all the states sampled.

Most of the armored scales on avocado were found in low numbers; only three species of *Hemiberlesia* were detected in large groups, infesting several structures of the trees.

A very large group of parasitoids were detected, associated with most of the avocado armored scales found.

Acknowledgements

The authors are grateful to the National Council of Science and Technology (CONACYT) for the scholarship to pursue doctoral studies for the first author. Thanks to the Colegio de Postgraduados for funding this research, to Dra. Elba Lidia Castañeda González (Fundación Salvador Sánchez Colín CICTAMEX S.C.); also to Víctor Hugo Campos Martínez (Comité Estatal de Sanidad Vegetal del Estado de Morelos), Alejandro Sánchez Cortez (Comité Estatal de Sanidad Vegetal del Estado de Puebla), Alejandro Figueroa García (Comité Estatal de Sanidad Vegetal del Estado de Colima), Juan Carlos López, Diego López (Comité Estatal de Sanidad Vegetal del Estado de Jalisco), Dr Agustín Bermúdez Robles, Dr Néstor Isordia Aquino (Universidad Autónoma de Nayarit) and José Luís Hernández Rodríguez (Comité Estatal de Sanidad Vegetal del Estado de Querétaro) for their support in the fieldwork and transport of collected plant material to the laboratory. We are also grateful to all the avocado producers of the states visited who allowed us to take samples from their orchards for our study, and to Dr Beatriz Rodríguez Vélez of the National Center of Reference in Biological Control (DGSV-SENASICA-SADER) for corroboration and identification of Encyrtidae species. We also thank Drs Natalia von Ellenrieder and Douglass R. Miller whose comments helped to improve the manuscript.

References

- Balachowsky, A.S. (1948) Les cochenilles de France, d'Europe, du nord de l'Afrique et du bassin Méditerranéen. IV. Monographie des Coccoidea, classification—Diaspidinae (Premiere partie). *Entomologie Appliquée Actualités Scientifiques et Industrielles*, 1054, 243–394.
- Berlese, A.M. (1895) Le cocciniglie Italiane viventi sugli argumi. Parte III. I. Diaspiditi. [Cap. I. Note di sistematica e descrizione delle specie]. *Rivista di Patologia Vegetale, Firenze*, 4, 74–170.
- Berlese, A.M. & Leonardi, G. (1896) Diagnosi di cocciniglie nuove. (Cont.). *Rivista di Patologia Vegetale, Firenze*, 4, 345–352.
- Berlese, A.M. & Leonardi, G. (1898) n.k. In: *Notizie in torno alle cocciniglie Americane che Minacciano la frutticoltura Europea. Annali di Agricoltura. Vol. 2.* Ministero di Agricoltura, Industria e Commercio, Firenze, Roma, pp. 1–142.
- Bodenheimer, F.S. (1952) The Coccoidea of Turkey. I. *Revue de la Faculté des Sciences de l'Université d'Istanbul, Series B*, 17, 315–351.
- Bodkin, G.E. (1922) The scale insects of British Guiana. *Journal of the Board of Agriculture of British Guiana*, 15, 56–63.
- Boisduval, J.B.A. (1867) Essai sur l'entomologie horticole. Librairie d'horticulture de E. Donnaud, Paris, 648 pp.
<https://doi.org/10.5962/bhl.title.36467>
- Boisduval, J.B.A. (1868) Conférence faite le 18 août par le Dr. Boisduval, au Palais de l'Industrie, sur les insectes qui ont ravagé les plantes exposées par Mm. Burel et Rivière. *Journal l'Insectologie Agricole*, 2, 266–283.
- Boratynski, K. (1968) A note on some species of the genus *Diaspis* Costa, 1828, (Hemiptera, Coccoidea) in the collections of the Naturhistorisches Museum in Vienna; with the description of a new species. *Annalen Naturhistorische Museum Wien*, 72, 33–43.
- Borchsenius, N.S. (1966) *A catalogue of the armoured scale insects (Diaspidoidea) of the world.* Nauka, Moscow and Leningrad, 449 pp.
- Bouché, P.F. (1833) *Naturgeschichte der Schädlichen und Nützlichen Garteninsekten und die bewährtesten Mittel.* Nicolai, Berlin, 176 pp.

- Bouché, P.F. (1851) Neue Arten der Schildlaus-Familie. *Entomologische Zeitung, Stettin*, 12, 110–112.
- Carimini, M. (1930) Una varietà di “*Aspidiotus*”. *Aspidiotus hederæ* var. *unipectinata carmini*. *Redia*, 18, 121–123.
- Chou, I. (1985) n.k. In: *Monograph of the Diaspididae of China. Vol. 2*. Shanxi Publ. House of Science & Technology, Shanxi, pp. 196–432 + 9.
- Cockerell, T.D.A. (1893a) Notes on some Mexican Coccidae. *Annals and Magazine of Natural History*, Series 6, 12, 47–53.
<https://doi.org/10.1080/00222939308677598>
- Cockerell, T.D.A. (1893b) A list of West Indian Coccidae. *Journal of the Institute of Jamaica*, 1, 252–256.
- Cockerell, T.D.A. (1894) Notes on some scale insects of the sub-family Diaspinae. *Canadian Entomologist*, 26, 127–132.
<https://doi.org/10.4039/Ent26127-5>
- Cockerell, T.D.A. (1895) On a new scale insect found on plum. *Canadian Entomologist*, 27, 16–19.
<https://doi.org/10.4039/Ent2716-1>
- Cockerell, T.D.A. (1896) A check list of the Coccidae. *Bulletin of the Illinois State Laboratory of Natural History*, 4, 318–339.
<https://doi.org/10.21900/j.inhs.v4.435>
- Cockerell, T.D.A. (1897a) The San Jose scale and its nearest allies. *United States Department of Agriculture, Division of Entomology, Technical Series*, 6, 1–31.
<https://doi.org/10.5962/bhl.title.87461>
- Cockerell, T.D.A. (1897b) Further notes on Coccidae from Brazil. *Revista do Museo Paulista*, 2, 383–384.
- Cockerell, T.D.A. (1898a) New Coccidae from México. *Annals and Magazine of Natural History*, Series 7, 1, 426–440.
<https://doi.org/10.1080/00222939808677997>
- Cockerell, T.D.A. (1898b) The Coccidae of the Sandwich Islands. *The Entomologist*, 31, 239–240.
- Cockerell, T.D.A. (1899a) First supplement to the check-list of the Coccidae. *Illinois Natural History Survey Bulletin*, 5 (1–12), 389–398.
<https://doi.org/10.21900/j.inhs.v5.418>
- Cockerell, T.D.A. (1899b) Rhynchota, Hemiptera—Homoptera. [Aleurodidae and Coccidae]. *Biologia Centrali-Americana*, 2, 1–37. [<https://www.biodiversitylibrary.org/item/14634#page/23/mode/1up>]
- Cockerell, T.D.A. (1900) Table to separate the commoner scales (Coccidae) of the orange. *Memorias de la Sociedad Científica “Antonio Alzate”*, 13, 349–351.
- Cockerell, T.D.A. (1905a) A table to facilitate the determination of the Mexican scale-insects of the genus *Aspidiotus* (sens. latiss.). *American Naturalist*, 39, 45–46.
<https://doi.org/10.1086/278483>
- Cockerell, T.D.A. (1905b) Tables for the identification of Rocky Mountain Coccidae (Scale insects and mealybugs). *Colorado University Studies*, 2, 189–203.
- Cockerell, T.D.A. & Parrott, P.J. (1899) Contributions to the knowledge of the Coccidae. IX. A green *Mytilaspis*. *The Industrialist*, 25, 276–284.
- Colvée, P. (1880) Ensayo sobre una nueva enfermedad del olivo, producida por una nueva especie del genero *Aspidiotus*. *Gaceta Agrícola del Ministerio de Fomento*, 14, 21–41.
- Colvée, P. (1881) *Estudios sobre algunos insectos de la familia de los coccidos*. Nicasio Rius Monfort, Valencia, 40 pp.
- Colvée, P. (1882) *Nuevos estudios sobre algunos insectos de la familia de los coccidos*. Nicasio Ruis Monfort, Valencia, 16 pp.
- Comstock, J.H. (1881a) Notes on Coccidae. *Canadian Entomologist*, 13, 8–9.
<https://doi.org/10.4039/Ent138-1>
- Comstock, J.H. (1881b) Report of the Entomologist. *Report of the Commissioner of Agriculture, United States Department of Agriculture*, 1880/1881, 276–349.
- Comstock, J.H. (1883) Second report on scale insects, including a monograph of the sub-family Diaspinae of the family Coccidae and a list, with notes of the other species of scale insects found in North America *Department of Entomology Report, Cornell University Agricultural Experiment Station*, 2, 47–142.
- Costa, O.G. (1829) *Fauna del Regno di Napoli, famiglia de coccinigliferi, o de gallinsetti*. Emitteri, Napoli, 23 pp.
- Costa Lima, A.M. da (1942) Insectos do Brasil. 3º Tomo, Homopteros. *Escola Nacional de Agronomia in its Série Didáctica*, 4, 1–327.
<https://doi.org/10.1093/aesa/35.3.338>
- De Gregorio, A. (1915) Caratteri e biologia del *Chrysomphalus dictyospermi* Morg. auctorum (an potius *Aspidiotus agrumicola* De Greg.?) e del suo parassita distruttore *Aphelinus chrysomphali* Gar. Merc. var. *silvestrii* De Greg. con cenni di due ragni submicroscopici (Li-cosa). *Il Naturalista Siciliano*, 22, 125–190.
- Deitz, L.L. & Davidson, J.A. (1986) *Synopsis of the armored scale genus Melanaspis in North America (Homoptera: Diaspididae)*. North Carolinian State University, Technical Bulletin No. 279. North Carolina State University, Raleigh, North Carolina, 92 pp.
- Doane, R.W. & Hadden, E. (1909) Coccidae from the Society Islands. *Canadian Entomologist*, 41, 296–300. Available from: <https://www.biodiversitylibrary.org/item/22162#page/312/mode/1up> (accessed 5 September 2023)
<https://doi.org/10.4039/Ent41296-8>
- Evans, G.A., Watson, G.W. & Miller, D.R. (2009) A new species of armored scale (Homoptera: Coccoidea: Diaspididae) found on avocado fruit from México and a key to the species of armored scales found on avocado worldwide. *Zootaxa*, 1991 (1),

57–68.

<https://doi.org/10.11646/zootaxa.1991.1.5>

- Fernald, M.E. (1903) A catalogue of the Coccidae of the world. *Bulletin of the Hatch Experiment Station of the Massachusetts Agricultural College*, 88, 1–360.
<https://doi.org/10.5962/bhl.title.8533>
- Ferris, G.F. (1921) Notes on Coccidae—VII & VIII (Homoptera). *Canadian Entomologist*, 53, 57–61 & 91–95.
<https://doi.org/10.4039/Ent5391-4>
- Ferris, G.F. (1937) Contributions to the knowledge of the Coccoidea (Homoptera). V. *Microentomology*, 2, 47–101.
- Ferris, G.F. (1938) *Atlas of the scale insects of North America. Series II*. Stanford University Press, Palo Alto, California, 131 pp.
- Ferris, G.F. (1941a) *Atlas of the scale insects of North America. Series III*. Stanford University Press, Palo Alto, California, 115 pp.
- Ferris, G.F. (1941b) The genus *Aspidiotus* (Homoptera; Coccoidea; Diaspididae). *Microentomology*, 6, 33–69.
- Ferris, G.F. (1942) *Atlas of the scale insects of North America. Series IV. The Diaspididae. Second Printing*. Stanford University Press, Stanford, California, 253 pp.
- Froggatt, W.W. (1914) Descriptive catalogue of the scale insects (“Coccidae”) of Australia (Part I.). *Agricultural Gazette of New South Wales*, 25, 127–136.
<https://doi.org/10.5962/bhl.title.9276>
- García Morales, M., Denno, B.D., Miller, D.R., Miller, G.L., Ben-Dov, Y. & Hardy, N.B. (2016) *ScaleNet: a literature-based model of scale insect biology and systematics*. Database. Available from: <http://scalenet.info> (accessed 2 August 2023)
<https://doi.org/10.1093/database/bav118>
- Gennadius, P. (1881) Sur une nouvelle espèce de cochenille du genre *Aspidiotus* (*Aspidiotus coccineus*) *Annales de la Société entomologique de France*, 6 (1), 189–192.
- Giannoti, O. (1942) Duas novas especies de coccideos do Brasil (Homoptera—Coccoidea). *Archivos do Instituto Biológico São Paulo*, 13, 213–216.
- Gómez-Menor Ortega, J. (1941) Cócidos de la República Dominicana (Hom. Cocc.). *EOS*, 16 (1940), 125–143. [<https://archive.org/details/eos-0013-9440-147800>]
- González, H.H. & Atkinson, T.H. (1984) Coccoideos (Homoptera: Coccoidea) asociados a árboles frutales de la región central de México. *Agrociencia*, 57, 207–225.
- González, H.H., Ortega-Arenas, L.D., Villegas, N., López, M.F. & Rojas, P. (2008) *Escamas armadas (Homoptera: Diaspididae) del aguacate Persea americana var. Hass en huertos certificados para exportación del estado de Michoacán. Asociación de Productores y Empacadores Exportadores de Aguacate de Michoacán, A.C. (APEAM). Internal Report (restricted distribution)*. s.n., s.l., 15 pp.
- Gordon, R.D. (1985) The Coccinellidae (Coleoptera) of North America of México. *Journal of the New York Entomological Society*, 93 (1), 1–912.
- Green, E.E. (1890) *Insect pests of the tea plant. Part I*. Independent Press, Colombo, 104 pp.
- Green, E.E. (1896) Catalogue of Coccidae collected in Ceylon. *Indian Museum Notes*, 4, 2–10.
<https://doi.org/10.5962/bhl.title.8551>
- Green, E.E. (1905) On some Javanese Coccidae: With descriptions of new species. *Entomologist's Monthly Magazine*, 41, 28–33.
- Green, E.E. (1915) New species of Coccidae from Australia. *Bulletin of Entomological Research*, 6, 45–53.
<https://doi.org/10.1017/S000748530004339X>
- Green, E.E. (1922) Supplementary notes on the Coccidae of Ceylon. Part IV. *Journal of the Bombay Natural History Society*, 28, 1007–1037. [<https://www.biodiversitylibrary.org/page/52170643#page/561/mode/1up>]
- Hall, W.J. (1923) Further observations on the Coccidae of Egypt. *Ministry of Agriculture, Egypt, Technical and Scientific Service, Bulletin*, 36, 1–61.
- Hempel, A. (1900) As coccidas Brasileiras. [Brazilian coccids]. *Revista do Museu Paulista, São Paulo*, 4, 365–537.
- Hempel, A. (1932) Descrição de vinte a duas espécies novas de coccideos (Homoptera—Homoptera). *Revista de Entomologia*, 2, 310–339.
- Houser, J.S. (1918) The Coccidae of Cuba. *Annals of the Entomological Society of America*, 11, 157–172.
<https://doi.org/10.1093/aesa/11.2.157>
- Hunter, S.J. (1899) The Coccidae of Kansas. *Kansas University Quarterly*, 8, 1–15.
<https://doi.org/10.5962/bhl.title.135366>
- Kawai, S. (1987) The coccid fauna of the Ogasawara (Bonin) Islands. In: *Development, Technique and Cooperation in Agriculture: a Collection of Papers to Commemorate the 30th Anniversary*. Tokyo University of Agriculture, Tokyo, pp. 75–86.
- Komosinska, H. (1969) Studies on the genus *Abgrallaspis* Balachowsky, 1948, (Homoptera, Coccoidea, Diaspididae). *Acta Zoologica Cracoviensia*, 14, 43–85. [<https://archive.org/details/actazoolcrac-14-03>]
- Kosztarab, M. (1963) The armored scale insects of Ohio (Homoptera: Coccoidea: Diaspididae). *Bulletin of the Ohio Biology Survey, New Series*, 2, 120 pp.
- Kuwana, S.I. (1925) The diaspine Coccidae of Japan. II. The genus *Lepidosaphes*. *Bulletin of Agriculture and Commerce*,

Imperial Plant Quarantine Station, Yokohama, 2, 1–42.

- Kuwana, S.I. (1932) Description of two new Coccidae from Japan. *Kontyu*, 6, 143–148.
- Lázaro-Castellanos, C., González-Hernández, H., Lomelí-Flores, J.R., Myartseva, S.N., Ortega-Arenas, L.D. & Ochoa-Ascencio, S. (2012) Enemigos naturales de escamas armadas (Hemiptera: Diaspididae) en aguacate Hass en Michoacán, México. *Revista Colombiana de Entomología*, 38 (1), 6–13.
<https://doi.org/10.25100/socolen.v38i1.8907>
- Leonardi, G. (1897a) Generi e specie diaspiti. Saggio di sistematica degli *Aspidiotus*. *Rivista di Patologia Vegetale, Firenze*, 6, 102–134.
- Leonardi, G. (1897b) Monografia de genere *Aspidiotus* (nota preventiva). *Rivista di Patologia Vegetale, Firenze*, 5, 283–286.
- Leonardi, G. (1898) Generi e specie di diaspiti saggio di sistematica degli *Aspidiotus*. *Rivista di Patologia Vegetale, Firenze*, 7, 38–86.
- Leonardi, G. (1899) Generi e specie di diaspiti. Saggio di sistematica degli *Aspidiotus*. *Rivista di Patologia Vegetale, Firenze*, 7, 173–225.
- Leonardi, G. (1900) Generi e specie di diaspiti. Saggio di sistematica degli *Aspidiotus*. *Rivista di Patologia Vegetale, Firenze*, 8, 298–363.
- Leonardi, G. (1911) Contributo alla conoscenza delle coccinglie della Repubblica Argentina. *Bollettino del R. Laboratorio di Entomologia Agraria di Portici*, 5, 237–284.
- Leonardi, G. (1914) Contributo alla conoscenza delle coccinglie dell’Africa occidentale e meridionale. *Bollettino del Laboratorio di Zoologia Generale e Agraria della R. Scuola Superior Agricoltura, Portici*, 8, 187–224. [<https://biostor.org/reference/105621>]
- Lindinger, L. (1913) Einige Cocciden aus dem ausserdeutschen Ostafrika. [Supplement to Afrikanische Schildläuse V]. *Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten. Hamburg*, 30, 96–100.
- Lindinger, L. (1921) Tätigkeitsbericht der Schädlingsabteilung des Instituts für angewandte Botanik zu Hamburg für die Zeit vom 14. Februar bis zum 30. Juni 1920. *Zeitschrift für Angewandte Entomologie*, 7, 424–440.
<https://doi.org/10.1111/j.1439-0418.1921.tb01488.x>
- Lindinger, L. (1935) Die nunmehr gültigen Namen der Arten in meinem ‘Schildläusebuch’ und in den ‘Schildläusen der Mitteleuropäischen Gewächshäuser’. *Entomologisches Jahrbuch*, 44, 127–149.
- Lindinger, L. (1937) Verzeichnis der Schildlaus-Gattungen. (Homoptera—Coccoidea Handlirsch, 1903). *Entomologisches Jahrbuch*, 46, 178–198. [https://www.zobodat.at/pdf/Ent-Jb-Krancher_1937_0178-0198.pdf]
- Lindinger, L. (1949) Einige Mitteilungen über Schildläuse (Homopt., Coccoidea). *Zeitschrift für die Gesam. Insektenkunde Entomologischen Internationaler*, 1, 210–213.
- MacGillivray, A.D. (1921) *The Coccidae. Tables for the identification of the subfamilies and some of the more important genera and species, together with discussions of their anatomy and life history*. Scarab Company, Urbana, Illinois, 502 pp.
<https://doi.org/10.5962/bhl.title.8556>
- Malenotti, E. (1916) Nuovi diaspiti. *Redia*, 12 (1917), 183–194.
<https://doi.org/10.25291/VR/1916-VLR-183>
- Mamet, R.J. (1936) New species of Coccidae (Hemipt. Homopt.) from Mauritius. *Proceedings of the Royal Entomological Society of London, Series B*, 5, 90–96.
<https://doi.org/10.1111/j.1365.3113.1936.tb00599.x>
- Marchal, P. (1904) Sur la biologie du *Chrysomphalus dictyospermi* var. *minor* Berlese, et sur l’extension de cette cochenille dans le Bassin Méditerranéen. *Bulletin de la Société entomologique de France*, 16, 246–249. [https://www.persee.fr/doc/bsef_0037-928x_1904_num_9_16_23581]
<https://doi.org/10.3406/bsef.1904.23581>
- Maskell, W.M. (1879) On some Coccidae in New Zealand. *Transactions and Proceedings of the New Zealand Institute*, 11 (1878), 187–228.
- Maskell, W.M. (1884) Further notes on Coccidae in New Zealand, with descriptions of new species. *Transactions and Proceedings of the New Zealand Institute*, 16 (1883), 120–144.
- Maskell, W.M. (1885) Further notes on Coccidae in New Zealand. *Transactions and Proceedings of the New Zealand Institute*, 17 (1884), 20–31.
- Maskell, W.M. (1895) Further coccid notes: with description of new species from New Zealand, Australia, Sandwich Islands, and elsewhere, and remarks upon many species already reported. *Transactions and Proceedings of the New Zealand Institute*, 27 (1894), 36–75. [<https://paperspast.natlib.govt.nz/periodicals/TPRSNZ1894-27.2.6.1.2>]
- Maskell, W.M. (1897) On a collection of Coccidae, principally from China and Japan. *Entomologist’s Monthly Magazine*, 33, 239–244.
<https://doi.org/10.5962/bhl.part.18316>
- Maskell, W.M. (1898) Further coccid notes: with descriptions of new species, and discussion of points of interest. *Transactions and Proceedings of the New Zealand Institute*, 30 (1897), 219–252.
- Maxwell-Lefroy, H.M. (1902) Scale insects of the West Indies. *West Indian Bulletin*, 3, 295–319.
- McKenzie, H.L. (1939) A revision of the genus *Chrysomphalus* and supplementary notes on the genus *Aonidiella* (Homoptera: Coccoidea: Diaspididae). *Microentomology*, 4, 51–77.
- Merrill, G.B. (1953) A revision of the scale insects of Florida. *Bulletin of the Florida State Plant Board*, 1, 1–143.

- Miller, D.R. & Davidson, J.A. (1998) A new species of armored scale (Hemiptera: Coccoidea: Diaspididae) previously confused with *Hemiberlesia diffinis* (Newstead). *Proceedings of the Entomological Society of Washington*, 100 (2), 193–201. [<https://biostor.org/reference/56938>]
- Miller, D.R. & Davidson, J.A. (2005) *Armored scale insect pests of trees and shrubs*. Cornell University Press, Ithaca, New York, 442 pp.
- Morgan, A.C.F. (1889) Observations on Coccidae. No. 5. *Entomologist's Monthly Magazine*, 25, 349–353.
- Morse, J.G., Rugman-Jones, P.F., Watson, G.W., Robinson, L.J., Bi, J.L. & Stouthamer, R. (2009) High levels of exotic armored scales on imported avocados raise concerns regarding USDA-APHIS' phytosanitary risk assessment. *Journal of Economic Entomology*, 102 (3), 855–867.
<https://doi.org/10.1603/029.102.0303>
- Murray, A. (1871) Cocci of the orange trees. *Gardeners' Chronicle and Agricultural Gazette*, 1871, 342. [18 March 1871]
- Myartseva, S.N. & Evans, G.A. (2008) *Genus Encarsia Foster of México (Hymenoptera: Chalcidoidea: Aphelinidae): a revision, key and description of new species. 1st Edition*. Departamento de Fomento Editorial, UAT. Ciudad Victoria, Tamaulipas, 320 pp.
- Myartseva, S.N. & Ruíz-Cancino, E. (2001) Mexican species of parasitoid wasps of the genus *Marietta* (Hymenoptera: Aphelinidae). *Florida Entomologist*, 84 (2), 293–297.
<https://doi.org/10.2307/3496182>
- Myartseva, S.N., Ruíz-Cancino, E. & Coronado-Blanco, J.M. (2010) El género *Aphytis* Howard (Hymenoptera: Chalcidoidea: Aphelinidae) en México, clave de especies y descripción de una especie nueva. *Dugesiana*, 17 (1), 81–94.
<https://doi.org/10.21829/azm.2010.261676>
- Myartseva, S.N., Coronado-Blanco, J.M. & Ruíz-Cancino, E. (2012) El género *Ablerus* Howard (Hymenoptera: Aphelinidae) en América del norte, con la descripción de dos especies nuevas de México. *Acta Zoológica Mexicana, New Series*, 28 (2), 447–456.
<https://doi.org/10.21829/azm.2012.282845>
- Myartseva, S.N., Ruíz-Cancino, E. & Coronado-Blanco, J.M. (2016) Two new species of the genus *Coccobius* Ratzeburg, 1852 (Hymenoptera: Chalcidoidea: Aphelinidae) from México. *Zoosystematica Rossica*, 25 (1), 165–172.
<https://doi.org/10.31610/zsr/2016.25.1.165>
- Newell, W. (1899) On the North American species of the subgenera *Diaspidiotus* and *Hemiberlesia*, of the genus *Aspidiotus*. *Contributions of the Department of Zoology and Entomology, Iowa State College*, 3, 1–31.
<https://doi.org/10.31610/zsr/2016.25.1.165>
- Newstead, R. (1893a) Observations of Coccidae. No. 5. *Entomologist's Monthly Magazine*, 29, 185–188.
- Newstead, R. (1893b) Observations on Coccidae. No. 7. *Entomologist's Monthly Magazine*, 29, 279–280.
- Normark, B.B., Morse, G.E., Krewinski, A. & Okusu, A. (2014) Armored scale insects (Hemiptera: Diaspididae) of San Lorenzo National Park, Panama, with descriptions of two new species. *Annals of the Entomological Society of America*, 107 (1), 37–49.
<https://doi.org/10.1603/AN13110>
- Noyes, J.S. (1980) A review of the genera of Neotropical Encyrtidae (Hymenoptera: Chalcidoidea). *Bulletin of the British Museum (Natural History) Entomology*, 41 (3), 107–253.
- Noyes, J.S. (1982) Collecting and preserving chalcid wasps (Hymenoptera: Chalcidoidea). *Journal of Natural History*, 16, 315–334.
<https://doi.org/10.1080/00222938200770261>
- Noyes, J.S. (2019) Universal Chalcidoidea database. World Wide Web electronic publication. Available from: <http://www.nhm.ac.uk/chalcidoids> (accessed 12 December 2019)
- Noyes, J.S., Woolley, J.B. & Zolnerowich, G. (1997) Encyrtidae. In: Gibson, G.A.P., Huber, J.T., Woolley, J.B. & Woolley, J.B. (Eds.), *Annotated keys to the Genera of the Nearctic Chalcidoidea (Hymenoptera)*. NRC Research Press, Ottawa, Ontario, pp. 170–320.
- Paoli, G. (1915) Contributo alla conoscente della cocciniglie della Sardegna. *Redia*, 11 (1916), 239–268. [<https://biostor.org/reference/103242>]
- Ramakrishna Ayyar, T.V. (1921) A check list of the Coccidae of the Indian region. *Proceedings of the Entomology Meetings, India*, 4, 336–362.
- Ramírez-Ahuja, M.L., Dal Molin, A., González-Hernández, A. & Woolley, J.B. (2015) Sinopsis y clave para la identificación de las especies de *Signiphora* (Hymenoptera: Signiphoridae) de México, con notas sobre biología y distribución. *Revista Mexicana de Biodiversidad*, 86, 337–347.
<https://doi.org/10.1016/j.rmb.2015.04.026>
- Sasaki, I. (1935) On three new species of *Aspidiotus* and *Chrysomphalus* discovered in plant inspection. *Journal of Plant Protection, Nippon Plant Protection Society (Byochugai Zasshi)*, 22, 864–867.
- Schauff, M.E., LaSalle, J. & Coote, L.D. (1997) Eulophidae. In: Gibson, G.A.P., Huber, J.T., Woolley, J.B. & Woolley, J.B. (Eds.), *Annotated keys to the Genera of the Nearctic Chalcidoidea (Hymenoptera)*. NRC Research Press, Ottawa, Ontario, pp. 327–429.
- Schmutterer, H. (1952) Die Ökologie der Cocciden (Homoptera, Coccoidea) Frankens. 2. Abschnitt. *Zeitschrift für Angewandte Entomologie*, 33 & 34, 369–420 + 544–584 & 65–100.

<https://doi.org/10.1111/j.1439-0418.1952.tb00684.x>

- Signoret, V. (1869a) Essai sur les cochenilles ou gallinsectes (Homoptères—Coccides) 2e partie. *Annales de la Société entomologique de France*, 8, 829–876.
- Signoret, V. (1869b) Essai sur les cochenilles ou gallinsectes (Homoptères—Coccides), 4e partie. *Annales de la Société entomologique de France*, Series 4, 9, 109–138. [<https://biostor.org/reference/236188>]
- Signoret, V. (1869c) Essai sur les cochenilles ou gallinsectes (Homoptères—Coccides), 4e partie. [Essay on the gall forming insects (Homoptera—Coccidae). 4th Part.]. *Annales de la Société entomologique de France*, 9, 109–138.
- Signoret, V. (1870) Essai sur les cochenilles ou gallinsectes (Homoptères—Coccides), 6e partie. *Annales de la Société entomologique de France*, 4 (10), 91–110.
- Signoret, V. (1877) Essai sur les cochenilles ou gallinsectes (Homoptères—Coccides), 18e et dernière partie. *Annales de la Société entomologique de France*, Series 5, 6, 591–676.
- Smith-Pardo, A.H., Evans, G.A. & Dooley, J.W. (2012) A review of the genus *Chrysomphalus* Ashmead (Hemiptera: Coccoidea: Diaspididae) with descriptions of a new species and a new, related genus. *Zootaxa*, 3570 (1), 1–24. <https://doi.org/10.11646/zootaxa.3570.1.1>
- Solis, A.J.F., Tejada, M.L.O. & González-Hernández, H. (1992) Escamas (Homoptera: Coccoidea) asociadas con árboles frutales de Apodaca y Allende, y con plantas ornamentales del área de Monterrey, Nuevo León, México. *Folia Entomológica Mexicana*, 85, 5–19.
- Soria, S., Moreno, M., Viñuela, E. & Del Estal, P. (2000) Localización en España de *Diaspis coccois* (Lichtenstein 1882) sobre palmera. *Boletín de sanidad vegetal. Plagas*, 26, 317–321.
- Stocks, I.C. & Evans, G.A. (2017) Armored scales (Hemiptera: Diaspididae) infesting Hass avocado intercepted in Florida and a new parasitoid-host association for *Davidsonaspis aguacatae*. *Florida Entomologist*, 100 (2), 491–494. <https://doi.org/10.1653/024.100.0244>
- Takagi, S. (1984) Some aspidiotine scale insects with enlarged setae on the pygidial lobes (Homoptera: Coccoidea: Diaspididae). *Insecta Matsumurana*, New Series, 28, 1–69. Available from: <https://archive.org/details/313a95fd3a275b1ce4e5e0d8b546bde0d16c0fa4/page/3/mode/2up> (accessed 13 August 2023)
- Takagi, S. & Kawai, S. (1966) Some Diaspididae of Japan (Homoptera: Coccoidea). *Insecta Matsumurana*, New Series, 28, 93–119. Available from: [https://eprints.lib.hokudai.ac.jp/dspace/bitstream/2115/9732/1/28\(2\)_p93-119.pdf](https://eprints.lib.hokudai.ac.jp/dspace/bitstream/2115/9732/1/28(2)_p93-119.pdf) (accessed 13 August 2023)
- Takagi, S. & Moghaddam, M. (2005) New or noteworthy armoured scale insects occurring in Iran (Homoptera: Coccoidea: Diaspididae). *Insecta Matsumurana*, New Series, 61, 43–74. Available from: https://eprints.lib.hokudai.ac.jp/dspace/bitstream/2115/9922/1/61_p43-74.pdf (accessed 13 August 2023)
- Takagi, S. & Yamamoto, M. (1974) Two new banana-infesting scale insects of *Hemiberlesia* or *Abgrallaspis* from Ecuador (Homoptera: Coccoidea). *Insecta Matsumurana*, New Series, 3, 35–42. Available from: https://eprints.lib.hokudai.ac.jp/dspace/bitstream/2115/9775/1/3_p35-42.pdf (accessed 13 August 2023)
- Takahashi, R. (1933) Observations on the Coccidae of Formosa. III. Report. Government Research Institute. *Department of Agriculture, Formosa*, 60, 1–64.
- Targioni Tozzetti, A. (1867) Studii sulle Cocciniglie. *Memorie della Società Italiana di Scienze Naturali, Milano*, 3 (3), 1–87. <https://doi.org/10.4081/memorieSEI.2008.3>
- Targioni Tozzetti, A. (1868) Introduzione alla seconda memoria per gli studi sulle cocciniglie, e catalogo dei generi e delle specie della famiglia dei coccidi. *Atti della Società italiana di scienze naturali*, 11, 721–738. Available from: <https://biostor.org/reference/235892> (accessed 12 August 2023)
- Targioni Tozzetti, A. (1881) Relazione intorno ai lavori della R. Stazione di Entomologia Agraria di Firenze per gli anni 1877–78. Parte scientifica. Fam. Coccidi. *Annali di Agricoltura. Ministero di Agricoltura, Industria e Commercio, Firenze, Roma*, 1881, 134–161.
- Targioni Tozzetti, A. (1888) Relazione intorno ai lavori della R. Stazione di Entomologia Agraria di Firenze per gli anni 1883–84–85. Article VI. Ord. eterotteri-omotteri. Hemiptera, 1. pars, Rhyngota, F. Rhyncota, Fieb. (sottord. coccidi). *Annali di Agricoltura (Ministero di Agricoltura, Industria e Commercio), Firenze*, 1888, 415–437.
- Teliz, D. & Mora, A. (2007) *El aguacate y su manejo integrado. 2nd Edition*. Colegio de Postgraduados, Biblioteca Básica de Agricultura, México, D.F., 300 pp.
- Thiem, H. & Gerneck, R. (1934) Untersuchungen an Deutschen Austernschildläusen (Aspidiotini) im vergleich mit der San José-Schildlaus (*Aspidiotus perniciosus* Comst.). *Arbeiten über morphologische und taxonomische Entomologie aus Berlin-Dahlem*, Band I (2), 130–158. Available from: <https://sdei.senckenberg.de/media/openaccess/01697.pdf> (accessed 12 August 2023)
- Townsend, C.H.T. (1897) Locality and food plant catalogue of Mexican Coccidae. *Journal of the New York Entomological Society*, 5, 178–190. Available from: <https://biostor.org/reference/13925> (accessed 13 August 2023)
- Townsend, C.H.T. & Cockerell, T.D.A. (1898) Coccidae collected in México by Messrs. Townsend and Koebele in 1897. *Journal of the Entomological Society of New York*, 6, 165–180. Available from: <https://www.jstor.org/stable/25002818> (accessed 13 August 2023)
- Vernalha, M.M. (1953) Coccideos da colecao I.B.P.T. *Arquivos de Biologia e Tecnologia, Curitiba*, 8, 111–304.
- Watson, G.W. (2002) *Arthropods of Economic Importance: Diaspididae of the World 2.0. An illustrated identification guide and information source. Web version of a CD-ROM released by ETI Bioinformatics*. University of Amsterdam, Amsterdam.

Available from: https://diaspididae.linnaeus.naturalis.nl/linnaeus_ng/app/views/introduction/topic.php?id=3377&epi=155 (accessed 2 August 2023)

- Wei, J., Schneider, S.A., Normark, R.D. & Normark, B.B. (2021) Four new species of Aspidiotini (Hemiptera, Diaspididae, Aspidiotinae) from Panama, with a key to Panamanian species. *ZooKeys*, 1047, 1–25.
<https://doi.org/10.3897/zookeys.1047.68409>
- Westwood, J.O. (1840) *An introduction to the modern classification of insects; founded on the natural habits and corresponding organization of different families. Vol. II.* Longman, Orme, Brown, Green and Longmans, London, 587 pp.
<https://doi.org/10.5962/bhl.title.12455>
- Wise, K.A.J. (1977) A synonymic checklist of the Hexapoda of the New Zealand sub-region. The smaller orders. *Bulletin of the Auckland Institute and Museum. Auckland, New Zealand*, 11, 1–145.
- Woolley, J.B. & Dal Molin, A. (2017) Taxonomic revision of the *flavopalliata* species group of *Signiphora* (Hymenoptera: Signiphoridae). *Zootaxa*, 4315 (1), 1–150.
<https://doi.org/10.11646/zootaxa.4315.1.1>
- Zahradnik, J. (1977) Aleyrodinea-Coccinea. In: “Enumeratio Insectorum Bohemoslovakiae”. *Acta Faunistica Entomologica Musei Nationalis Pragae*, Supplementum 4, pp. 117–122.