CIRCULAR

FDACS-P-02203
Issue No. 445 | November 2023

Florida Department of Agriculture and Consumer Services
Division of Plant Industry

An initial list of arthropods on hemp (*Cannabis sativa* L.; Cannabaceae) in Florida

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INTRODUCTION

Hemp (*Cannabis sativa* L., Rosales: Cannabaceae) is an upright, annual herb that originated in Europe, India and China (McPartland 2017). It can grow throughout the world in temperate and tropical climates (Dodge 1898). Its cultivation has a long and checkered history in the United States, dating back to the early American colonies in Virginia (Deitch 2003, Johnson 2019). It is used for fiber (e.g., rope, linen, paper, livestock bedding), seed or oil (e.g., food, flavorings, soap), or cannabidiol (CBD) extracts (Clarke 1999). It can be grown hydroponically or in soil, in protected areas (e.g., greenhouses) or in open fields. The cultural practices (e.g., fertilization) used to produce a crop can affect plant susceptibility to different pests and diseases (McPartland 1999). The arthropod pest complex, specifically, can also vary with the hemp variety, plant growth stage, plant part (e.g., seeds or stems) to be harvested, as well as geographic location. Guidelines for optimal plant growth and pest management within different regions of the U.S. are still being determined (Cranshaw et al. 2019).

BACKGROUND

The formal classification of *Cannabis* species and subspecies is a source of confusion (McPartland 2017). Thus, for our regulatory purposes, we recognize two types of *Cannabis*: industrial hemp (grown for fiber or fruit/seed (Edde 2022)) and marijuana (McPartland 2017). They are mainly distinguished by how much of a psychoactive cannabinoid, delta-9-tetrahydrocannabinol (THC), they contain. Plants with a concentration of less than 0.3% THC are considered industrial hemp and those plants with greater concentrations are considered marijuana (Small and Cronquist 1976) or "weed" (Johnson 2019). However, *Cannabis* plants also contain many other compounds, or cannabinoids, that are useful for medical purposes.

Regulations prohibiting the domestic growth and use of *C. sativa* were a result of the illicit production of 'wild' or 'feral' *Cannabis* plants for marijuana and misunderstanding about the plants (Johnson 2019). *Cannabis* was federally prohibited in the United States in 1937 (Marihuana Tax Act) and all production ceased. However, the Hemp for Victory program in 1942 temporarily promoted industrial hemp production for wartime use. The domestic production of hemp decreased significantly by 1945 and enforcement of the Marihuana Tax Act resumed (Johnson 2019), but wild *Cannabis* continued to thrive. Growing the plants outdoors became 'risky' due to widespread herbicide (e.g., 2, 4-D, paraquat) use in the 1970s in the U.S. and Mexico and the federal eradication campaigns in the 1980s. Thus, indoor cultivation (e.g., in basements and greenhouses) of *Cannabis* under grow lights became the norm (Johnson 2017).

California was the first state to legalize medical uses for approved patients with written medical consent in 1996, and Colorado followed in 2000. Colorado and Washington were the first states to legalize the adult use of recreational marijuana in 2012. Florida legalized the use of medical marijuana in 2016. Then, the 2018 Farm Bill (Agriculture Improvement Act 2018) federally authorized the production and sale of industrial hemp, removed hemp from the Drug Enforcement Administration's list of Controlled Substances, and gave the Food and Drug Administration authority over hemp and CBD products.

Several reviews document the arthropods associated with hemp in the U.S. and globally (Mostafa and Messenger 1972, McPartland 1996, McPartland et al. 2000, Cranshaw et al. 2019). Some of the most damaging and universal pests have been the cannabis aphid, *Phorodon cannabis* Passerini (Hemiptera: Aphididae) (Cranshaw et al. 2018), Eurasian hemp borer, *Grapholita delineana* (Walker) (Lepidoptera: Tortricidae) (McPartland et al. 2000), and the hemp russet mite, *Aculops cannabicola* (Farkas)

(Acari: Eriophyidae) (McPartland and Hillig 2003). Among native North American species, the corn earworm, *Helicoverpa zea* (Boddie) (Lepidoptera: Noctuidae), is the most damaging insect pest of outdoor hemp in the U.S. (McPartland et al. 2000, Britt et al. 2020, Hansen et al. 2020). However, little is known about the arthropod pest complex on hemp in Florida (Osborne et al. 2021).

Because of the federal regulations of *Cannabis* from 1937 to 2018, the Florida Department of Agriculture and Consumer Services, Division of Plant Industry's (FDACS-DPI) plant inspectors and arthropod identifiers could not survey illegally grown plants and rarely received samples of pests from *Cannabis*. However, with hemp's legalization in 2018, interested growers were licensed by the state to produce hemp crops.

In early 2019, FDACS-DPI inspectors and several researchers began monitoring industrial hemp plantings (e.g., field, greenhouse, and indoor) in Florida and began submitting arthropod samples for identification. This circular summarizes what was found and considers each arthropod's pest potential in Florida.

METHODS USED TO GENERATE THIS LIST

The FDACS-DPI (or its predecessor, the State Plant Board) sample records were searched for any arthropods found on hemp that were submitted for identification from March 2023 back to the 1920s. A gap from the 1930s through 2018 exists because of the federal regulations of *Cannabis* and lack of specimens collected/submitted for official identification. Most of the samples were submitted by state Plant Inspectors and researchers.

The table of taxa generated from these records was organized taxonomically. No distinction was made between native or exotic-but-naturalized species. Taxa were only included once, despite some repeated sample identifications. Arthropods identified only to family were excluded. New host records reported here were published in FDACS-DPI's Tri-ology and were cited appropriately.

The table ranks each arthropod as one of five potential pest categories: major, minor, predator or parasitoid, incidental, or unknown. **Major** pests were reported to cause significant damage in other regions and were established and damaging hemp in Florida. **Minor** pests were those reported to cause minor damage in other regions and were found feeding on hemp in Florida, but their impact in Florida was uncertain. **Predators** or **parasitoids** did not feed on plants and were not pests. **Incidental** species were not known to be herbivorous, were those simply resting on the plants with no apparent feeding damage, or those with a restricted host range that excluded *Cannabis*. Those ranked as **unknown** had unknown habits, were not previously associated with hemp, were in genera where the species was not determined (most species in these genera are host specific and require species identification), and/or their taxonomy needed improvement. Comments related to feeding habits and other relevant information were also included in Table 1.

The status of arthropods on hemp in Florida could be very different from their status in other regions and could change over time. For example, the Japanese beetle, *Popillia japonica* Newman, a widespread pest reported on hemp in the northern U.S., is occasionally intercepted on shipments of commodities coming into Florida. Follow up surveys have found no evidence of even a temporary establishment or population in the state. Thus, the Japanese beetle is not a pest in Florida because it is not established in Florida. Caution is needed comparing pest lists from other regions when considering presence and extrapolating a pest's status in this state.

We will learn more of the insects and their impact on Florida's hemp industries as time passes, observations are made, and samples are submitted for identification. Hemp samples or specimens observed damaging hemp may be sent to the Division of Plant Industry for identification. For more information on how to submit a sample, visit https://www.fdacs.gov/DPIsamples.

RESULTS AND DISCUSSION

Table 1 contains the comprehensive list of taxa [127 species (or genus, if no species was identifiable)] associated with industrial hemp in Florida as recorded by FDACS-DPI. The arthropod class or insect order, family, scientific name, common name (if available), potential pest status for Florida, and additional comments were provided.

Acari. Twelve mites were identified from Florida samples (Table 1). The two major pests were the eriophyid hemp russet mite (*Aculops cannabicola* (Farkas)) and twospotted spider mite (*Tetranychus urticae* Koch). *Aculops cannabicola* is a destructive mite, which feeds on leaves, petioles, meristems and glandular trichomes (McPartland et al. 2000, McPartland and Hillig 2003, Cranshaw et al. 2019). It has been frequently intercepted in hemp shipments coming into Florida and is established in at least one Florida county. The three minor pests were a broad mite (*Polyphagotarsonemus latus* Banks), Glover mite (*Tetranychus gloveri* Baker) and a spider mite (*Tetranychus ludeni* Zacher). *Polyphagotarsonemus latus* is a pest of cannabis crops grown indoors in the U.S. (Wainwright-Evans 2017). *Tetranychus gloveri* is a little-known pest in tropical and subtropical climates and infests more than 110 host plants (Jeppson et al. 1975). The two phytoseiid predators were *Neoseiulus ilicis* Denmark and Evans and *Typhlodromips swirskii* Athias-Henriot. The four incidentals included mold mites *Carpoglyphus* sp., *Glycyphagus* sp., *Tyrophagus* sp. and *Brevipalpus yothersi* (Baker), and one with unknown habits (*Tarsonemus* sp.). Other mites cited on cannabis included the carmine spider mite

(*Tetranychus cinnabarinus (Boisduval)*), oriental mite (*Eutetranychus orientalis (Klein)*), privet mites (*Brevipalpus obovatus* Donnadieu and *B. rugulosus* Chaudhri, Akbar and Rasool) and *Typhlodromus cannabis* Ke and Xin (Clarke 1999).

Coleoptera. Fourteen beetles were identified (Table 1), including two minor pests (*Trachyderes mandibularis* Dupont and *Diabrotica balteata* LeConte), one predator (*Harmonia axyridis* (Pallas)), eight incidentals and three of unknown status (*Altica* sp., *Colaspis* sp., *Mordellistena* sp.). The long-jawed or horse-bean longhorn beetle, *T. mandibularis*, was reared from a hemp stem in Florida, but other known hosts include horse bean, citrus, ficus, willow and hackberry (InsectIdentification 2022). Its range includes the southern U.S. and Mexico. The hemp longhorn beetle (*Thyestilla gebleri* Faldermann) is another known stem-boring pest of hemp (Edde 2022), which is native to eastern Asia and not yet known in North America.

Some beetles can damage hemp leaves as adults and damage roots as larvae. Flea beetle (*Altica* sp., *Colaspis* sp.) (Chrysomelidae) adults can damage hemp by chewing out small pits in leaves that eventually become holes. Other flea beetles known to attack hemp include the western black flea beetle (*Phyllotreta pusilla* Horn), the palestriped flea beetle (*Systena blanda* Melsheimer) and the hop flea beetles (*Psylloides attenuata* Koch and *P. punctulata* Melsheimer) (Angelova 1968, Cranshaw et al. 2019, Edde 2022). Only *S. blanda* currently occurs in Florida but has not yet been found on hemp. Larvae of these species eat the fine hairs and other roots in the soil, but only minimally reduce plant growth. The banded cucumber beetle (*Diabrotica balteata* LeConte) was also on Florida hemp and considered a minor pest because its host plants span several families (Capinera 2020). Cranshaw et al. (2019) reported that the southern corn rootworm/spotted cucumber beetle *(Diabrotica undecimpunctata howardi* Barber) is a leaf and flower feeder commonly observed on hemp in the eastern U.S. It is common in Florida but has not been reported on hemp. Tumbling flower beetles (*Mordellistena* sp.) were also found on Florida hemp (Table 1). The larvae of *Mordellistena micans* Germar can damage hemp stems and roots in Europe and northern Africa (Clarke 1999).

Collembola. Three springtails were identified (*Seira brasiliana* Arlé, *Seira dowlingi* (Wray) and *Salina* sp.). We considered them incidentals, but large populations could become damaging in protected cultures (Haze 2023). The garden springtail (*Bourletiella hortensis* (Fitch)), which is not in Florida, can injure plants grown in greenhouses, but most springtails feed on decaying material and microorganisms, not healthy plants (Clarke 1999). Another species, the Lucerne flea (*Sminthurus viridis* Linnaeus), can damage hemp, alfalfa, clover and cereal crops in Eurasia, Australia, New Zealand, South Africa and the Americas (Annecke and Moran 1982, Clarke 1999), but is not known to be in Florida.

Diptera. Three flies were found on Florida hemp (Table 1): the American serpentine leafminer (*Liriomyza trifolii* (Burgess)), a biting midge (*Bezzia* sp.) and a shore fly (*Scatella* sp.). The midge and shore fly were not considered plant pests, but the status of *L. trifolii* was uncertain. With greater populations, it could be a minor pest. Agromyzid leafminers already associated with hemp include *Liriomyza strigata* (Meigen) (in Europe (Ellis 2023)), *Phytomyza horticola* Goureau, *Agromyza reptans* Fallén, *Liriomyza eupatorii* (Kaltenbach) and *Liriomyza cannabis Hendel* (Clarke 1999).

Hemiptera. Fifty-five hemipterans were identified from hemp samples (Table 1). Information has been summarized within pest groups.

Aphids. Four aphid species were identified on hemp in Florida, including the cotton or melon aphid (*Aphis gossypii* Glover)), cannabis aphid (*Phorodon cannabis* Passerini), rice root aphid (*Rhopalosiphum rufiabdominale* (Sasaki)) and the Asian woolly hackberry aphid (*Shivaphis celti* Das). *Aphis gossypii* was previously recorded from *Cannabis* in India (Cherian 1932). Other aphids on hemp in other regions include the black bean aphid (*Aphis fabae* Scopoli), foxglove aphid (*Aulacorthum solani* (Kaltenbach)), green peach aphid (*Myzus persicae* (Sulzer)), hop aphid (*Phorodon humuli* (Schrank)) and *Aphis craccivora* Koch (Clarke 1999, Blackman and Eastop 2018, Lagos-Kutz et al. 2021). *Phorordon cannabis* is considered the most damaging of these species (Halbert 2016, Cranshaw et al. 2019). It presently is established in at least one Florida county and is suspected in two others. It can vector several viruses: cannabis streak virus (Kennedy et al. 1962), hemp mosaic virus, hemp leaf chlorosis virus (Ceapoiu 1958), cucumber mosaic, hemp mottle virus and alfalfa mosaic virus (Schmidt and Karl 1970). Most of those aphid species are widely distributed, have large host ranges and often infest greenhouses (Lagos-Kutz et al. 2018). However, recent observations suggest *R. rufiabdominale* may be a more significant pest than *P. cannabis* (S. Halbert, pers. comm.).

Scales. Because scale insects attach to plants after nymphs briefly disperse, any species found on hemp indicates it was feeding directly on the plant. The soft and armored scales on hemp in Florida were all considered minor pests: Indian wax scale (*Ceroplastes ceriferus* (F.); new host record, Halbert 2022), fig wax scale (*Ceroplastes rusci* L.; new host record, Halbert 2020), brown soft scale (*Coccus hesperidum* L.), Philephedra scale (*Philephedra tuberculosa* Nakahara and Gill; new host record, Halbert 2021a), a pulvinaria scale (*Pulvinaria urbicola* Cockerell; new host record, Halbert 2022), Mexican black scale (*Saissetia miranda* (Cockerell and Parrott); new host record, Halbert 2021b), *Chrysomphalus dictyospermi* (Morgan) and camphor or camellia scale (*Pseudaonidia duplex* (Cockerell); new host record, Anonymous 1985). The scale species previously recorded on hemp include the European fruit lecanium (*Parthenolecanium corni* (Bouché)), hemispherical scale (*Saissetia coffeae* (Walker)), white peach scale (*Peudaulacaspis pentagona* (Targioni-Tozzetti)) and *Coccus herperidum* (Clarke 1999, Villanueva et al. 2020).

Mealybugs. *Nipaecoccus viridis* (Newstead) (new host record, Halbert 2021b and Deeter and Ahmed 2023) and *Phenacoccus madeirensis* Green (new host record, Halbert 2020) are expected to be major pests of hemp in Florida. *Nippaecoccus viridis* is polyphagous, with more than 148 host plant genera in 53 families (ScaleNet 2023a). Proper identification of *N. viridis* is challenging because it has at least 16 pseudonyms, eight common names and occurs in 67 countries (ScaleNet 2023a). *Phenacoccus madeirensis* is also polyphagous (at least 161 host plants) and occurs in 91 countries (ScaleNet 2023b).

Lace bugs. The only tingid identified was the cotton or bean lace bug, *Corythucha gossypii* (Fabricius), and it was ranked as a minor pest and a new host record (Halbert 2020). Live nymphs and adults were collected from hemp in 2020 and 2022, indicating the presence of breeding populations in two counties. This species has the broadest host range of any tingid in Florida (Mead 1989).

Leafhoppers. Eleven cicadellid species were identified (Table 1), all of which were incidental or of unknown pest status. Cranshaw et al. (2019) reported 14 species were on hemp in Colorado, and only an *Empoasca* sp. caused modest leaf damage. *Empoasca* sp. leafhoppers can also infest hemp and create a 'hopperburn' (Dudley 1920). Lago and Stanford (1989) found 19 leafhopper species in Mississippi, of which *Agallia constricta* (Van Duzee) and *Graphocephala versuta* (Say) were the most abundant.

Planthoppers and spittlebugs. All the planthoppers identified were considered incidentals, including *Acanalonia* sp., *Cedusa* sp., *Megamelus palaetus* (Van Duzee), *Metadelphax propinqua* (Fieber), *Metcalfa pruinosa* (Say) and *Pygospina spinata* Caldwell. The two cercopids, *Clastoptera querci* Thompson, Halbert and Rothschild and *Prosapia bicincta* (Say), were also incidentals.

Treehoppers. The keeled treehopper (*Entylia carinata* (Forster)) was considered an incidental and the threecornered alfalfa hopper (*Spissistilus festinus* (Say)) was a minor pest. *Spissistilus festinus* is polyphagous and can vector a virus in grapes (Preto et al. 2019). Breeding populations of both *Spissistilus festinus* and *Micrutalis calva* (Say) were on hemp in Colorado (Cranshaw et al. 2019) and Mississippi (Lago and Stanford 1989).

Whiteflies. The major pest found on hemp in Florida was the sweet potato whitefly (*Bemisia tabaci Gennadius*). The greenhouse whitefly (*Trialeurodes vaporariorum* (Westwood)) is a polyphagous pest, also occurring in Florida but not yet found on hemp. Both whiteflies can transmit plant viruses (Ceapoiu 1958, Clarke 1999, McPartland et al. 2000). They tend to be more damaging in greenhouses (McPartland et al. 2000).

True bugs (suborder Heteroptera). The leaf-footed bugs, *Leptoglossus phyllopus* (L.) and *Zicca taeniola* (Dallas), and peanut burrower bug (*Pangaeus bilineatus* (Say)), although known plant-feeders in Florida, were listed as incidentals on hemp (Table 1). Other true bugs reported on hemp include the tarnished plant bug (*Lygus lineolaris (*Palisot de Beauvois)), false chinch bug (*Nysius ericae* (Schilling)), potato bug (*Calocoris norvegicus* Leston) and a mirid (*Microtechnites bractatus* (Say) (Cranshaw et al. 2019)). *Lygus lineolaris* also occurs in Colorado, Tennessee and Virginia (Cranshaw et al. 2019). Of these, only *Lygus lineolaris* and *Mictotechnites bractatus* occur in Florida.

Stink bugs. Several polyphagous stink bugs were identified on hemp in Florida, including *Euschistus obscurus* (Palisot de Beauvois), *E. quadrator* Rolston, brown stink bug (*E. servus* (Say)), southern green stink bug (*Nezara viridula* (L.)) and *Thyanta perditor* (F.). *Nezara viridula* was found previously on hemp in Florida (Hartowicz et al. 1971), feeds on hemp flowers, seeds and leaves, and occurs on hemp throughout the U.S. (Cranshaw et al. 2019). The polyphagous and invasive brown marmorated stink bug, *Halyomorpha halys* (Stål), was detected and reared from hemp seeds in Virginia but did not cause detectable damage (Britt et al. 2019). It has a very limited distribution within Florida.

Predatory bugs. Several predatory bugs were found (Table 1), including an ambush bug (*Phymata* sp.), big-eyed bug (*Geocoris punctipes* (Say)), spined soldier bug (*Podisus maculiventris* (Say)), spined assassin bug (*Sinea diadema* (F.)) and insidious flower bug (*Orius insidiosus* (Say). *Orius insidiosus* was also on hemp in Nebraska (Ajayi and Samuel-Foo 2021). *Geocoris punctipes* is an omnivorous predator that can cause negligible to minor plant damage, but it is not considered a pest (Stoner 1970, Schuman et al. 2013).

Hymenoptera. Nine hymenopterans were identified, including five ants (*Brachymyrmex minutus* Forel, *Forelius mccooki* (McCook), *Nylanderia fulva* (Mayr), *Paratrechina longicornis* (Latreille) and *Solenopsis invicta* (Buran)) and four parasitoids (*Cotesia* sp., *Ceropales* sp., *Psix striaticeps* (Dodd) and *Trimorus* sp.). None were considered primary or major pests, although the ants may tend and protect any honeydew-producing hemipterans on hemp plants. In Colorado, pavement ants (*Tetramorium caespitum* (L.)) damaged seedlings and small transplants (Cranshaw et al. 2019). Leafcutter ants (*Atta* sp.), which occur in the southwestern U.S., can cut *Cannabis* plants into small pieces and take them to underground nests (Clark 1999).

Isoptera. Two subterranean termites were found on Florida hemp: the Formosan subterranean termite (*Coptotermes formosanus* Shiraki) and a *Reticulitermes* sp. Wood chips used to mulch around hemp plants (Clark 1999) can either be the source of a termite infestation or possibly attract termites already present in the soil. Termites can hollow out stems and branches, leading to plant death (Clarke 1999).

Lepidoptera. Twenty moth species from seven families were identified (Table 1), including six major pests, eight minor pests, five incidentals and one of unknown status. Major pests included the tobacco budworm (*Chloridea virescens* (F.)), soybean looper (*Chrysodeixis includens* (Walker)), corn earworm (*Helicoverpa zea* (Boddie)), gray-streaked armyworm (*Spodoptera albula* (Walker)), southern armyworm (*Spodoptera eridania* (Stoll)) and cabbage looper (*Trichoplusia ni* (Hübner)). *Helicoverpa zea*, a native North American species, is considered the most damaging insect pest of outdoor hemp throughout the U.S. (McPartland et al. 2000; Britt et al. 2020, 2021; Hansen et al. 2020).

Minor pests included: prominent moth (*Datana* sp.), saltmarsh caterpillar (*Estigmene acrea* (Drury)), forest tent caterpillar (*Malacosoma disstria* Hübner), leafrollers (*Platynota* sp. and *Sparganothis* sp.), Virginian tiger moth or yellow woollybear (*Spilosoma virginica* (F.)), velvet armyworm (*Spodoptera latifascia* (Walker)) and yellow-striped armyworm (*Spodoptera ornithogalli* Guenée). Other species, including *Spodoptera exigua*, *Peridroma saucia* (Hübner), *Spodoptera ornithigalli* and *Melanchra picta* (Harris), have been observed consuming hemp leaves, but the latter two species were also closely associated with developing flowers and seeds (Cranshaw et al. 2019).

Other known, damaging lepidopteran pests of hemp include stem borers, such as the European corn borer (*Ostrinia nubalis* Hübner, infrequent pest in Florida) and Eurasian hemp borer (*Grapholita delineana* Walker, not known in Florida), and defoliators like the zebra caterpillar (*Melanchra picta* Harris, not known in Florida) (Cranshaw et al. 2019, Edde 2022).

Incidentals were a sod webworm (*Fissicrambus profanellus* (Walker)), the tropical sod webworm (*Herpetogramma phaeopteralis* (Guenée)), stained-glass moth (*Samea castellalis* Guenée) (Hayden 2014), fall webworm (*Hyphantria cunea* (Drury)) (Sourakov and Paris 2021) and the alfalfa leaf tier (*Dichomeris acuminata* (Staudinger)). The only species of undetermined potential was the omnivorous leafroller (*Platynota stultana* Walsingham). It is important to distinguish between species with adults that could land anywhere and species whose larvae are known to feed on cannabis.

Neuroptera. Only a predatory green lacewing (family Chrysopidae), *Ceraeochrysa* sp., was identified from Florida samples. Lacewing larvae are predators of soft-bodied insects, like aphids.

Orthoptera. The two grasshoppers (family Acrididae) collected on hemp in Florida were the American grasshopper (*Schistocerca americana* Drury) and eastern lubber grasshopper (*Romalea microptera* (Palisot de Beauvois)) (Table 1). Other species that have been observed eating hemp in the U.S. were *Camnula pellucida* (Scudder), *Chloealtis conspersa* (Scudder), *Melanoplus differentialis* (Thomas), *M. bivittatus* (Say), *M. femurrubrum* (De Geer) and *M. lakinus* (Scudder) (McPartland et al. 2000, Cranshaw et al. 2019). Of these, only *M. femurrubrum* has been reported in the western Florida panhandle (BugGuide 2023). Cranshaw et al. (2019) stated that grasshoppers were the most important defoliators of hemp in Colorado.

Psocoptera. The two psocids found on hemp were the outer barklouse (*Ectopsocus thibaudi* Badonnel) and a *Lachesilla* sp. (Table 1). *Ectopsocus thibaudi* occurs from Florida to the West Indies and French Guiana and has been collected from mangrove and cabbage palm (Mockford 2018). More than 350 species of *Lachesilla* Westwood bark lice exist (Garcia 1974).

Thysanoptera. Four thrips were identified (Table 1) on hemp in Florida, including two major pests (Florida flower thrips, *Frankliniella bispinosa* Morgan and common blossom thrips, *F. schultzei* (Trybom)) and two minor pests (*Caliothrips phaseoli* (Hood) and *Echinothrips americanus* Morgan). Other species considered as hemp pests in Florida, but not yet found on hemp, include the greenhouse thrips (*Heliothrips haemorrhoidalis* Bouché), western flower thrips (*Frankliniella occidentalis* (Pergande)) and onion thrips (*Thrips tabaci* Lindeman) (Cranshaw et al. 2019). Lago and Stanford (1989) commonly found the tobacco thrips (*Frankliniella fusca* Hinds) on young plants in Mississippi.

CONCLUSION

Florida's subtropical and tropical climates can support a large diversity of arthropods. As such, it presents unique concerns for crops commonly grown in more temperate areas of North America. For emerging crops, predicting pest pressures in Florida can only be hypothesized while taking proper caution when reviewing pest lists from other areas and from continued research and observations of crops grown in Florida. The hemp industry in Florida is new and our understanding of these pests and pressures is at its infancy. With continued work in future years, we will grow in knowledge of these pests, learning which are of concern and how to manage them.

ACKNOWLEDGMENTS

We acknowledge Drs. M. Z. Ahmed (USDA-ARS) and L. Osborne (University of Florida) for submitting many samples from their field and greenhouse work with hemp. FDACS-DPI identifiers included M.Z. Ahmed, S. Bolton, L. Deeter, S. Halbert, J. Hayden, C. Nance, E. Powell, K. Schnepp, F. Soto-Adames, G. Steck and E. Talamas. D. Greer kindly prepared the databases for our search and consulted paper archives for older records.

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Table 1. Florida-resident arthropods found on industrial hemp (*Cannabis sativa* L.) submitted to FDACS-DPI for identification (1920s to 2023). Anticipated status: Ma = major pest, Mi = minor pest, P = predator or parasitoid, I = incidental, U = unknown.

Taxon	Family	Scientific name	Common name	Status	Comments
Acari	Acaridae	*Tyrophagus* sp.	Mold mite	I	Occurs in livestock bedding and food; can cause skin and respiratory problems. Not a plant pest.
	Carpoglyphidae	*Carpoglyphus* sp.	-	I	Not a plant pest.
	Eriophyidae	*Aculops cannabicola* (Farkas)	Hemp russet mite	Ma	Infests hemp buds and leaves. Frequently intercepted and found in greenhouses. Presently only found in Suwannee Co. in the field.
	Glycyphagidae	*Glycyphagus* sp.	Forage mite	I	Occurs in livestock bedding and food. Not a plant pest.
	Phytoseiidae	*Neoseiulus ilicis* Denmark & Evans	-	P	Predator.
		Typhlodromips swirskii Athias-Henriot	Swirski mite	P	Predator. (Synonymy: *Amblyseius swirskii*)
	Tarsonemidae	*Polyphagotarsonemus latus* Banks	Broad mite	Mi	Polyphagous.
		Tarsonemus sp.	Tarsonemid mite	U	Normally fungivorous, rarely feeds on plants.
	Tenuipalpidae	*Brevipalpus yothersi* (Baker)	Flat mite	I	Main vector of Cileviruses that causes citrus leprosis disease in citrus.
	Tetranychidae	*Tetranychus gloveri* Baker	Glover mite	Mi	Polyphagous.
		Tetranychus ludeni Zacher	Spider mite	Mi	Polyphagous.
		Tetranychus urticae Koch	Twospotted spider mite	Ma	Polyphagous.
Coleoptera	Cerambycidae	*Trachyderes mandibularis* Dupont	Long-jawed longhorn beetle	Mi	Reared from larva feeding in old woody hemp stem**.**
	Chrysomelidae	*Altica* sp.	Flea beetle	U	Adult may have damaged a leaf. *Altica* spp. are host-specific, most are not on hemp.
		Colaspis sp.	Leaf beetle	U	*Colaspis* spp. are host-specific, most are not on hemp.
		Diabrotica balteata LeConte	Banded cucumber beetle	Mi	Polyphagous.
		Disonycha conjugata (F.)	Flea beetle	I	Known to feed on *Polygonum* spp., not hemp.
		Donacia sp.	Aquatic leaf beetle	I	Feeds on aquatic host plants.
	Coccinellidae	*Harmonia axyridis* (Pallas)	Multicolored Asian ladybird beetle	P	Predator.
	Corylophidae	*Sericoderus* sp.	Minute hooded beetle	I	Not a plant pest.
	Curculionidae	*Notolomus basalis* LeConte	Palm pollenating weevil	I	Adults feed on pollen and larvae develop in palm flowers.
	Erotylidae	*Loberus impressus* LeConte	Pleasing fungus beetle	I	Feed on rotting vegetation.
	Latridiidae	*Corticarina* sp.	Fungus beetle	I	Adults and larvae feed on molds in rotting vegetation.
	Mordellidae	*Mordellistena* sp.	Tumbling flower beetle	U	Feed on plants of aster family and some trees like oak.
	Scarabaeidae	*Strigoderma pygmaea* (F.)	Pygmy chafer	I	Adults perch on leaves, grubs develop in soil.
	Tenebrionidae	*Blapstinus fortis* LeConte	Darkling beetle	I	Adults and larvae feed on decaying plant matter on ground.
Collembola	Entomobryidae	*Seira brasiliana* (Arlé)	Slender springtail	I	Can be a nuisance pest indoors, not a plant pest.
		Seira dowlingi (Wray)	Slender springtail	I	Not a plant pest.
	Paronellidae	*Salina* sp.	Springtail	I	Not a plant pest.
Diptera	Agromyzidae	*Liriomyza trifolii* (Burgess)	American serpentine leafminer	U	Leaf mining as larva. Adult flies found on hemp.
	Ceratopogonidae	*Bezzia* sp.	Biting midge	I	Not a plant pest.
	Ephydridae	*Scatella* sp.	Shore fly	I	Not a plant pest.

Taxon	Family	Scientific name	Common name	Status	Comments
Hemiptera	Acanaloniidae	*Acanalonia* sp.	Planthopper	I	Polyphagous. Not known as a plant pest.
	Aleyrodidae	*Bemisia tabaci* (MEAM1) (Gennadius)	Sweet potato whitefly	Ma	Previously called *B. tabaci* biotype B. Common in greenhouses.
	Anthocoridae	*Orius insidiosus* (Say)	Insidious flower bug	P	Predator that may also feed on plants.
	Aphididae	*Aphis gossypii* Glover	Cotton/melon aphid	Ma	Polyphagous; heavy infestations can occur on hemp.
		Phorodon cannabis Passerini	Cannabis/bhang aphid	Ma	Frequently intercepted and found in greenhouses. Recorded in the field in three counties.
		Rhopalosiphum rufiabdominale (Sasaki)	Rice root aphid	Ma	On hemp roots; common in hydroponics.
		Shivaphis celti Das	Asian woolly hackberry aphid	I	Host specific to hackberry (*Celtis* spp.).
	Cercopidae	*Clastoptera querci* Thompson	Spittlebug	I	Feeds on oaks.
		Prosapia bicincta (Say)	Two-lined spittlebug	I	Pest of grasses and holly.
	Cicadellidae	*Agallia albidula* Uhler	Leafhopper	I	Male sitting on plant. Not known to be a pest.
		Agallia constricta Van Duzee	Leafhopper	U	Not known to be a pest.
		Agallia nielsoni Freytag	Leafhopper	U	From hemp in greenhouse. Not known to be a pest.
		Balclutha sp.	Leafhopper	U	On hemp buds, but normally on grasses.
		Cuerna costalis (F.)	Lateral-lined sharpshooter	I	Polyphagous.
		Curtara insularis (Caldwell)	Ringspot leafhopper	U	Intercepted on imported plants; not in Florida.
		Graminella sp.	Leafhopper	I	*Graminella* spp. feed on grasses.
		Homalodisca vitripennis (Germar)	Glassy-winged sharpshooter	U	Polyphagous; vectors *Xylella fastidiosa* which causes Pierce's and phony peach diseases.
		Hortensia similis (Walker)	Common green leafhopper	I	Found on hemp plant inside a greenhouse.
		Norvellina seminuda Say	Leafhopper	I	Found on hemp plant inside a greenhouse.
		Scaphytopius sp.	Leafhoppers	U	Polyphagous genus not on hemp.
	Coccidae	*Ceroplastes ceriferus* (F.)	Indian wax scale	Mi	Polyphagous**.**
		Ceroplastes rusci L.	Fig wax scale	Mi	On hemp in nurseries.
		Coccus hesperidum L.	Brown soft scale	Mi	Polyphagous, recorded on field hemp in Florida in 1923. Reported on hemp in Kentucky.
		Philephedra tuberculosa Nakahara & Gill	Soft scale	Mi	Polyphagous.
		Pulvinaria urbicola Cockerell	Soft scale	Mi	Polyphagous pest.
		Saissetia miranda (Cockerell & Parrott)	Mexican black scale	Mi	Infested leaves become discolored and plant growth declines.
	Coreidae	*Leptoglossus phyllopus* (L.)	Eastern leaf-footed bug	I	Polyphagous pest of fruits and seeds.
		Zicca taeniola (Dallas)	Leaf-footed bug	I	Feeds on *Amaranthus* and *Phytolacca*.
	Cydnidae	*Pangaeus bilineatus* (Say)	Peanut burrower bug	Mi	Root feeder, pest of peanut seeds.
	Delphacidae	*Megamelus palaetus* (Van Duzee)	Delphacid planthopper	I	Feeds on water lilies.
		Metadelphax propinqua (Fieber)	Delphacid planthopper	I	Polyphagous, mostly on grasses.
		Pygospina spinata Caldwell	Delphacid planthopper	I	Feeds on cattails (*Typha* sp.).
	Derbidae	*Cedusa* sp.	Planthopper	I	Feeds on fungi, sits on plants.

Taxon	Family	Scientific name	Common name	Status	Comments
	Diaspididae	*Chrysomphalus dictyospermi* (Morgan)	Dictyospermum scale	Mi	Polyphagous. Significant pest of citrus. Recorded on hemp in Florida in 1923, which needs to be substantiated.
		Pseudaonidia duplex (Cockerell)	Camphor scale	Mi	Polyphagous.
	Flatidae	*Metcalfa pruinosa* (Say)	Citrus flatid planthopper	I	Polyphagous. Pest of field crops, ornamentals, drupes, and fruit trees.
	Geocoridae	*Geocoris punctipes* (Say)	Big-eyed bug	P	Predator.
	Membracidae	*Entylia carinata* (Forster)	Keeled treehopper	I	Feeds on leguminous plants, but not known as a pest.
		Spissistilus festinus (Say)	Threecornered alfalfa hopper	Mi	Polyphagous.
	Miridae	*Ceratocapsus punctulatus* (Reuter)	Plant bug	I	Not known to be a pest.
		Macrolophus sp.	Plant bug	U	Predator that also feeds on solanaceous crops.
		Microtechnites bractatus (Say)	Garden fleahopper	Mi	Polyphagous. Pest on other plants in shade.
		Reuteroscopus ornatus (Reuter)	Ornate plant bug	I	Feeds on ragweed.
		Taylorilygus apicalis (Fieber)	Broken-backed bug	I	Polyphagous. Not known to be a pest.
	Pentatomidae	*Euschistus obscurus* (Palisot de Beauvois)	Pale-lined stink bug	Mi	Polyphagous.
		Euschistus quadrator Rolston	Brown stink bug	Mi	Polyphagous.
		Euschistus servus (Say)	Brown stink bug	Mi	Polyphagous.
		Nezara viridula (L.)	Southern green stink bug	Mi	Known hemp pest.
		Podisus maculiventris (Say)	Spined soldier bug	P	Predator.
		Thyanta perditor (F.)	Red-shouldered stink bug	Mi	Seed-feeder.
	Pseudococcidae	*Nipaecoccus viridis* (Newstead)	Hibiscus mealybug	Ma	Polyphagous, invasive pest from Asia.
		Phenacoccus madeirensis Green	Madeira mealybug	Ma	Polyphagous.
	Reduviidae	*Phymata* sp.	Ambush bug	P	Predator.
		Sinea diadema (F.)	Spined assassin bug	P	Predator.
	Tingidae	*Corythucha gossypii* (F.)	Cotton or bean lace bug	Mi	Polyphagous; nymphs and adults feed on leaves.
Hymenoptera	Braconidae	*Cotesia* sp.	Braconid wasp	P	Caterpillar parasitoid.
	Formicidae	*Brachymyrmex minutus* Forel	Minute rover ant	P	Predator, nests under rocks or at base of plant.
		Forelius mccooki (McCook)	Ant	P	Predator.
		Nylanderia fulva (Mayr)	Tawny crazy ant	P	Predator.
		Paratrechina longicornis (Latreille)	Longhorn crazy ant	P	Predator.
		Solenopsis invicta Buren	Red imported fire ant	P	Predator. May protect plants from some pests and tend others.
	Pompilidae	*Ceropales* sp.	Spider wasp	P	Predator. Adults paralyze and provision nests with spiders.
	Scelionidae	*Psix striaticeps* (Dodd)	Parasitic wasp	P	Parasitoid of stink bug eggs. Reared from a scale insect on hemp.
		Trimorus sp.	Parasitic wasp	P	Parasitize ground beetle larvae.
Isoptera	Rhinotermitidae	*Coptotermes formosanus* Shiraki	Formosan subterranean termite	Mi	Can damage woody roots.
		Reticulitermes sp.	Subterranean termite	I	On woody roots of old or dead plants.

Taxon	Family	Scientific name	Common name	Status	Comments
Lepidoptera	Crambidae	*Fissicrambus profanellus* (Walker)	Sod webworm	I	Grass feeder.
		Herpetogramma phaeopteralis (Guenée)	Tropical sod webworm	I	Adults found on hemp, but larvae are grass-feeders.
		Samea castellalis Guenée	Stained-glass moth	I	Adults found on hemp, but larvae feed on Tropical Mexican clover.
	Erebidae	*Estigmene acrea* (Drury)	Saltmarsh caterpillar	Mi	Polyphagous, larvae eat leaves.
		Hyphantria cunea (Drury)	Fall webworm	I	Polyphagous and gregarious. Forms diffuse silken nests in branches.
		Spilosoma virginica (F.)	Virginian tiger moth	Mi	Larvae (yellow woolly bear) eat leaves of low-growing plants.
	Gelechiidae	*Dichomeris acuminata* (Staudinger)	Alfalfa leaf tier	I	Larval host plants are Fabaceae.
	Lasiocampidae	*Malacosoma disstria* Hübner	Forest tent caterpillar	Mi	Larvae feed on hardwood trees and sometimes other woody plants; last instar wanders before pupating.
	Noctuidae	*Chloridea virescens* (F.)	Tobacco budworm	Ma	Polyphagous; larvae eat hemp flowers, buds, and leaves.
		Chrysodeixis includens (Walker)	Soybean looper	Ma	Polyphagous, including soybean, cotton, peanut. Larvae were on hemp.
		Helicoverpa zea (Boddie)	Corn earworm	Ma	Larvae found eating hemp leaves.
		Spodoptera albula (Walker)	Gray-streaked armyworm	Ma	Larvae fed on hemp leaves and flowers.
		Spodoptera eridania (Stoll)	Southern armyworm	Ma	Larvae were on hemp.
		Spodoptera latifascia (Walker)	Velvet armyworm	Mi	Polyphagous.
		Spodoptera ornithogalli Guenée	Yellow-striped armyworm	Mi	Larvae were eating hemp leaves.
		Trichoplusia ni (Hübner)	Cabbage looper	Ma	Larvae were eating hemp plant.
	Notodontidae	*Datana* sp.	Prominent moth/ Yellownecked caterpillar	Mi	Suspected pest.
	Tortricidae	*Platynota stultana* Walsingham	Omnivorous leafroller	U	Polyphagous leaf rolling larvae. Adults found on hemp.
		Platynota sp.	Leafroller	Mi	Unidentifiable leaf rolling larva collected on hemp.
		Sparganothis sp.	Leafroller	Mi	Larva unidentifiable to species.
Neuroptera	Chrysopidae	*Ceraeochrysa* sp.	Green lacewing	P	Larvae and adults predatory, adults can also feed on nectar.
Orthoptera	Acrididae	*Schistocerca americana* Drury	American grasshopper	Mi	Native species, occasional outbreaks occur.
	Romaleidae	*Romalea microptera* (Palisot de Beauvois)	Eastern lubber grasshopper	Mi	Native, flightless, and localized.
Psocoptera	Ectopsocidae	*Ectopsocus thibaudi* Badonnel	Outer barklouse	I	Not a plant pest, feeds on algae, fungi or molds growing on plant.
	Lachesillidae	*Lachesilla* sp.	Psocid	I	Not a plant pest, feeds on algae, fungi or molds growing on plant.
Thysanoptera	Thripidae	*Caliothrips phaseoli* (Hood)	Thrips	Mi	Leaf-feeder.
		Echinothrips americanus Morgan	Poinsettia thrips	Mi	Polyphagous, heavily infested leaves appear dusty or chlorotic. Major pest in some greenhouse crops.
		Frankliniella bispinosa Morgan	Florida flower thrips	Ma	Polyphagous, damages flowers and transmits several tospoviruses.
		Frankliniella schultzei (Trybom)	Common blossom thrips	Ma	Damages flowers and transmits tospoviruses.