

A Concise Guide on the Bionomics and Key Morphological Characteristics for Identifying *Aedes pertinax* (Grabham, 1906) – a Mosquito Species from the Neotropics Expanding in Geographic Range¹

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Abstract

Aedes pertinax is a mosquito species first described in Jamaica by Grabham in 1906. It is currently classified in the Protoculex Group. *Aedes pertinax*, and *Aedes nubilus* were considered synonyms with *Aedes serratus* until 1970 when Belkin et al. restored them to species status. This non-invasive species was first identified in the United States in 2015 from adults and larvae previously collected in Florida in 2011 (Shroyer et al. 2015). Since then, it has also been found in Collier County, Lee County, and Miami-Dade County, all in Florida (Riles and Conelly 2021; Tyler-Julian et al. 2022; Sloyer et al. 2022). The current distribution of *Aedes pertinax* in the United States is unknown due to the lack of identification resources that give identifiers the ability to separate it from other mosquito species that are morphologically similar. Little information is available about *Aedes pertinax*. It has not been reported in association with humans or animal diseases, but *Aedes Atlanticus*, another mosquito species in the Protoculex Group, is a vector of the Keystone virus (Henry et al. 2022)

and the West Nile virus (CDC), which have the potential to cause encephalitis and death. Moreover, *Aedesserratus*, once classified as synonym of *Ae. pertinax*, was reported infected with yellow fever in Brazil in 2008 (Cardoso et al. 2010). Considering this, and the fact that *Ae. pertinax* has expanded its geographical range, it is important to closely monitor it, this requires the ability to identify this species, which is the main focus of this paper.

Intended Audience and Purpose

This is an *Aedes pertinax* fact sheet for mosquito control professionals, students, scientists, and the general public. This publication is structured similarly to those from Walter Reed Biosystematics Unit (WRBU) so that readers may obtain details similar to those offered through WRBU species pages (<https://wrbu.si.edu/vectorspecies>), which is a worldwide renowned platform dedicated to conducting laboratory and field research on the systematics of medically important arthropod species and widely used by anyone interested in mosquito biology, research, and

1. This document is ENY-2100, one of a series of the Entomology and Nematology Department, UF/IFAS Extension. Original publication date June 2023. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication.
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education. Here we provide information about taxonomy, bionomics and distribution of *Aedes pertinax* adults and larvae that will help to identify this mosquito species and separate it from morphologically similar species.

Neartic and Neotropical Regions

Family: Culicidae

Subfamily: Culicinae

Tribe: Aedini

Genus: *Aedes*

Subgenus: *Ochlerotatus*

Group: Protoculex (Reinert et al. 2000)

Etymology

From Latin per- ("very") + tenāx ("tenacious")

Brief Species Description

Aedes pertinax was originally identified in Jamaica by Grabham in 1906. It has also been found in other Caribbean countries including Haiti, Puerto Rico, the Dominican Republic, and the Bahamas, as well as the continental United States (Florida).

Type Locality

Kingston Jamaica

Type Depository

The Smithsonian Institution, formerly the United States National Museum, Washington D.C., United States (officially cited as USNM, reflecting its original name.)

Diagnostic Characters

Aedes pertinax (Grabham 1906) is a medium-sized mosquito with brown coloration due to the presence of a narrow, mid-longitudinal stripe of yellowish to white scales on the scutum (Figure 1). *Aedes pertinax* adults are very similar morphologically to *Aedes atlanticus* (Dyar and Knab 1906), *Aedes dupreei* (Coquillett 1904), and *Aedes tormentor* (Dyar and Knab 1906) in the Nearctic region, and *Aedes aenigmaticus* (Cerqueira and Costa 1946), *Aedes eucephalaeus* (Dyar 1919), *Aedes hastatus* (Dyar 1922), *Aedes oligopisthus* (Dyar 1918), *Aedes serratus* (Theobald 1901), and *Aedes nubilus* (Theobald 1903) in the West Indies

and Neotropics (Belkin et al. 1970). In some instances, *Aedes infirmatus*, *Aedes scapularis*, and *Aedes condolecens* mosquitoes can resemble other species in the Protoculex Group (including *Ae. pertinax*), if specimens are damaged or weathered. However, distinctions between these similar-looking mosquito species can be made based on coloration of head scales; coloration; length and thickness of longitudinal stripe (scutum); presence of bands in the abdomen; and banding and claws in the legs. Adult female morphological characteristics used to differentiate these mosquitoes are summarized in Table 1.

Adult Females

Head

A broad patch of white to greyish scales is present on the head just before the prescutellar area, extending into the interocular space, and bordering the eyes. Whitish or with slight yellowish cast (Figure 1). The antenna is dark brown and filiform with silvery hairs on the joint.

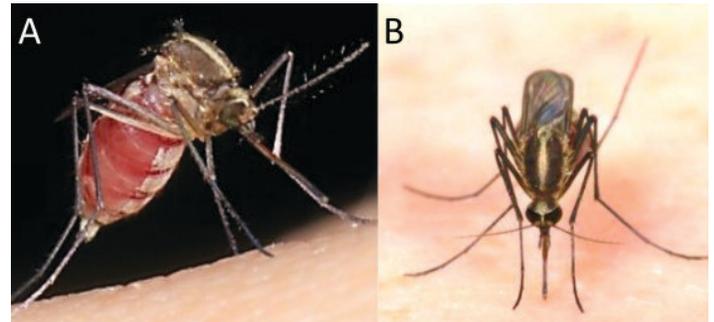


Figure 1. *Aedes pertinax* adult female. A: lateral view B: dorsal view. Credits: K. Sloyer, UF/IFAS, FMEL

Palpus

Three-segmented and entirely dark scaled; shorter than the proboscis.

Proboscis

Entirely dark scaled, rather short, subcylindrical, uniform. The labellae are conically tapered; the setae are minute and curved.

Thorax

The mesonotal scales are narrow, predominantly dark bronzy; sometimes a narrow acrostichal line of whitish scales is present. The lateral thoracic pleura has greyish to whitish scales and will never have silver scales. The scutum is entirely dark scaled with a narrow gray to white acrostichal line, which could have variations of orientation anteriorly (Figure 2). Dark bronzy scales are always present on the posterior doroscentral and prescutellar lines.

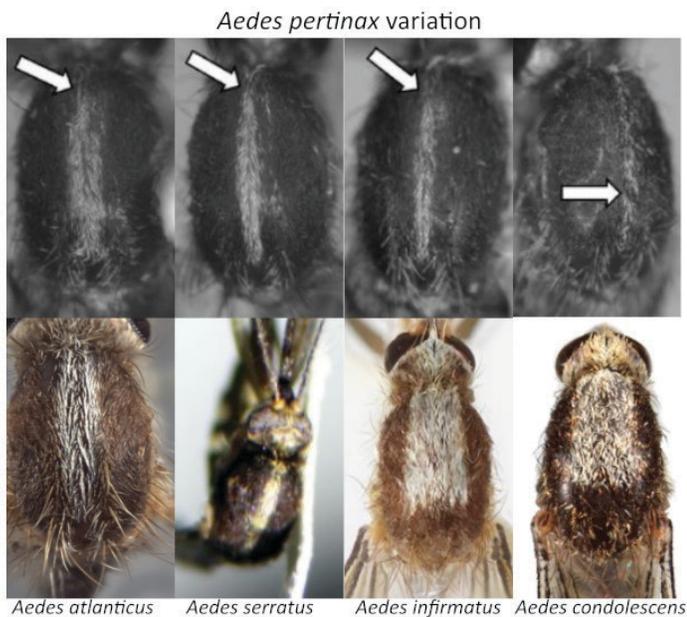


Figure 2. Dorsal view of *Aedes pertinax* thorax and the thoraxes of other, similar mosquitoes. Top row: *Aedes pertinax*, variations in thickness and length of scutal pale scales as indicated by the arrows. Bottom row: other common *Aedes* mosquitoes that could be mistaken for *Aedes pertinax*.

Credits: Top Row: modification from Shroyer et al. 2015, reproduced with permission from the American Mosquito Control Association; Bottom Row: *Aedes atlanticus* modified from Walter Reed Biosystematics Unit [2023]. *Aedes atlanticus* species page. Walter Reed

Legs

The coxae have white to yellowish scales. Dark tibiae and tarsi claws with prominent subbasal tooth. Leg characteristics are not needed for differentiation from other *Aedes* species.

Abdomen

The abdominal tergites are mostly dark scaled with large basolateral patches of white to yellowish scales. The abdominal sternites are pale scaled with prominent apico-lateral dark scales.

Wings

Approximately 4.0 mm long and dark scaled with a blue reflection along the costa and a few scattered pale scales observed at base of costa (Figure 3). Wing characteristics are not needed for differentiation from other *Aedes* species.

Adult Males

Head

Scaling head predominantly pale except for erect scales. The antenna is plumose; the last two joints are black, slender rugose, and pilose; the others are pale, narrowly black

ringed at insertions of hair-whorls; the hairs are long, black, and dense.

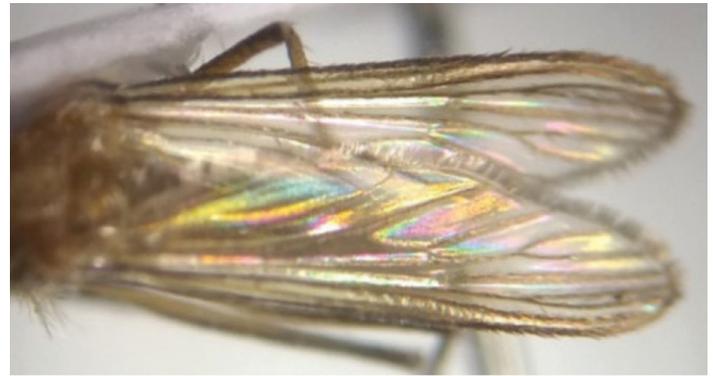


Figure 3. *Aedes pertinax* wings.

Credits: Boldsystems https://v3.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxid=1073464 License: Creative Commons Attribution Non-Commercial Share-Alike (2019) <https://creativecommons.org/licenses/by-nc-sa/3.0/legalcode> License Holder: Unspecified, Labor

Palpus

Exceeds the proboscis by the length of the last joint. The apical part of the long joint and the last two joints are considerably swollen and with dense long black hairs.

Proboscis

Longer and slenderer than in females. Straight with bronzy-black scales.

Thorax

A band of conspicuous golden scales is present in the center.

Legs

The unguis of the fore and mid legs are unequal; the larger claw has two teeth and the smaller has one. The unguis of the hind legs are equal and unserrated.

Abdomen

Elongated and depressed, the lateral spots tending to form white basal segmental bands, abundant lateral ciliation, long, coarse, and pale. An acrostichal light-scaled line is present and apparently more frequently developed than in female.

Wings

The male wings are narrower than in the female, approximately 3.5 mm. The stalks of the fork-cell are longer. The vestiture is less abundant than in females.

Male Genitalia

The gonocoxite is elongated, three times as long as wide, and with numerous scales laterally and ventrally and occasionally with a few scales dorsally. The gonostylus is long and slender with a long articulate filament. The tergite lobe of segment IX is small but prominent. The thumblike apical tergomesal lobe is conspicuous with several short, thin setae. The sternomesal margin of the apical lobe has 2 irregular rows of bristles. The basal tergomesal lobe is detached (separated by a membrane) from the tergomesal margin of the side piece and joined to the base of the claspette tergally, with a small lobe bearing a long, specialized seta and 1 or 2 short, simple setae, sternally with a long, slender lobe bearing about 12 setae of varied lengths. The claspettes are slender and long but shorter than the gonostylus and form a roughly triangular shape, with a broad, sickle-shaped filament at the base. The aedeagus is moderately tapered. The proctiger is moderately developed (Figure 4).

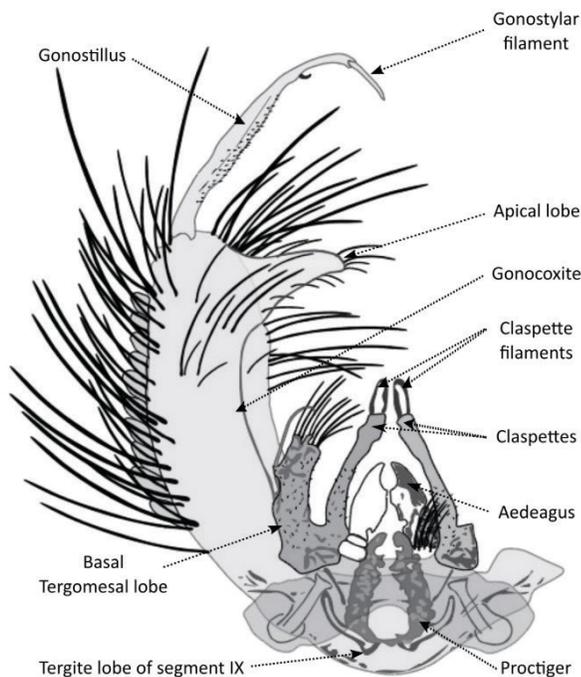


Figure 4. *Aedes pertinax* male genitalia showing characteristic structures.

Credits: Daniel Killingsworth, Environmental Security Pest and Lawn, Cantonment, Florida

Larva

The Serratus Group species that include *Aedes pertinax* are characterized by a single row of spiney comb scales. The length of seta 6-C of dorsal apotome is 0.21–0.38; the bases of setae 5 and 6-P are connected by a narrow arcuate anterior plate; the comb is comprised of a single row of spine-like scales.

Head

Rounded, widest through eyes. The antenna is moderate, slender, and uniform with a small turf near the middle. Both pairs of dorsal head-hairs are single; the ante-antennal turf is multiple. Seta 4-C is conspicuously long. Denticles are present in the anterior ocular area (Figure 5A).



Figure 5. (A) *Aedes pertinax* larva head, the red rectangles show denticles present in the anterior ocular area and (B) thorax, the red rectangle shows a narrow arcuate anterior plate connecting the prothoracic setae 5,6-P.

Credits: Mike Riles, Beach Mosquito Control District, Panama City, Florida

Thorax

Prothoracic setae 5 and 6-P are connected by a narrow, arcuate anterior plate (Figure 5B).

Abdomen

Lateral comb of eight abdominal segments with about 10 to 12 scales in a single irregular row, each scale with a long central spine. The sides are finely fringed.

Anal Segment and Siphon

Comb scales arranged in a single, irregular row (Segment VIII, Figure 6). Comb scales are large and fringed at base. The saddle and siphon are both dark and short, each with a black basal ring. Saddle encircles Segment X. Anal brush (4-X) with approximately eight pairs of branched setae on a grid. Two caudal setae (1,3-X) originating near dorsal brush (2-X) or piercing saddle (Figure 6). Uneven and long gills.

Pecten

With about ten evenly spaced teeth, ending before the middle of the siphon, it does not extend as far as that of *Aedes tormentor*. The tuft (1-S) is positioned at the last tooth.

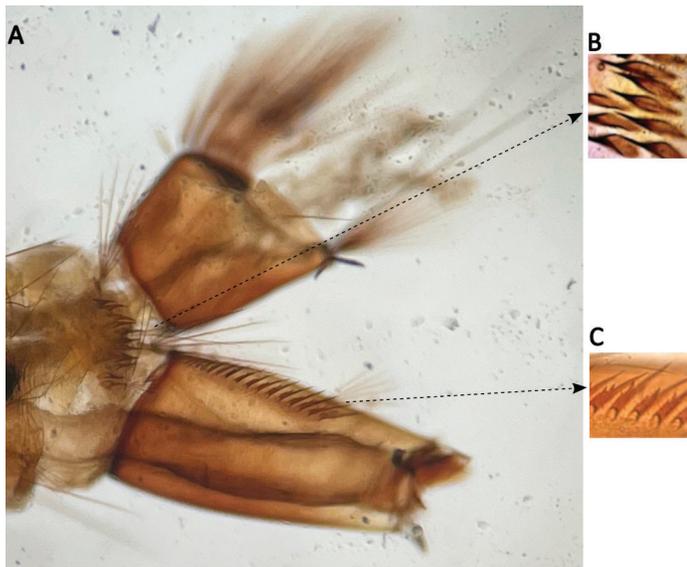


Figure 6. A: Siphon and saddle of *Aedes pertinax* (credit: Mike Riles, Beach Mosquito Control District, Panama City, Florida). B: Comb scales in Segment VIII (Credit: modified from Rueda and Alarcon-Elbal 2020, used with permission). C: Pecten scales in siphon. Credits: Mike Riles, Beach Mosquito Control District, Panama City, Florida

Taxonomic Keys

Dyar 1918

Dyar 1922

Bonne & Wepster 1925

Belkin et al. 1970

Darsie et al. 2010

Howard et al. 1917

Exemplar DNA Sequences

Taxonomy ID 1640878

Gene Bank:

KP262407.1 — *Ochlerotatus pertinax* voucher IRCFL7 5.8S ribosomal RNA gene and internal transcribed spacer 2, partial sequence

KP262406.1 — *Ochlerotatus pertinax* voucher IRCFL6 5.8S ribosomal RNA gene and internal transcribed spacer 2, partial sequence

KP262405.1 — *Ochlerotatus pertinax* voucher JA792-3 5.8S ribosomal RNA gene and internal transcribed spacer 2, partial sequence

KP262404.1 — *Ochlerotatus pertinax*

voucher JA792-2 5.8S ribosomal RNA gene and internal transcribed spacer 2, partial sequence

Source: Shroyer et al. 2010

Bionomics

Little is known about the preferred larval and adult habitat, host-seeking behaviors, feeding preference, or seasonal distribution of *Aedes pertinax*.

Immatures

Belkin et al. (1970) reported a single collection of *Aedes pertinax* larvae in Jamaica from a coral rock hole filed with brackish water. Rueda Alarcon-Elba (2020) reported *Aedes pertinax* larvae found in temporary ground pools usually fully exposed to the sun. Shroyer et al. (2015) collected larvae from a cypress-oak-palm depression swamp in Indian River County, Florida.

Adults

Female adults were collected landing on humans in Jamaica (Belkin 1970). Adult specimens were collected using CDC miniature light traps baited with octenol on Lee Stocking Island and Gordo Cay, Bahamas (Darsie et al. 2010). Adult specimens were collected by aspiration from ground litter in a cypress-oak-palm depression swamp in Indian River County, Florida, and by CDC light trap, passive box, exit traps, and human landing catch collections (Shroyer et al. 2015). Giordano et al. (2021) collected a single specimen using a suction trap baited with 2 kg of dry ice in hydric hammock habitat in Indian River County. In Miami Dade County, adult mosquitoes were collected from tree buttresses, tree holes, animal burrows, and stream banks using a custom-made, small-diameter aspirator (Sloyer et al. 2022).

Associated Pathogens

None

Distribution Notes

Darsie et al. (2010); Belkin and Heinemann (1972); Belkin and Heinemann (1975); Belkin et al. (1970); Knight and Stone (1977); Shroyer et al. (2015); Rueda and Alarcón-Elbal (2020)

Distribution (Figure 7): Jamaica, Bahamas, Costa Rica, Cuba, Dominican Republic, Haiti, Puerto Rico, United States (Florida)



Figure 7. *Aedes pertinax* distribution. Distribution in the southern United States, Caribbean, and Central America is widely unknown. This map represents published records only.

Credits: Created in ArcMap v. 10.7.1 using the World Countries (Generalized) product available directly from ESRI (<https://hub.arcgis.com/datasets/esri:world-countries-generalized/about>)

Available GIS Models

None as of December 2021.

Synonyms

The following were considered synonyms of *Ae pertinax* until 1970, when they were all restored to species by Belkin et al. (Belkin et al. 1970)

Aedes (Ochlerotatus) serratus (original combination: *Culex serratus*, Theobald, 1901)

Aedes (Ochlerotatus) (original combination: *Culex nubilus*, Theobald, 1903)

Protoculex (Ochlerotatus) pertinax (original combination: *Protoculex quasiserratus*, Theobald 1907)

Funding

We acknowledge funding support of the Southern IPM Center (Project S21-002) as part of USDA National Institute of Food and Agriculture Crop Protection and Pest Management Regional Coordination Program (Agreement No. 2018-70006-28884) and the USDA National Institute of Food and Agriculture (Hatch Multistate project 1025565).

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Table 1. Adult female morphological characteristics of *Aedes pertinax* and other morphologically similar mosquitoes (Dyar 1921; Bonne and Wepster 1925; Belkin 1970; Arnell 1976; Consoli and Lourenco de Oliveira 1998; Darsie and Ward 2021; Wilkerson et al. 2021; Reeves et al. 2021).

	Adult female morphological characteristics												
	Head			Thorax					Abdomen				Legs
	White to yellow scales extended on interocular space and along orbital line	Occiput clothed medially with white or yellow scales	Head filled with white scales	Scutum with narrow acrostichal line of whitish scales; absence of pale scales on anterior end; extremely thin anterior stripe; or disconnected exceptionally narrow stripe	Scutum with median longitudinal stripe extending from anterior margin to	Scutum with median longitudinal stripe extending full length, narrower than lateral dark-scaled areas	Scutum with median longitudinal stripe extending full length, wider than lateral dark-scaled areas	Mesonotum uniformly dark scaled	Abdominal terga with pale-scaled basolateral patches	Abdominal terga with median basal white patches or bands on most segments	Abdominal terga VI–VIII with light colored scales medially	Abdominal terga VI–VIII dark scaled medially	Hind tibia with basal and apical dark-scaled bands
Group Protoculex													
<i>Aedes pertinax</i> ^{1,2}	X	X		X				X					
<i>Aedes Atlanticus</i> ¹		X				X		X					
<i>Aedes tormentor</i> ^{1,2}	X	X				X		X					
<i>Aedes dupreei</i> ^{1,2}	X		X				X	X					
<i>Aedes serratus</i> ²	X	X				X		X					
<i>Aedes eucephalaesus</i> ²	X		X			X		X					
<i>Aedes aenigmaticus</i> ²						X		X					
<i>Aedes hastatus</i> ²			X					X					
<i>Aedes oligopisthus</i> ²	X		X			X		X					
<i>Aedes nubilus</i> ²		X					X	X					
Group Ochlerotatus													
<i>Aedes infirmatus</i> ^{1,2}		X			X						X		
<i>Aedes scapularis</i> ^{1,2}	X	X			X					X		X	
<i>Aedes condolecens</i> ^{1,2}		X			X			X					
¹ Species found in United States ² Species found in South America and Mexico													