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Authors: Nalen, Catherine M. Zettel, Kline, Daniel L., Sutton, Bruce D., Müller, Günter, and Cilek, James E.

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An annotated checklist of the horse flies, deer flies, and yellow flies (Diptera: Tabanidae) of Florida

Catherine M. Zettel Nalen[1], Daniel L. Kline[1], Bruce D. Sutton[2], Günter Müller[3], and James E. Cilek[4]*

Abstract

The last compilation of the Tabanidae of Florida was published in 1964 by Calvin Jones & Darrell Anthony. Since then, several taxonomic and distributional changes have been made, as well as the addition of several state locality records. We have compiled a list of Tabanidae species currently present in the state of Florida, or potentially present in Florida based on surrounding state records, using literature surveys and personal examinations of the collections at the Florida State Collection of Arthropods, Gainesville, Florida, USA. Currently, 124 species/subspecies are recorded from Florida, with an additional 15 species with likely Florida distributions from 15 different genera. In contrast, Jones & Anthony (1964) recognized 118 species among 14 genera. Although the number of species is not vastly different, much taxonomic revision has been done to the Florida Tabanidae. Three new Florida records are presented for *Tabanus reinwardtii* Weidemann, 1828, *Chlorotabanus mexicanus* (L.,1758), and *Tabanus yucatanus* Townsend, 1897.

Key Words: tabanid; *Tabanus*; *Chrysops*; *Chlorotabanus*; *Hybomitra*; *Agkistrocerus*; *Merycomyia*; *Microtabanus*; *Stenotabanus*; *Whitneyomyia*

Resumen

La última compilación de los Tabanidae de Florida fue publicada en 1964 por Calvin Jones y Darrell Anthony. Desde entonces, se han hecho varios cambios taxonómicos y de distribución, así como la adición de varios registros de localidad del estado. Hemos compilado una lista de especies de Tabanidae presentes actualmente en el estado de la Florida, o potencialmente presentes en la Florida basado en registros de los otros estados cercanos, a través de una revisión de literatura y un exámen cuidadoso de los especimenes de la Colección Estatal de Artrópodos de Florida en Gainesville, Florida. Actualmente, se registran 124 especies/subespecies de la Florida, con 15 especies adicionales de 15 géneros diferentes cuyas distribución en la Florida es probable. Por el contrario, Jones y Anthony (1964) reconocen 118 especies en 14 géneros. Mientras que el número de especies no es muy diferente, se ha hecho mucho revisión taxonómica para los Tabanidae de la Florida. Tres nuevos registros para la Florida se presentan, *Tabanus reinwardtii* Weidemann 1828, *Chlorotabanus mexicanus* (L., 1758), y *Tabanus yucatanus* Townsend, 1897.

Palabras Clave: tabanid; *Tabanus*; *Chrysops*; *Chlorotabanus*; *Hybomitra*; *Agkistrocerus*; *Merycomyia*; *Microtabanus*; *Stenotabanus*; *Whitneyomyia*

The family Tabanidae includes horse flies, deer flies, and yellow flies, which are considered significant pests of livestock in the United States (Hansens 1979; Goodwin et al. 1985). Most females require a blood meal for egg production, although autogeny has been documented in several species (Rockel 1969; Anderson 1971; Burger & Lake 1980). In Florida, there is 1 known species, *Asaphomyia floridensis* Pechuman, that does not feed on blood at all (Pechuman 1974), and the reduced mouthparts of the genus *Merycomyia* suggest that this genus also is not hematophagous although data on feeding habits and behavior is still lacking (Jones & Anthony 1964). Anautogenous tabanid females ingest blood by lacerating the skin with serrated mouthparts and lapping up the pooled blood, which can cause significant irritation to the host. Several commercial adult tabanid traps are available along with blueprints for homemade traps on the internet, though studies focusing on population reduction in the environment are lacking.

Eggs are laid in a variety of habitats, often on vegetation along the perimeter of permanent or temporary bodies of water (Jones & Anthony 1964). Most Tabanidae are thought of as having aquatic larval stages, with larvae inhabiting moist or saturated soils around lakes, streams, ponds, and even roadside ditches; however, Wilson (1969) collected several larval specimens of serious pest species from the soil and debris of mostly dry hardwood hammocks in an alluvial forest in Louisiana. The larval and pupal ecology of many species is still unknown, perhaps due to a sampling bias towards aquatic environments. Many larvae are predacious, feeding on macroinvertebrates in the environment. Larval and pupal descriptions, habitats, and life histo-

[1]Center for Medical, Agricultural, and Veterinary Entomology, USDA-ARS, Gainesville, FL 32608, USA
[2]Department of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, FL 32607, USA
[3]Department of Microbiology and Molecular Genetics, Institute for Medical Research Israel–Canada, Kuvin Centre for the Study of Infectious and Tropical Diseases, Hebrew University, Jerusalem, Israel
[4]Department of Testing and Evaluation, Navy Entomology Center of Excellence, Jacksonville, FL 32212, USA
*Corresponding author; E-mail: cnalen@wcchd.org
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ries are still undocumented for several tabanid species. Life cycles can range from a few weeks to several years (Jones & Anthony 1964). Larval control methods have been attempted such as water impoundment and chemical controls with mediocre results (Anderson & Kneen 1969; Anderson 1985). Long-term control is difficult to achieve due to ecological patchiness of larval habitats, large population numbers, varying life histories, different seasonal distributions, and extensive life cycles.

Tabanids can easily become a major pest of man, especially salt marsh species that are known to readily feed on humans and often inhabit coastal tourist areas, golf courses, campgrounds, etc. (Hansens 1979). In extreme cases, tabanid infestations can cause a decrease in property values (Gerhardt et al. 1973). Tabanids are known to be mechanical vectors of several animal diseases such as equine infectious anemia virus, bovine leukemia virus, hog cholera virus, anaplasmosis, anthrax, tularemia, and several other serious diseases of veterinary concern (Krinsky 1976; Foil 1989). Perhaps even more significant than livestock pathogen transmission are the economic losses farmers experience during large tabanid infestations. Laceration of the skin by feeding females causes significant irritation to the host. Many livestock hosts respond with an attempt to dislodge the flies, but tabanids are persistent biters and will relocate until fully engorged (Foil 1983). During heavy infestations, livestock may decrease grazing and lose body weight due to the amount of time spent trying to dislodge the flies (Perich et al. 1986), which can also decrease milk production (Hansens 1979). Cattle that have been fed on by 66 to 90 horse flies per day may suffer from decreased feeding efficiency by up to 16.9% (Perich et al. 1986). Further studies on economic and veterinary impacts of tabanid feeding are still needed. In order to proceed with veterinary, ecological, and economic studies of the Tabanidae in Florida, we have developed a taxonomically organized and up-to-date record of species for the state. Currently, we have identified 124 species/subspecies documented from Florida, with an additional 15 possible species, representing 15 genera. In comparison, 138 species have been recorded from Georgia at the time of Burger's (1995) catalog. Sampling in Alabama has not extensively been undertaken, but it is likely that species numbers are similar to neighboring Georgia and Florida.

Materials and Methods

The last complete compilation of the Tabanidae of Florida was conducted in 1964 by Calvin Jones and Darrell Anthony (Jones & Anthony 1964). Since then, several taxonomic and distributional changes have been made by various authors. The included annotations following species names are those records that have been published since Jones and Anthony's 1964 publication or personal notes. If no annotations are present after a species name, no records have been updated since 1964. For annotations prior to 1964, see Jones & Anthony (1964) and Bargren (1961).

Nomenclature for our list follows that of Burger (1995). Burger (1995) noted that many species had designated variations or subspecies based solely on color. After studying several of these species, he determined that southern specimens often exhibited a melanistic variation (with intermediates) of the color form fairly consistently, and therefore determined that these are not varieties or subspecies but simply melanistic forms of the corresponding northern species.

Following Fairchild & French (1999), we have included 15 species (in parentheses) that have distribution records in surrounding states but no official records from Florida. It is possible, based on habitats and distribution, that these species are present in Florida though not yet documented. We removed *Tabanus catenatus* Walker, 1848 from that list due to the possible misidentification of the Georgia specimens. Burger (1995) lists the southern distribution of *T. catenatus* to only North Carolina; therefore it is not included here. To date, Florida has 124 species/subspecies of Tabanidae, with an additional 15 possible species representing 15 genera lacking a current Florida record.

Additionally, we have not included any misidentifications in the synonymy of species names unless they directly relate to Florida records. To see synonymous misidentifications, see Burger (1995). Subspecies status was assigned following Burger's (1995) catalog. A notation of "FSCA" after the Florida record indicates CMZN personally examined specimens housed at the Florida State Collection of Arthropods (FSCA) at the Department of Plant Industry in Gainesville, Florida. Notations on several species were compiled from literature and collection records, though much remains unknown, especially regarding larval ecology. In many cases, observations are based on 1 or few specimens or records. The FSCA houses many personal Tabanidae collections, and a thorough examination of individual specimens may yield extended flight times and distributions for the state. The majority of Florida species have a distribution of "North" or "North and Central" Florida. It is true that North Florida represents the southernmost range extension for many species; however, sampling has historically been biased towards these locations. Very little sampling has been done in Central and South Florida, wherefore a species identification should never be ruled out simply based on our locality data. It is also possible that there may be unidentified or undocumented species from that region, including Caribbean species that have established populations in South Florida.

A new state record is presented for *Tabanus reinwardtii* Wiedemann, 1828. Four specimens were caught in Bay County, Florida, in 1999 in a French 2-tier box trap by James Cilek and Mary Ann Olson of the Public Health Entomology Research and Education Center, Florida A&M University, Panama City, Florida. Identifications were confirmed by John Burger. Previously, *T. reinwardtii* was known only from Canada, south to Georgia and Louisiana, and west to Colorado (Burger 1995). A new state record is presented for *Chlorotabanus mexicanus* (L., 1758), previously recorded from Panama to Mexico. Three females and 1 male were caught and identified on Big Pine Key, Florida, by Günter Müller of the Institute for Medical Research Israel–Canada, Hebrew University, Jerusalem, Israel, in 1999. Finally, a new state record also is presented for *Tabanus yucatanus* Townsend, 1897, previously documented from the Yucatan Peninsula. Two specimens were taken in a malaise trap on Cedar Key, Florida, by Müller and Revay, of the Institute for Medical Research Israel-Canada, Hebrew University, Jerusalem, Israel.

Results

Supplementary material for this article is online in Florida Entomologist 98(2) (June 2015) at http://purl.fcla.edu/fcla/entomologist/browse. Each supplementary table and figure is referred to herein as either Suppl. Table or as Suppl. Fig.

Annotated checklist of Florida Tabanidae

Agkistrocerus finitimus (Stone), 1938
Florida Record: Stone 1938 (as *Dicladocera finitima*), FSCA
Synonym: *Dicladocera finitimus* Stone, 1938

Agkistrocerus megerlei (Wiedemann), 1828
Florida Record: Osten Sacken 1878 (as *T. megerlei*), FSCA
Synonymy: *Tabanus megerlei* Wiedemann, 1828, *Dicladocera megerlei* (Wiedemann)

Anacimas limbellatus Enderlein, 1923
Florida Record: Stone 1938 (as *A. geropogon*), FSCA
Synonymy: *Anacimas geropogon* Philip, 1936

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Fairchild 1978. Notes on classification.

Asaphomyia floridensis Pechuman, 1974
Florida Record: Pechuman 1974, FSCA
Pechuman 1974. New species.
Note: Listed as a "Species of Concern". Reviewed for threatened or endangered status by the Florida Fish and Wildlife Commission in 1994.

Chlorotabanus crepuscularis (Bequaert), 1926 (Suppl. Fig. 7)
Florida Record: Osten Sacken 1876 (as *T. mexicanus*), FSCA
Synonymy: *Chlorotabanus flavus* Macquart, 1834; *Chlorotabanus mexicanus*, authors, not Linnaeus; *Chlorotabanus sulphureus*, authors, not Palisot de Beauvois

Chlorotabanus mexicanus (Linnaeus, 1758)

NEW RECORD

Florida Record: G. Müller & E. Revay 1998 (unpubl.). Three females and 1 male were collected in a malaise trap on the Big Pine Key in Apr 1999. Previously, this species is known from northern South America, throughout Mexico, and in the Caribbean.
The specimens are deposited in Col. G.C. Müller and in the Florida State Collection of Arthropods, Department of Plant Industry, Gainesville, Florida.

Chrysops abatus Philip, 1941
Florida Record: Philip 1941
Note: Species pair with *C. dorsovittatus* (Fairchild 1978).

Chrysops amazon Daecke, 1905
Florida Record: Philip 1955, FSCA
Synonymy: *Chrysops amazon hubbelli* Philip 1955
Burger 1995. Notes on classification.

Chrysops atlanticus Pechuman, 1949 (Suppl. Table 2)
Florida Record: Walker 1848 (as *C. canifrons*), FSCA
Synonymy: *Chrysops canifrons* Walker, 1848
Note: Member of the *C. flavidus* species group (Baier 1999).

Chrysops beameri Brennan, 1935
Florida Record: Fairchild 1937 (misidentified as *C. hinei*)

Chrysops bistellatus Daecke, 1905
Florida Record: Fairchild 1937

Chrysops brimleyi Hine, 1904
Florida Record: Fairchild 1937, FSCA

Chrysops brunneus Hine, 1903
Florida Record: Brennan 1935, FSCA
Synonymy: *Chrysops brunnea* (Hine 1903)
Note: Member of the *C. flavidus* species group (Baier 1999).

Chrysops callidus Osten Sacken, 1875 (Suppl. Table 2)
Florida Record: Johnson and Coquillett 1895
Synonymy: *Chrysops callidulus* Philip, 1941

Chrysops calvus (Pechuman & Teskey, 1967)
Florida Record: Pechuman & Teskey 1967, FSCA
Pechuman & Teskey 1967. New species.
Note: Species pair with *Chrysops niger* (Drees et al. 1980).

Chrysops carbonarius Walker, 1848
Florida Record: Philip 1955 (as *C. carbonaria*)
Synonymy: *Chrysops provocans* Walker, 1850

Chrysops celatus Pechuman, 1949
Florida Record: Tidwell 1973, FSCA
Synonymy: *Chrysops flavidus celata* Pechuman, 1949
Note: Member of the *C. flavidus* species group (Baier 1999).

Chrysops cincticornis Walker, 1848 (Suppl. Table 2)
Florida Record: Fairchild 1937, FSCA
Synonymy: *Chrysops celer* Osten Sacken, 1875

Chrysops cincticornis nigropterus Fairchild, 1937
Florida Record: Fairchild 1937, FSCA
Synonymy: *Chrysops celer* var. *nigroptera* **var. nov.** Fairchild, 1937

Chrysops cursim Whitney, 1879 (Suppl. Fig. 1)
Florida Record: Brennan, 1935, FSCA

Chrysops dacne Philip, 1955
Florida Record: Philip 1955
Note: Species pair with *C. parvulus* as noted in collections in the Florida State Collection of Arthropods, Department of Plant Industry, Gainesville, Florida.

Chrysops dimmocki Hine, 1905
Florida Record: Philip, 1947 (mentioned as part of the *C. pudicus* species group), FSCA

Chrysops divisus Walker, 1848
Florida Record: Walker 1848
Synonymy: *Chrysops atropos* Osten Sacken, 1875

Chrysops dixianus Pechuman, 1974
Florida Record: Pechuman 1974, FSCA
Pechuman 1974. New species.
Note: Member of the *C. flavidus* species group (Baier 1999).

Chrysops dorsopunctus Fairchild, 1937
Florida Record: Fairchild 1937 (as *C. fulvistigma* var. *dorsopuncta* **var. nov.**)
Synonymy: *Chrysops fulvistigmus dorsopunctus* Fairchild, 1937

Chrysops dorsovittatus Hine, 1907
Florida Record: Hine 1907
Note: Species pair with *C. abatus* (Fairchild 1978).

Chrysops flavidus Wiedemann, 1821 (Suppl. Table 2; Suppl. Fig. 2)
Florida Record: Johnson & Coquillett 1895, FSCA
Synonymy: *Chrysops pallida* Macquart, 1838; *Chrysops pallidus* Bellardi, 1859
Note: The *C. flavidus* species group contains: *C. atlanticus*, *C. brunneus*, *C. dixianus*, *C. flavidus*, *C. reicherti*, (*C. sandyi*), *C. tumidicornis*, and *C. celatus* (Baier 1999).

Chrysops floridanus Johnson, 1913
Florida Record: Johnson 1913 (as *C. vittatus* var. *floridanus*), FSCA
Synonymy: *Chrysops vittatus floridanus* Johnson, 1913
Burger, 1995. Note on classification.
Note: Species pair with *C. vittatus*. *Chrysops vittatus* is thought to be an inland species and *C. floridanus* is thought to be a coastal species (Burger 1995).

Chrysops fuliginosus Wiedemann, 1821 (Suppl. Fig. 3)
Florida Record: Walker, 1848, FSCA
Synonymy: *Chrysops plangens* Wiedemann, 1828; *Chrysops confusus* Harris, 1835
Note: There is a larger inland variation of *C. fuliginosus* with distinct yellow abdominal markings. Ecology of the inland variation is unknown.

Chrysops fulvistigma Hine, 1904
Florida Record: Philip 1950

Chrysops geminatus Wiedemann, 1828
Florida Record: Fairchild 1937

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Synonymy: *Chrysops fallax* Osten Sacken, 1875

Chrysops hinei Daecke, 1907 (Suppl. Fig. 4)
Florida Record: Johnson 1913

Chrysops hyalinus Shannon, 1924
Florida Record: Philip & Jones 1962
Synonymy: *Chrysops vitripennis* Shannon, 1916; *Chrysops claripennis* Krober, 1926

Chrysops ifasi Fairchild, 1978
Florida Record: Fairchild 1978
Fairchild, 1978. New species.

Chrysops macquarti Philip, 1961
Florida Record: Philip 1961
Synonymy: *Chrysops univittatus*, authors, not Macquart
Philip 1961. Note on classification, name change.

Chrysops moechus Osten Sacken, 1875
Florida Record: Bargren 1961

Chrysops montanus Osten Sacken, 1875 (Suppl. Table 2)
Florida Record: Fairchild 1937
Synonymy: *Chrysops montanus perplexa* Philip, 1955
Burger 1995. Note on classification.

Chrysops niger Macquart, 1838
Florida Record: Philip 1950 (as *C. nigra*)
Synonymy: *Chrysops nigra taylori* Philip, 1955
Burger 1995. Note on classification.
Note: Species pair with *Chrysops calvus* (Drees et al. 1980).

Chrysops nigribimbo Whitney, 1879
Florida Record: Philip 1947, FSCA

Chrysops obsoletus Wiedemann, 1821 (Suppl. Table 2)
Florida Record: Osten Sacken 1875 (as *C. morosus*), FSCA
Synonymy: *Chrysops obsoletus lugens* Wiedemann, 1821; *Chrysops trinotatus* Macquart, 1838; *Chrysops morosus* Osten Sacken, 1875; *Chrysops ultimus* Whitney, 1914

Chrysops parvulus Daecke, 1907
Florida Record: Johnson 1913
Note: Species pair with *C. dacne* as noted in collections in the Florida State Collection of Arthropods, Department of Plant Industry, Gainesville, Florida.

Chrysops pikei Whitney, 1904
Florida Record: Fairchild 1937
Synonymy: *Chrysops harmani* Tidwell, 1973

Chrysops pudicus Osten Sacken, 1875 (Suppl. Table 1; Suppl. Fig. 5)
Florida Record: Osten Sacken 1875, FSCA
Note: Member of the *C. flavidus* species group (Baier 1999).

Chrysops reicherti Fairchild, 1937
Florida Record: Fairchild 1937, FSCA
Synonymy: *Chrysops flavidus reicherti* Fairchild, 1937
Note: Member of the *C. flavidus* species group (Baier 1999).

(*Chrysops sandyi* Baier, 1999)
Baier 1999. New species.

Chrysops tidwelli Philip & Jones, 1962
Florida Record: Philip & Jones 1962
Philip & Jones 1962. New species.

Chrysops tumidicornis Baier, 1999
Florida Record: Baier 1999, FSCA
Baier 1999. New species.
Note: Member of the *C. flavidus* species group (Baier 1999).

Chrysops univittatus Macquart, 1855
Florida Record: Johnson & Coquillett 1895
Synonymy: *Chrysops fraternus* Kröber, 1926; *Chrysops wiedemanni* Kröber, 1926

Chrysops upsilon Philip, 1950
Florida Record: Fairchild 1978
Fairchild 1978. New record.

Chrysops vittatus Wiedemann, 1821 (Suppl. Table 1; Suppl. Table 2; Suppl. Fig. 6)
Florida Record: Johnson & Coquillett 1895, FSCA
Synonymy: *Chrysops areolatus* Walker, 1848; *Chrysops lineatus* Jaennicke 1867; *Chrysops vittatus floridana* Johnson, 1913; *Chrysops ornatus* Kröber, 1926

Diachlorus ferrugatus (Fabricius), 1805 (Suppl. Table 1; Suppl. Fig. 8)
Florida Record: Walker 1848 (as *Chrysops approximans*), FSCA
Synonymy: *Diachlorus americanus* Palisot de Beauvois, 1819; *Diachlorus ataenia* Macquart, 1838; *Diachlorus approximans* Walker, 1848

Haematopota punctulata (Macquart), 1838
Florida Record: Johnson & Coquillett 1895 (as *H. americana*; corrected by Johnson 1912), FSCA
Synonymy: *Chrysozona punctulata* (Macquart), 1838

Hamatabanus annularis (Hine), 1917
Florida Record: Stone 1935 (as *Dicladocera sexfasciata* Stone), FSCA
Synonymy: *Hamatabanus sexfasciatus* (Stone), 1935
Burger 1995. Note on classification.

Hamatabanus carolinensis (Macquart), 1838
Florida Record: Philip 1947 (as *H. scitus*), FSCA
Synonymy: *Hamatabanus scitus* (Walker), 1848; *Tabanus hirtiocu-latus* Macquart, 1855; *Tabanus cerastes* Osten Sacken, 1876; *Tabanus fraterna* Kröber, 1931; *Tabanus frater* Kröber, 1934

Hamatabanus exilipalpis (Stone), 1938
Florida Record: Stone 1938 (as *T. exilipalpis*), FSCA

Hamatabanus floridensis (Hine), 1912
Florida Record: Hine 1912 (as *T. floridensis*), FSCA
Synonymy: *Stenotabanus floridensis* (Hine), 1912; *Tabanus floridensis* Hine
Burger 1995. Note on classification.

Hybomitra cincta (Fabricius), 1794
Florida Record: Jones & Anthony 1964, FSCA
Synonymy: *Tabanus cincta* (F.), 1794

Hybomitra difficilis (Wiedemann), 1828
Florida Record: Philip 1961, FSCA
Synonymy: *Tabanus carolinensis*, authors, not Macquart; *Tabanus difficilis* (Wiedemann), 1828

Hybomitra hinei (Johnson), 1904
Florida Record: Stone 1938 (as *T. hinei*), FSCA
Synonymy: *Tabanus politus* Johnson, 1900; *Tabanus hinei* (Johnson), 1904; *Hybomitra hinei wrighti* (Whitney), 1915
Burger 1995. Note on classification.

Hybomitra trispila (Wiedemann), 1828 (Suppl. Table 2)
Florida Record: Goodwin 1976, FSCA
Synonymy: *Tabanus trispila* (Wiedemann), 1828
Goodwin, 1976. New record.

Leucotabanus annulatus (Say), 1823
Florida Record: Fairchild 1937 (as *T. annulatus*), FSCA

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Synonymy: *Tabanus annulatus* (Say), 1823; *Tabanus argenteus* Wiedemann in Philip, 1950

Merycomyia microcera (Walker), 1848
Florida Record: Stone 1953 (as *M. brunnea*), FSCA
Synonymy*: Merycomyia brunnea* Stone, 1953
Note: Listed as a "Species of Concern". Reviewed for threatened or endangered status by the Florida Fish and Wildlife Commission in 1994.

Merycomyia whitneyi (Johnson), 1904
Florida Record: Philip 1954, FSCA
Synonymy*: Merycomyia geminata* Hine, 1912; *Merycomyia mixta* Hine, 1912

Microtabanus pygmaeus (Williston), 1885
Florida Record: Williston 1885 (as *T. pygmaeus*), FSCA
Synonymy: *Tabanus pygmaeus* (Williston), 1885; *Atylotus pygmaeus* (Williston)

Stenotabanus (Aegialomyia) magnicallus (Stone) 1935
Florida Record: Tidwell 1973, FSCA
Synonymy: *Tabanus magnicallus* Stone, 1935; *Tabanus maritimus* Townsend, 1898; *Tabanus nanus* Macquart, 1846

Stenotabanus (Aegialomyia) psammophilus (Osten Sacken) 1876
Florida Record: Osten Sacken 1875 (as *T. psammophilus*), FSCA
Synonymy: *Tabanus psammophilus* Osten Sacken, 1876

Tabanus aar Philip, 1941
Florida Record: Philip 1941, FSCA

Tabanus abdominalis Fabricius, 1805
Florida Record: Walker 1848, FSCA

Tabanus acutus (Bigot), 1892
Florida Record: Fairchild 1937, FSCA
Synonymy: *Atylotus acutus* Bigot, 1892

Tabanus americanus Forster, 1771 (Suppl. Table 1; Suppl. Table 2; Suppl. Fig. 9)
Florida Record: Walker 1848 (as *T. ruficornis*), FSCA
Synonymy: *Tabanus plumbeus* Drury, 1773; *Tabanus ruficornis* Fabrucius, 1775; *Tabanus limbatus* Palisot De Beauvois 1806

Tabanus aranti Hays, 1961
Florida Record: Philip & Jones 1962; Recorded by Fairchild (1937) as *T. nigrescens atripennis*, though not reassigned to *T. aranti* until 1980 (Fairchild 1980), FSCA
Goodwin 1976. New record.

Tabanus atratus Fabricius, 1775 (Suppl. Table 1; Suppl. Table 2; Suppl. Fig. 10)
Florida Record: Osten Sacken 1875, FSCA
Synonymy: *Tabanus americanus* Drury, 1773; *Tabanus niger* Palisot De Beauvois, 1806; *Tabanus validus* Wiedemann, 1828; *Tabanus atratus nantuckensis* Hine, 1917; *Tabanus atratus fulvopilosis* Johnson, 1919
Burger 1995. Note on classification

Tabanus birdiei Whitney, 1914
Florida Record: Whitney 1914, FSCA

Tabanus bishoppi Stone, 1933
Florida Record: Stone 1935, FSCA

(*Tabanus calens* Linnaeus, 1767)
Florida Record: Williston 1885 (as *T. giganteus*)
Synonymy: *Tabanus giganteus* De Geer, 1776; *Tabanus lineatus* Fabricius, 1781; *Tabanus pallidus* Palisot De Beauvois, 1809; *Tabanus bicolor* Macquart, 1847; *Tabanus coesiofasciatus* Macquart, 1855
Note: Williston (1885) and Johnson & Coquillett (1895) reported this species from an unknown location in Florida as *T. giganteus*. Stone (1938) also reported this species from Florida and Fairchild (1950) lists Florida within the range, but *T. calens* has not been recorded, because Burger (1995) does not consider Florida within the distribution range and there is much debate about the identification of the original *T. giganteus* specimens (Philip 1952b).

Tabanus cayensis Fairchild, 1935
Florida Record: Fairchild 1935, FSCA

Tabanus cheliopterus Rondani, 1850
Florida Record: Philip 1936 (as *T. subfronto*)
Synonymy: *Tabanus cheliopterus subfronto* Philip, 1936
Burger 1995. Note on classification.

Tabanus coarctatus Stone, 1935
Florida Record: Stone 1935, FSCA

Tabanus colon Thunberg, 1827
Florida Record: Fairchild 1937, FSCA
Synonymy: *Tabanus nigrescens atripennis* Stone, 1935
Note: Both names are still used in the literature, but refer to the same species.

Tabanus conterminus Walker, 1850
Florida Record: Johnson 1913, FSCA
Note: Fairchild & French (1999) note that *T. nigrovittatus* and *T. conterminus* will key out the same. In Florida, there likely is 1 or more undescribed species in this complex (Sutton & Carlson 1997) and one can realistically expect only to identify specimens to the *T. nigrovittatus complex*, not to species (B. D. Sutton, Florida Department of Agriculture and Consumer Services, Department of Plant Industry, unpublished data.)

(*Tabanus cymatophorus* Osten Sacken, 1876)
Florida Record: Johnson 1913
Note: Johnson (1913) notes specimens taken in Biscayne Bay and West Palm Beach, Florida. Müller caught 2 specimens near St. Augustine, Florida in the late 1990s (unpublished data). Burger (1995) lists the southern distribution of *T. cymatophorus* as Georgia.

Tabanus daedalus (Stone), 1938
Florida Record: Stone 1938 (as *S. daedalus*)
Synonymy: *Stenotabanus daedalus* Stone, 1938

Tabanus endymion Osten Sacken, 1878
Florida Record: Fairchild 1937

(*Tabanus equalis* Hine, 1923) (Suppl. Table 2)
Synonymy: *Tabanus uniformis* Hine, 1917

Tabanus fairchildi Stone, 1938
Florida Record: Stone 1938
Synonymy: *Tabanus vivax*, authors, not Osten Sacken

Tabanus fronto Osten Sacken, 1876
Florida Record: Williston 1885
Synonymy: *T. cheliopterus* var. *fronto* Philip, 1936
Burger 1995. Note on classification.

Tabanus fulvilineis Philip, 1957
Florida Record: Philip 1957 (as *T. nigrovittatus fulvilineis*), FSCA
Synonymy: *Tabanus nigrovittatus fulvilineis* Philip, 1957
Burger 1995. Note on classification.
Note: Member of the *Tabanus nigrovittatus* complex. See note under *T. nigrovittatus*.

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Tabanus fulvulus Wiedemann, 1828
Florida Record: Johnson 1913, FSCA
Synonymy: *Tabanus fulvofrater* Walker, 1848; *Tabanus mutatus* Walker, 1850

Tabanus fumipennis Wiedemann, 1828 (Suppl. Table 1; Suppl. Table 2; Suppl. Fig. 11)
Florida Record: Osten Sacken 1875 (as *T. rufus*), FSCA
Synonymy: *Tabanus rufus* Palisot De Beauvois, 1809; *Tabanus flammans* Walker, 1848; *Tabanus formosus* Walker, 1848

(*Tabanus fuscicostatus* Hine, 1906) (Suppl. Table 2)
Florida Record: Pechuman 1949, FSCA
Note: The presence of *T. fuscicostatus* in Florida is still unclear. Several Florida specimens exist at the FSCA labeled *T. fuscicostatus*; however, a note left by Sandy Fairchild suggests that based on the dark femurs and dark costal cells, these were misidentifications and *T. fuscicostatus* does not have a Florida distribution.

Tabanus fusconervosus Macquart, 1838
Florida Record: Walker 1848 (2 records by Walker, as *T. recedens* and *T. fusco-nervosus*)
Synonymy: *Tabanus confusus* Walker, 1848; *Tabanus recedens* Walker, 1848; *Tabanus fur* Williston, 1885, *Tabanus turbidus* Wiedemann, 1828

Tabanus fuscopunctatus Macquart, 1850
Florida Record: Osten Sacken 1876, FSCA

Tabanus fuscopunctatus pechumani Philip, 1960
Florida Record: Philip 1960 (as *T. imitans pechumani*), FSCA
Synonymy: *Tabanus imitans pechumani* Philip, 1960
Burger 1995. Note on classification.

Tabanus gladiator Stone, 1935
Florida Record: Fairchild 1937, FSCA

Tabanus gracilis Wiedemann, 1828 (Suppl. Table 1; Suppl. Table 2; Suppl. Fig. 12)
Florida Record: Williston 1885, FSCA

Tabanus hinellus Philip, 1960 (Suppl. Table 1; Suppl. Fig. 13)
Florida Record: Fairchild 1983, FSCA
Synonymy: *Tabanus lineola hinellus* Philip, 1960

Tabanus imitans Walker, 1848
Florida Record: Fairchild 1937, FSCA

Tabanus johnsoni Hine, 1907 (Suppl. Table 1; Suppl. Fig. 14)
Florida Record: Hine 1907, FSCA

Tabanus kisliuki Stone, 1935
Florida Record: Philip 1950 (as *T. quirinus*)
Synonymy: *Tabanus quirinus* Philip, 1950

Tabanus lineola complex Fabricius, 1794 (Suppl. Table 1; Suppl. Table 2; Suppl. Fig. 15)
Florida Record: Walker, 1848, FSCA
Note: The *T. lineola* complex has extensive morphological variation and further work needs to be done on this group. Several variations and subspecies have been proposed, though the taxonomy is still cloudy. This species is thought to be the inland variation of *T. hinellus*.

(*Tabanus limbatinevris* Macquart, 1847)

Tabanus longiusculus Hine, 1907
Florida Record: Fairchild 1937, FSCA

Tabanus maculipennis Wiedemann, 1928
Florida Record: Stone 1938 (as *T. imitans* var. *excessus*), FSCA
Synonymy: *Tabanus imitans* var. *excessus* Stone, 1938

Tabanus melanocerus Wiedemann, 1828
Florida Record: Osten Sacken 1875, FSCA
Synonymy: *Tabanus lacustris* Stone, 1935; *Tabanus melanocerus* var. *lacustris* Stone, 1935
Burger 1995. Note on classification.
Note: Burger (1995) places *T. melanocerus* and *T. melanocerus lacustris* as a synonymous group under the name *T. melanocerus*. After studying several specimens, it should be noted there is a distinct spur on vein R4 in the former *T. melanocerus lacustris* that is clearly absent in *T. melanocerus*. Following Fairchild & French (1999), we are labeling *lacustris* as a variation of *T. melanocerus*.

Tabanus mixis Philip, 1950
Florida Record: Philip 1950b, FSCA
Synonymy: *Tabanus molestus mixis* Philip, 1950

Tabanus moderator Stone, 1938
Florida Record: Fairchild & French 1999, FSCA

Tabanus molestus Say, 1823
Florida Record: Johnson & Coquillett 1895, FSCA
Synonymy: *Atylotus tennessensis* Bigot, 1892
Burger 1995. Note on classification.

Tabanus mularis Stone, 1935 (Suppl. Table 2)
Florida Record: Stone 1935, FSCA
Note: Member of the *Tabanus nigrovittatus* complex. See note under *T. nigrovittatus*.

(*Tabanus nefarius* Hine, 1907)

(*Tabanus nigrescens* Palisot de Beauvois, 1809)
Florida Record: Stone 1938. No records since.

Tabanus nigrescens atripennis Stone, 1935
See *Tabanus colon* Thunberg, 1827

Tabanus nigripes Wiedemann, 1821 (Suppl. Table 1; Suppl. Fig. 16)
Florida Record: Osten Sacken 1875 (as *T. coffeatus*), FSCA
Synonymy: *Tabanus coffeatus* Macquart, 1847; *Tabanus winthemi* Kröber, 1931

Tabanus nigrovittatus Macquart, 1847 (Suppl. Table 1; Suppl. Table 2; Suppl. Fig. 17)
Florida Record: Johnson & Coquillett 1895, FSCA
Synonymy: *Tabanus simulans* Walker, 1848; *Tabanus vicarious* Walker, 1848 ex parte
Note: *Tabanus nigrovittatus* belongs to the *T. nigrovittatus* complex which contains several lined species. Fairchild & French (1999) note that *T. nigrovittatus* and *T. conteminus* will key out the same. Jones & Anthony (1964) list *T. quinquevittatus* as an inland Florida species, but note that some previous *T. quinquevittatus* specimens were misidentified and were actually *T. nigrovittatus*. Burger (1995) and Fairchild & French (1999) do not consider *T. quinquevittatus* sensu stricto to have a Florida distribution. In Florida, there likely is 1 or more undescribed species in this complex (Sutton & Carlson 1997) and one can realistically expect to identify specimens only to the *T. nigrovittatus* complex, not to species (B. D. Sutton, Florida Department of Agriculture and Consumer Services, Department of Plant Industry).

Tabanus pallidescens Philip, 1936 (Suppl. Table 1; Suppl. Table 2; Suppl. Fig. 18)
Florida Record: Stone 1938 (as *T. fulvulus* var. *pallidescens*), FSCA

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Synonymy: *Tabanus fulvulus pallidescens* Philip, 1936

Tabanus petiolatus Hine, 1917 (Suppl. Table 1; Suppl. Fig. 19)
Florida Record: Fairchild 1937, FSCA
Synonymy: *Tabanus yulensus* Philip, 1950

Tabanus proximus Walker, 1848
Florida Record: Walker 1848
Synonymy: *Tabanus benedictus* Whitney, 1904

Tabanus pumilus Macquart, 1838 (Suppl. Table 1; Suppl. Fig. 20)
Florida Record: Osten Sacken 1875, FSCA

Tabanus quinquevittatus Wiedemann, 1821 (Suppl. Table 1; Suppl. Fig. 21)
Florida Record: Osten Sacken 1875 (as *T. costalis*), FSCA
Synonymy: *Tabanus baitimorensis* Macquart, 1855; *Tabanus costalis* Wiedemann, 1828; *Tabanus manifestus* Walker, 1850; *Tabanus vicarious* Walker, 1848
Note: Member of the *T. nigrovittatus* complex. Jones & Anthony (1964) and Bargren (1961) list *T. quinquevittatus* as an inland Florida species, but Jones & Anthony (1964) note that some previous *T. quinquevittatus* specimens were misidentified and were actually *T. nigrovittatus*. Burger (1995) and Fairchild & French (1999) do not consider *T. quinquevittatus* sensu stricto to have a Florida distribution. In Florida, there likely is 1 or more undescribed species in this complex (Sutton & Carlson 1997) and one can realistically expect to identify specimens only to the *T. nigrovittatus complex*, not to species (B. D. Sutton, Florida Department of Agriculture and Consumer Services, Department of Plant Industry).

Tabanus reinwardtii Wiedemann, 1828

NEW RECORD

Florida Record: Cilek & Olson 1999 (unpublished). Four specimens were collected in a 2-tier box trap in Bay County, Florida, in 1999 by Jim Cilek and Mary Ann Olson. Specimens confirmed by J. F. Burger.
Synonymy: *Tabanus erythrotelus* Walker, 1850

Tabanus rufofrater Walker, 1850
Florida Record: Osten Sacken 1875 (as *T. tener*), FSCA
Synonymy: *Tabanus unicolor* Macquart, 1847; *Tabanus lateritius* Rondani, 1863; *Tabanus tener* Osten Sacken, 1876

(Tabanus sackeni Fairchild, 1934)

(*Tabanus sagax* Osten Sacken, 1876)
Synonymy: *Atylotus baal* Townsend, 1895; *Tabanus dawsoni* Philip, 1931

Tabanus sparus sparus Whitney, 1879
Florida Record: Johnson & Coquillett 1895, FSCA

Tabanus sparus milleri Whitney, 1914 (Suppl. Table 1; Suppl. Fig. 22)
Florida Record: Whitney 1914 (as *T. milleri*), FSCA
Synonymy: *Tabanus sparus* var. *milleri* Whitney, 1914

Tabanus stygius Say, 1823
Florida Record: Walker 1848

(*Tabanus sublongus* Stone, 1938)

Tabanus subsimilis Bellardi, 1859
Florida Record: Philip 1952a (as *T. vittiger schwarti*); originally recorded by Philip (1941), but Fairchild (1978) states it was most likely a misidentification. FSCA
Synonymy: *Tabanus nippontucki* Philip, 1942; *Tabanus vittiger schwardti* Philip, 1943

Tabanus sulcifrons Macquart, 1855 (Suppl. Table 2)
Florida Record: Johnson 1913, FSCA
Synonymy*: Tabanus variegatus* Fabricius, 1805; *Tabanus tectus* Osten Sacken, 1876; *Tabanus exul* Osten Sacken, 1878

(*Tabanus superjumentarius* Whitney, 1879) (Suppl. Table 2)

(*Tabanus texanus* Hine, 1907)

Tabanus trijunctus Walker, 1854 (Suppl. Table 1; Suppl. Fig. 23)
Florida Record: Osten Sacken 1858

Tabanus trimaculatus Palisot De Beauvois, 1806
Florida Record: Fairchild 1937, FSCA
Synonymy: *Tabanus quinquelineatus* Macquart, 1834; *Tabanus apicalis* Walker, 1848

Tabanus turbidus Wiedemann, 1828
Florida Record: Johnson & Coquillett 1895, FSCA

(*Tabanus venustus* Osten Sacken, 1876) (Suppl. Table 2)

Tabanus vittiger guatemalanus Hine, 1906
Florida Record: Fairchild 1978 (Florida forms of *T. vittiger* mentioned by Philip, 1957)
Synonymy: *Tabanus bellardi* Szilády, 1926; *Tabanus appendiculatus* Bequaert, 1940 (♀ only); *Tabanus carneus* Bequaert, 1940 (♀ only); *Tabanus caymanicus* Fairchild. 1942; *Tabanus angustivitta* Bequaert and Renjifo-Salcedo, 1946

Tabanus wiedemanni Osten Sacken, 1876
Florida Record: Osten Sacken 1875–76
Synonymy: *Tabanus ater* Palisot de Beauvois of Wiedemann, 1828

(*Tabanus wilsoni* Pechuman, 1962)

Tabanus yucatanus Townsend, 1897

NEW RECORD

Florida Record: Müller & Revay 2003 (unpublished). Two specimens were collected in a malaise trap in Cedar Key, Florida.
Note: Previously documented from the Yucatan Peninsula. The 2 Florida specimens are deposited in Col. G.C. Müller and in the Florida State Collection of Arthropods, Department of Plant Industry, Gainesville, Florida.

Tabanus zythicolor Philip, 1936 (Suppl. Table 1; Suppl. Fig. 24)
Florida Record: Stone 1938

Whitneyomyia beatifica (Whitney), 1914
Florida Record: Whitney 1914 (as *Tabanus beatificus*), FSCA
Synonymy: *Snowiellus styguis* Enderlein, 1925; *Tabanus ater* Pallisot De Beauvois, 1811; *Tabanus beatifica* Whitney, 1914; *Tabanus lugubris* Macquart, 1838

Whitneyomyia beatifica var. *atricorpus* Philip, 1950
Florida Record: Philip 1950a, FSCA
Synonymy: *Whitneyomyia atricorpus* Philip, 1950

Discussion

PEST SPECIES

We have listed 24 tabanid pest species of Florida (Suppl. Table 1) with their respective locations, habitats, biting preferences, and additional notes. Data were compiled through literature and collection records; however, the majority of collections throughout the years have been based in North or Central Florida. Many previous Florida tabanid researchers were based out of North Florida universities and other in-

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stitutions, and therefore sampling in North Florida was more feasible and cost effective. Very few collection records exist for South Florida, and therefore species data may be biased towards North/Central Florida. In the case of *C. pudicus*, *C. flavidus*, *C. vittatus*, and *T. nigrovittatus*, we have only included representatives of the species groups. Different species within the species groups may be dominant in different regions of the state or the USA.

DISEASE TRANSMISSION

Tabanids are competent disease vectors in many parts of the world. In Africa, *Chrysops* species are the primary vectors of *Loa loa* (Cobbold, 1864) (Spirurida: Onchocercidae) filariasis, and several tabanid species have been implicated in the mechanical transmission of African trypanosomiasis, commonly known as nagana (Krinsky 1976; Foil 1989). In North America, tabanids are considered minor disease vectors but have the potential to become a serious problem if conditions are right. Tularemia, after *L. loa*, is the second principal human disease vectored by tabanids (Minter 2009). In western states, tularemia is often referred to as "deer fly fever." However, it is also spread through other means such as ticks and infected animal tissue, specifically rodents and rabbits (Jellison & Parker 1945; Hopla 1960; Cooney & Burgdorfer 1974). Interestingly, no cases of "deer fly fever" are reported from eastern states of the USA with a high incidence of tularemia, suggesting the principle tabanid vector is a western species, likely *Chrysops discalis* (Jellison 1950). Tularemia is a bacterial infection that causes flu-like symptoms in humans, often with the presence of a skin ulcer. In animals, infection can lead to death if untreated. Tularemia does not present with skin ulcers in animals, and is difficult to culture in the laboratory unless infection is suspected (Kahn 2005), wherefore detection in animals is difficult, but tularemia is not a major threat to the livestock industry in the USA. Although the suspected vector species are not present in Florida, Florida tabanids may be capable of disseminating the disease.

Anaplasmosis is a rickettsial infection that is common in livestock. In the USA, anaplasmosis is caused by *Anaplasma marginale* and mechanical transmission is the primary route of dissemination via flies (Foil 1989). Several species inhabiting or potentially inhabiting Florida have been found to be viable rickettsial vectors including *T. sulcifrons*, *T. lineola*, (*T. fuscicostatus*), *T. mularis*, and *T. pallidescens* (Lotze & Yiengist 1941; Hawkins et al. 1982). Symptoms in hoofstock include anemia, haematuria, diarrhea, and anorexia. If detected, anaplasmosis can be treated with antibiotics.

The 3rd bacterial disease of concern to livestock owners is infection with *Bacillus anthracis*, commonly called anthrax. Anthrax spores are incredibly resilient and can persist dormant in the environment for years. Cutaneous anthrax outbreaks in hoofstock are often attributed to tabanids (Foil 1989), and there is evidence that tabanids are capable of transmitting the infection to humans. Although anthrax is no longer a common disease in the USA, outbreaks are severe and can take down entire herds in short periods of time. Prior to a mass-produced vaccine in the 1950s, anthrax was a major concern for livestock producers throughout North America and still is a concern in wild animal populations throughout the USA (Blackburn et al. 2007), though primarily centered in the Midwest and western states.

A greater concern to Florida is the transmission of the equine infectious anemia virus (EIAV) or "swamp fever." This retrovirus is spread through mechanical transmission and is present worldwide. EIAV-capable Florida tabanid vectors include *T. fuscicostatus* and *C. flavidus* (Foil 1983; Issel et al. 1988). Often, infected horses do not exhibit symptoms of the disease but are still capable of transmission. When horses do exhibit symptoms, they often present with recurring fever, anemia, and swelling of the abdomen and legs, and EIAV may cause abortion in pregnant mares. In extreme cases, the disease can be fatal. Infection is persistent for life once contracted, and positive individuals should be quarantined from the herd (Kahn 2005).

Bovine leukemia virus is a retrovirus of cattle that causes malignant tumors of the lymph nodes. The virus can be transmitted by flies, specifically *T. fuscicostatus* (Foil 1989) but is also transmitted through infected milk consumed by calves. Sheep and goats serve as secondary hosts to the virus. Most infected cattle do not exhibit symptoms of the virus but are capable of transmission. The virus is usually fatal for those that do exhibit symptoms and affects multiple organs within the body leading to organ failure and cardiac arrest. Dairy cows are generally more susceptible than beef cattle, and cattle between 4 and 8 yr old are most commonly affected (Kahn 2005).

Hog cholera virus (classical swine fever) is a mechanically transmitted *Pestivirus*, a genus of viruses that belong to the family Flaviviridae. Viruses in the genus *Pestivirus* infect mammals, including members of the Bovidae and the Suidae. Hog cholera is endemic to Florida and the USA, and it can affect both domestic and feral hogs. Swine may contract acute or chronic forms of the virus, both of which cause poor reproductive performance. Swine with severe infection present with fever, depression, constipation followed by diarrhea and hemorrhaging under the skin. Survival with chronic infections is usually less than 30 d (Kahn 2005). The USA has experienced several outbreaks in the past leading to an eradication program starting in 1961. The United States Department of Agriculture declared a national emergency in 1972 after an especially widespread epidemic, and in 1978, the Secretary of Agriculture declared the USA hog cholera–free (Martin 1978). In Florida, farmers are still urged to watch for resurgence as feral hogs are widespread and difficult to keep away from farms. Florida tabanid species implicated in hog cholera transmission include *T. lineola*, *T. quinquevittatus*, *T. americanus*, *T. molestus*, and *T. atratus* (Tidwell et al. 1972; Foil 1989).

Several other parasites and diseases can be transmitted by tabanids, though usually tabanids are not the primary vector. *Borrelia burgdorferi* (Lyme disease) has been detected in bloodfed female tabanids, though the competence for transmitting the spirochetes is unknown. There have been reports of erythema migrans forming at the site of deer fly bites, but transmission studies have not been done (Magnarelli et al. 1986; Foil 1989). We have compiled a list of Florida tabanid species with known disease transmission capabilities, and associated pathogens (Suppl. Table 2) (Tidwell et al. 1972; Krinsky 1976; Magnarelli et al. 1986; Foil 1989). For a comprehensive review of potential transmittable agents, see Krinsky (1976) and Foil (1989).

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