A Review of the Hawaiian Species of *Anagrus* (Hymenoptera: Mymaridae)

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Abstract. A brief historical account of the use of *Anagrus* Haliday (Hymenoptera: Mymaridae) in biological control in the Hawaiian Islands is given. Twelve species of *Anagrus*, ten of them named, are keyed and descriptive notes are provided. One new species, *A. oahuensis* S. Triapitsyn and Beardsley, is described and illustrated. *A. osborni* (Fullaway) and *A. panicicolae* Sahad are synonymized under *A. optabilis* (Perkins); *A. cicadulinae* Ferrière is synonymized under *A. frequens* Perkins. Lectotypes are designated for *A. cicadulinae* Ferrière, *A. columbi* Perkins, *A. frequens* Perkins, *A. insularis* Dozier, *A. yawi* Fullaway and *Paranagrus optabilis* Perkins.

Keywords: Hymenoptera, Mymaridae, *Anagrus*, Hawaiian Islands, biological control

Introduction

Nishida (1994) listed eight species of *Anagrus* (Hymenoptera: Mymaridae) for the Hawaiian Islands; one of which is a junior synonym of another listed species, and one which is an apparent misidentification. In the present paper we treat 12 species, one of which is described as new. Five of these species were purposely introduced for biological control of pests; the others are either relatively recent accidental introductions or are endemic. *A. nigriventris* Girault, one of the most common species in Hawaii, probably was introduced accidentally since there is no record of its purposeful introduction. The two species that are not identified, but which are listed as "*A.* sp. #1 and *A.* sp. #2", probably are also accidental immigrants. We suppose that these species may have originated from areas such as Asia (e.g., *A.* sp. #2) or Australia (e.g., *A.* sp. #1), where the mymarid faunas, particularly *Anagrus* spp., are as yet very poorly known. One or both of these species eventually may be found among the many named but poorly understood forms in those regions. To avoid the possible creation of additional synonyms in the already cluttered genus *Anagrus*, we have not named these presumably non-endemic species.

Two of the named *Anagrus* species, *A. insularis* Dozier and *A. oahuensis* n. sp., are not known outside the Hawaiian Islands. The former species has been reared from eggs of Odonata and the host is an endemic *Megalagrion* species (Coenagrionidae). This species of *Anagrus* may be endemic to the Hawaiian Islands although it is morphologically close to the European species *Anagrus brocheri* Schulz. Possibly a complex of *Anagrus* species is associated with the eggs of *Megalagrion*, but additional research is needed to demonstrate this.

In addition to Odonata, the known hosts of Hawaiian *Anagrus* species are the eggs of Auchenorrhyncha (Homoptera), mainly planthoppers (Delphacidae) and leafhoppers (Cicadellidae); and Hemiptera—plant bugs (Miridae) and lace bugs (Tingidae). In all cases, host eggs are inserted into plant leaf or stem tissue. Because a few species of Delphacidae and Miridae have been major pests of agriculture in Hawaii, several *Anagrus* species have been utilized in biological control programs there. These programs are reviewed briefly below.

Use of *Anagrus* in Biological Control in Hawaii

1. Sugarcane planthopper, *Perkinsiella saccharicida* Kirkaldy (Delphacidae) (often referred to as "sugar cane leafhopper" in literature).

This planthopper, a previously unknown species that appeared in Hawaii in 1900, caused catastrophic damage to commercial sugarcane as it spread throughout the islands (Pemberton 1948, Swezey 1936).

During the summer of 1903, the exploratory entomologist Albert Koebele, working with Otto Swezey in Ohio, shipped material containing an *Anagrus* species, later described as *A. columbi* Perkins (1905), to Honolulu, but the species apparently failed to become established (Swezey 1925).

In 1903, the British entomologist R. C. L. Perkins, then living on Oahu I., was hired by the Experiment Station, Hawaiian Sugar Planters' Association (H.S.P.A.) in Honolulu to establish an entomology program and to seek control of the sugarcane planthopper. In 1902 Perkins had determined that northeastern Australia was the likely area of origin for the planthopper, and, in company with Albert Koebele, he traveled to Queensland in 1904 to seek natural enemies which could be shipped to Hawaii to combat this pest. The first natural enemies that they discovered were mymarids. Two species of *Anagrus* were shipped from Queensland to Honolulu for propagation and release. These later were described by Perkins (1905) as *Anagrus frequens* and *Paranagrus optabilis,* both of which quickly became established throughout Hawaiian sugarcane fields (Swezey 1936). Koebele apparently later sent material that contained another species, named *Paranagrus perforator* by Perkins (1905), from Fiji. However, detailed records of that introduction are lacking.

Anagrus (Paranagrus) optabilis (Perkins) became the most important egg parasitoid attacking *P. saccharicida* in Hawaii (Swezey 1936). The Queensland race that was introduced in 1905 apparently was thelytokous, and males were very uncommon. In 1916 another race of this parasitoid was introduced into Hawaii from Taiwan. The Taiwan race had a significant proportion of males and apparently was normally bisexual, although morphologically indistinguishable from the Queensland race (Swezey 1936). Although it is not now abundant in Hawaii, *A. optabilis* has maintained its presence in sugarcane fields there. In addition to *P. saccharicida,* it has been reared in Hawaii from eggs of the corn planthopper, *Peregrinus maidis* (Ashmead), as well as from eggs of an endemic Hawaiian planthopper, *Kelisia emoloa* Kirkaldy, in native bunchgrass (Swezey 1916).

Anagrus frequens Perkins apparently was the first introduced natural enemy of the sugarcane planthopper to be recovered in Hawaii. Initially it became abundant, but was soon largely replaced by *P. optabilis* in sugarcane (Swezey 1936). *A. frequens* develops also in the eggs of other planthoppers, particularly those of *P. maidis,* and today it is one of the more common mymarids found in the Hawaiian Islands.

Anagrus (Paranagrus) perforator (Perkins) was described from specimens reared from the eggs of "delphacid leafhoppers" in Fiji. It is presumed to have been introduced into Hawaii with material of the eulophid egg predator *Aprostocetus* (*Ootetrastichus*) *beatus* (Perkins). It was never common in sugarcane fields, and apparently preferred planthopper eggs laid in "the upper exposed internodes of the cane stalk" (Swezey 1936). This species also has been reared from the eggs of an endemic Hawaiian delphacid, *Aloha ipomoeae* Kirkaldy, in morning glory stems (Swezey 1936). A female specimen of *A. perforator* was collected on Hawaii I. in 1995, indicating that the species still is present in Hawaii.

Partial biological control of the sugarcane planthopper was obtained in Hawaii following the initial introductions of *Anagrus* and *Ootetrastichus* from Queensland and Fiji in 1905. Further exploratory work by H.S.P.A. entomologists resulted in the establishment in Hawaii of additional parasitoids and predators, and culminated with the introduction in 1920 of the mirid egg predator *Tytthus mundulus* (Breddin). Complete economic control of the

sugarcane planthopper throughout Hawaii was then achieved (Pemberton 1948).

2. Corn planthopper, *Peregrinus maidis* (Ashmead) (Delphacidae).

In 1915, H. T. Osborn, an entomologist then employed by the Experiment Station, H.S.P.A., shipped parasitized eggs of the corn planthopper from Los Baños, Philippine Islands, to Honolulu. *Anagrus* parasitoids which emerged from that material were released on Oahu I., and voucher specimens were described by D. T. Fullaway (1919) as *Paranagrus osborni*, type material of which is now in the Bishop Museum in Honolulu. Except for the minor size differences that are detailed in Fullaway's description, these specimens are morphologically indistinguishable from those of Perkins' *Paranagrus optabilis*, under which *P. osborni* is synonymized in this paper. In Hawaii, the eggs of the corn planthopper are attacked by both *Anagrus frequens* and *A. optabilis.*

3. Bean capsid, *Pycnoderes quadrimaculata* Guérin-Méneville (Miridae).

In 1943, the Hawaii Department of Agriculture imported from Sinaloa, Mexico, material containing an *Anagrus* parasitoid of the eggs of the bean capsid, an important pest of beans, cucurbits and other vegetable crops. The species was described as *Anagrus yawi* Fullaway (1944b) who named it in honor of the Mexican collector. During the same year Fullaway (1944a) reported the species to be established on Oahu I. There are no literature records of *A. yawi* in Hawaii after that time but the bean capsid is no longer an important pest in Hawaii. On the basis of recent collections, *A. yawi* is recorded here from the islands of Molokai and Oahu.

In summary, based on available records, five valid species of *Anagrus* were purposely introduced into the Hawaiian Islands between 1903 and 1943: *A. (A.) columbi, A. (A.) frequens, A. (A.) yawi, A. (P.) optabilis* and *A. (P.) perforator.* Of these, *A. columbi* was never recovered from the target host, but a form close to this species is recorded in this paper as a parasitoid of the eggs of Odonata. Collections made since about 1960 have confirmed the occurrence in Hawaii of the four others.

Materials and Methods

Two hundred and twenty-eight microscope slides were examined during this study. The actual number of specimens studied was much greater since many of the older slides contained at least several, but often more than a dozen, specimens under the same cover slip. Many of the newer slides were prepared by the authors from material which was recently collected by J.W.B. and his colleagues in Hawaii. The junior author also undertook a search for the old slide-mounted specimens of *Anagrus*, some of which were rediscovered in the collection of the Hawaii Department of Agriculture in Honolulu. Many of these specimens were examined for the first time in 70–90 years. J.W.B. wrote the introduction to this paper while S.V.T. is responsible for compiling the key and for making taxonomic descriptions of the species included in this review.

Terminology for morphological features is that of Chiappini (1989) and Chiappini et al. (1996). Measurements and ratios (as length/width) are given in micrometers (μm), with the mean followed, in parentheses, by the range. Acronyms for collections are as follows:

BMNH, The Natural History Museum, London; J. Noyes.

BPBM, Bernice P. Bishop Museum, Honolulu; K. Arakaki.

CISC, University of California, Berkeley; R. Zuparko.

CNCI, Canadian National Collection of Insects, Ottawa; J. Huber.

HDOA, Hawaii Department of Agriculture, Honolulu; B. Kumashiro.

UCRC, University of California, Riverside; S. Triapitsyn.

USNM, National Museum of Natural History, Washington, D.C.; M. Schauff.

An abbreviation used in the description is: F = funicular (flagellar in males) segment. Abbreviations for the collecting methods (used under the heading of "material examined") are as follows: (S) = sweeping, (YPT) = yellow pitfall or pan trap, (YSBT) = yellow sticky board trap. All specimens listed are on slides unless stated otherwise.

Discussion. The systematics of the genus *Anagrus* is based primarily on the female sex. Although males possess taxonomically useful characters, for the most part these have not been studied comparatively, and identification of unassociated males is therefore difficult. For this reason we have not attempted to provide a key to Hawaiian *Anagrus* males, although we have cited males that we have been able to identify, and which in a few occasions were described, in the listings of material examined.

Genus *Anagrus* Haliday, 1833

Anagrus Haliday, 1833: 346.
Pteratomus Packard, 1864: 137–138.
Packardiella Ashmead, 1904: 364.
Paranagrus Perkins, 1905: 199.
Anagrella Bakkendorf, 1962: 372.

Diagnosis: Tarsi 4-segmented; pronotum entire; mesophragma projected posteriorly beyond base of hindcoxae; metasoma sessile; face without subantennal groove; radicle fused with scape; female funicle 6-segmented and club 1-segmented; male flagellum 11-segmented or, very rarely, 10-segmented; mandible usually tridentate, rarely bidentate; posterior scutellum about as long as half its width and completely divided into two paramedial plates by a distinct longitudinal groove; forewing venation with macrochaetae distal to hypochaeta.

Discussion: Although the diagnosis of *Anagrus* given by Chiappini et al. (1996) works perfectly for all known Hawaiian species treated below, our modified diagnosis of the genus also incorporates some other morphological characters that are helpful for its definition (Chiappini and Lin 1998, Triapitsyn 1999). For a complete list of references on *Anagrus* and diagnoses of its three subgenera, i.e. *Anagrus* Haliday, 1833 s. str., *Paranagrus* Perkins, 1905 and *Anagrella* Bakkendorf, 1962, see Chiappini et al. (1996). Members of *Anagrella* have not yet been found in Hawaii.

Key to the Hawaiian Species of *Anagrus* Haliday

(females)

1 F1 long, subequal to pedicel; triangular paramedial plates on postscutellum widely separated (subgenus *Paranagrus* Perkins) 2

1' F1 shorter than 2/3 length of pedicel (as in Fig. 3); triangular paramedial plates on postscutellum very close to each other (Fig. 25) (subgenus *Anagrus* Haliday s. str.) .. 3

2 Ovipositor very long, exserted beyond apex of metasoma by about 1/3–1/4 of its total length; ovipositor length/foretibia length 3.1–3.4/1 ..... *A. perforator* (Perkins)

2' Ovipositor of variable length but never exserted beyond apex of metasoma by more than 1/5 of its total length; ovipositor length/foretibia length less than 2.7/1, usually 2.2–2.4/1 ..... *A. optabilis* (Perkins)

3 Club with 3 sensory ridges; forewing with proximal macrochaeta of marginal vein less than 1/2 as long as distal macrochaeta (*atomus* species group) 4
3' Club with 5 sensory ridges [the fifth sensory ridge is often hard to see]; proximal macrochaeta 1/2 as long as distal macrochaeta or longer (*incarnatus* species group) . 5

4 F3 with 1 sensory ridge; forewing relatively broad, length/width 7–8/1 ..... *A.* sp. 1
4' F3 without sensory ridges; forewing relatively narrow, length/width 11–12/1 ..... *A. frequens* Perkins

5 Antenna with F2 and F3 each much shorter than F4 or F6; forewing relatively short and broad, length/width 5–6/1 ..... *A. takeyanus* Gordh
5' Antenna not as above; forewing more elongate, length/width 7/1 or more 6

6 Mesoscutum with a pair of adnotaular setae (Fig. 25, marked by arrows) 7
6' Mesoscutum without a pair of setae near notauli ..... *A.* ?*columbi* Perkins

7 F2 with 1 sensory ridge ..... *A. yawi* Fullaway
7' F2 without sensory ridges 8

8 Forewing disc with a more or less distinct hairless area at broadest part (as in Figs. 13, 16, 19) 9
8' Forewing disc without distinct hairless area (as in Fig. 22) 11

9 Forewing with a single row of discal hairs in basal 2/3 of blade (Fig. 13) ..... *A. oahuensis* new species
9' Forewing with 2 or more rows of discal hairs in basal 2/3 of blade 10

10 External plates of ovipositor with 3 distal setae each..... *A. empoascae* Dozier
10' External plates of ovipositor with 2 distal setae each..... *A.* sp. 2

11 Body color uniformly dark brown .....*A. insularis* Dozier
11' Body color contrasting black (head and metasoma) and yellow (parts of mesosoma) .. *A. nigriventris* Girault

Anagrus (Paranagrus) perforator (Perkins)

Paranagrus perforator Perkins, 1905: 199.
Anagrus perforator (Perkins); Sahad and Hirashima, 1984: 71–72.
Anagrus perforator (Perkins); Chiappini et al., 1996: 567–568.

For the complete list of references on this species, including its distribution and host associations, and for the detailed taxonomic description, see Chiappini et al. (1996). Illustrations of *A. perforator* can be found in both of the revisions by Sahad and Hirashima (1984) and Chiappini et al. (1996).

Type locality: Fiji.

Type material: Not examined (lost from BPBM).

Material examined: Hawaiian Islands. **HAWAII I.**: Kauhiula, at edge of Hilo Bay, 20.X.–3.XI.1995, W. D. Perreira, 1 ♀ (YSBT). **OAHU I.**: Waimanalo, University of Hawaii Farm, 5.VI.1995, J. W. Beardsley and W. D. Perreira, 1 ♀ (S) [BPBM]. **Japan**. Ishikawa Pref., Kanazawashi, 13.X.1954, E. Kawase and H. Ishizaki, ex. eggs of *Hirozuunka japonica*

Matsumura and Ishihara, 1 ♀ [CISC]. **Philippines**. Luzon I.: Los Baños: 9.VIII.1931, "D. J. H., ex. eggs of *Megamelus proserpina*", 10 ♀ on 2 slides [BPBM]; IRRI, 17.XI.1980, A. T. Barrion et al., ex. eggs of *Nephotettix virescens* (Distant), 1 ♀. Sagayan, Solano, 29.XI.1981, C. Miguel, ex. eggs of *Sogatella furcifera* (Horvath), 1 ♀ [BMNH].

Comments: Because we were unable to find any specimens of *A. perforator* from the type locality in Fiji, it was difficult for us to define this species. Based on our study of the specimens from Philippines which appear to be closest to Perkins' original description, *A. perforator* can be easily distinguished from *A. optabilis* and other species of the subgenus *Paranagrus* by having a very long ovipositor exserted beyond the metasoma apex by about 1/3–1/4 of its total length (ovipositor length/foretibia length 3.1–3.4/1). Also in these Philippine specimens, F1 is consistently slightly longer than pedicel, and forewing length/width ratio is about 14–15/1.

Only one of the two Hawaiian specimens available for this study appears to belong to *A. perforator* (collected on Hawaii I.). The other, collected on Oahu I., is only provisionally assigned to *A. perforator* since it is quite different from the first specimen and from all known Japanese and Philippine specimens of this species. This female has much shorter antenna, with pedicel as long as F1, F2 markedly shorter than F3, and ovipositor exserted from apex of metasoma by about 1/7 of its total length (ovipositor length/foretibia length 3.2/1). It appears to represent an intermediate form between *A. perforator* and *A. optabilis* (Perkins).

Anagrus (Paranagrus) optabilis (Perkins) (Figs. 1–2)

Paranagrus optabilis Perkins, 1905: 199.
Paranagrus osborni Fullaway, 1919: 53. **New synonym**.
Anagrus optabilis (Perkins); Sahad and Hirashima, 1984: 65–68, 73–75.
A. panicicolae Sahad, 1984; *in* Sahad and Hirashima, 1984: 68–71. **New synonym**.
Anagrus optabilis (Perkins); Chiappini et al., 1996: 564–566.

Type locality: Queensland, Australia.

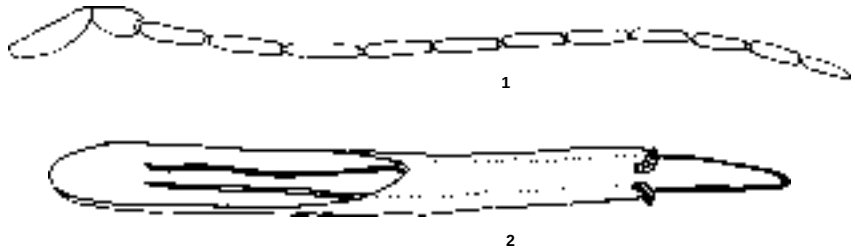
Type material: Lectotype ♀, here designated, labeled: 1. "2230 [Koebele's number] Sugar Cane Bundaberg Dec. 1904 (14) cane collected on Nov. 18. 04 still coming out", 2. "*Paranagrus optabilis* Perkins LECTOTYPE ♀ [circled in black ink] PARALECTOTYPES 4 ♀ des. S. Triapitsyn and J. W. Beardsley 1997 + *Cremastobaeus* sp. ♀", under one cover slip with 4 ♀ paralectotypes and 1 ♀ of *Cremastobaeus* sp. Paralectotypes, here designated: the above 4 ♀; 4 ♀ on 2 slides, original labels: "Ex material sent per S. S. "Ventura", 4.X.[19]05. Bundaberg, Queensland. Coll. Perkins and Koebele" [BPBM].

Perkins (1905) did not designate a type in his description of *P. optabilis*, although he was usually quite good in marking his type specimen(s). We believe that these specimens from Bundaberg, Queensland, Australia, in fact represent a part of Perkins' original material.

Type material of *P. osborni* (type locality: Los Baños, Philippines): Holotype ♀ labeled: 1. "TYPE and paratypes. Bishop 5596"; 2. "From corn H.T.O. Nov. 20, 15 Los Baños" (slide contains 2 ♀, the holotype and a paratype, under the cover slip. However, there are several more specimens (ca. 6), apparently of both sexes, in the excess balsam that has squeezed out around side of cover slip. This is a poor slide; the specimens are shriveled due to improper dehydration. H.T.O. = Herbert T. Osborn) [BPBM]; 4 ♀, 3 ♂ paratypes labeled: "*Paranagrus osborni* paratypes ♀ ex *Peregrinus maidis* (Ashm) Los Banos Luzon, [no date], H. T. Osborn" [CISC]; same label data, 6 ♀, 1 ♂ paratypes [BPBM].

Material examined: Australia. Queensland, Brisbane, 1.XI.1920, H. Hacker, 1 ♀ [CISC]. Hawaiian Islands. [No locality indicated], II.1916, O. H. Swezey, ex. eggs of *P. saccharicida*

Figures 1–2. *Anagrus optabilis* (Perkins): 1. antenna, ♂; 2. genitalia, ♂.



on sugar cane, 24 ♀ [UCRC]. **Hawaii I.**: Hakalau Plantation, V.1914, ex. eggs of *P. saccharicida*, 18 ♀, 4 ♂ on 5 slides [HDOA]. **Oahu I.**: Aiea, 3.VIII.1968, E. F. Drake, 3 ♀, 2 ♂. Ewa, 23.XII.1968, S. Fluker, "ex. cane leaf by vacuum cleaner", 2 ♂ [BPBM]. Honolulu: 16.XI.1912, ex. *P. saccharicida*, numerous ♀ on 4 slides [UCRC]; same label data, 30 ♀, 1 ♂ on 4 slides [CISC]; 23.XI.1916, 1 ♂ under one cover slip with 8 ♀ of *A. frequens*; H.S.P.A. Expt. Sta., IX.1960, J. W. Beardsley, "ex. sugar cane in lab", 1 ♀. Waimanalo, 13.III.1927, O. H. Swezey, "ex. eggs of *Kelisia emoloa* in *Eragrostis*", 4 ♀. Numerous ♀ and ♂ on 11 slides, collected during 1916–1918 and some faintly marked in pencil "ex. corn", "ex. eggs of corn leafhopper", "Honolulu", "Hawaii", etc., mixed with numerous ♀ and ♂ specimens of *A. frequens* [HDOA]. **Indonesia**. Java I., F. Muir, 2 ♀, 1 ♂. Seram I., F. Muir, "reared from eggs of leaf-hoppers", 3 ♀, 3 ♂ [BPBM]. **Philippines**. Luzon I., Los Baños: [no date], F. Muir, "ex *Perkinsiella vastatrix* and others", 14 ♀; VI.1916, H. T. Osborn, ex. corn leafhopper?, 11 ♀ and 2 ♂ on 5 slides together with 10 ♀ of *A. frequens*; same collector except VII.1916 and also labeled as "Emerged in cage brought by Osborn to Honolulu Aug. 1916", 4 ♂ [BPBM]. **Taiwan**. [no locality or date], F. Muir, "reared from eggs of *Perkinsiella* on sugar cane", 2 ♀, 5 ♂ together with 1 ♂ of *A. frequens*; same data, 3 ♀ and 9 ♂ on other slide; 1 ♀ labeled "ex sugar cane Formosa. Dec. 7, 1916" [BPBM].

Comments: The type specimens of *P. osborni* are all in very poor condition. Despite Fullaway's designation of only one male paratype, which was among 16 paratype females mounted on three type slides (Fullaway 1919), we found at least four males on those slides. We could not positively separate this species from *A. optabilis* based on morphological characters. In the holotype of *P. osborni*, F1 of the female antenna is definitely longer than pedicel (ratio 1.06/1).

Similarly, we could not justify separation of *A. panicicolae* from *A. optabilis*. As discussed by Chiappini et al. (1996), the only available specimen of this species (the holotype) is shriveled; however, all morphological features studied are within the range of such characters in *A. optabilis* (e.g., ovipositor length/foretibia length ratio in *A. panicicolae* is 2.5/1, see below for comparison with *A. optabilis*). In addition, the proposed synonymy is supported by the fact that both forms are known to parasitize eggs of the two closely related species of the genus *Sogatella* (Delphacidae): *A. optabilis* of *S. furcifera* (Horvath) and *A. panicicolae* of *S. panicicola* Ishihara (Sahad and Hirashima 1984).

Intraspecific variability: The variability of morphological characters depending on the host or the geographic region has never been studied in *A. optabilis*. Below we provide a

rough comparison of some characters as a result of measuring female specimens belonging to four different populations of *A. optabilis*. One is from Australia, representing the original A. Koebele material, and three others are Hawaiian populations reared from three different hosts.

1. Australia, Queensland, Bundaberg, ex. eggs of *P. saccharicida* on sugar cane, collected in 1904. Measurements (*n*=3): body: 643 (639–650); ovipositor: 326 (320–333). Antenna: scape: 86 (73–99); pedicel: 40 (37–42); F1: 47 (46–47); F2: 62 (62–62); F3: 61 (59–62); F4: 63 (62–64); F5: 58 (58–58); F6: 57 (56–58); club: 97 (95–98). Forewing length/width 615 (612–621)/46 (44–47). Ratio between lengths of F1 and pedicel 1.19/1 (1.13–1.25/1); ovipositor length/foretibia length 2.2/1 (2.1–2.3/1); ovipositor exserted beyond apex of metasoma by about 1/8–1/13 of its total length. Anteriorly, ovipositor overlapping mesophragma.

2. Hawaiian Islands, Hawaii I., Hakalau Plantation, ex. eggs of *P. saccharicida* on sugar cane, collected in 1914. Measurements (*n*=3): body: 765 (720–837); ovipositor: 345 (335–360). Ratio between lengths of F1 and pedicel 1.19/1 (1.17–1.20/1); ovipositor length/foretibia length 2.3/1 (2.2–2.4/1); ovipositor exserted beyond apex of metasoma by about 1/9–1/19 of its total length. Anteriorly, ovipositor either not overlapping mesophragma (in majority of specimens studied) or slightly overlapping mesophragma.

3. Hawaiian Islands, Oahu I., Waimanalo, ex. eggs of *Kelisia emoloa* Kirkaldy on *Eragrostis* sp., collected in 1927. Measurements (*n*=3): body: 631 (630–633); ovipositor: 343 (333–352). Ratio between lengths of F1 and pedicel 1.09/1 (1.05–1.15/1); ovipositor length/foretibia length 2.5/1 (2.4–2.5/1); ovipositor exserted beyond apex of metasoma by about 1/9–1/12 of its total length. Anteriorly, ovipositor overlapping mesophragma.

4. Hawaiian Islands, Oahu I., Honolulu, ex. eggs of *Peregrinus maidis* (Ashmead) on corn, collected in 1917–1918. Measurements (*n*=10): body: 578 (555–589); ovipositor: 275 (252–290). Ratio between lengths of F1 and pedicel 1.06/1 (0.85–1.18/1); ovipositor length/foretibia length 2.3/1 (2.2–2.3/1); ovipositor exserted beyond apex of metasoma by about 1/7–1/40 of its total length. Anteriorly, ovipositor overlapping mesophragma except in a few specimens where there is no overlap.

Discussion: The specimens from the four different *A. optabilis* populations are in general very similar to each other except for the ones reared from eggs of *P. maidis*. The latter are smaller in body size and display an extreme variation in relative lengths of pedicel versus F1 of the female antenna, i.e., the pedicel is usually subequal to F1 but often either longer or sometimes shorter than F1. We attribute this variability to an unknown influence of the host egg. Adults of corn planthopper are smaller than adults of sugar cane planthopper, and we assume that this is true for the size of their eggs as well.

Males of *A. optabilis* appear to be rare. Here we provide the first, brief, description of the males.

Male (*n*=5). Similar to female except some sexually dimorphic characters characteristic of the genus and subgenus (see Chiappini et al. 1996). Antenna (Fig. 1): with F1 subequal to or only slightly shorter than following flagellomeres (in members of *Anagrus* s. str., F1 of male antenna is markedly shorter than other flagellomeres). Genitalia as in Fig. 2. Measurements: body: 583 (540–675). Antenna: scape: 74 (69–77); pedicel: 38 (37–40); F1: 55 (49–60); F2: 59 (55–67); F3: 63 (58–68); F4: 61 (57–66); F5: 62 (57–69); F6: 60 (56–68); F7: 59 (55–66); F8: 59 (55–67); F9: 58 (54–67); F10: 58 (51–66); F11: 59 (53–69). Forewing length/width: 626 (558–702)/53 (47–58). Genitalia: 187 (168–202).

Figures 3–4. *Anagrus* sp. 1: 3. antenna, ♀; 4. forewing, ♀.

***Anagrus (Anagrus)* sp. 1.** (Figs. 3–4)

Material examined: Hawaiian Islands. **Molokai I**.: nr. Kamalo Bridge, 5. VI.1995, W. D. Perreira, 1 ♀ (YSBT) [UCRC]. **Oahu I**.: Lualualei, 27.III.1986, K. Murai, on lettuce, 1 ♀ [HDOA]. Waimanalo, University of Hawaii Farm, 5.VI.1995, J. W. Beardsley and W. D. Perreira, 1 ♀ (S) [BPBM].

Comments: The above females fit well into the redescription (Trjapitzin 1995) of *A. baeri* Girault, so far known and originally described from a single female specimen captured at Babinda, Queensland, Australia, from the foliage of a wild imported citron which was infested with coccids and leafhoppers (Girault 1912). It can be easily recognized from all other known *Anagrus* species which belong to the *atomus* species group by the combination of the following two characters: presence of a sensory ridge on F3 and the forewing disc without a markedly differentiated hairless area (Fig. 4). However, we cannot positively identify the specimens which belong to *A.* sp. 1 as *A. baeri* because in *A.* sp. 1, F4 of the female antenna is distinctly longest of funiculars including F3 (Fig. 3), whereas in *A. baeri*, F3 is slightly longer, or almost subequal, to F4 (Trjapitzin 1995). In addition, F3–F6 possess only one sensory ridges each in *A. baeri* whereas in this species, F4, F6, and sometimes F5 have two sensory ridges each.

Other important morphological features of *A.* sp. 1 are as follows: general body coloration light brown or pale yellow with flagellum and mesoscutum markedly darker, antenna

with F2 shorter than following funicular segments, club longer than F5 and F6 together, mesoscutum without adnotaular setae, forewing length/width ratio 7–8/1, and ovipositor length/foretibia length 2.0–2.1/1.

Anagrus (Anagrus) frequens Perkins (Fig. 5)

Anagrus frequens Perkins, 1905: 198.

Anagrus armatus var. *australiensis* Girault, 1912: 158; synonymized by Trjapitzin, 1995: 106–107.

A. cicadulinae Ferrière, 1930: 40–41. **New synonym.**

Anagrus frequens Perkins; Dozier, 1936: 176.

Anagrus frequens Perkins; Sahad and Hirashima, 1984: 58–60.

Anagrus frequens Perkins; Chiappini et al., 1996: 571–572.

Type locality: Queensland, Australia.

Type material: Lectotype ♀, here designated, labeled: 1. "2230 *Perkinsiella sacharicida* eggs on sugar cane - Bundaberg, Q. Nov. 1904 A. Koebele", 2. "*Anagrus frequens* Perkins LECTOTYPE ♀ des. S. Triapitsyn and J. W. Beardsley 1997". Paralectotypes, here designated: 17 ♀ under 2 cover slips, original label: "2232 *Liburnia* - on Bermuda grass Bundaberg, Q. Oct. 1904 A. Koebele"; 1 ♀, 1 ♂, original label: "*Delphax* - *Liburnia* on Bermuda grass street in front of Royal Hotel - Bundaberg, Q. Sept. 1904", under one coverslip with 1 ♂ of *Gonatocerus* sp. (*litoralis* group) [BPBM].

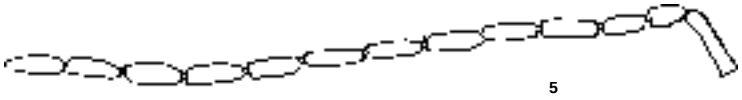
The lectotype and paralectotype designations are warranted in this case because similarly to *A. optabilis*, the above specimens from Bundaberg, Queensland, Australia, undoubtedly represent a part of the material on which Perkins (1905) based his description of *A. frequens*.

Lectotype ♀ of *A. cicadulinae* Ferrière, here designated, on slide labeled: 1. "Sth AFRICA Durban. - 27.III.1925 C.P.v.d Merwe. No 1804 (Ac. N. 1549) Ex eggs of (*Balclutha*) *Cicadulina mbila* B42", 2. "Mymaridae: *Anagrus cicadulinae* sp.n. Ch. Ferriere det. types"; 3. "*Anagrus cicadulinae* Ferrière LECTOTYPE ♀ [circled in black ink] 7 ♀, 3 ♂ PARALECTOTYPES des. S. Triapitsyn 1997" under one coverslip with 7 ♀ and 3 ♂ paralectotypes, also designated [BMNH].

The *A. cicadulinae* specimens are in poor condition, having been slide-mounted without prior maceration. One female and two out of three males lack their heads.

Material examined: Fiji. Levuka, 16.III.1905, A. Koebele, "ex. *Dicranotropis vastatix*?, on black native cane (above town)" (Koebele No. 2346), 5 ♀ [BPBM]. Hawaiian Islands. **Hawaii I**.: Hakalau Plantation, V.1914, ex. eggs of *P. saccharicida*, 15 ♀ [HDOA]. Hilo Coast, Kolekole Beach Pk., 19.X.1983, D. M. LaSalle, 5 ♀ and additional ♀ on points [CNCI]. **Molokai I**.: 6 ♀ labeled "ex leafhopper on sweetpotato. Judge Conradt" [HDOA]. **Oahu I**.: Honolulu: 2.VI.1910, "on Hemipterous egg", 3 ♀ [HDOA]; 30.I.1916, P. H. Timberlake, "ex. eggs of *Kelisia sporobolicola* on *Sporobulus virginicus*, Kapiolani Park", 3 ♀; same data except 31.I.1916, 1 ♀; same data except 1.II.1916, 1 ♀; 16.I.1916, P. H. Timberlake and O. H. Swezey, ex. eggs of *P. maidis* (reared 23.I.1916), 21 ♀ [UCRC]; 16.I.1916, [no collector's name], ex. eggs of *P. maidis*, 3 ♀; 25.II.1941, O. H. Swezey, ex. eggs of *P. maidis*, 22 ♀, 1 ♂ [HDOA]; University of Hawaii Manoa Campus, 3.VI.1995, J. W. Beardsley, 23 ♀ (S) [BPBM]. Waimanalo: Expt. Sta., 21–28.VIII.1986, L. LeBeck, 2 ♀ [CNCI]; University of Hawaii Farm, 5.VI.1995, J. W. Beardsley and W. D. Perreira, 19 ♀, 1 ♂ (S); same locality and collectors, 5–12.VI.1995, 1 ♀ (YPT); same locality and collectors, 20–22.II.1996, 2 ♀ (YPT nr. eggplant); same data except YPT nr. coffee, 1 ♀; same data, 3 ♀ (S). Waipahu, 20.IV.1905, A. Craus, ex. eggs of *P. saccharicida* on sugar cane, 5 ♀. Waipio Peninsula, 4.V.1966, J. W. Beardsley, 1 ♀ [BPBM]. **Philippines**. Luzon

Figure 5. *Anagrus frequens* Perkins: antenna, ♂.



I., Los Baños, VI.1916, H. T. Osborn, "ex. corn leafhoppers?", 13 ♀ on 5 slides together with 11 ♀, 2 ♂ of *A. optabilis* [BPBM]. **Taiwan**. [No locality or date], F. Muir, "reared from eggs of *Perkinsiella* on sugar cane", 1 ♂ under one cover slip with 2 ♀, 5 ♂ of *A. optabilis* [BPBM].

Description: Although the females of this species were redescribed and illustrated in detail by both Sahad and Hirashima (1984) (based on Japanese specimens) and Chiappini et. al. (1996) (based on Hawaiian specimens), here we provide measurements of the Hawaiian, Australian, and Fiji specimens that we studied. The description of the male of *A. frequens*, which appears to be rare, follows.

Female (*n*=8). Measurements: body: 646 (567–792); mesosoma: 225 (180–315); metasoma: 290 (252–342); ovipositor: 313 (279–427). Antenna: scape: 72 (64–80); pedicel: 41 (33–44); F1: 17 (13–20); F2: 53 (46–62); F3: 44 (40–58); F4: 48 (44–60); F5: 45 (40–56); F6: 49 (43–60); club: 99 (88–110). Forewing length/width: 532 (468–585)/48 (44–52); proximal macrochaeta: 16 (13–22); distal macrochaeta: 75 (65–86); longest marginal cilia: 165 (132–193). Hindwing length/width: 483 (423–540)/17 (15–18); longest marginal cilia: 128 (117–142). Legs: [given as femur, tibia, tarsus]: fore: 111 (95–131), 115 (100–135), 170 (146–182); middle: 102 (88–110), 169 (150–201), 166 (146–186); hind: 101 (80–124), 176 (161–223), 177 (164–189).

Male (*n*=6). Similar to female except general body color slightly darker; forewing usually wider (length: width ratio 9–10:1), with bare area sometimes not as distinct as in the female. Genitalia (poorly seen and mounted laterally in all of specimens studied) typical for *atomus* species group (Chiappini 1989). Measurements: body: 603 (549–639). Antenna (Fig. 5): scape: 57 (55–58); pedicel: 38 (37–40); F1: 40 (38–42); F2: 56 (55–57); F3: 53 (52–56); F4: 54 (53–56); F5: 55 (51–57); F6: 55 (51–58); F7: 54 (51–56); F8: 55 (51–57); F9: 55 (51–57); F10: 56 (53–58); F11: 58 (55–62). Forewing length/width: 546 (504–620)/58 (55–62). Genitalia: 84 (73–91).

Comments: The Australian and Fiji specimens that we studied are very similar to the Hawaiian ones except they are generally larger bodied (especially those collected in Fiji) and with relatively longer antennal segments. In addition, in some Australian and in all Fiji specimens the ovipositor is more exserted beyond the metasoma apex (by about 1/5–1/6 of its total length) and the forewing length/width ratio is slightly lower (10.5–11.0/1).

The *A. cicadulinae* specimens fit well in *A. frequens*, except the forewing chaetotaxy in some specimens appears to be slightly different from that of the Hawaiian and Australian specimens. In *A. cicadulinae*, a few discal cilia sometimes are present along the posterior margin of forewing blade medially (this area is usually bare in typical *A. frequens*). Nevertheless, as forewing chaetotaxy is often subject to intraspecific variability in many *Anagrus* spp., we have little doubt in synonymizing *A. cicadulinae* under *A. frequens*. Thus, *A. frequens* is for the first time recorded from Africa and from a cicadellid host, if the original host record of *Cicadulina mbila* (Naude) was correct.

Anagrus (Anagrus) takeyanus Gordh **New State Record**

Anagrus takeyanus Gordh; *in* Gordh and Dunbar, 1977: 85–90.
Anagrus takeyanus Gordh; Chiappini et al., 1996: 575–576.

Type locality: Mt. Carmel, Connecticut, USA.

Material examined: Hawaiian Islands. **Molokai I.**: Mapulehu nr. Ililiopae Heiau, IX–X.1994, W. D. Perreira, 2 ♀ (YSBT); same data except XI–XII.1994, 1 ♀. **Oahu I.**: Dillingham Field, 15–28.V.1996, W. D. Perreira, 2 ♀ (YSBT). Pupukea Rd., 15–28.V.1996, W. D. Perreira, 5 ♀ (YSBT) [BPBM, UCRC].

Comments: This is the first record of *A. takeyanus* from the Hawaiian Islands. Previously it was known only from the continental United States and Japan (Chiappini et al. 1996). The species is very easy to recognize using the characters given in the key. For good illustrations and description, see papers by Gordh and Dunbar (1977) and Chiappini et al. (1996). The known hosts of *A. takeyanus* are *Stephanitis pyrioides* (Scott) and *S. takeyai* Drake and Maa (Tingidae). Since only *S. pyrioides* is known to be established in Hawaii (Nishida 1994), that species is the likely host of *A. takeyanus* there.

Anagrus (Anagrus) ?columbi Perkins (Figs. 6–7)

Anagrus columbi Perkins, 1905: 198.
Anagrus columbi Perkins; Chiappini et al., 1996: 579–580 .

Diagnosis: This mainly North American species is very close to the Palearctic species *A. incarnatus* Haliday. It differs from *A. incarnatus* (body color yellow-reddish to brown) in having only 1 (sometimes 0) sensory ridge on F5 of female antenna and in having F2 shorter relative to F3 and other funiculars (Fig. 6). However, the Hawaiian specimens differ from the lectotype of *A. columbi* in darker body color, which is smoky yellow in the latter, as well as in having ovipositor shorter relative to foretibia length (2.4/1 or less contrasting with 2.7/1 in the lectotype of *A. columbi*). Therefore, here we provide a detailed description of the available Hawaiian material in anticipation that in future this form, which we call *A.* ?*columbi*, may be proven to represent a separate species.

Type locality: Columbus, Ohio, USA.

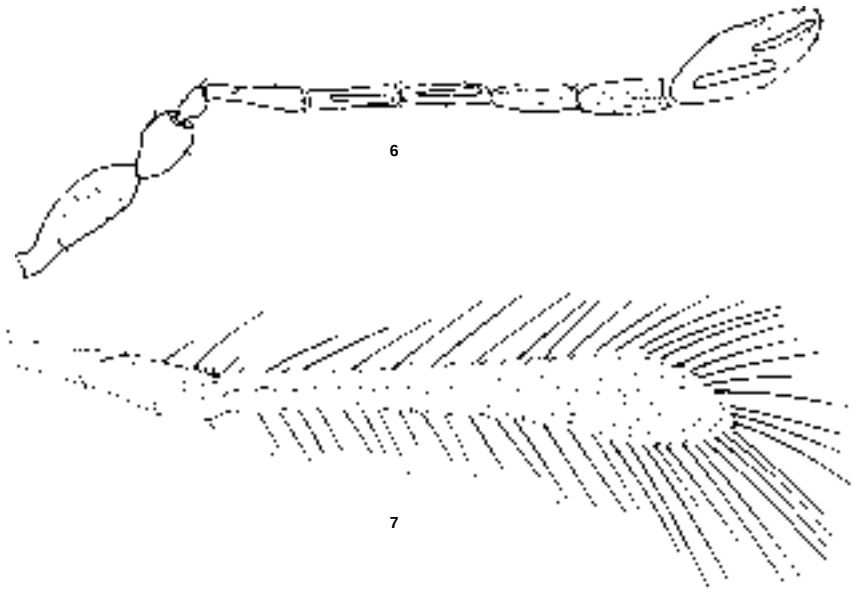
Type material: Lectotype ♀, here designated, labeled: 1."*Anagrus columbi* Type. 5697"; 2."2193 Parasitic? on Eggs of *Liburnia* or jassid on blue-grass. Columbus, Ohio aug. 20.1903"; 2. "Lectotype des. J. W. Beardsley and S. Triapitsyn 1997" [BPBM]. Paralectotype ♀, here designated, on slide labeled: 1."*Anagrus columbi* P. = *armatus armatus* Girault", 2."2193 Parasitic? on eggs of *Liburnia* or jassid on blue-grass - Columbus, Ohio aug. 5, 1903 A. Koebele"; 2. "Paralectotype des. J. W. Beardsley and S. Triapitsyn 1997" [BPBM].

Comments: Although there is no doubt that the two "types" of *A. columbi* represent a part of Koebele's original material, the holotype and paratype designations in the BPBM collection are invalid. In his description, Perkins (1905) mentions Koebele's number 2320, not 2193, for the material of *A. columbi* from Ohio on which he based this species. Moreover, Perkins (1905) did not designate any type specimen(s) of *A. columbi*. For these reasons, we designate the "holotype" specimen as a lectotype and the "paratype" one as a paralectotype of this species.

Material examined: Hawaiian Islands. **Hawaii I.**: Kailua-Kona, 21.X.1985, D. Tsuda, "reared ex eggs of damsel fly in leaf tissue", 9 ♀ on separate slides and 7 ♀ on points [BPBM, HDOA, UCRC]. **Maui I.**: Hanawi Stream, el. 1040 ft., 18.XI–2.XII.1995, W. D. Perreira, 1 ♀ (YSBT) [BPBM].

Description (Hawaiian specimens only): *Female* (*n*=4). Color: body uniformly dark

Figures 6–7. *Anagrus columbi* Perkins: 6. antenna, ♀; 7. forewing, ♀.



brown; in some specimens antennal scape and pedicel, distal part of mesosoma, and legs slightly lighter.

Head: Antenna (Fig. 6) sparsely setose; scape about twice as long as pedicel, F1 cylindrical, F2 longest of funicle, without sensory ridges, F3–F6 subequal, with 1(0), 1, 1(0), and 2 sensory ridges each respectively, club with 5 sensory ridges.

Mesosoma: about 0.7 x as long as metasoma. Mesoscutum narrow, without adnotaular setae. Forewing (Fig. 7) shorter than body; 9.1 (8.7–9.5) x longer than wide; with 1 or 2 (on basal half of blade) to 5 (at its broadest part) irregular rows of setae, leaving no distinct bare area. Lengths of distal and proximal macrochaetae in ratio 1.9/1 (1.5–2.4/1). Marginal fringe with longest cilia 2.7–2.9 x forewing width. Hindwing disc asetose except for a complete row of small setae along posterior margin and an incomplete row along anterior margin on distal half.

Metasoma: Ovipositor at most reaching (usually not), but not overlapping, mesophragma anteriorly, slightly exserted beyond apex of metasoma; ratio of total ovipositor length to length of its exserted part about 8/1. External plates of ovipositor each with 3 distal setae. Ovipositor length/foretibia length 2.3/1 (2.2–2.4/1).

Measurements: body: 671 (648–720); mesosoma: 209 (189–243); metasoma: 317 (297–342); ovipositor: 291 (285–297). Antenna: scape: 78 (75–84); pedicel: 40 (40–40); F1: 19 (10–20); F2: 58 (53–64); F3: 52 (51–55); F4: 49 (46–51); F5: 50 (47–51); F6: 49 (47–53); club: 95 (91–99). Forewing length/width: 569 (549–578)/63 (58–66); proximal macrochaeta: 45 (33–51); distal macrochaeta: 78 (77–80); longest marginal cilia: 174 (157–183). Hindwing length/width: 461 (432–504)/18 (18–18); longest marginal cilia: 135 (128–139). Legs: [given as femur, tibia, tarsus]: fore: 122 (113–128), 127 (120–131), 170 (164–175); middle: 104

(91–113), 199 (192–204), 168 (164–175); hind: 119 (110–126), 179 (172–186), 157 (153–161).

Male. Unknown.

Biology: The host damselfly is an unknown species of Coenagrionidae, the only family of Zygoptera known from the Hawaiian Islands. *A. insularis* is known to parasitize the eggs of an endemic *Megalagrion* damselfly on Oahu, and it is possible that *A.* ?*columbi* also utilizes eggs of that genus.

Anagrus (Anagrus) yawi Fullaway (Figs. 8–11)

Anagrus yawi Fullaway, 1944b: 57.

Anagrus (Anagrus) yawi Fullaway; Triapitsyn, 1997: 8.

Diagnosis: *A. yawi* is one the most easily recognizable Hawaiian species of *Anagrus* s. str. (*incarnatus* species group) as it possesses a sensory ridge on F2 of female antenna. It differs from *A. puella* Girault, a North American species which sometimes also displays this character, by a smaller body size and by a much narrower forewing. In *A. puella*, the female forewing length/width ratio is about 6/1 (Chiappini et. al. 1996) compared to 7/1 in *A. yawi*.

Type locality: Los Mochis, Sinaloa, Mexico.

Type material: Lectotype ♀, here designated, mounted under one coverslip with 3 ♂ paralectotypes, labeled: 1. "April'43 mymarid Ex. squash Mexico D. T. Fullaway"; 2. "*Anagrus yawi* Fullaway Lectotype ♀ Paralectotypes 3 ♂ Des. S. Triapitsyn and J. Beardsley, 1995". Paralectotypes, here designated: the above 3 ♂; 4 ♀ on separate slide, same data [BPBM].

Material examined: Hawaiian Islands. **Molokai I.**: nr. Honomuni Stream, IX–X.1994, W. D. Perreira, 1 ♀ (YSBT); same data except X.1994 and 11–25.XI.1994, 2 ♀ [BPBM, UCRC]. **Oahu I.**: Honolulu: [no date or collector's name], "ex. squash bug", 4 ♀, 2 ♂; V.1943, "ex. squash", 4 ♂; [no date], M. Chong, "ex. squash bug greenhouse" 2 ♀, 6 ♂ [HDOA]. Mokuleia, 15–28.V.1996, W. D. Perreira, 1 ♀ (YSBT) [BPBM].

Description: *Female* (*n*=6). Color: "Female with thorax reddish except the mesothoracic scutum which is black. Head and abdomen blackish. Legs and basal three antennal segments yellowish; antennae beyond third segment fuscous" (Fullaway 1944b). In our slide-mounted specimens, the head and metasoma are dark brown to black, remainder of body brown except distal mesosoma light brown.

Head: about as wide as mesosoma. Antenna (Fig. 8) with F1 subcylindrical, about 1/2 length of pedicel, F2–F6 generally subequal (some specimens with either F4 or F5 slightly longer than other funiculars); F2 with 1, F3–F6 with 2 sensory ridges each (F5 and F6 sometimes with 3 sensory ridges each), club with 5 sensory ridges.

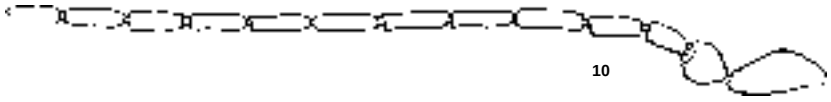
Mesosoma: 0.7–0.9 x as long as metasoma. Mesoscutum with a pair of adnotaular setae. Forewing (Fig. 9) 7.0 (6.7–7.3) x longer than wide; with 2 or 3 irregular rows of setae basally beyond venation and with 5 to 7 such rows in the broadest part, the setae more sparsely arranged along posterior margin of blade, sometimes leaving a narrow bare area. Lengths of distal and proximal macrochaetae in ratio 1.6–1.7/1. Marginal fringe with longest cilia 2–3 x forewing width. Hindwing disc asetose except for a complete row of small setae along posterior margin and another incomplete row along anterior margin in distal half.

Metasoma: Ovipositor moderately long, anteriorly barely reaching mesophragma and posteriorly generally slightly exserted beyond apex of metasoma. Ratio of total ovipositor length to length of its exserted part 8/1 (6–10/1). External plates of ovipositor each with 3

Figures 8–11. *Anagrus yawi* Fullaway: 8. antenna, ♀; 9. forewing, ♀; 10. antenna, ♂; 11. genitalia, ♂: a. dorsal view, b. lateral view.

8

9



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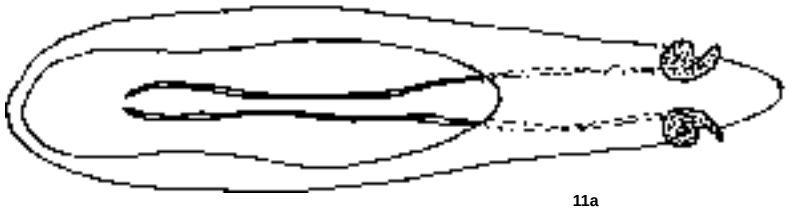
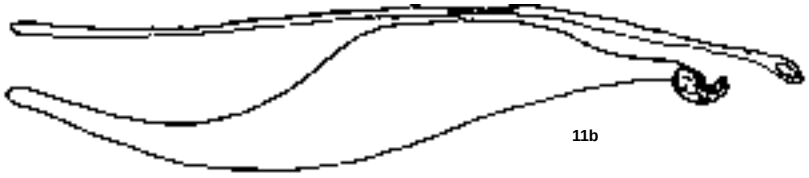


11a



11b

distal setae. Ovipositor length/foretibia length 1.9/1 (1.7–2.2/1).

Measurements: body: 601 (585–630); mesosoma: 223 (198–243); metasoma: 268 (252–292); ovipositor: 247 (225–274). Antenna: scape: 84 (73–95); pedicel: 46 (44–47); F1: 26 (24–27); F2: 54 (51–62); F3: 55 (49–62); F4: 60 (58–62); F5: 57 (51–62); F6: 57 (55–58); club: 112 (106–120). Forewing length/width: 575 (549–612)/83 (80–88); proximal macrochaeta: 42 (35–50); distal macrochaeta: 67 (57–80); longest marginal cilia: 176 (153–212). Hindwing length/width: 528 (495–576)/22 (20–24); longest marginal cilia: 136 (122–146). Legs: [given as femur, tibia, tarsus]: fore: 140 (130–158), 129 (117–135), 192 (180–212); middle: 153 (134–172), 181 (160–204), 177 (160–193); hind: 121 (113–130), 182 (158–201), 160 (162–208).

Male (*n*=6). Similar to female except general body color slightly darker; forewing usually wider (average length/width ratio about 6.5/1), often with a well differentiated bare area. Genitalia (Figs. 11a, 11b) typical for *incarnatus* species group. Measurements: body: 551 (482–621). Antenna (Fig. 10): scape: 59 (58–62); pedicel: 37 (33–42); F1: 45 (36–49); F2: 56 (40–62); F3: 51 (40–64); F4: 58 (42–64); F5: 59 (44–66); F6: 60 (46–68); F7: 58 (43–65); F8: 58 (45–62); F9: 57 (44–64); F10: 57 (46–62); F11: 63 (49–69). Forewing length/width: 523 (513–530)/88 (71–99). Genitalia: 135 (130–139).

Anagrus (Anagrus) oahuensis S. Triapitsyn and Beardsley, **new species** (Figs. 12–14)

Diagnosis: This species is easy to distinguish from all other known Hawaiian species which belong to the *incarnatus* species group by the characteristic forewing which has only one row of discal setae in basal 2/3 of blade (Fig. 13).

Type material: Holotype ♀ labeled: 1. "Hawaiian Is.: O'ahu I. Waimanalo at UH Farm el 60–80 ft. 20–22.II.1996 Yellow pitfall trap nr. sugarcane J. W. Beardsley and W. D. Perreira, collectors"; 2. "*Anagrus oahuensis* S. Triapitsyn and Beardsley HOLOTYPE" [BPBM]. Paratypes: Hawaiian Islands. OAHU I.: Waimanalo, University of Hawaii Farm, el. 60–80 ft., 20–22.II.1996, J. W. Beardsley and W. D. Perreira, YPT in basil, 2 ♀; same data except YPT nr. sugar cane, 2 ♀; same locality and collectors, 5.VI.1995, 1 ♂ (S); same locality, 22–28.II.1996, J. W. Beardsley, J. A. Furuyama and W. D. Perreira, 1 ♀, 1♂ on points and 1 ♂ on slide. Dillingham Field, el. 10 ft., 15–28.V.1996, W. D. Perreira, 1 ♀ (YSBT) [BPBM, CNCI, UCRC, USNM].

Description: *Female* (*n*=7). Color: Body pale with following parts brown: eyes, antennae (except pedicel), mesoscutum, legs, wing venation, base and apex of metasoma.

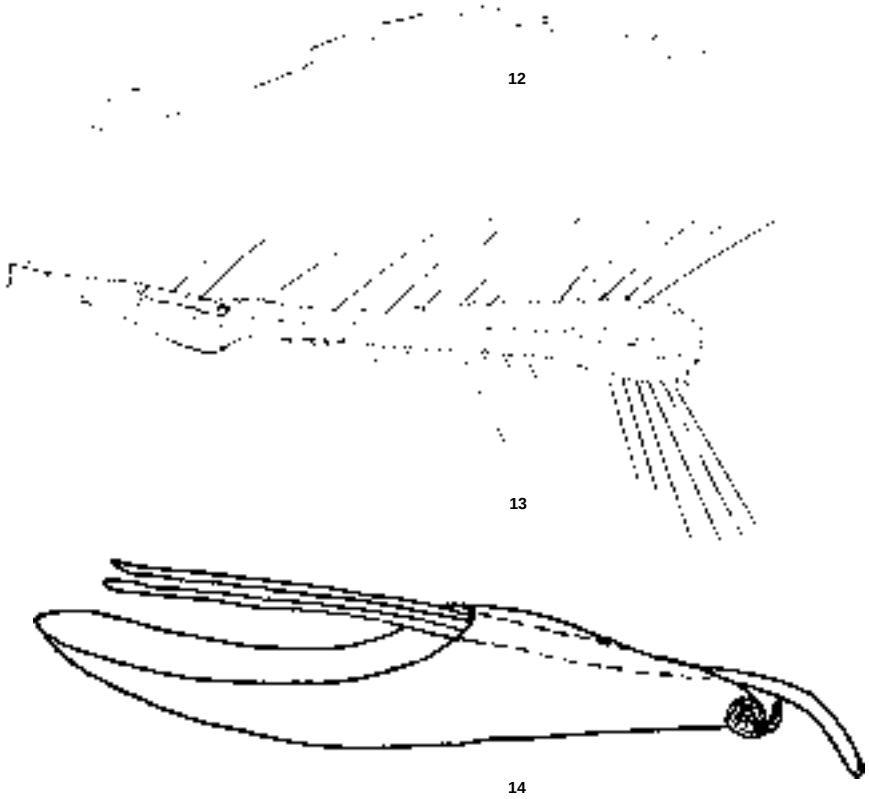
Head: Antenna (Fig. 12) with scape about 2 x as long as pedicel; F1 cylindrical, about half length of pedicel, F2–F6 subequal (F2 usually slightly longer than other funiculars); F2 without sensory ridges, F3–F5 with 1 sensory ridges each (F4 sometimes with 2), F6 with 2 sensory ridges, club with 5 sensory ridges.

Mesosoma: 0.7–0.9 x as long as metasoma. Mesoscutum with a pair of adnotaular setae. Forewing (Fig. 13) shorter than body; 9–10 x longer than wide; with 1 row of discal setae and several additional, irregularly arranged setae in apical (broadest) part of blade. Lengths of distal and proximal macrochaetae in ratio 1.8–1.9/1. Marginal fringe with longest cilia 2–3 x forewing width.

Metasoma: Ovipositor moderately long, anteriorly barely reaching mesophragma and posteriorly markedly exserted beyond apex of metasoma. Ratio of total ovipositor length to length of its exserted part 4–5/1. External plates of ovipositor each with 2 distal setae. Ovipositor length/foretibia length 3.2/1 (3.0–3.4/1).

Measurements (*n*=5): body: 644 (576–698); ovipositor: 362 (351–387). Antenna: scape: 79 (69–84); pedicel: 37 (36–38); F1: 19 (18–22); F2: 51 (44–58); F3: 48 (40–54); F4: 49

Figures 12–14. *Anagrus oahuensis* sp. n.: 12. antenna, ♀; 13. forewing, ♀; 14. genitalia, ♂ (lateral view).



(44–51); F5: 46 (40–52); F6: 48 (42–52); club: 97 (89–104). Forewing length/width: 510 (459–558)/54 (40–62); proximal macrochaeta: 37 (32–41); distal macrochaeta: 68 (60–73); longest marginal cilia: 152 (120–164). Hindwing length/width: 489 (441–522)/17 (15–20); longest marginal cilia: 139 (117–157). Legs: [given as femur, tibia, tarsus]: fore: 105 (95–113), 117 (102–128), 168 (146–180); middle: 102 (102), 177 (168–186), 183 (161–199); hind: 101 (91–117), 190 (168–206), 185 (153–208).

Male (*n*=3). Similar to female except general body color darker (head and dorsum of mesosoma and metasoma brown), eyes pale. Genitalia (Fig. 14) typical for *incarnatus* species group. Measurements (*n*=2): body: 639 (684–594). Antenna (Fig. 10): scape: 63 (58–66); pedicel: 40 (40); F1: 37 (33–40); F2: 47 (44–51); F3: 48 (42–51); F4: 47 (42–51); F5: 45 (42–48); F6: 47 (43–50); F7: 46 (42–50); F8: 47 (43–50); F9: 48 (42–53); F10: 51 (51); F11: 54 (54). Forewing length/width: 509 (459–558)/58 (51–66). Genitalia: 143 (135–150).

Comments: Host associations of this species are unknown.

Anagrus (Anagrus) empoascae Dozier (Figs. 15–17) **New State Record**

Anagrus empoascae Dozier, 1932: 86–87.

Anagrus (Anagrus) empoascae Dozier; Triapitsyn, 1997: 8-9.

Type locality: Damien, Haiti.

Type material: Examined. This species is redescribed by Triapitsyn (1997), based on the study of Dozier's original material.

Material examined: Hawaiian Islands. **Hawaii I**.: Mt. Hualalai, 14.IV.1994, G. Markin and E. Yoshioka, "ex. *Z. giardi*", 1 ♀, 1 ♂ [HDOA]. **Molokai I**.: Mapulehu nr. Ililiopae Heiau, 19.VIII–02.IX.1994, W. D. Perreira, 1 ♀ (YSBT) [BPBM]. **Oahu I**.: Honolulu, Univ. of Hawaii Campus, 27.IV.1986, L. LeBeck, 4 ♀ (YPT, Gilmore Hall) [CNCI]. Waimanalo: 06.IX.1988, J. W. Beardsley, 1 ♀; HITAHR Expt. Sta., 04.VI.1991, J. W. Beardsley, 1 ♀, 1 ♂ (S); University of Hawaii Farm: 5.VI.1995, J. W. Beardsley and W. D. Perreira, 11 ♀, 1 ♂ (S); same collectors, 5–12.VI.1995, 1 ♀ (YPT); same collectors, 20–22.II.1996, 1 ♀ (YPT in basil); same collectors, 20.II.1996, 2 ♀ (S) [BPBM].

Comments: This species displays all the characters typical for *incarnatus* species group and seems to be very close to *A. nigriventris* Girault (Chiappini et al. 1996). *A. empoascae* differs from *A. nigriventris* mainly in the presence of a small bare area on the forewing (Fig. 16) [absent in *A. nigriventris* (Fig. 22)]. In addition, the body color in *A. empoascae* is uniformly light brown or pale yellow whereas *A. nigriventris* has the scutellum, metanotum and propodeum shining yellow, and the head and metasoma are entirely or at least partially black.

***Anagrus (Anagrus)* sp. 2**. (Figs. 18–19)

Material examined: Hawaiian Islands. **Molokai I**.: Halawa Valley, 06.V.1992, J. W. Beardsley, 1 ♀ (S) [UCRC].

Comments: This species is closest to *A. breviphragma* Soyka, although the two species are clearly separate. The unique combination of the following morphological characters, in addition to the ones typical for *incarnatus* species group (Chiappini et al. 1996), distinguish the above specimen from all other known *Anagrus* species: general body coloration light brown except head and base of metasoma brown; antenna (Fig. 19) with F2–F6 subequal, bearing 0, 1, 1, 1 (2), and 2 sensory ridges, respectively; mesoscutum with a pair of adnotaular setae; forewing about 8 x as long as wide, chaetotaxy as in Fig. 18, sparsely distributed discal setae leaving a distinct bare area along posterior margin; ovipositor moderately long but not overlapping mesophragma anteriorly, ovipositor length/foretibia length 2.6/1, external plates of ovipositor each with 2 distal setae, ovipositor projecting beyond apex of metasoma by about 1/9 of its total length.

Although the specimen appears to represent a good species, we are reluctant to describe it until more material becomes available.

Anagrus (Anagrus) insularis Dozier (Figs. 20–21 and 27–28)

Anagrus insularis Dozier, 1936: 175–176.

Diagnosis: Depending on the presence and number of sensory ridges on F3 and F4 and the length of the exserted part of the ovipositor, *A. insularis* keys (see Chiappini et al. 1996)

Figures 15–17. *Anagrus empoascae* Dozier: 15. antenna, ♀; 16. forewing, ♀; 17. genitalia, ♂ (dorsal view).

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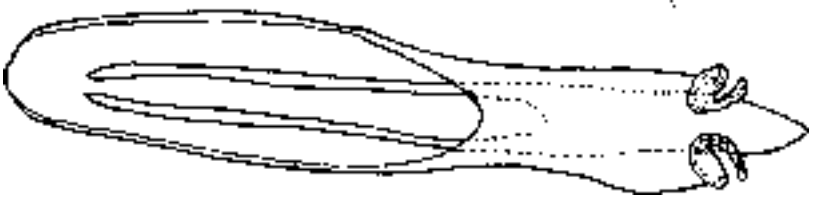

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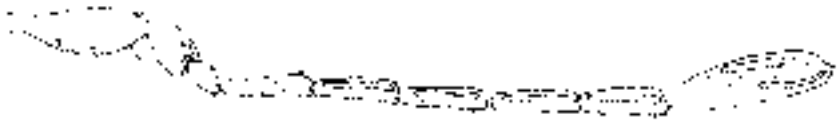
either to couplet 33 (together with *A. nigriventris* Girault), 38 (with *A. brocheri* Schulz), or 41 (with *A. obscurus* Foerster sensu Soyka). It can be easily distinguished from *A. nigriventris* by its uniformly brown color (mesosoma at least partially shining yellow in *A. nigriventris*). *A. insularis* differs from the European *A. brocheri* mainly in the presence of a sensory ridge on F3 of at least one of the female antennae, and from *A. obscurus* in proportions of the funicle segments.

Type locality: Haleauau and Tantalus, Oahu I., Hawaiian Islands.

Type material: Lectotype ♀, here designated (rounded in black ink), mounted together with 14 ♀ and 2 ♂ paralectotypes on slide labeled: 1. "Anagrus *insularis* Dozier 2 ♂ 15 ♀ Type No. 5696"; 2. "Anagrus *insularis* Dozier ex eggs in *Ipomoea bona-nox* leaf Haleauau 9–14–30" [BPBM]. No collector indicated on label. Label is in handwriting of O. H. Swezey

Figures 18–19. *Anagrus* sp. 2: 18. antenna, ♀; 19. forewing, ♀.

18



19

or J. S. Rosa (technician). Paralectotypes, here designated: the above 14 ♀ and 2 ♂; 10 ♀ and 12 ♀ on 2 separate slides, same data; 5 ♀ labeled: "Hering Valley, Tantalus, VIII.1933, F. X. Williams, in *Agrion* eggs in *Commelina* leaf"; 4 ♀ on separate slide, same data [BPBM].

Material examined: 9 ♀ on slide, same data as above (Oahu: Tantalus) but not designated by Dozier (1936) as part of the type series because he mentioned only "nine females on two slides, reared from eggs of *Agrion*, a native damsel fly" from this locality [HDOA].

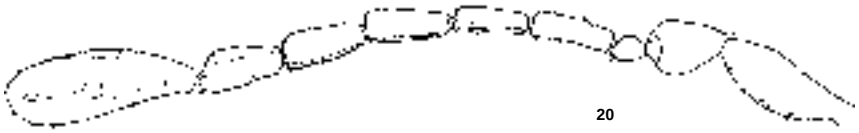
Description: *Female* (Fig. 27, *n*=7). Color: Body uniformly brown except pedicel, F1 and sometimes scape light brown.

Head: antenna (Fig. 20) with pedicel about 1/2 length of scape, F1 cylindrical or oval, F2, F4, and F6 usually subequal but sometimes F2 longest of funicle, F3 and F5 slightly shorter, club slightly longer than F5 and F6 combined; F2 without sensory ridges; F3 either without sensory ridges or with 1, F4 with 1 or 2 sensory ridges, F5 with 1, F6 with 2 sensory ridges each, club with 5 sensory ridges.

Mesosoma: about 3/4–4/5 length of metasoma. Mesoscutum with a pair of adnotaular setae. Forewing (Fig. 21) 8.8 (8.6–9.0) x longer than wide; with 4 or 5 irregular rows of setae at broadest part, setae uniformly distributed on disc, sometimes sparser along posterior margin. Lengths of distal and proximal macrochaetae in ratio 1.3–1.6/1. Marginal fringe with longest cilia about 2.5 x forewing width. Hindwing disc with 2 rows of setae along margins.

Metasoma: Ovipositor anteriorly slightly overlapping mesophragma. Ratio of total ovipositor length to length of its exserted part 8.7/1 (6–13/1). External plates of ovipositor each with 3 distal setae. Ovipositor length/foretibia length 2.2/1 (2.1–2.3/1).

Figures 20–21. *Anagrus insularis* Dozier: 20. antenna, ♀; 21. forewing, ♀.



Measurements: body: 530 (479–574); mesosoma: 195 (171–228); metasoma: 246 (228–274); ovipositor: 270 (266–281). Antenna: scape: 78 (76–80); pedicel: 39 (36–42); F1: 20 (19–23); F2: 48 (44–53); F3: 45 (42–48); F4: 46 (42–49); F5: 42 (38–46); F6: 46 (42–48); club: 98 (95–100). Forewing length/width: 555 (538–573)/63 (61–67); proximal macrochaeta: 37 (34–40); distal macrochaeta: 53 (49–61); longest marginal cilia: 154 (152–160). Hindwing length/width: 516 (494–539)/18 (17–19); longest marginal cilia: 117 (106–129). Legs: [given as femur, tibia, tarsus]: fore: 111 (106–114), 123 (118–129), 151 (148–160); middle: 100 (91–106), 169 (163–175), 140 (129–144); hind: 108 (102–114), 185 (179–198), 153 (144–160).

Male (*n*=2). Similar to female. Genitalia (mounted laterally in both specimens) typical for *incarnatus* species group. Measurements: body: 521 (499–542). Antenna (Fig. 28): scape: 67 (65–68); pedicel: 38 (38–38); F1: 39 (36–42); F2: 49 (48–49); F3: 48 (46–50); F4: 50 (47–53); F5: 51 (48–53); F6: 51 (48–53); F7: 51 (48–53); F8: 51 (49–53); F9: 52 (51–53); F10: 55 (53–57); F11: 53 (51–55). Forewing length/width: 594 (570–618)/73 (68–78). Genitalia: 131 (125–137).

Comments: Member of *incarnatus* species group of *Anagrus* s. str. *A. insularis* appears to be very close to the European species *A. brocheri* and *A. obscurus*. Because the presence or absence of a sensory ridge on F3 of the female antenna may vary among different individuals of a single *Anagrus* species, or sometimes in the same individual (i.e., it may be present only on one antenna), in future all three species may be proven to be conspecific. The existing biological data supports such an assumption: like *A. insularis*, *A. brocheri* was reported to parasitize eggs of damselflies (Coenagrionidae) in Europe (Henriksen 1922).

Figures 22–26. *Anagrus nigriventris* Girault: 22. forewing, ♀; 23. genitalia, ♂ (dorsal view); (facing page) 24. antenna, ♀; 25. mesosoma, ♀; 26. habitus, ♀.

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Anagrus (Anagrus) nigriventris Girault (Figs. 22–26)

Anagrus armatus var. *nigriventris* Girault, 1911: 291.

?*Anagrus* sp.; Dozier, 1936: 176.

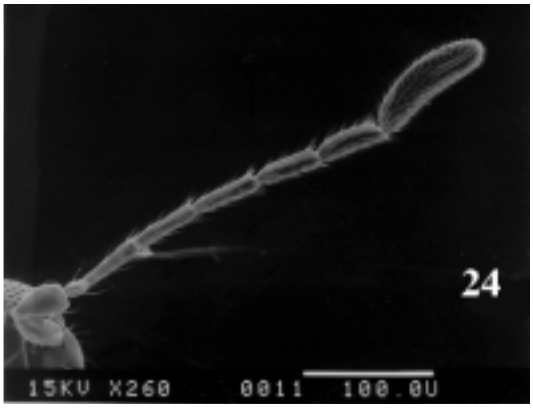
Anagrus nigriventris Girault; Chiappini et al., 1996: 581–583.

To avoid unnecessary repetition, see Chiappini et. al. (1996) for the list of synonyms, hosts, distribution, and detailed description which unfortunately lacks illustrations. Here we provide illustrations of the female antenna (Fig. 24) and forewing (Fig. 22) as well as of the male genitalia (Fig. 23). These should help to correctly identify this species when using the key.

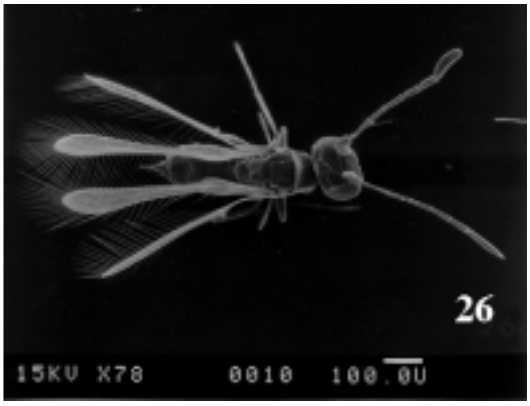
Type locality: Centralia, Illinois, U.S.A.

Type material: examined by S.V.T. (Chiappini et al. 1996).

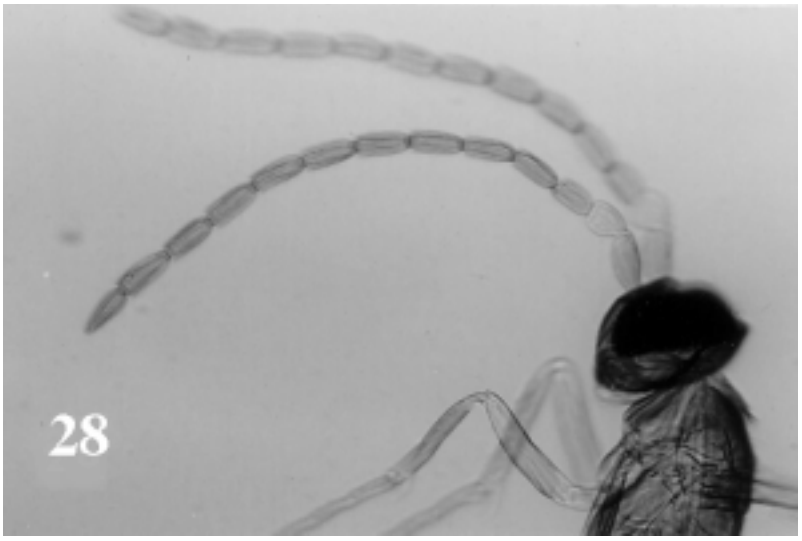
Material examined: Hawaii Islands. **Oahu I**.: Ewa, 4.V.1966, J. W. Beardsley, 1 V. Hickam A.F.B., 19.V.1988, J. W. Beardsley, 5 ♀ (S) [BPBM]. Honolulu: VII.1942, D. T. Fullaway, ex. eggs of *Empoasca solana*, 5 ♀, 1 ♂ [HDOA]; University of Hawaii Campus, 28.IX.1965, J. W. Beardsley, 4 ♀ [BPBM]; same locality, 27.IV.1986, L. LeBeck, 1 ♀ (YPT, Gilmore Hall) [CNCI]; Manoa, 19.IV.1991, J. W. Beardsley, 1 ♀. Waimanalo: 12.I.1966, J. W. Beardsley, 1 ♀; 2.VIII.1988, J. W. Beardsley, 2 ♀ (S); same data except


24
15KV X260 0011 100.0U


25
15KV X320 0009 100.0U


26
15KV X78 0010 100.0U

Figures 27–28. *Anagrus insularis* Dozier: 27. habitus, ♀ (paralectotype); 28. antennae and head, ♂ (paralectotype).



6.IX.1988, 1 ♀; HITAHR Expt. Sta, 4.VI.1991, J. W. Beardsley, 1 ♀ (S); University of Hawaii Farm, 5.VI.1995, J. W. Beardsley and W. D. Perreira, 2 ♀ (S); same data except 5–12.VI.1995, 1 ♀ (YPT) [BPBM].

Comments: *A. nigriventris* is one of the most common mymarid species in Hawaii. It apparently is an accidental immigrant to these islands, and might have been present in Honolulu as early as 1930. Both sexes of an *Anagrus* sp. were reared in abundance from eggs of *Empoasca solana* DeLong in foliage of *Amaranthus spinosus* on June 28, 1930 by O. H. Swezey (Dozier 1936). We suspect that *Anagrus* sp. mentioned by Dozier is conspecific with *A. nigriventris* because that species was reared from *E. solana* in Hawaii in 1942 (see "material examined" above) and because *A. nigriventris* is a very common (and so far the only known) parasitoid of *Empoasca* eggs on *Amaranthus* spp. in California (S.V.T., unpubl. data). In addition, Dozier (1936) stated that his *Anagrus* sp. appeared to be close to *A. giraulti* Crawford, which is a junior synonym of *A. nigriventris* (Chiappini et al. 1996).

Acknowledgments

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