Zootaxa 3750 (3): 237–250
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

http://dx.doi.org/10.11646/zootaxa.3750.3.4
http://zoobank.org/urn:lsid:zoobank.org:pub:51C59B89-D7A1-4650-BDA0-D16F9E52E4EC

An update of the blow flies (Diptera: Calliphoridae) of the Galápagos Islands, and first record of *Chrysomya rufifacies* (Macquart) from mainland Ecuador

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Abstract

Seven species of Calliphoridae are reported from the Galápagos Islands, Ecuador: *Lucilia pionia* (Walker), *L. setosa* (James), *L. deceptor* (Curran), *L. eximia* (Wiedemann), *Cochliomyia macellaria* (Fabricius), *Chrysomya albiceps* (Wiedemann), and *Chrysomya megacephala* (Fabricius). *Lucilia eximia* is newly recorded from the islands. *Lucilia* sp. near *pionia* is recorded from the island of Española. The distribution and collection records of these species are discussed and listed, and a key to their identification is provided. *Chrysomya rufifacies* (Macquart) is reported for the first time from mainland Ecuador and the identification of this species is outlined.

Key words: Calliphoridae, endemic *Lucilia* species, *Lucilia eximia*, *Chrysomya rufifacies*, Galápagos Islands, Ecuador

Introduction

The Galápagos Islands (Ecuador) are famous worldwide for their unique flora and fauna and are now one of the most intensively studied areas in the Neotropical Region, especially the marine biota, seed plants and vertebrates. The diversity of the arthropod fauna has been intensively surveyed and studied over the past several decades, as highlighted by the detailed reviews of the beetles and minor insect orders of the Galápagos by Peck (2001, 2006).

Knowledge of the Galápagos Diptera has been reviewed by Sinclair (2009) and a checklist is available at: http://checklists.datazone.darwinfoundation.org/terrestrial-invertebrates/diptera/. Introduced species and threats to the indigenous fauna have been discussed and analyzed by Peck *et al*. (1998) and Causton *et al*. (2006).

This paper continues a series of studies by various authors reviewing families of Galápagos Diptera (listed in Sinclair & Cumming, 2013). Seven species of Calliphoridae belonging to three genera are recorded from the Galápagos Islands: *Lucilia pionia* (Walker, 1849), *L. setosa* (James, 1966), *L. deceptor* (Curran, 1934), *L. eximia* (Wiedemann, 1819b), *Cochliomyia macellaria* (Fabricius, 1775), *Chrysomya albiceps* (Wiedemann, 1819a), and *Chrysomya megacephala* (Fabricius, 1794). Specimens collected from Española Island are assigned as *Lucilia* sp. near *pionia.* The study also reports the first record of *Chrysomya rufifacies* (Macquart, 1844) from mainland Ecuador.

Material and methods

This study is based on blow fly (Diptera: Calliphoridae) specimens collected from the Galápagos Islands and deposited in the California Academy of Sciences (CAS), the Canadian National Collection of Insects (CNC), the Charles Darwin Research Station (CDRS), and the United States National Museum of Natural History (USNM) (Appendix 1). Dates of collection of examined specimens range from 1899 to 2007. The individual island records listed in Table 1 are based primarily on specimens examined by the authors and supplemented by additional records from Curran (1934) and James (1966).

Accepted by J. O'Hara: 21 Nov. 2013; published: 19 Dec. 2013

TABLE 1. Blow fly species known to occur in the Galápagos Islands.

Species	First record	Island distribution
Chrysomya albiceps (Wiedemann, 1819a)	1989	Caa, Flo, Isa, Mar, SCl, SCz, SFe, Sgo
Chrysomya megacephala (Fabricius, 1794)	1989	Bal, Caa, Isa, SCz
Cochliomyia macellaria (Fabricius, 1775)	1835	Bar, Esp, Fer, Flo, Gen, Isa, Pon, SCl, SCz, SFe, Sgo
Lucilia deceptor (Curran, 1934)	1899	Bar, Caa, Esp, Fer, Flo[1], Isa, Mar, SCz, Sey, SFe
Lucilia eximia (Wiedemann, 1819b)	1989	Flo, Isa, SCl, SCz
Lucilia pionia (Walker, 1849)	1835	Fer, Flo[1], Gen, Mar, Pta, SCz, Sgo
Lucilia setosa (James, 1966)	1899	Dar, Wol[2]
Lucilia sp. near *pionia*	1967	Esp

Abbreviations: Bal, Baltra; Bar, Bartolomé; Caa, Caamaño; Dar, Darwin; Esp, Española; Fer, Fernandina; Flo, Floreana; Gen, Genovesa; Isa, Isabela; Mar, Marchena; Sey, Seymour Norte; Pon, Pinzón; Pta, Pinta; SCl, San Cristóbal; SCz, Santa Cruz; SFe, Santa Fé; Sgo, Santiago; Wol, Wolf.
[1]Record from Curran (1934).
[2]Record from James (1966).

Specimens were identified to species using the works of Walker (1849), Shannon (1926), Curran (1934), James (1966), Dear (1985), Smith (1986), Wells & Kurahashi (1996), Carvalho & Ribeiro (2000), Spradbery (2002), Mello (2003), Rognes & Paterson (2005), Amat *et al*. (2008), Carvalho & Mello-Patiu (2008), Amat (2009), Whitworth (2010a, b), Almeida Silva *et al*. (2012), and Kosmann *et al*. (2013). The type specimens of *Lucilia deceptor* and *L. setosa* were examined. A key is provided to facilitate the separation of the seven blow fly species. Taxonomic terms follow those of Rognes (1991) and Whitworth (2010a).

Measurements of frons to head ratio of male *Lucilia* species were made after Whitworth (2010a). The male terminalia of the endemic species of *Lucilia* were detached from the body, macerated overnight in cold 20% sodium hydroxide solution, neutralized in 10% aqueous glacial acetic acid for 30 minutes, rinsed twice in distilled water, and then examined in glycerol under a stereomicroscope. Digital images of the male and female head, male fifth sternite, and male terminalia of each endemic species of *Lucilia* were taken with a Leica camera (model DFC425C) controlled by a Leica Digital Imaging System.The Zerene Stacker software program was used to view and assembly the images.

Key to adults of the blow flies species of the Galápagos Islands

The following key is purposely highly detailed with numerous diagnostic features of the species as an aid to the future recognition of new species records to the Galápagos.

1 Basal section of stem vein bare above; suprasquamal ridge posteriorly with conspicuous cluster of setae near base of scutellum; lower calypter bare above, its hind margin and corner rounded; outer posthumeral seta present . . . . . ***Lucilia*** … 2

\- Basal section of stem vein setose above; suprasquamal ridge posteriorly without conspicuous cluster of setae near base of scutellum; lower calypter haired above, its hind margin relatively straight and its corner angular; outer posthumeral seta absent 6

2 Body dull black or greenish-black; first flagellomere 2 times as long as pedicel; basicosta yellow; mid tibia without anterodorsal seta; male frons broader, 0.24–0.26 of head width at narrowest (Fig. 1D); male sternite 5 large, incised, and drawn out into elongated, hairy and bristly lobes (Fig. 1G); male terminalia as in Figures 1E, and 1F . . . . . ***Lucilia deceptor***

\- Body green or bluish green; first flagellomere 4 times as long as pedicel; basicosta brown or black; mid tibia with anterodorsal seta; male frons narrower, 0.03–0.17 of head width at narrowest; male sternite 5 not large or incised, with broad triangular plates or lobes (Figs 2G, 3I, 4G) 3

3 Abdominal tergites 3 and 4 without posterior marginal black bands; abdominal tergites 4 and 5 polished; genal dilation and parafacial mostly tan to orange in ground colour and covered with golden or yellow microtomentum; eyes in male closely approximated, fronto-orbital plates touching, or nearly so; male frons narrow, 0.03–0.05 of head width at narrowest; lower calypter white or infuscated in female and infuscated in male (for male terminalia, see Amat *et al*. 2008, fig. 48; Whitworth 2010a, figs 70a, 70b) . . . . . ***Lucilia eximia***

\- Abdominal tergites 3 and 4 with posterior marginal black bands when viewed from certain angles; abdominal tergites 4 and 5 not polished; genal dilation and parafacial black in ground colour and covered with silvery microtomentum; eyes in male

widely separated; male frons broad, 0.12–0.17 of head width at narrowest; lower calypter in male and female yellowish white 4

4 Body shining green, bluish green or coppery; presutural mesonotal area without white microtomentum but covered with brown microtomentum mainly between presutural dorsocentral and acrostichal setae; midline in postsutural mesonotal area, when viewed from rear, not complete, covered with brown microtomentum; male frons 0.12–0.14 of head width at narrowest 5

- Body dull; presutural mesonotum covered with dense white microtomentum best seen without magnification and no evident brown microtomentum; midline in postsutural mesonotal area, when viewed from rear, complete, not covered with brown microtomentum; tergite 4 with a broad black midline and usually 1–3 stout discal setae; tergite 5 with erect long discal setae set apart; male frons 0.15–0.17 of head width at narrowest (Fig. 2D); male terminalia as in Figures 2E and 2F . . . . ***Lucilia setosa***

5 Head extended downward and forward (Fig. 3C); first flagellomere black; midline of tergite 4 not obvious; tergite 5 in female with fine small discal setae (good quality specimens are needed to assess the size of these setae in the male); male frons 0.12–0.13 of head width at narrowest (Fig. 3F); male terminalia as in Figures 3G and 3H (most Galápagos Islands, not Española) . . . . . ***Lucilia pionia***

- Head not extended downward but slightly forward (Fig. 4C); first flagellomere yellowish or reddish brown; tergite 4 with narrow midline; tergite 5 in female and male with stout long discal setae, slanted (directed) posteriorly; male frons 0.12–0.14 of head width at narrowest (Fig. 4D); male terminalia as in Figures 4E and 4F (Española) . . . . . ***Lucilia* sp. near *pionia***

6 Mesonotum with 3 black longitudinal vittae; greater ampulla pubescent; lower calypter with hairs above on basal part only; palpus short, slender and filiform. Specific characters: lower one-half to one-third of fronto-orbital plate with pale setulae outside row of frontal setae; tergite 5 usually with pronounced lateral areas of silvery microtomentum; postgenal setae usually pale yellow; female usually with yellowish basicosta and two pairs of proclinate orbital setae (for male terminalia, see Dear 1985, figs 43, 44; Amat 2009, fig. 31) . . . . . ***Cochliomyia macellaria***

- Mesonotum without black longitudinal vittae; greater ampulla setose; lower calypter entirely covered with appressed hairs above; palpus normal, clavate 7

7 Anterior spiracle white; proepimeral (prostigmatic) seta absent. Specific characters: Male: eyes closely approximated, fronto-orbital plates not touching; facets of eye scarcely enlarged above and not sharply demarcated from area of slightly smaller facets below; outer vertical seta present. Female: fronto-orbital plate without setae in front of lateroclinate seta; tergite 5 with hind margin incised mid-dorsally (for male terminalia, see Guimarães *et al*. 1978, figs 9–12; Amat 2009, fig. 27). . . . . ***Chrysomya albiceps***

- Anterior spiracle dark brown to black; proepimeral (prostigmatic) seta present. Specific characters: Male: holoptic, facets of eye much enlarged above and sharply demarcated from area of smaller facets below; outer vertical seta absent. Female: frontal stripe broader in middle, not parallel sided; tergite 5 with hind margin entire (for male terminalia, see Guimarães *et al*. 1978, figs 1–4; Amat 2009, fig. 28) . . . . . ***Chrysomya megacepahala***

Comments on the Galápagos species

Lucilia Robineau-Desvoidy

Lucilia pionia and *L. setosa* are exclusively endemic to the Galápagos Islands (James 1966), whereas *L. deceptor* is considered endemic to the Galápagos and Cocos islands (Costa Rica) (Curran 1934). According to the literature and specimens examined in this study, *L. setosa* exists only on Darwin and Wolf islands and no other blow fly species has been collected from these islands. To date, the biology of the three endemic species of *Lucilia* is unknown. *Lucilia eximia* is an introduced species and a new record to the Galápagos Islands. It was first collected in 1989 from the islands of Santa Cruz, Floreana, and San Cristóbal. This species is the most common and widespread blow fly in the Neotropical Region (James 1970), where it breeds in carrion (Moretti & Godoy 2013). Morphologically, the four species of *Lucilia* commonly share a pubescent (not setulose) subcostal sclerite and two postsutural acrostichal setae. The three endemic species lack a coxopleural streak, which is present in *L. eximia*.

Lucilia pionia was described by Walker (1849: 880) in the genus *Musca* Linnaeus, based on an unknown number of male specimens of unknown island origin collected by Charles Darwin in 1835. A single type specimen with missing abdomen was redescribed by Aubertin (1933)[1] and James (1966). Based on this specimen, Shannon (1926) erected the subgenus *Viridinsula* in the genus *Lucilia* because he noted that the epistome is greatly protruded, a character not found in any other species of *Lucilia.* Subsequently, Curran (1934), based on this feature in two females of *L. pionia* collected from Santa Cruz and Floreana and six males and 14 females of *L. deceptor* collected from Seymour Norte, Isabela, Española, Floreana, and Cocos islands, raised the subgenus *Viridinsula* to

1. Walker (1849: 880) did not specify whether *L. pionia* was based on one or more male specimens. Subsequent workers have assumed the single male in the Natural History Museum (London; NHM) to be a unique holotype. Rather than perpetuate this assumption, we regard Aubertin's (1933: 399) examination of the male "type" from the Galápagos Islands in NHM as a lectotype fixation.

genus level. James (1966) noted in his key that the head is distinctly extended downward and forward in *L. pionia*, whereas in *L. setosa* and *L. deceptor*, the head is extended forward but not strongly downward. In our study, we found that the degree of protrusion of the epistome varies greatly among specimens of *L. pionia* regardless of the sex (Fig. 3A–E) and was hardly or even not recognized in all *L. deceptor*, *L. setosa* and *L.* sp. near *pionia* specimens examined (Fig. 1A–C, Fig. 2A–C & Fig. 4A–C, respectively). The genus-group name *Viridinsula* was synonymized with *Lucilia* by Rognes (1991).

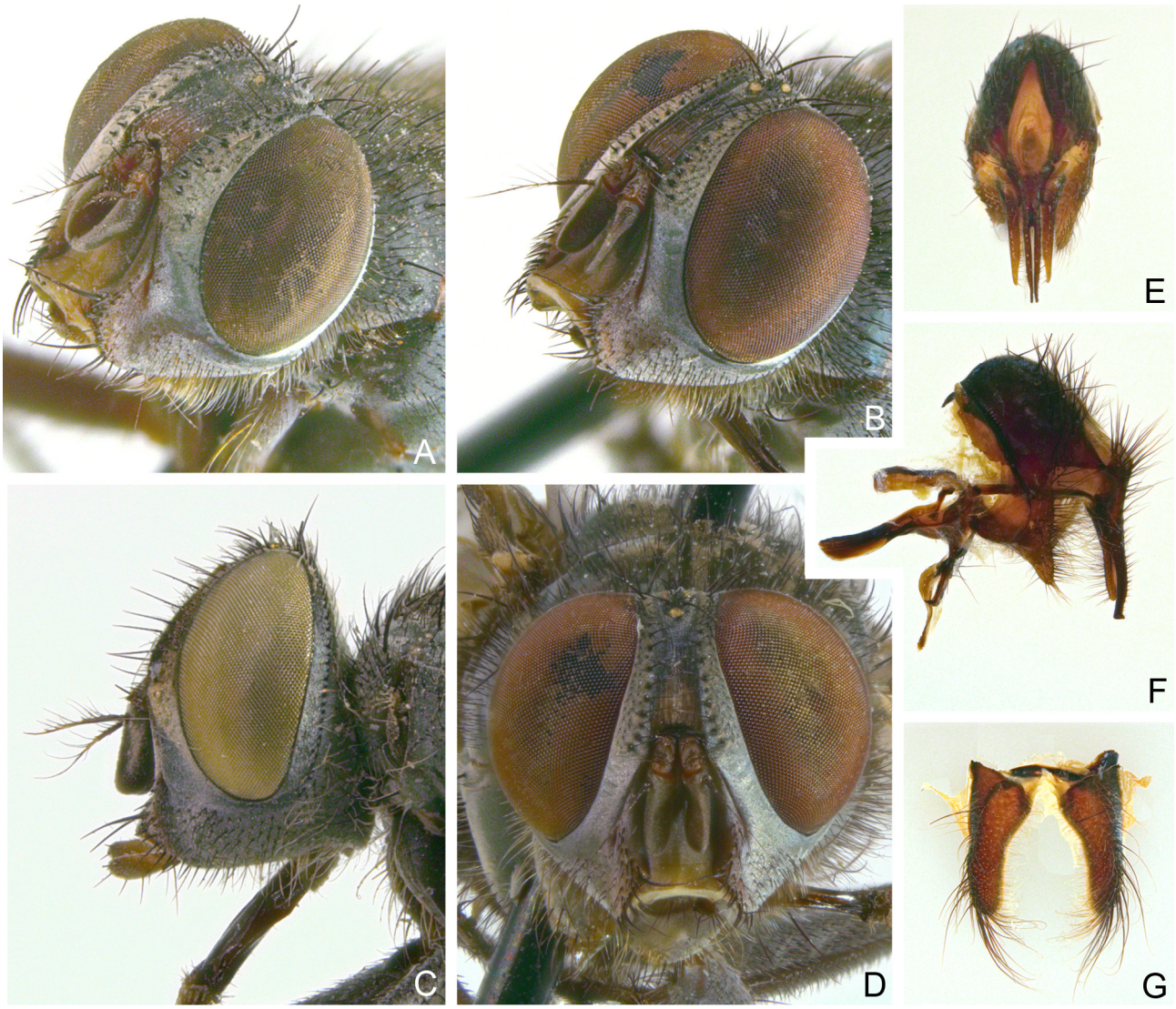

FIGURE 1. *Lucilia deceptor*. A. Head, female (Española), anterolateral view. B. Head, male (Bartolomé), anterolateral view. C. Head, male (Santa Fé), lateral view. D. Head, male (Bartolomé), anterior view. E–F. Male terminalia (Española). E. Posterior view. F. Lateral view. G. Male sternite 5 (Española).

It is of interest to note that the CNC specimens of *Lucilia*, other than *L. deceptor*, collected from the island of Española in 1985 are morphologically different from *L. pionia* specimens collected from other islands. Additionally, four males in CAS from Española that were originally identified as *L. setosa* by James share the same features. Unlike *L. setosa*, these specimens possess a shining green body and the presutural mesonotal area is not densely covered with white microtomentum. Given this finding and due to the poor condition and low number of *L. pionia* males and few females of the above mentioned CNC specimens from Española, we prefer at present to treat the Española specimens as *Lucilia* sp. near *pionia*. The status of this apparent variant of *L. pionia* should be reevaluated when better specimens from Española become available.

We examined the male terminalia of one paratype of *L. setosa* in CAS from Darwin; one specimen of *L.* sp. near *pionia* from Española (CAS, misidentified as *L. setosa* by James); one specimen of *L. pionia* from Santa Cruz

(CAS, identified by James); eight specimens of *L.* sp. near *pionia* from Española (CNC); and one specimen of *L. pionia* from Fernandina (CNC). The terminalia of all specimens appear identical and no clear separation was identified.

FIGURE 2. *Lucilia setosa* (Darwin Island). A. Head, female, anterolateral view. B. Head, male, anterolateral view. C. Head, male, lateral view. D. Head, male anterior view. E–F. Male terminalia. E. Posterior view. F. Lateral view. G. Male sternite 5.

Cochliomyia Townsend

In this study, we consider the secondary screwworm fly *Cochliomyia macellaria* native (not an introduced species) to the Galápagos Islands because this species was first collected with *L. pionia* by Darwin in 1835 (James 1966) and it is a member of the native species composition of carrion calliphorids in the Neotropical Region (James 1970; Dear 1985). However, James (1966), Peck *et al*. (1998) and Causton *et al*. (2006) have labeled *Co. macellaria* in their studies as an introduced species.

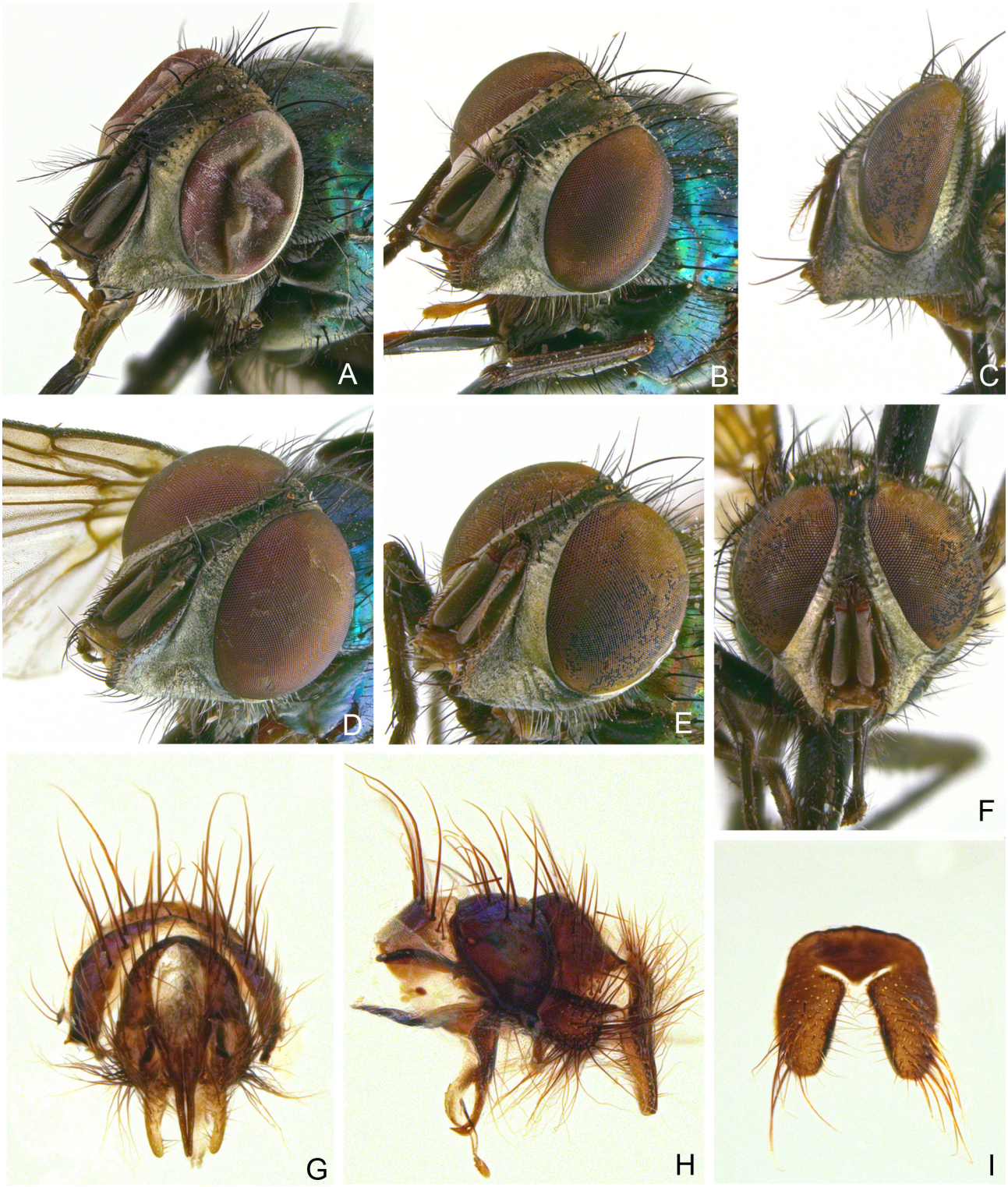

FIGURE 3. *Lucilia pionia*. A. Head, female (Fernandina), anterolateral view showing strong head protrusion. B. Head, female (Santa Cruz), anterolateral view showing weaker head protrusion. C. Head, male (Santa Cruz), lateral view. D. Head, male (Santiago), anterolateral view showing strong head protrusion. E. Head, male (Santa Cruz), anterolateral view showing weaker head protrusion. F. Head, male (Santa Cruz), anterior view. G–H. Male terminalia (Santa Cruz). G. Posterior view. H. Lateral view. I. Male sternite 5 (Santa Cruz).

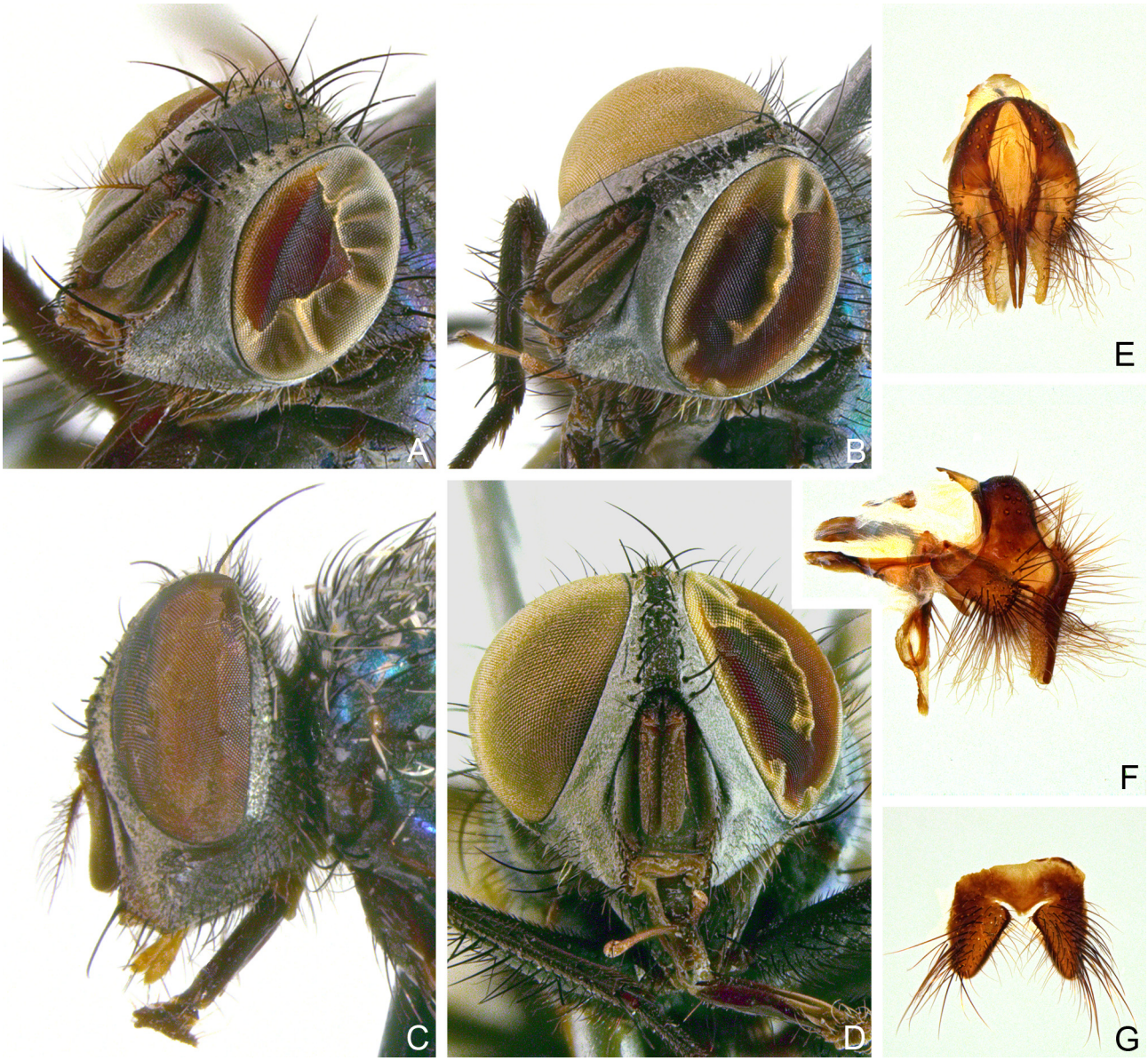

FIGURE 4. *Lucilia* sp. near *pionia* (Española Island). A. Head, female, anterolateral view. B. Head, male, anterolateral view. C. Head, male lateral view. D. Head, male, anterior view. E–F. Male terminalia. E. Posterior view. F. Lateral view. G. Male sternite 5.

Chrysomya Robineau-Desvoidy

The hairy maggot blow fly *Chrysomya albiceps* and the Oriental latrine blow fly *Ch. megacephala* are introduced species to the Galápagos Islands, which were first collected in the Galápagos in 1989 (Peck *et al*. 1998, where first record of *Ch. albiceps* was incorrectly cited as 1985). In the same year or earlier, Olsen *et al*. (1992) recorded for the first time *Ch. megacephala* from the Ecuadorian mainland. These two species along with *Ch. putoria* (Wiedemann, 1830) were introduced from the Old World and first recorded in southern Brazil in 1975–1977 (Guimarães *et al*. 1978, 1979), and since then have become widespread in South America.

Chrysomya albiceps and *Ch. megacephala* are well known to breed in carrion (Vasconcelos & Araujo 2012; Moretti & Godoy 2013), and both species are of forensic and medical importance (Zumpt 1965; Greenberg 1971; Guimarães *et al*. 1983; Smith 1986; Olsen *et al*. 1993; Mavarez-Cardozo *et al*. 2005; Ferraz *et al*. 2011). Because third-instar larvae of *Ch. albiceps* are facultative predators on larvae of other necrophagous flies (Zumpt 1965; Faria *et al*. 2004), this behavior may have a negative effect on the native fly species in the Galápagos Islands.

Laboratory studies have shown that *Ch. albiceps* can dramatically lower the abundance of *Co. macellaria* and *Ch. megacephala* in South America (Aguiar-Coelho & Milward-de-Azevedo 1995; Aguiar-Coelho *et al*. 1995; Rosa *et al*. 2006). *Chrysomya rufifaces* (Macquart), a species which also has the same predatory behaviour as *Ch. albiceps*, could significantly reduce the populations of *Co. macellaria* in carrion wherever the two species coexist (Wells & Greenberg 1992a, b). In a major survey of human cases of wound myiasis in Goiás State, Brazil, during February 2005–August 2006, Fernandes *et al*. (2009) did not record a single case involving *Co. macellaria*. They attributed this to the ongoing dramatic decrease in the populations of this native Neotropical species resulting from competition with introduced Old World species, especially *Ch. albiceps*. Results of a study on the abundance of species of Calliphoridae of public health and forensic importance in the Tinguá Biological Reserve, Nova Iguaçu, R.J., Brazil during March 1995–February 1996 strongly suggest the displacement of *Co. macellaria* by *Ch. albiceps* (Batista-da-Silva *et al*. 2011).

Because carrion fly communities are primarily structured by competition (Norris 1965; Kneidel 1984; Hanski 1987), future field studies on carrion calliphorids in the Galápagos Islands should explore the biological and ecological interactions between introduced and endemic species (see Hanski (1977) for the Canary Islands and Sinclair (2009) for the Galápagos Islands). It should be borne in mind that small isolated islands are characterized by a lower species richness of carrion flies due to fierce interspecific competition (Hanski 1977). In contrast, a higher species richness can be found on large islands and the mainland, where competition among different fly species may be alleviated mainly by differences in habitats (Lane 1975; Martin-Vega & Baz 2013) and seasonality (Tantawi *et al*. 1996; Martin-Vega & Baz 2013), thus facilitating coexistence.

Chrysomya rufifacies (Macquart, 1844) from mainland Ecuador

We record for the first time the presence of *Chrysomya rufifacies* from mainland Ecuador. Two females of this species were collected along with six specimens of *Ch. albiceps* by S. & J. Peck from Pichincha Province, 4 km west of Alóag, 19–25.vii.1985. The two *C. rufifacies* are deposited in the CNC and were only recently examined. *Chrysomya rufifacies*, an Oriental and Australasian blow fly, was first introduced into Central America in 1978 from where it has dispersed rapidly across North America (Baumgartner 1993; Rosati & VanLaerhoven 2007). In South America, this species has been recorded from Argentina in 1986/1987 (Mariluis & Schnack 1989), Colombia in 1991/1992 (Barreto *et al*. 2002), and recently from Brazil in 2010 (Almeida Silva *et al*. 2012).

Chrysomya rufifacies can be easily separated from its biological equivalent (James 1947), *Ch. albiceps*, by the presence of a proepimeral seta on the thorax. This seta is absent in the latter species. The third instars of these species possess specific morphological differences (Tantawi & Greenberg 1993; Wells *et al*. 1999).

We provide a key to differentiate between adults of *Ch. rufifacies* and *Ch. putoria* for three main reasons: 1) the two species are the only Neotropical members in the genus *Chrysomya* that possess a white anterior spiracle with a proepimeral seta (incorrectly termed proepisternal by Almeida Silva *et al*. 2012), 2) South American specimens of *Ch. rufifacies* have been previously misidentified as *Ch. putoria* (see Almeida Silva *et al*. 2012), and 3) we find the key of Almeida Silva *et al*. (2012) to be inadequate (i.e., differences in the colour of the notum and genal dilation and chaetotaxy of the fronto-orbital plates are not mentioned). Our key is based on Rognes & Paterson (2005) and Whitworth (2010b).

1 Both sexes: notum shining, with little white microtomentum; genal dilation mostly or entirely yellow to orange in ground colour. Male: frons width twice width of anterior ocellus; outer vertical seta present. Female: tergite 5 with hind margin incised mid-dorsally; fronto-orbital plate without setae in front of lateroclinate seta . . . . . ***Chrysomya rufifacies*** (for male terminalia, see Almeida Silva *et al*. 2012, figs 6, 7)

- Both sexes: notum with conspicuous white microtomentum; genal dilation blackish in ground colour. Male: frons width less than width of anterior ocellus; outer vertical seta absent. Female: tergite 5 with hind margin entire; fronto-orbital plate with 1–3 outwardly directed setae in front of lateroclinate seta . . . . . ***Chrysomya putoria*** (for male terminalia, see Rognes & Paterson 2005, fig. 10)

Acknowledgements

The following curators and their collections kindly loaned specimens for this study: C.E. Griswold (CAS), H.W.

Herrera (CDRS) and N.E. Woodley (USNM). We thank Terry Whitworth (Washington State University) and one anonymous reviewer for their valuable and critical comments on the manuscript. We also thank Jim O'Hara (CNC) for critical comments and nomenclatural guidance. Special thanks to Scott Brooks of the CNC for his generous assistance in photographing the specimens.

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APPENDIX 1. Collection records for all specimens of Calliphoridae examined from the Galápagos Islands. Records listed under individual islands, using preferred Ecuadorian names (see Peck 2001).

Chrysomya albiceps

Caamaño: 1.ii.2007, A. Mieles (1♀, CNC).

Floreana: Black beach, arid zone, 21.iii.1989, B.J. Sinclair (1♀, CNC); 6 km E, Black beach, 380 m, 21–28.iii.1989, *Scalesia* forest, Malaise, FIT, S. Peck & B.J. Sinclair (3♀, CNC); Black beach, 10 m littoral-arid, FIT, 21–28.iii.1989, S. Peck & B.J. Sinclair (1♀, CNC); 3 km E, Black beach, 120 m, 21–28.iii.1989, upper arid zone, Malaise, FIT, S. Peck & B.J. Sinclair (1♂, 2♀, CNC); 5 km E, Black beach, 350 m, 22–25.iii.1989, *Scalesia* forest, carrion trap, B.J. Sinclair (1♂, 2♀, CNC); 8 km E, Black beach, 360 m, 22–28.iii.1989, *Scalesia*, FIT, S. Peck & B.J. Sinclair (2♀, CNC); 5 km E, Black beach, 250 m, 22–28.iii.1989, trans. zone, Malaise, FIT, S. Peck & B.J. Sinclair (1♂, 1♀, CNC); 3 km E, Black beach, 100 m, 24.iii.1989, arid zone, dung trap, B.J. Sinclair (1♂, 2♀, CNC).

Isabela: Villamil, 4 km NW, 2–15.iii.1989, arid forest Malaise, 20 m, S. Peck & B.J. Sinclair (1♂, 1♀, CNC); Villamil, 12 km NW, 2–15.iii.1989, trans. forest, 150 m, FIT, S. Peck & B.J. Sinclair (1♂, CNC); Villamil, 2 km W, 2–15.iii.1989, brackish meadow, 2 m, Malaise, S. Peck & B.J. Sinclair (1♂, 1♀, CNC); Villamil, 9–15.iii.1989, 3 m arenal scrub carrion trap, S. Peck (2♂, 6♀, CNC); V. Alcedo, Zona Cumbre, Trampa Amarilla, 16–18.x.1999, L. Roque (1♂, CDRS); Alcedo Bosque Pega-Pega, 29.x. –2.xi.2000, yellow trap, L. Roque (1♀, CDRS); V. Alcedo, Zona Pega Pega, Trampa amarilla, 28.x.–

1.xi.2000, L. Roque (1♂, CDRS); Volcan Alcedo, Bosque Pega Pega, 20.x. –2.xi.2000, yellow trap, L. Roque (3♂, 5♀, CDRS); Volcan Alcedo, Zona Guayabillos, 13–16.v.2000, Trampa Amarilla, L. Roque (1♀, CDRS).

Marchena: Z. no infestada (Parte alta), ex: Aspirador, 4.iv.2002, A. Mieles (1♀, CDRS).

San Cristóbal: 3 km E, Baquerizo, 100 m, trans. zone, 12–23.ii.1989, FIT, S. Peck & B.J. Sinclair (1♂, CNC); 4 km E, Baquerizo, 150 m, trans. zone, 12–23.ii.1989, FIT, S. Peck & B.J. Sinclair (1♂, 1♀, CNC); Pto. Baquerizo, littoral, 14.ii.1989, B.J. Sinclair (3♀, CNC); 2 km NE, Baquerizo, arid zone, 15–18.ii.1989, carrion trap, B.J. Sinclair (1♂, 3♀, CNC); Progresso, 1 km E, Guava ravine, 370 m, 15–23.ii.1989, FIT, S. Peck & B.J. Sinclair (1♀, CNC); Z. Agricola O. Rios, ex: Amarilla # 6, 15.xi.2002, L. Guaman & J. Loayza (1♀, CDRS); Soledad. (A. Criollo), 23.xi.2002, T. Amarilla # 2, L. Guaman & J. Loayza (1♂, CDRS); Z. Agricola, Soledad, Naranja-Platano-Yuca, 10.iv.2003, pitfall 1, P. Lincango & A. Mieles (1♂, CDRS).

Santa Cruz: CDRS, arid zone, 19–31.i.1989, B.J. Sinclair (1♀, CNC); CDRS, arid zone, 5–9.ii.1989, dung trap, B.J. Sinclair (5♀, CNC); Puntudo, 650 m, *Scalesia* forest, 1–30.iii.1989, FIT, S. Peck & B.J. Sinclair (1♂, CNC); 1km N, Puntudo, *Scalesia*, 650 m, 1–8.iv.1989, FIT, S. Peck (3♂, CNC); Media Luna, Miconia, 550 m, Malaise, 1–8.iv.1989, S. Peck (1♀, CNC); agriculture zone, 1–9.iv.1989, Malaise, S. Peck & B.J. Sinclair (3♂, 1♀, CNC); agriculture zone, Bellavista, field, 160 m, 1–9.iv.1989, FIT, S. Peck & B.J. Sinclair (1♂, CNC); arid zone, 12.xi.2001, B.J. Sinclair (1♀, CNC); CDRS, arid zone, 12–13.xi. 2001, B.J. Sinclair (3♂, CNC); Academy Bay, 2 km E, CDRS, 18.xi.2001, B.J. Sinclair (2♀, CNC).

Santa Fé: arid zone, 10–15 m, 3–6.iv.1989, carrion trap, B.J. Sinclair (1♀, CNC).

Santiago: Playa Espumillo, 0 m, pan, arid zone, 3–9.vi.1991, J. Heraty (1♀, CNC); 1km NE, Aquacate, 600 m, 4–9.vi.1991, humid forest, Malaise and FIT, S. Peck (1♂, 1♀, CNC).

Chrysomya megacephala

Baltra: 6 m, 5.xi.2006, E. Lomas, Aspirador; Bodega de carga, Aerogal, misidentified as *Ch. albiceps* by F. Berosa (1♀, CDRS).

Caamaño: 3–10.iv.1989, littoral, carrion trap, B.J. Sinclair (1♀, CNC); 1.ii.2007, A. Mieles (1♀, CNC).

Isabela: Pto. Villamil-hotel, arid zone, 2–14.ii.1989, B.J. Sinclair (4♂, 3♀, CNC); Villamil, 4 km NW, 2–15.iii.1989, arid forest, 20 m, FIT, Malaise, S. Peck & B.J. Sinclair (2♂, CNC); Villamil, 1 km W, 2–15.iii.1989, Malaise, littoral scrub on sand, S. Peck & B.J. Sinclair (1♂, CNC); Villamil, 3 m, arenal scrub carrion trap, 9–15.iii.1989, S. Peck (1♀, CNC).

Santa Cruz: CDRS, arid zone, 19–31.i.1989, B.J. Sinclair (1♂, CNC); CDRS, arid zone, 5–9.ii.1989, dung trap, B.J. Sinclair (2♂, CNC).

Cochliomyia macellaria (251 specimens examined)

Bartolomé: lava bed in contact with mangrove swamp, N end of island, 5' alt., 3.ii.1967, I.L. Wiggins (CAS).

Española: x.1905, F.W. Williams (CAS); 15.v.1899 (CAS); Punta, Juarez, 10–12.ii.1967, traps among *Lycium minimum*, *Prosopis doleis* and *Cryptocarpus pyriformus* (Gubarsbia), I.L. Wiggins, det. James 1977 (CAS); Bahia Manzanilla, 5–10.vi.1985, *Prosopis* grove behind beach, carrion trap, S. & J. Peck (CNC).

Fernandina: 13.i.1899, det. James 1964 (CAS).

Floreana: x.1905, F.X. Williams (CAS); 10.v.1899, James 1964 (CAS).

Genovesa: 23.vi.1899, James 1964 (CAS).

Isabela: 1.i.1899, James 1964 (CAS); 16.i.1899, James 1964 (CAS); 7.ii.1899 (CAS); nr. Punta Tortuga, N. Tagus cove, 28–30.i.1967, I.L. Wiggins, det. H.S. Lopes (CAS).

Pinzón: Summit and upper Caldera Areas, 7.ii.1964, D.Q. Cavagnaro (CAS).

San Cristóbal: 17–18.iv.1932, M.W. Willows Jr., Templeton Crocker Expedition 1932, det. Curran (CAS).

Santa Cruz: vii.1958, P.W. Richardson, det. James (CAS); Academy Bay, Darwin Research Station: 23.i.1964, D.Q. Cavagnaro & R.O. Schuster, 24.i.1964, D.Q. Cavagnaro & R.O. Schuster, 25.i.1964, D.Q. Cavagnaro & R.O. Schuster, 26.i.1964, R.O. Schuster, 29.i.1964, R.O. Schuster (CAS); Bella Vista Trail, 11.ii.1964, R.O. Schuster (CAS); Grassland 750 m, 6.iv.1964, D.Q. Cavagnaro, det. James (CAS).

Santa Fé: 20.x.1905, F.X. Williams (CAS).

Santiago: N end Bahia James, 1–2.ii.1967, I.L. Wiggins, det. James 1973 (CAS).

Lucilia deceptor

Bartolomé: Lava bed in contact with mangrove swamp N end of island, 5' alt., 3.ii.1967, I.L. Wiggins, det. Mello (1♂, CAS).

Caamaño: 3–10.iv.1989, littoral carrion trap, B.J. Sinclair (1♀, CNC); 01.ii.2007, A. Mieles (10♂, 6♀, CNC).

Española:18.v.1899, det. James 1965 (6♂, 1♀, USNM); Bahia Manzanilla, 7–10.vi.1985, carrion trap, sand beach, S.&J. Peck (4♂, 3♀, CNC); xii.1905, F.X. Williams, det. Curran (1♀, Paratype, CAS); 2.ii.1964, E.G. Linsley, det. James (2♂, 1♀, CAS); Punta Juarez, 10-12.ii.1967, I.L. Wiggins, trap among *Lycium minimum*, *Prosopis doleis* and *Cryptocarpus pyriformus* (Gubarsbia) (3♂, two identified by Mello and one by James in 1977, CAS).

Fernandina: 13.i.1899, det. James 1965 (1 ♂, USNM); 26.i.1899 (2♂, 1♀, USNM); Tagus Cove, 27.v.1932, M. Willows Jr., Templeton Crocker Expedition 1932, det. Curran (1♀, allotype, CAS); 26–27.i.1967, I.L. Wiggins, det. Mello and James 1977 (1♂, 3♀, 1 ?, CAS); Cabo Hammond, 0 m, 4–11.v.1991, J. Heraty, pan on beach at light (3♂, 2♀, CNC); Cape Douglas, 11.vii.2003, N.K. Whiteman, ex. CDU trap nr. pool (1♀, CNC).

Isabela: 16.i.1899 (1♀, USNM); 28-30.i.1967, near Punta Tortuga, N. of Tagus Cove, det. Mello (4♀, CAS).

Marchena: Pta. Espejo, arid zone, 11.iii.1992, Bursera grassland, night colln., S. Peck & J. Cook (1♀, CNC).

Santa Cruz: Academy Bay, Darwin Research Station, 23.ii.1964, D.Q. Cavagnaro & R.O. Schuster (1♂, CAS).

Santa Fé: N.E. corner of island 50 yards from beach, 15–16.ii.1967, in *Cryptocarpus* thicket, I.L. Wiggins (1♀, CAS); 3–6.iv.1989, littoral carrion trap, B.J. Sinclair (2♀, CNC); Sea Lion beach, 4.iv.1989, sweeping, B.J. Sinclair (1♂, CNC); littoral beach, Malaise, 4–6.iv.1989, S. Peck & B.J. Sinclair (1♂, CNC).

Seymour Norte: 12.vi.1932, M. Willows Jr., Templeton Crocker Expedition 1932, det. Curran (1♂, holotype, CAS); 23.i.1989, littoral & intertidal (1♀), MV-lights (1♀), Arid zone, dry path (1♀), B.J. Sinclair (CNC).

Lu
cilia eximia

Floreana: Black beach, arid zone, 21.iii.1989, B.J. Sinclair (1♀, CNC); 3 km E, Black beach, 120 m, 21–28.iii.1989, upper arid zone, FIT, S.Peck & B.J. Sinclair (1♀, CNC); 6 km E, Black beach, 380 m, 22–25.iii.1989, *Scalesia* forest dung trap, B.J. Sinclair (1♂, CNC); 5 km E , Black beach, 250 m, 22–28.iii.1989, trans. zone, FIT, S.Peck & B.J. Sinclair (1♂, CNC); 8 km E, Black beach, 360 m, 22–29.iii.1989, *Scalesia*, FIT, S. Peck & B.J Sinclair (1♂, 1♀, CNC); Z. Agricola A. San Miguel F1, SO1. 299723 WO90. 447263, MT, 1.xi.2003, P. Lincango & E. Lomas (1♂, CDRS); Z. Agricola Finca 3, S01 18.3919 W090 26.6475, T. Amarilla (lechuga), 1.xii.2002, P. Lincango, J.M. (1♂, CDRS); Z. Agricola Finca # 3, Ex: Trampa Amarilla, 1.xii.2002, M. Lincango & F. Bersosa J.M. (1♂, CDRS); Z. Agricola S. Moreno, S01.3145722 W090. 444549, Amarilla Pasto, 1.xi.2003, P. Lincango & E. Lomas (1♀, CDRS); Z. Agricola S. Moreno, S01.3145722 W090.49, Amarilla Pasto, 1.xi.2003, P. Lincango & E. Lomas (1♀, CDRS); Z. Agricola Finca # 3, ex; Trampa amarilla, 1.xii.2002, M. Lincango & F. Bersosa J.M. (1♀, CDRS); Z. Agricola, S. Moreno, 1.xi.2003, Amarilla Pasto, P. Lincango & E. Lomas (2♀, CDRS); Z. Agricola, Finca 3, 1.xii.2002, T. Amarilla, Lechuga, P. Lincango, J.M. (1♀, CDRS); Z. Agricola, F. Abandonada, 1.xi.2003, Succion, Pina-Yuca, P .Lincango & E. Lomas (1♂, CDRS).

Isabela: Z. Agricola Merceditas W.M, S00 52.3819 W091 00.8443, MT 1, 1.xi.2003, A. Ortega, A. Mieles & C. Garcia (1♂, CDRS); Z. Agricola J. Nieto, ex: Pitfall trap # 5, 4.xii.2002, FCD 12 003, A. Mieles & C. Garcia (1♂, CDRS); V. Alcedo, Zona Guayabillos, Trampa Amarilla, 13–16.v.2000, L. Roque (1♀, CDRS); Z. Agricola V. Paute, ex: Pitfall trap # 5, 3.xii.2002, FCD 12 004, A. Mieles & C. Garcia (1♂, CDRS); Z. Agricola, Alfagia, J.N., S00 51.5631 W091 01.7112, Pitfall #5, 9.xii.2002, A. Mieles & C. Garcia (1♂, CDRS); Volcan Alcedo, Zona Guayabillos, 13–16.v.2000, Trampa Amarilla, L. Roque (1♀, CDRS).

San Cristóbal: 4km E, Baquerizo, 150 m, trans. zone, 12-23.ii.1989, FIT, S. Peck & B.J. Sinclair (1♀, CNC); Progresso, 1 km E, Guava ravine, 370 m, 15–23.ii.1989, FIT, S. Peck & B.J. Sinclair (1♀, CNC); Sierra San Janquin, 700 m, 17.ii.1989, B.J. Sinclair (1♂, CNC); Pampa zone, 560–700 m, 18–21.ii.1989, carrion trap, B.J. Sinclair (3♀, CNC); 1 km E, El Junco, 550 m, 18–21.ii.1989, trans. zone, 115 m, 20.i.1989, dung, B.J. Sinclair (1♂, 1♀), carrion trap, Miconia-stream valley, B.J. Sinclair (3♀, CNC); agricultural zone, 500 m, 23.ii.1989, Guava, B.J. Sinclair (2♀, CNC); agriculture zone, 300 m, 20.ii.1989, sweeping, B.J. Sinclair (3♀, CNC); 1km E Progresso, 320 m, agriculture zone, carrion trap, 18–21.iii.1989, B.J. Sinclair (3♀, CNC); El Chino, S 00 54 28.6 W 89, 27 5.1.222 msnm, Amarilla, Zanahoria, 15.xi.2002, L. Guaman & L. Loayza (2♂, CDRS); Socavon, S 00 55 27.2 W 89, 33 42.8.204 msnm, Amarilla, maiz, 26.xi.2002, L. Guaman & L. Loayza (5♂, CDRS); Z. Agricola V. Guamaquishpe, ex: T. Amarilla # 4, 26.xi.2002, L. Guaman & L. Loayza (2♂, CDRS); Junco, S 0 53 23.3 W 89 28, 29.5 589 msnm, T. Amarillas, MT # 5, 15.xi.2002, L. Guaman & L. Loayza (1♂, CDRS); Z. Agricola, C. Verde, S00 53.5285 W089 26.2090, Barrido P. Elefante, 28.xi.2003, P. Lincango & A. Mieles (1♀, CDRS); Z. Agricola, Soledad, Naranja-Platano-Yuca, 10.iv.2003, pitfall 1, P. Lincango & A. Mieles (3♂, 14♀, CDRS); Zona Agricola, Socavon, 10.iv.2003, McPhail 2, P. Lincango & A. Mieles (1♂, 3♀, CDRS); Z. Agricola, Tres Palos, Guayaba, 11.iv.2003, McPhail 12, P. Lincango & A. Mieles (2♂, 4♀, CDRS); Z. Agricola, Tres Palos, Aguacate, 11.iv.2003, McPhail 11, P. Lincango & A. Mieles (3♀, CDRS).

Santa Cruz: trans. zone, 115 m, 20.i.1989, dung, B.J. Sinclair (1♂, 1♀, CNC); CDRS, 27.i.-7.ii.1989, littoral zone, B.J. Sinclair (2♂, CNC); Los Gemelos, 600 m, *Scalesia* forest, dung trap, 31.i. –4.ii.1989, B.J. Sinclair (1♀, CNC); Media Luna, 500 m, Miconia, 1–29.ii.1989, Malaise, S. Peck & B.J. Sinclair (1♂, CNC); Tortoise Res., 180 m trans. 6.ii.1989, swept tortoise dung, B.J. Sinclair (1♀, CNC); Sierra Crocker, hill top, 860 m, 8.ii.1989, sweeping, B.J. Sinclair (1♀, CNC); Bellavista, agriculture zone, 27.ii.1989, MV-lights, 160 m, B.J. Sinclair (1♀, CNC); Agriculture zone, 400 m, 17.iii.1989, MV-lights, B.J. Sinclair (1♀, CNC); Los Gemelos, 1–9.iv.1989, *Scalesia*, 600 m, Malaise, S. Peck & B.J. Sinclair (1♀, CNC); agriculture zone, 1–9.iv.1989, Malaise, S. Peck & B.J. Sinclair (1♂, CNC); CDRS, arid/littoral zone, 10.xi.2001, B.J. Sinclair (1♂, 1♀, CNC); El Cascajo, Finca, agriculture, 11.xi.2001, B.J. Sinclair (6♂, 1♀, CNC).

Lucilia pionia

Fernandina: 5km NE, Cabo Hammond, 110 m, CerroVerde trans. forest, 4–11.v.1991, Malaise, S. & J. Peck (4♀, CNC); 10km NE, Cabo Hammond, 400 m, 6–10.v.1991, edge of valley, forest Malaise, S. & J. Peck (1♂, 1♀, CNC).

Genovesa: 23.vi.1899; det. James 1965 (1♂, 2♀, USNM).

Marchena: II Viajp, 12 5 # 2, pitfall trap, A. Mieles (1♀, CDRS); Parte alta (zona no infestada), 5–10.iv.2002, MT, A. Mieles (2♀, CDRS).

Pinta: Playa Ibbetson, 40 m, 13–22.iii.1992, open Bursera forest, Malaise, S. Peck (5♀, CNC); 14–22.iii.1992, 200 m, trans. zone forest, Malaise (Bursera, Trema, Zanthox), S. Peck (13♀, CNC).

Santa Cruz: 6.v.1932, M. Willows Jr., Templeton Crocker Exped. 1932, det. Curran (1♀, CAS); Horneman Farm, 220 m, 25.iii.1964, D.Q. Cavagnaro, det. James (1♂, CAS).

Santiago: N end Bahia James, 1–2.ii.1967, I.L.Wiggins, det. James 1977 (1♂, CAS).

Lucilia setosa

Darwin: 10.xii.1899 (2♀, paratypes (incorrectly cited as 2♂ by James 1966), USNM); 29.i.1964, D.Q. Cavagnaro, det. James (24♂, 16♀, paratypes, CAS; 10♂, 5♀, not types; 1♂, 1♀, det. James 1977, CAS; 1♂, holotype, CAS; 1 ♀, paratype, USNM).

Lucilia* sp. near *pionia

Española: Punta Juarez, 10–12.ii.1967, I.L. Wiggins, trap among *Lycium minimum*, *Prosopis doleis* and *Cryptocarpus pyriformus* (Gubarsbia), identified as *Phaenicia setosa* (name of identifier not written, probably James) (4♂, CAS); Bahia Manzanilla, 5–10.vi.1985, littoral *Cryptocarpus* and *Prosopis*, FIT, MT, S. & J. Peck (4♂, 3♀, CNC); Bahia Manzanilla, 7–10.vi.1985, carrion trap, sand beach, S. & J. Peck (1♀, CNC); Bahia Manzanilla, 8–10.vi. 1985, dung trap, *Prosopis* grove behind beach, S. & J. Peck (9♂, 5♀, CNC).