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Drosophilidae (Diptera) of the Cook Islands

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Abstract. In 2017 a survey was conducted of the Drosophilidae on the remote Cook Islands: Rarotonga, Aitutaki and Mangaia in the Tropical South Pacific. A diverse range of collecting methods was implemented, at different elevations and in domestic, rural, and montane-forest habitats. Only two widespread species *Drosophila ananassae* and *D. simulans* have previously been reported from Cook Islands. Among the 8036 specimens collected, 12 species were found, one of which—*Drosophila rarotongae* sp. nov.—is described here as new; it is endemic to Rarotonga and found only in montane forest. *Drosophila suzukii* was absent. An unusual species close to *Drosophila funebris* was collected (one female); various measures revealed its morphological difference from Afrotropical and Palaearctic *D. funebris* specimens. Possible synonymies between *Scaptodrosophila bryani* and *S. anuda,* and between *S. concolor* and *S. marjoryae* were discovered and are discussed. *Drosophila pallidifrons* was found among *D. sulfurigaster* in very low frequency (1%).

Introduction

The Cook Islands are a group of very isolated atolls and higher volcanic islands in the South Pacific Ocean between French Polynesia and Samoa. They are part of the Cook-Austral island chain within the larger biogeographic categorization: the islands of the Tropical South Pacific (TSP). Islands in the TSP are known to be centres of speciation (Sear *et al*., 2020), home to colonists, or refugia for relictual taxa (Keppel *et al*., 2009).

Species of the family Drosophilidae have been the focus of a number of studies in the TSP (Malloch 1932, 1934a,b; Curran, 1934; Harrison, 1954; Wheeler & Takada, 1964; Wheeler & Kambysellis, 1966; McEvey & Polak, 2005) but the species composition of the Cook Islands was, before the present study, very poorly known. Islands of the TSP are known to be home to a variety of insular endemic drosophilid species (McEvey & Polak, 2005; McEvey & Schiffer, 2015; Schug *et al*., 2007), some so different that they have warranted erection of new genera or subgenera—*Dicladochaeta* Malloch, 1934, *Idiomyia* Grimshaw, 1901, *Marquesia* Malloch, 1932, *Rosenwaldia* Malloch, 1934, and *Samoaia* Malloch, 1934 (Malloch, 1932, 1934a,b).

Further to the west, and outside the TSP (sensu Keppel *et al*., 2009: fig. 1), the Drosophilidae have been studied over a long period of time. Southeast Asia, New Guinea, Australia and New Caledonia are known to have several thousand species in more than 40 genera (Brake & Bächli, 2008). New Zealand, by contrast, has a relatively small number of species in three genera—16 species are described, 2 since 1981 (Bock & Parsons, 1981). Other TSP islands like Tahiti, Samoa and Fiji—islands of varying sizes, altitudes and remoteness (Fig. 1, Table 1)—are known to have a mixture of locally endemic species and genera, often restricted to montane forests together with more widespread human-commensal species abundant in and around villages at sea-level. There are many insular endemics with very restricted distributions, for example, of the seven *Mycodrosophila*

Keywords: Cook Islands; Drosophilidae; Diptera; new species; biogeography; taxonomy
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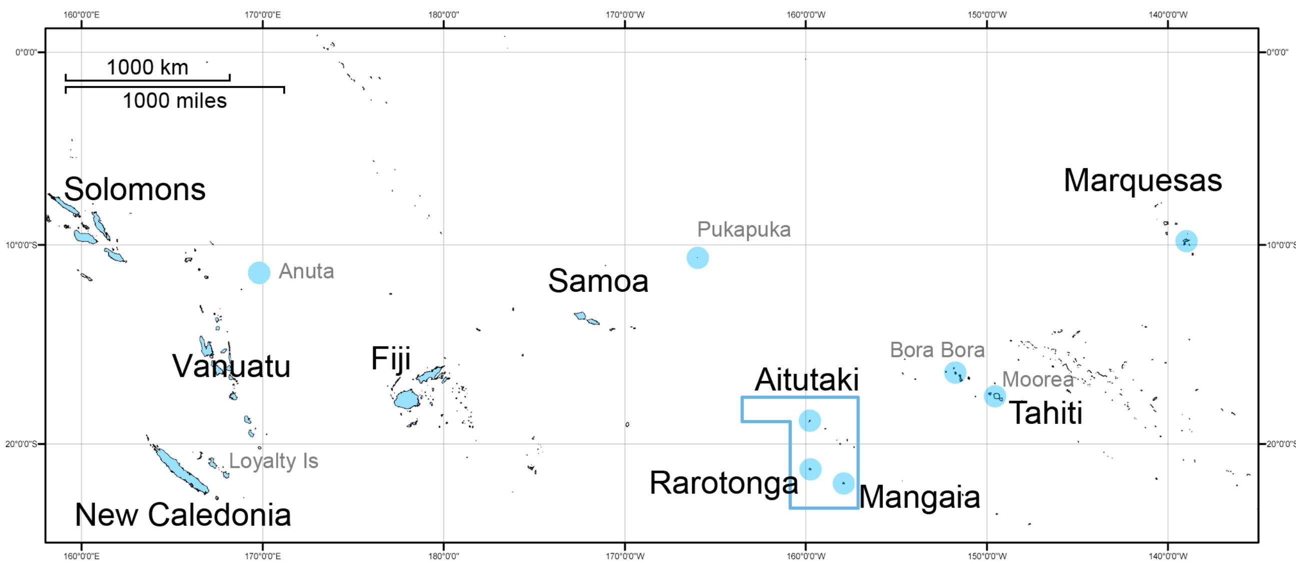


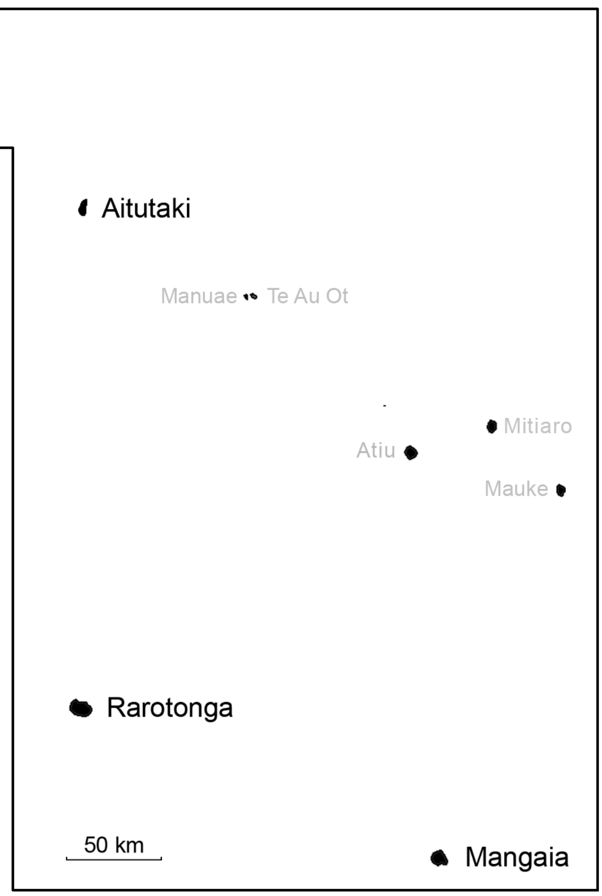


Figure 1. Main islands or archipelagos of the Tropical South Pacific (TSP, above). The Cook Islands, as a country, includes Pukapuka coral atoll in the northern group; the present survey is restricted to the three large islands—Rarotonga, Aitutaki and Mangaia—of the Cook Islands southern group, boxed in blue above and enlarged below. Atolls and smaller islands in the Cook Islands southern group are named in grey below (see also Fig. 2 and Tables 1–3).

Oldenberg, 1914 species that occur on Vanuatu only the widespread *Mycodrosophila gratiosa* (de Meijere, 1911) occurs also on Samoa (which has 3 species, 2 endemics) and similarly on Fiji (which has 4 species, 3 endemics) (McEvey & Polak, 2005). The Hawaiian fauna c. 4,500 km to the north (Table 1) is exceptionally diverse in two genera: the endemic *Idiomyia* Grimshaw, 1901 and *Scaptomyza* Hardy, 1850; nearly all species of these two genera have distributions restricted to the Hawaiian Archipelago.

Rarotonga is the largest (67 km^2) and highest (652 m, Table 1, Fig. 2) of the Cook Islands; it lies 21° South of the Equator, and is part of the compact Southern Group (Fig. 1). Mangaia, also in the Southern Group, is the second largest (52 km^2) of the Cook Islands, it lies about 203 km ESE of Rarotonga (Table 1). Aitutaki is the third largest (18 km^2) of the Southern Group volcanic islands and it lies about 265 km to the North of Rarotonga (Table 1, Fig. 1). A Northern Group of more scattered and lower islands lies between Aitutaki and 8°S. Such low islands and vegetated atolls might easily be inundated during interglacial periods, or swept bare during cyclones, thus not providing long-term sustainability for drosophilids that have low vagility and are vulnerable to desiccation stress (Hoffmann & Parsons, 1991).

Thompson *et al*. (1998) cite several studies giving available ages for Mangaia (22–11 Ma), Rarotonga (ranging from 2.3–1.6 Ma for an early phase of basaltic volcanism and 1.4–1.1 Ma for a group of more fractionated rocks), and Aitutaki (c. 1 Ma with young exposed volcanic rocks). "The island of Rarotonga … is the emergent summit of a Pliocene-Pleistocene volcanic complex built by effusive and pyroclastic eruptions of mainly mafic magma" (Thompson *et al*., 1998: 95). According to a single hot-spot model, with the active centre now located beneath Macdonald Seamount (c. 29°S 140°W, just off lower right corner of map in Fig. 1), producing the Cook-Austral island chain, Rarotonga should be at least 20 Myr old (Thompson *et al*., 1998). But, unlike Mangaia, Rarotonga and Aitutaki (and Atiu) lie outside the models prediction, being much younger in the 3–1 Ma range (Thompson *et al*., 1998).

Table 1. The isolation by distance (and direction) of Rarotonga from nearest island groups and mainlands, with area, elevation and approximate human population size (see also Fig. 1).

archipelago or mainland	distance (km)	direction	area (km^2)	elevation	population
Rarotonga (Cook Islands)	0	—	67	652 m	13,044
Mangaia (Cook Islands)	203	111°	52	169 m	744
Aitutaki (Cook Islands)	265	359°	18	123 m	c. 2,000
Niue (South Pacific)	1,079	281°	269	c. 60 m	1,624
Tahiti (Society Islands, South Pacific)	1,150	71°	1,045	2,241 m	189,517
Moorea (Society Islands, South Pacific)	1,130	71°	134	1,207 m	16,191
Pukapuka atoll (Cook Islands)	1,313	330°	5	c. 10 m	507
Upolu (Samoa, South Pacific)	1,500	301°	1,125	1,113 m	143,418
Tongatapu (Tonga, South Pacific)	1,598	268°	257	65 m	75,416
Viti Levu (Fiji, South Pacific)	2,300	274°	10,388	1,324 m	c. 600,000
Ua Pou (Marquesas, South Pacific)	2,483	61°	106	1,230 m	2,000
Nuku Hiva (Marquesas, South Pacific)	2,510	60°	339	1,224 m	2,660
Hiva Oa (Marquesas, South Pacific)	2,557	63°	316	1,213 m	2,190
Port Vila (Vanuatu, South Pacific)	3,300	270°			
New Caledonia (South Pacific)	3,400	261°			
Hawaii (Central Pacific)	4,560	6°			
Australia and New Guinea	5,500	West			
South America (Peru)	8,600	East			

The Cook Islands were settled by humans c. 1100–800 years ago, probably by Polynesians migrating from the Society and Marquesas Islands in the East and from Samoa in the West. Lake cores from Atiu (Fig. 1, Southern Group, Cook Islands) register evidence of pig and/or human occupation on a virgin landscape at c. 1100 years ago, changes in lake carbon followed c. 1000 years ago, and significant anthropogenic disturbance from c. 900 years ago (Sear *et al*., 2020). Aitutaki was possibly settled in the late 11th-century (Allen *et al*., 2016). Melanesia, to the west, was colonized about 5000–4000 years ago with later migrations to Fiji, Samoa and Tonga. The first European sighting was by Spaniard Alvaro de Mendaña in 1595 who reached the islands from the Americas, the first landing was by the Portuguese-Spaniard Pedro Fernández de Quirós in 1606 (also after having sailed from the East). James Cook's exploration of many of the islands of the Southern Group occurred c. 170 years later in 1773 and 1779. These timeframes establish earliest possible dates for the introduction of certain widespread drosophilid species (tramp species or peridomestic species) that spread with humans and the foods they transported. However, the general direction of non-human vicariant dispersal is from western islands and western land masses to eastern ones (Keppel *et al*., 2009).

Diptera surveys

Bezzi (1928) offers a comprehensive summary of the known Diptera of the islands of the South Pacific up to 1925, he refers to the specimens taken by H. W. Simmonds who, in 1921, collected a range of dipteran families on Rarotonga—but apparently not drosophilids. Curran (1936) lists *Drosophila ananassae* from Pukapuka (Fig. 1, Cook Islands Northern Group), giving collection date 9 April 1933. Among insects reported by Krauss (1961) from Aitutaki (Cook Islands Southern Group, Fig. 1), Drosophilidae are not mentioned. Futch (1966) refers to a dark form of *Drosophila ananassae* from Rarotonga and, presumably another culture, from Aitutaki, held as live cultures at the University of Texas, Austin. The Texas stock number 3036 is used. In other publications additional precision is given, Texas stock 3036.1 is Rarotonga *D. simulans* Sturtevant, 1919, and Texas stock 3036.2 is dark form Rarotonga *D. ananassae* (Narise, 1966; Spieth, 1966; Johnson *et al*., 1966). *Drosophila* surveys were extensive throughout the TSP in the 1960s related to US thermonuclear testing; McEvey & Schiffer (2015, 2018) provide an overview of the rather convoluted history of discovery of the several *D. ananassae* complex species that resulted. There is, unfortunately, no known traceable connection between behavioural or cytological observations of the then available cultures (e.g., Spieth, 1966) and species subsequently described (Bock & Wheeler, 1972). From these and other sources it is deduced that Stone and Wheeler were sampling *Drosophila* in the South Pacific (quite likely also in Rarotonga) in April 1962. In summary: the first and only records of Drosophilidae from Rarotonga are of *D. ananassae* and *D. simulans*, they were probably collected—and live stocks were established—in 1962 by Stone and Wheeler. Their work in the Cook Islands is probably also the source of Futch's (1966) mention of *D. ananassae* in Aitutaki.

Prior to the present study only two drosophilid species have been reported : *Drosophila ananassae* from the Northern (Pukapuka) and Southern Groups (Rarotonga and Aitutaki); and *D. simulans* only from Rarotonga in the Southern Group.

Other islands of the TSP (including Vanuatu, Fiji, Samoa, French Polynesia) have previously been surveyed by the authors, Samoa has 54 species (well-collected with a few undescribed species), Fiji has 27 described species (with many undescribed species) and French Polynesia including the Marquesas Islands has 29 described species and at least 38 undescribed species (from work unpubl. and in prep.).

There are few endemic Diptera from the Cook Islands, exceptions include the tephritid *Bactrocera melanota*

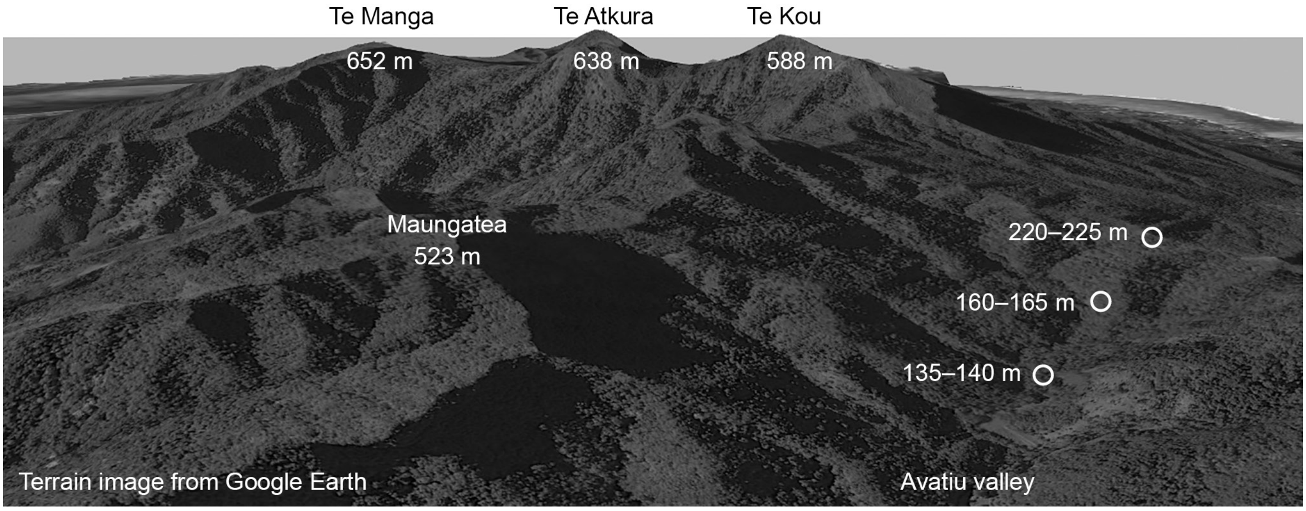


Figure 2. Montane forest terrain of Rarotonga showing the relationship between the three "high elevation" collecting sites in the upper Avatiu valley (circles, details in Table 2), close to the more inaccessible higher mountain peaks which could not be reached during the present survey—Te Manga, Te Atkura, Te Kou, and Maungatea. (Colour photo by Marcus Gleinig, terrain image [Te Kou to Te Manga profile distortion due to steepness of gradient] from Google Earth, June 2019).

(Coquillett, 1909) and the simulid (Black Fly) *Simulium teruamanga* Craig & Craig, 1986. A few other insects are also endemic: examples include the spittle-bug *Lallemandana rarotongae* Dumbleton, 1950 and the fulgoroid bug *Atylana rarotongae* Eyles & Linnavuori, 1974. Endemic molluscs, e.g., *Mautodontha rarotongensis* (Pease, 1870), and endemic birds, e.g., Lilac-crowned Fruit Dove *Ptilinopus rarotongensis* Hartlaub & Finsch, 1871, are also known (Butler, 2017; McCormack, 2015).

In January and February 2017, one of us (MP), conducted a survey of the Drosophilidae on Rarotonga, Aitutaki and Mangaia during the course of ongoing research into the evolutionary dynamics and biogeography of the *Drosophila bipectinata* sex comb across the TSP (Polak & Taylor, 2007; Polak *et al*., 2015). A range of collecting methods (including fruit-baiting, sweeping, direct aspiration from fungi, flowers and sap flux on cut stems), at different elevations (from coastal and lowland vegetation to forests at 225 m) and in different habitats (domestic, rural, and montane forest) (Tables 2 and 3) were used during the survey; 8036 specimens of Drosophilidae were collected. Data for all specimens collected is summarized in Table 3 and published in full separately as supplementary data—Tables S1–S3 (McEvey & Polak, 2021). As noted above, only two

Table 2. Geospatial data for the collection sites on three of the Cook Islands: Aitutaki, Mangaia and Rarotonga. Altitude range from Google Earth.

locality/collecting site	island	latitude	longitude	datum	precision	altitude range
Aitutaki south transect	Aitutaki	−18.885°	−159.794°	WGS84	±1 km	5–15 m
Arutanga 1 km NE	Aitutaki	−18.850°	−159.793°	WGS84	±100 m	10–15 m
Vaipae Noni site	Aitutaki	−18.877°	−159.779°	WGS84	±100 m	20–25 m
Vaipae mango site	Aitutaki	−18.881°	−159.791°	WGS84	±100 m	25–30 m
Vaipae forest	Aitutaki	−18.854°	−159.783°	WGS84	±100 m	40–45 m
Aitutaki bipec site	Aitutaki	−18.855°	−159.788°	WGS84	±100 m	55–60 m
Tamarua	Mangaia	−21.953°	−157.915°	WGS84	±100 m	5–60 m
Oneroa 2 km S	Mangaia	−21.938°	−157.960°	WGS84	±100 m	20–25 m
Oneroa citrus	Mangaia	−21.928°	−157.950°	WGS84	±100 m	55–65 m
Muri Noni	Rarotonga	−21.242°	−159.732°	WGS84	±100 m	5–10 m
Rarotonga papaya grove	Rarotonga	−21.264°	−159.780°	WGS84	±100 m	10–10 m
Rarotonga sow site	Rarotonga	−21.263°	−159.788°	WGS84	±100 m	10–15 m
Rarotonga goat site	Rarotonga	−21.264°	−159.789°	WGS84	±100 m	15–20 m
Rarotonga topend trail	Rarotonga	−21.232°	−159.790°	WGS84	±100 m	135–140 m
Rarotonga N end trail	Rarotonga	−21.235°	−159.789°	WGS84	±100 m	160–165 m
Rarotonga needle trail	Rarotonga	−21.238°	−159.788°	WGS84	±100 m	220–225 m

Table 3. Frequency abundance of all 12 Drosophilidae species, 8036 specimens, sampled on three Cook Islands in 2017 (collected by Michal Polak): Aitutaki, Mangaia and Rarotonga. Em-dash is zero specimens collected; 55 specimens of *Drosophila rarotongae* sp. nov. (circled) all collected at or above 135 m on Rarotonga.

	Aitutaki south transect	Arutanga 1 km NE	Vaipae Noni site	Vaipae mango site	Vaipae forest	Aitutaki bipec site	Tamarua	Oneroa 2 km S	Oneroa citrus	Muri Noni	Rarotonga papaya grove	Rarotonga sow site	Rarotonga goat site	Rarotonga topend trail	Rarotonga N end trail	Rarotonga needle trail
	Aitutaki						Mangaia			Rarotonga						
altitude (m)	5	10	20	25	40	55	5	20	55	5	10	10	15	135	160	220
Drosophila sp. aff. *funebris*	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
Drosophila immigrans	—	—	—	4	—	—	—	—	—	—	—	—	—	—	1	6
Drosophila pallidifrons	—	—	—	7	—	—	—	—	—	—	—	2	3	—	—	—
Drosophila sulfurigaster	15	13	6	—	1	12	94	—	36	60	41	141	46	87	353	43
Drosophila ananassae	793	336	333	293	206	275	509	43	147	788	254	536	153	162	180	2
Drosophila rarotongae sp. nov.	—	—	—	—	—	—	—	—	—	—	—	—	—	20	15	20
Drosophila bipectinata	31	18	12	208	15	276	17	—	—	58	15	179	96	29	47	4
Drosophila melanogaster	1	—	1	14	1	1	6	—	—	2	10	4	—	—	—	—
Drosophila simulans	5	1	—	11	1	17	15	—	1	15	10	98	11	—	11	5
Drosophila kikkawai	—	—	2	—	—	—	—	—	—	1	—	3	8	14	6	—
Scaptodrosophila bryani	66	99	65	59	30	114	120	—	8	69	31	30	9	3	4	1
Scaptodrosophila marjoryae	10	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
number of specimens	921	467	419	596	254	695	761	43	192	993	361	994	326	316	617	81
number of species	7	5	6	7	6	6	6	1	4	7	6	9	7	7	8	7

species of Drosophilidae have previously been reported from the Cook Islands: *Drosophila ananassae* and *D. simulans.* Therefore, in the following list (Table 3), all except these two species*,* represent new records for the Cook Islands (Okada & Evenhuis, 1989).

Among the species reported is a new one belonging to a group that was the subject of a recent comprehensive investigation (McEvey & Schiffer, 2015); our familiarity with that group allowed us to immediately recognize that the Cook Island specimens belonged to yet another nameless taxon from the TSP (see below).

These Cook Island records provide baseline data that will allow dating of the arrival of invasive species of human health or agricultural concern. *Culicoides belkini* Wirth & Arnaud, 1969 (one of the biting midges, Culicidae) was found for the first time during a survey of Aitutaki and Mitiaro in 2005 (McCormack, 2015). *Drosophila suzukii* is currently spreading throughout the world not having yet reached the Cook Islands, New Zealand or Australia, but recently reaching Moorea and Tahiti. The species was absent in the Marquesas and Society Islands during the extensive French Polynesian Terrestrial Arthropod Surveys of 2006–2008 (McEvey, Gillespie unpublished). An IPPC (2017) report notes: *Des specimens de* Drosophila suzukii *ont été collectés par un scientifique en vacances et de passage à Moorea en janvier 2017. Leur identification a été confirmée par l'Australia Museum Research Institute en février 2017. Une prospection a montré que cette mouche était également présente sur Tahiti, mais en faible nombre. Sa présence ne semble pas avoir d'impact économique sur les vergers de fruits.* The presence of this species in small numbers in Moorea and Tahiti, was an observation made and confirmed in 2017 with our colleagues Grandgirard and Putoa at the Service du développement rural, Laboratoire d'entomologie agricole, Département de la recherche agronomique, Papeete. High resolution images of *Drosophila suzukii* (specimens from Italy) have been published by McEvey (2017).

All specimens discussed below are preserved, either pinned or in alcohol, in the Australian Museum, Sydney (abbreviated AM and with register numbers prefixed "K.").

Family Drosophilidae Loew

Genus *Drosophila* Fallén

Subgenus *Drosophila* Fallén

Drosophila Fallén, 1823:4. Type species: *Musca funebris* Fabricius, by subsequent designation Macquart, 1835: 548.

Drosophila sp. aff. *funebris*

Figs 3–12

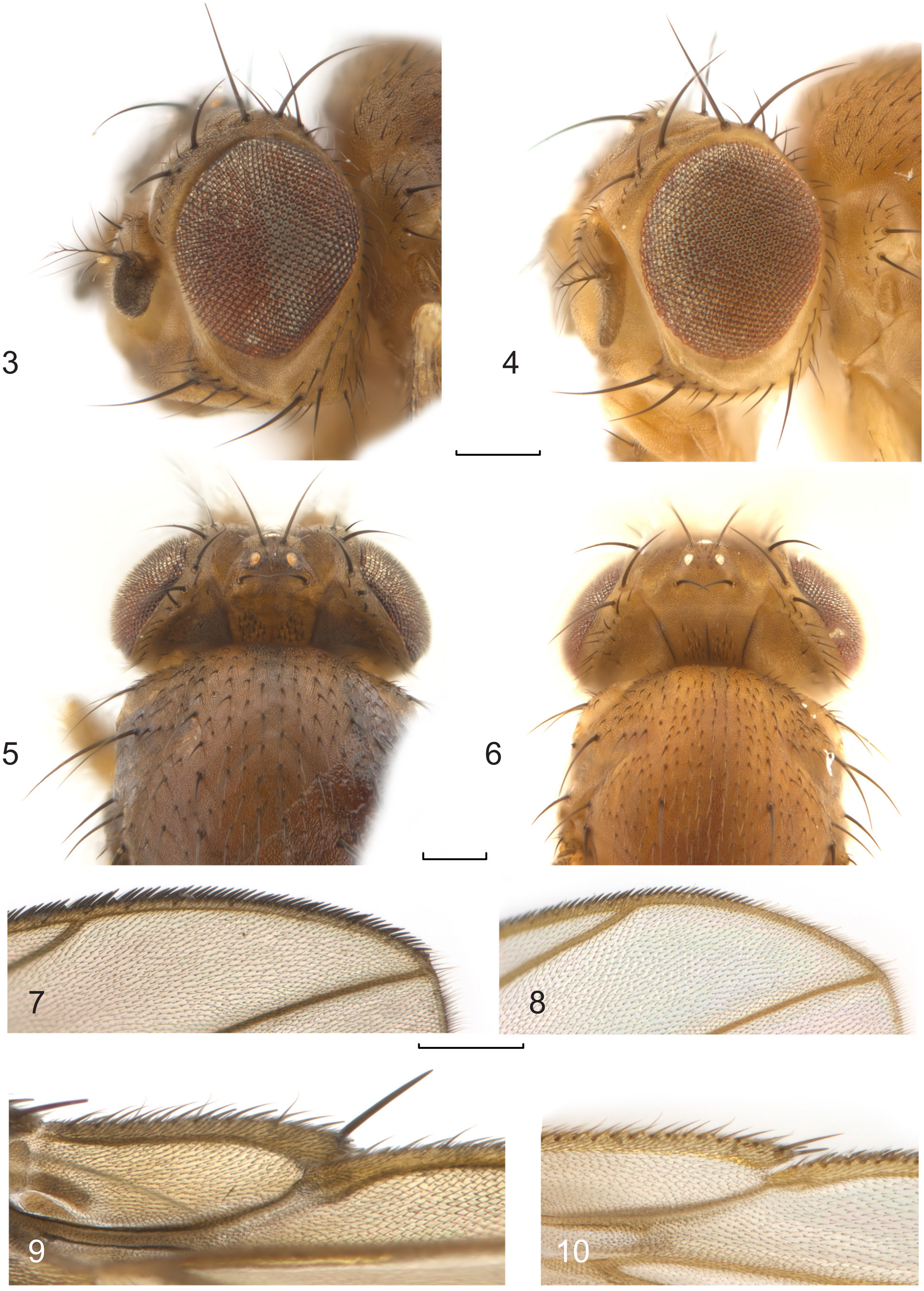
Drosophila funebris (Fabricius, 1787:345)*,* the type species of the genus *Drosophila,* and therefore of the family Drosophilidae, is rarely encountered in the Australian or Oceanian Regions. Listed from all major biogeographic regions of the world (Brake & Bächli, 2008), it is rare in the Oriental (Japan [Okada, 1968]; Korea [Okada, 1974]) and Australian Regions (specimens collected in Sydney e.g., 1916, 1917, 1924, 1949 and 1978: K.118090–92, K.118083–84, K.356399, K.118085–87, K.274079, K.471590–91, K.118089, no specimens collected in Sydney since 1978). It is apparently absent in New Guinea (Carson & Okada 1983, and pers. obs.). It is common in the Palaearctic Region (David & Tsacas, 1981) and in South Africa (McEvey *et al*., 1988).

A number of New Zealand (Christchurch, Wellington, Auckland, Dunedin, Rangiora) records of *Drosophila funebris* exist (Harrison, 1952, 1959). Harrison recognized that the New Zealand names *D. clarkii* Hutton, 1901 and *Leucophenga atkinsoni* Miller, 1921 were, in fact, junior synonyms of *D. funebris*.

A single female specimen (AM K.471932) was taken during the present survey at "Rarotonga top end trail" (Tables 2, 3). The specimen agrees in general morphology and cephalo-chaetotaxy (Figs 3–6) with others from elsewhere in the world but the wings and oviscapt differ. Wing metrics of specimens from New Zealand, Australia, Spain and South Africa have been examined. While specimens from around the world conform with each other, the Cook Island specimen stands out—the wing measures are significantly different (Table 4). For example: the C-index is about 2.0 in the Rarotonga fly, but 2.82–3.32 in specimens from South Africa, Spain, Australia and New Zealand; the fringe of heavy setation in the third costal section is almost entire in the Cook Islands fly but less than half in *D. funebris* from Australasia, Africa and Europe (Figs 7–8 and *C3F* in Table 4); and the 4c-index is 1.26 in Rarotonga but 0.65–0.79 in *D. funebris* worldwide (Table 4). There is also a remarkable difference in the size of the costal spine pair at the subcostal break (Figs 9–10).

The terminalia of the single available specimen has been dissected. The spermathecae, unfortunately, were not recovered. The oviscapt (Fig. 11) has a form quite unlike *Drosophila funebris*—there is no preapical bump on the dorsal margin (arrowed in Fig. 12), a distinguishing character for *D. funebris*. Furthermore, and also unlike *D. funebris*, there are 2–3 strong upward-pointing, subapical, peg ovisensilla (Fig. 11) and no single, long, ventral, subterminal, trichoid ovisensilla (cf. *D. funebris*, Fig. 12).

The magnitude of these differences is such that there would, under other circumstances, be little doubt that the Cook Islands specimen represents a new, undescribed species. However, only one female is available for study and



Figures 3–10. Comparison of *Drosophila* sp. aff. *funebris* from Cook Islands (left) and *D. funebris* (right): (*3, 4*) lateral views of head; (*5, 6*) dorsal views of cephalo-chaetotaxy, back of head, and scutum anteriorly; (*7, 8*) ratio of heavy to light costal setation in third costal section of wing—almost entire in Cook Island specimen, only about 0.4 in *D. funebris* (see Table 4); and (*9–10*) costal spine size at subcostal break (second spine of pair broken off in Fig. 9 photo). All specimens in AM: Figs 3, 5, 7, 9—K.471932 (Rarotonga); Figs 4 (K.353509), 6 (K.353514), 8 (K.353510), and 10 (K.353614) (all *D. funebris* from Johannesburg). Scale is 200 µm.

Figures 11–12. Dissimilar oviscapts of Cook Island species (left) and *Drosophila funebris* (right). (*11*) *Drosophila* sp. aff. *funebris* from Rarotonga, Cook Islands (Australian Museum, K.471932); (*12*) *Drosophila funebris*, with the unique preapical bump on the dorsal margin arrowed; AM K.353519 | Johannesburg | South Africa | vi.1985 | coll. S.F. McEvey | McE2956.

Table 4. Wing measurements of the cosmopolitan species *Drosophila funebris,* specimens from South Africa, Spain, Australia, New Zealand together with the Cook Islands close congener *Drosophila* sp. aff. *funebris**. Label data (all AM): K.353515 | Johannesburg | South Africa | vi.1985 | coll. S.F. McEvey; K.393580 | Cordoba, Spain | banana bait | vii.1988 | A. Alonso-Moraga & A. Munoz-Serrano; K.118087 | Spirit House | [Australian] Museum | Sydney | A. Musgrave | 18.vi.1917; K.353503 | VIC, Bridgewater | 36°36'S 143°57'E | 14.xii.1979 | winery J[ane] Tribe; K.118411 | [?Auckland] New Zealand, | 20.viii.2004 ex onions … ; K.471932 | COOK IS, Rarotonga | –21.2325° –159.7901° | 30.i.2017 flowers | Michal Polak.

locality	country	AM reg.	C	4v	4c	5x	M	ac	C3F	hb	prox.x	WL	L_1	L_{ax}
Johannesburg	South Africa	K.353515	3.32	1.30	0.65	1.08	0.33	1.78	0.45	0.46	0.52	2.68	2.62	3.08
Cordoba	Spain	K.393580	2.85	1.35	0.77	0.90	0.34	1.88	0.39	0.40	0.61	2.34	2.26	2.86
Sydney	Australia	K.118087	2.82	1.45	0.79	0.99	0.35	2.12	0.42	0.43	0.54	3.14	3.04	3.76
Bendigo	Australia	K.353503	3.09	1.36	0.70	1.02	0.35	1.97	0.41	0.42	0.52	2.71	2.62	3.19
Auckland	New Zealand	K.118411	3.22	1.40	0.70	0.85	0.36	1.73	0.40	0.41	0.59	3.23	3.14	3.81
Rarotonga*	Cook Islands	K.471932	2.02	1.95	1.26	1.27	0.56	2.58	0.95	0.96	0.82	2.51	2.42	2.91

so it is noted as exceptional but not used here to describe a new species. Additional specimens, and males, from the Rarotonga (and Cook Islands) population would permit a more confident determination and a better understanding of its morphological deviation in the TSP.

Drosophila sulfurigaster (Duda, 1923:48)

Drosophila sulfurigaster is a very common species in tropical parts of Australia and New Guinea (Madang is the type locality), numerous strains have been collected and studied from many Pacific islands above and below the equator (Wilson *et al*., 1969; Spieth, 1969; Kitagawa *et al*., 1982). The chromosomes vary in form throughout its range and this has led to the naming of certain insular populations as subspecies (*D. s. albostrigata* Wheeler, 1969 and *D. s. bilimbata* Wheeler, 1969). Since we cannot examine the Cook Island specimens cytologically or karyologically (quarantine control now largely precludes transportation of live *Drosophila* cultures from the wild into Australia, New Zealand, France or the US), since no lab strains can be established, we have no relevant data and are ignoring the subspecific classification. 948 (12% of total) specimens of *D. sulfurigaster* were collected at 14 of the 16 sites surveyed (Table 3); all are preserved in the AM.

Malloch (1933: 21) considered *Drosophila nasuta* Lamb, 1914 to be a species "probably distributed over most of the Pacific islands" but later Wilson *et al.* (1969) were able to confirm that the widespread species in the TSP was *D. sulfurigaster* and that *D. nasuta* was restricted to the Afrotropical Region. The *Cook Islands Biodiversity database* (McCormack, 2015) lists *D. nasuta* instead of *D. sulfurigaster.*

Drosophila pallidifrons Wheeler, in Wilson et al., 1969

In New Guinea, northeastern Australia and western TSP two species morphologically similar to *D . sulfurigaster* have been reported: *D. pallidifrons* Wheeler, 1969 (type locality Ponape, Micronesia) with no orbital pruinescence, first detected in Australia by us at the Daintree Rainforest Observatory and established there as live cultures by Schiffer in, 2018, and *D. niveifrons* Okada & Carson, 1982 (type locality Lae, Papua New Guinea) with full-frontal pruinescence, first detected in Torres Strait (McEvey, 1982), then in Iron Range (McEvey & Bock, 1982) and then at the Daintree Rainforest Observatory (by us initially and later with Schiffer, unpublished). Both differ from *D. sulfurigaster* which is distinct in having only orbital pruinescence in males. Molecular geneticists are persuaded that there may be other, more cryptic, species in New Guinea and surrounding islands. *Drosophila pallidifrons* was collected in low frequency with the more abundant *D. sulfurigaster* on Aitutaki and Rarotonga (Table 3). These records expand the known distribution of the species from Ponape, throughout New Guinea (e.g., Vogelkop AM K.580956, Tabubil K.355375–76, and Wau K.272119), northern Australia to New Caledonia (e.g., Mont Koghis AM K.355023–30 coll. 1975 by P.A. Parsons and K.355381–91 coll. 2000 by the authors with Barker and Starmer; see also Tsacas & Chassagnard, 1988) and now also to the Cook Islands.

Drosophila immigrans Sturtevant, 1921:83

A specimen of the widespread species, *Drosophila immigrans*, with label data: "Rarotonga | Cook Islands | Te Ko'u | 2 April 1999 | C. Mullins | 305 || BMNH(E) 2002-116 | Cook Islands | Gerald | McCormack Coll.", has been examined (SMcE Oct 2013) in the NHMUK. During the present survey the species was collected again, in very small numbers (< 1% of total) at several sites on Aitutaki and Rarotonga (Table 3). *Drosophila immigrans* is found worldwide (Brake & Bächli, 2008) and has previously been collected on islands of the South Pacific from French Polynesia (McE10225–227 in MNHN) to New Zealand (Harrison, 1959) and throughout non-arid Australia (Bock, 1976).

Subgenus *Sophophora* Sturtevant

Drosophila (Sophophora) Sturtevant, 1939:139. Type species: *Drosophila melanogaster* Meigen, by original designation. Proposed as a subgenus of *Drosophila* by Sturtevant.

Drosophila ananassae Doleschall, 1859:128

Drosophila ananassae is the most abundant and most frequently collected species in the South Pacific, including on all the Cook Islands surveyed in this study (Table 3) and others (e.g., Pukapuka, no abundance data). It can be collected at fruit baits in the thousands. It is also easily cultured in laboratories and samples from different populations have, since the 1960s, been the subject of numerous genetic, cytological and behavioural studies; see historical overview in McEvey & Schiffer (2015). Many of the male specimens of the *ananassae* species complex collected during the present survey from the Cook Islands, were dissected, and found to have terminalia corresponding either to *Drosophila ananassae* (sensu McEvey & Schiffer, 2015) or to a different, hitherto unknown species, described below.

Drosophila rarotongae sp. nov.

urn:lsid:zoobank.org:act:B7F9A72F-0A18-47A6-B88C-B867AF9416B5

Figs 13–20

Holotype ♂ "COOK IS, Rarotonga | –21.2347° –159.7893° | 1.ii.2017 banana bait | Michal Polak", Australian Museum K.385599. **Paratypes** 19 wild-caught males as follows: 7♂♂ same data as holotype, preserved in 80% alcohol, AM K.385598, AM K.385665–70; 6♂♂, dehydrated from OH and card-mounted: "COOK IS, Rarotonga | –21.2382° –159.7880° | 1.ii.2017 papaya bait | c.1060' Michal Polak", AM K.385659–64; 1♂, terminalia dissected, "COOK IS, Rarotonga | –21.2347° –159.7893° | 28.i.2017 sweep | Michal Polak", AM K.385592; 1♂ "COOK IS, Rarotonga | –21.2325° –159.7901° | 30.i.2017 flowers | Michal Polak", AM K.385602; 4♂♂, *ibid.* but "30.i.2017 swept", AM K.385603, K.385656–58.

Additional specimens (males and females collected with, and probably conspecific with, the above males), from the same three localities and the same three dates, all in AM as follows: K.385584–85 ♂♂, K.385594–97 ♂♂, K.385600–01 ♀ and ♂, K.385643–47 ♀♀, K.385648 ♂, K.385671–73 ♀♀, and nine unregistered in 80% alcohol; K.471879–80 ♂♂, K.471924–25 ♂♂, K.471926 ♀, K.471933–34 ♀♀, K.471935 ♂, K.471944 ♀, all field-pinned by MP.

Distinguishing features

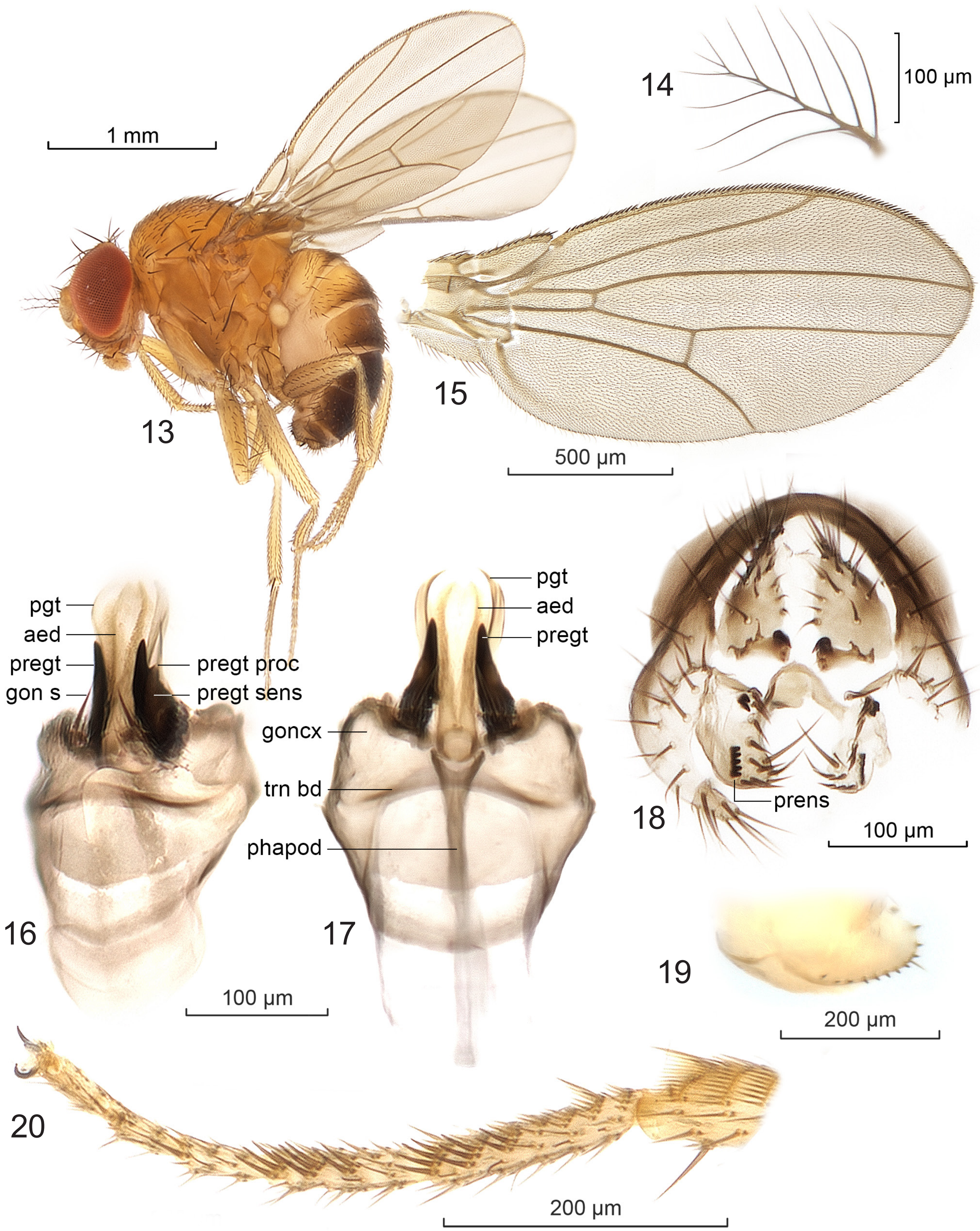
This species is distinguished from all others in the *D. ananassae* subgroup by reference primarily to the extraordinarily large, pointed, black, and prominent pregonites arising adjacent to the aedeagus (Figs 16–17, 26). This species can also be distinguished from many others in the subgroup by reference to the heavily pigmented and blackened tergites IV and V (Fig. 13).

Description (male)

Body length 2.5–2.7 mm.

Head. Arista (Fig. 14) with 5 rays above, 3 below, plus a terminal fork (10–11 free ends). Front and face pale brown. Fronto-orbital setae in the ratio proc orb : a.r.orb : p.r.orb = 6 : 3 : 7. Facial carina prominent. Head morphometrics: hw/fw(ov) = 1.8–2.1; hw/fw(iv) = 1.8–2.1; hw/fw(vt) = 1.7–2.0; hw/fw(a.oc) = 1.8–2.1; hw/fw(a.r.orb) = 1.9–2.3; hw/fw(x.r.orb) = 1.9–2.2; hw/fw(ptl) = 2.3–2.7; fw(ov)/fl = 1.4; fw(iv)/fl = 1.4; fw(vt)/fl = 1.4–1.5; fw(a.oc)/fl = 1.4–1.5; fw(a.r.orb)/fl = 1.2–1.4; fw(vt)/fw(ptl) = 1.3–1.4; orbito-index = 0.7–0.8; oc-gap/pv-gap = 0.4–0.5; fl/fw(ptl) = 0.9–1.0; fw(a.oc)/hw = 0.5–0.6); measurements from males: AM K.385592, K.385599, K.385602, K.385603.

Thorax (Fig. 13). Brown *sensu* Bock & Wheeler (1972). Acrostichal hairs in 8 rows in front of dorsocentral setae and 6 rows between. Ratio anterior:posterior dorsocentrals 0.55. Sterno-index 0.6–0.7. Preapical bristles on all tibiae; apicals on first and second tibiae. Sex comb of male (Fig. 20) in transverse rows of stout black bristles; 3 metatarsal rows of (from above down) 2, 3, and 4 teeth; 3 rows on the second tarsomere of (from above down) 2, 3, and 2 teeth; and a further tooth distally on the third tarsomere.



Figures 13–20. *Drosophila rarotongae* sp. nov. (*13*) male habitus; (*14*) arista of AM K.385602; (*15*) wing of AM K.385592; (*16, 17*) ventrolateral and dorsal views respectively, of hypandrium of AM K.385594 and K.385584—*aed*, aedeagus; *gon s*, gonopodal seta (one of a pair); *goncx*, gonocoxite; *pgt*, postgonite; *phapod*, phallapodeme; *pregt*, pregonite; *pregt proc* pregonite process; *pregt sens*, pregonite sensilla (three sensilla detected on this structure under high power); *prens*, prensisetae (lower of two series, upper series with two prensisetae); *trn bd*, transverse band; (*18*) epandrium of AM K.385594; (*19*) oviscapt of female AM K.385600; and (*20*) sex combs on foretarsi of male AM K.385592.

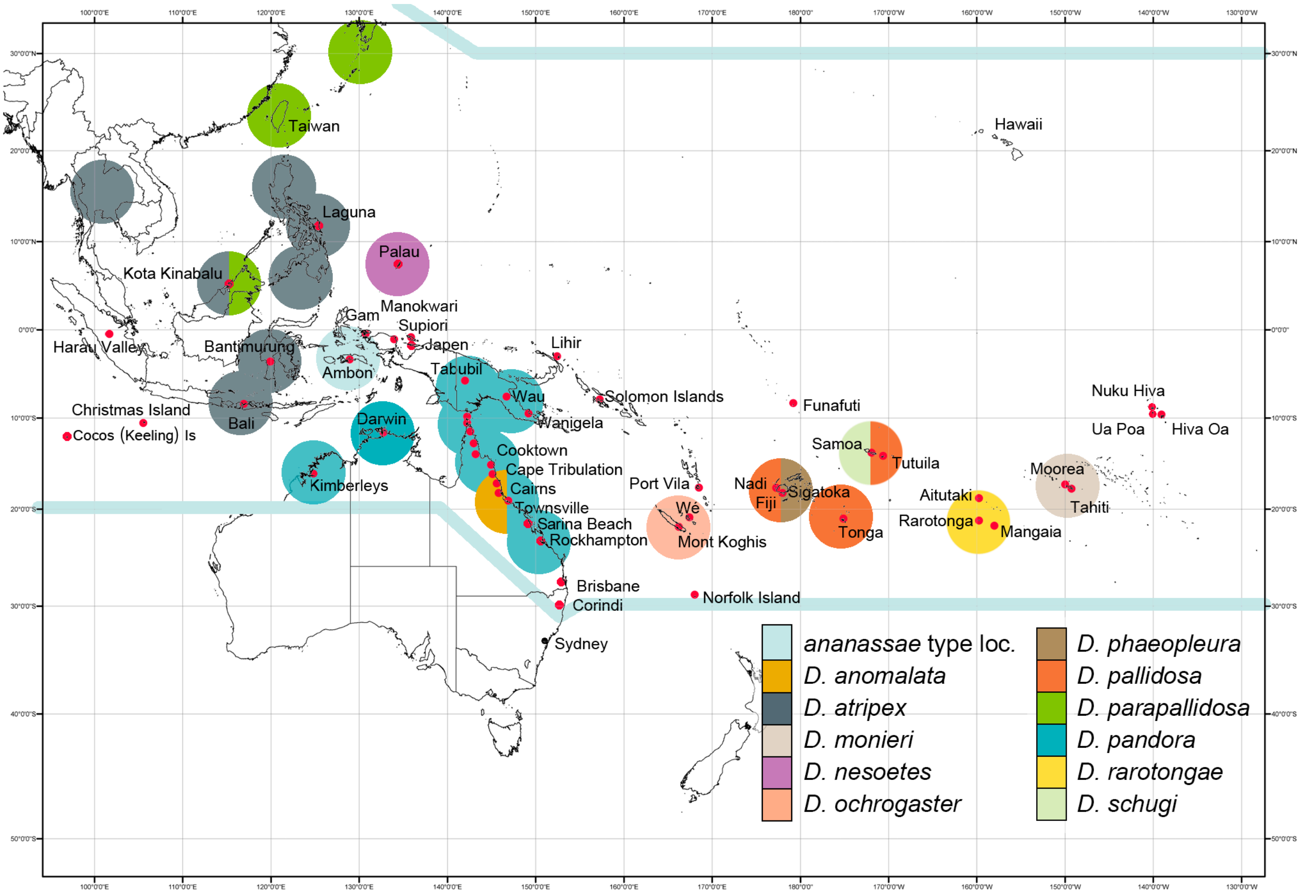


Figure 21. Distribution map of 12 species of the *Drosophila ananassae* complex. This map was first published by McEvey & Schiffer (2015) and then updated by them (2018). The discovery of the new species *D. rarotongae* sp. nov. from the southern group of Cook Islands is indicated on this map. *Drosophila ananassae* s.str. has pantropical distribution indicated within the pale blue lines, the Ambon type locality is shown. Three or more additional but undescribed species occur in New Guinea (and perhaps also in northern Australia), these are not shown (see McEvey & Schiffer, 2015, for further details).

Wing (Fig. 15) of AM K.385592: hyaline; C-index = 1.41, 4v-index = 2.46, 4c-index = 1.75, 5x-index = 2.74, M-index = 0.92, ac-index = 3.62, C3 fringe = 0.59, hb = 0.62, prox.x = 0.64. Wing lengths, from humeral crossvein to apex (sensu Okada, Bächli, *WL*) = 1.58 mm, from basal medial bifurcation to apex (sensu Grimaldi, Toda, L_l) = 1.51 mm; or from axis to apex (sensu Bock, Wheeler, L_{ax}) = 1.86 mm.

Abdomen (Fig. 13). Brown, tending to blackish brown on tergites 3–6.

Male terminalia. *Epandrium* (Fig. 18) closely resembles *D. pandora* McEvey & Schiffer, 2015 (see McEvey & Schiffer, 2015, figs 38–53), *D. schugi* McEvey & Schiffer, 2015, *D. ananassae* and other species of the *D. ananassae* complex and is, consequently, diagnostically less useful than the hypandrium. The surstylus is large with an inner or median row of about 5 strong, well-spaced setae that merge into a cluster of an additional 7–8 setae (one or two longer than the rest) and two series of short, blunt, thick prensisetae laterally to these (*prens,* Fig. 18). The upper series has 2 prensisetae, the lower series about 5 of similar form. The cercal ventral lobe (secondary clasper) is very small with a very large curved, black, medial tooth, and several small setae basally.

Hypandrium (Figs 16–17, 26). Aedeagus is pale brown, slightly expanded in apical half, hirsute (longer hairs in mid region). Laterally and adjacent to the aedeagus are a pair of very prominent, large, black, pregonites, two thirds the length of the aedeagus, and tapered caudally to an acute apex; the ventral side is smoothly curved, but the dorsal side is notched (*pregt proc*, Fig. 16). There are three sensilla detectable under high power, one arises on the dorsal notch or process, the remaining two lie halfway between it and the base (*pregt sens*, Fig. 16). The gonocoxite (*goncx*, Fig. 17) is hirsute submedially, the pair of submedian spines or *gonopodal setae* (*gon s,* Fig. 16) are very large and widely spaced (obscured in dorsal view, Fig. 17). Phallapodeme is narrow but provides a wide base for the aedeagus.

Female. Resembles male, also with abdomen tending to blackish-brown apically.

Female terminalia (Fig. 19). Oviscapt short, rounded apically, with short marginal spines.

Distribution. Known only from the island of Rarotonga (Cook Islands Southern Group, Tropical South Pacific) above 135 m altitude (Figs 2, 21; Table 3).

Etymology. The name "*rarotongae"* is proposed as a noun in the genitive case.

Remarks. *Drosophila rarotongae* sp. nov. is a member of the *Drosophila melanogaster* species group, the *D. ananassae* subgroup, and the *D. ananassae* complex. It resembles *Drosophila schugi* (Fig. 25) from Samoa and *D. phaeopleura* (Fig. 27) from Fiji. All three species are restricted to localities at altitude (Table 1) on islands of the Tropical South Pacific and are generally darker than lowland species of the region like *D. pandora, D. anomalata*, *D. pallida*, and *D. ochrogaster* (Fig. 21). Consistent differences exist, however, between *D. rarotongae* sp. nov.*,* *D. phaeopleura* and *D. schugi* in the arrangement and number of sex combs. Sex combs are pictured in Fig. 20 in the present work (see also *D. phaeopleura* Bock & Wheeler, 1972: fig. 60 and *D. schugi* McEvey & Schiffer, 2015: figs 66–71). Observed differences are quantified, results are presented in Table 5. *Drosophila schugi* has c. 63 teeth in the male sex combs of one foreleg, *D. phaeopleura* has c. 34, while *D. rarotongae* sp nov. has about 17.

The *Drosophila ananassae* species complex now has 13 species (Fig. 21):

Drosophila ananassae Doleschall, 1859:128
Drosophila anomalata McEvey & Schiffer, 2015:142
Drosophila atripex Bock & Wheeler, 1972:42
Drosophila lachaisei Tsacas, 1984:428
Drosophila monieri McEvey & Tsacas, McEvey *et al*., 1987:378
Drosophila nesoetes Bock & Wheeler, 1972:41
Drosophila ochrogaster Chassagnard, in Chassagnard & Groseille, 1992:63
Drosophila pallidosa Bock & Wheeler, 1972:38
Drosophila pandora McEvey & Schiffer, 2015:138
Drosophila parapallidosa Tobari, in Matsuda & Tobari, 2009:135
Drosophila phaeopleura Bock & Wheeler, 1972:40
Drosophila rarotongae sp. nov.
Drosophila schugi McEvey & Schiffer, 2015:143

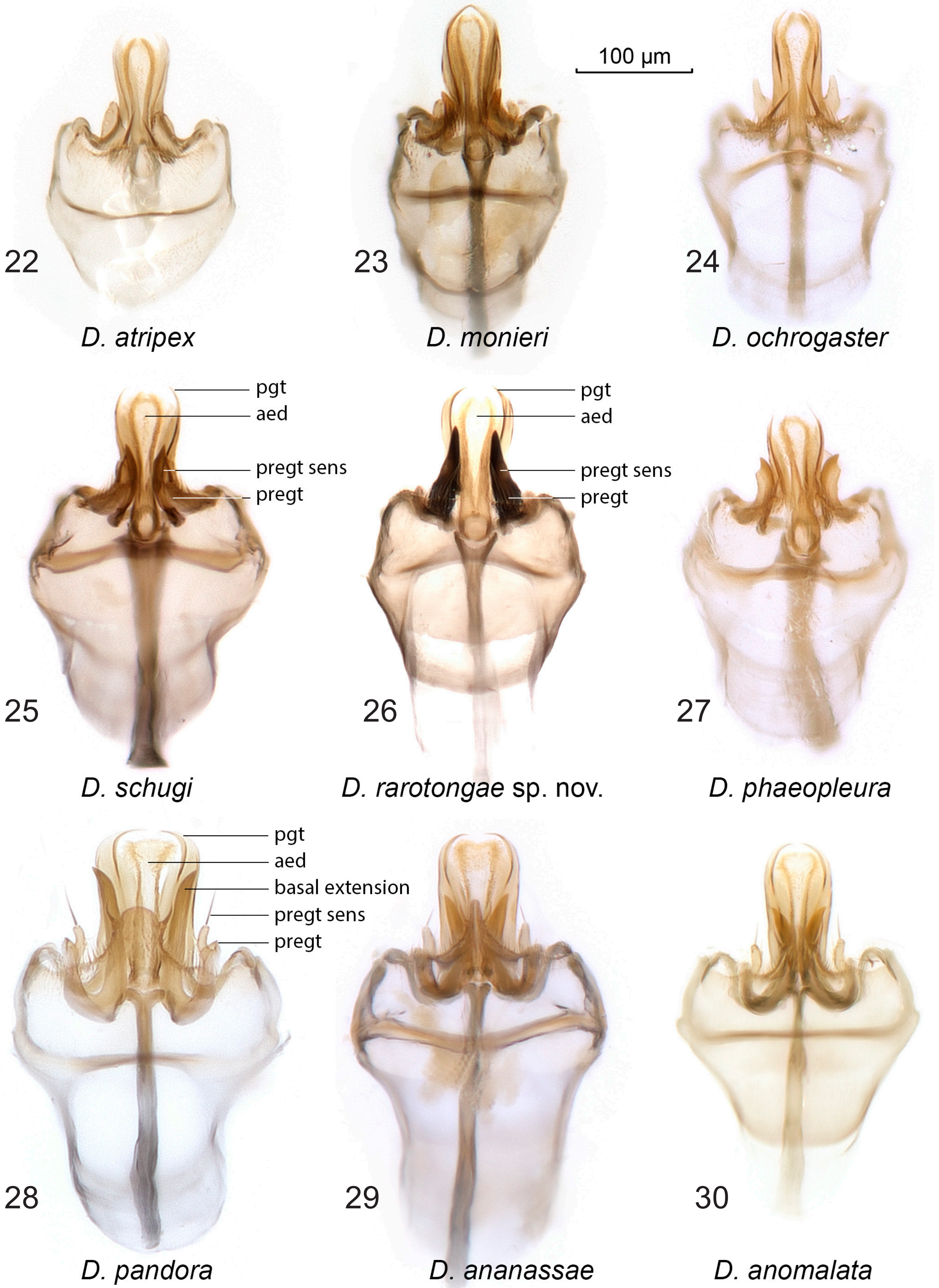
Drosophila rarotongae sp. nov. differs from all members of the *ananassae* complex by reference to the male genitalia, specifically the very prominent pair of black pregonites adjacent to the aedeagus. Bock & Wheeler (1972: 40) describe the homologous structure in *D. phaeopleura* as "anterior parameres very large, crescentic, articulated to aedeagus, laterally with 4 well-spaced minute sensilla"; and McEvey & Schiffer (2015: 146) describe the homologous structure in *D. schugi* as "large, scimitar-shaped or with ragged lateral edge, articulated to aedeagus, and laterally with no [but see below] minute sensilla". Sensilla have been observed on the lateral face of the *D. rarotongae* pregonite (*pregt sens* in Fig. 16).

In earlier works (McEvey & Polak, 2005; Schiffer & McEvey, 2006; McEvey & Schiffer, 2015) terms introduced by Bock, Wheeler, and Okada (Bock & Wheeler, 1972; Okada, 1954) were used when describing male terminalia, specifically anterior and posterior parameres for the appendages arising from the gonocoxite or near the base of the aedeagus. More recently arguments presented by Wood, Sinclair, and Cumming (Cumming, Sinclair, & Wood, 1995; Sinclair, 2000; Cumming & Wood, 2017) have compelled us to reconsider this practice and to adopt terms more widely accepted by dipterists. Motivation to adopt new terms comes also from the work of Grimaldi (1990) and recent involvement in the *Manual of Afrotropical Diptera* (McEvey & Grimaldi, 2021 in press), together with efforts among *Drosophila melanogaster* researchers to achieve consensus in terminology (Rice *et al*., 2019). The newly adopted terms *pregonite* and *postgonite* replace anterior and posterior paramere respectively; we now use gonocoxite for novasternum, and phallapodeme for apodeme. Pregonites are connected to the gonocoxite, postgonites are dorsal to them and connected to the phallus. Pregonites have sensilla (of variable size and often apically), postgonites do not; McEvey & Schiffer (2015: 146) stated that the *D. schugi* pregonite has "no minute sensilla", sensilla have in fact been detected in subsequent examinations using better microscopy. A pregonite may have a process extending from its base that curves caudally—the *basal extension* ("basal process" of some authors) (Fig. 28). The *basal extension* is a striking feature of the *D. ananassae* and *D. pandora* terminalia (McEvey & Schiffer, 2015); it is entirely bare. In *D. rarotongae* the pregonite itself is enlarged, a *basal extension* is entirely absent, several small sensilla are present, one arises on the small pregonite process (*pregt proc,* Fig. 16).

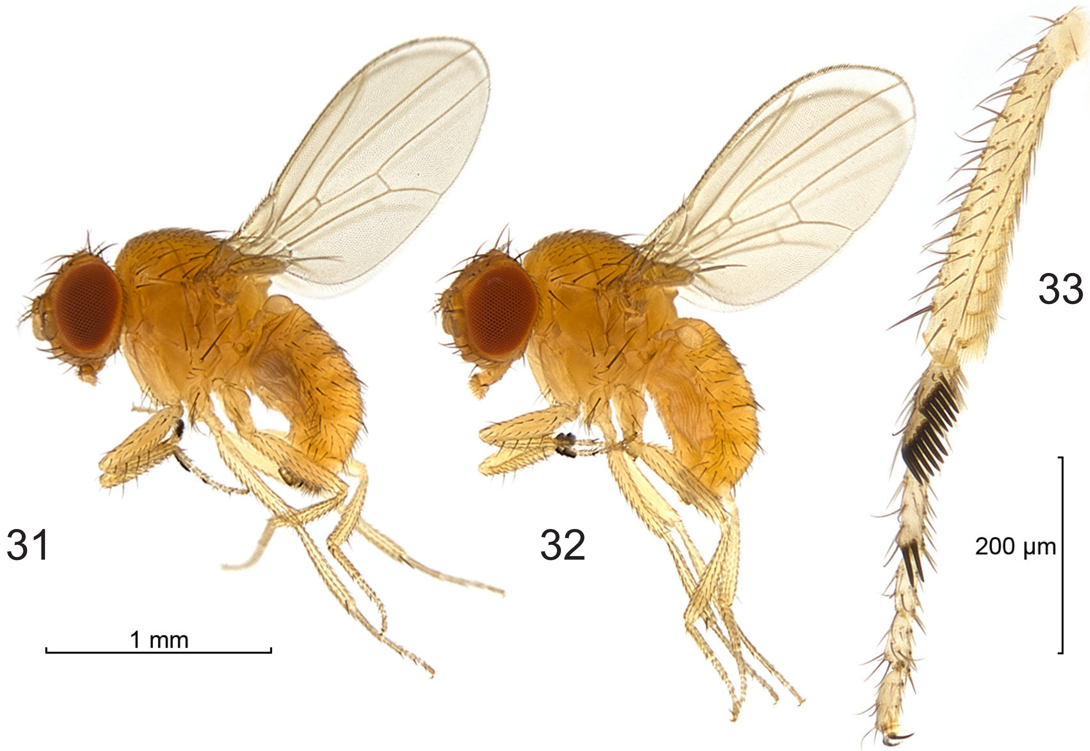
The base of each pregonite arises adjacent to and separate from the aedeagus and phallapodeme. Being so positioned, they possibly serve to anchor the male genitalia during copulation by moving into an outward pointing orientation (abduction) when the phallapodeme and aedeagus thrust forward.

Table 5. Number of teeth in each row of the sex comb on the male fore-tarsi of *Drosophila rarotongae* sp. nov., *D. schugi* McEvey & Schiffer (Samoa) and *D. phaeopleura* Bock & Wheeler (Fiji) showing total (median) number of teeth per leg; numbering of rows begins at proximal end of tarsomere.

	row	no. of teeth per row		
		D. rarotongae sp. nov.	*D. schugi*	*D. phaeopleura*
tarsomere I	1	0	0–1	0
	2	0	0–2	0
	3	0	2–4	0
	4	0	3–4	0
	5	0	3–6	0–4
	6	2	6–7	2–5
	7	3	6–8	5–6
	8	4	6–7	4–6
tarsomere II	1	0	0–2	0
	2	0	1–4	0
	3	0	4–6	0–4
	4	2	5–6	3–5
	5	3	5–7	5–6
	6	2	4–6	4–6
tarsomere III	1	1	2–4	1–3
	2	0	2–3	1–2
total (median)		17	63	34



Figures 22–30. Hypandria of *Drosophila rarotongae* sp. nov. and related species: (*22*) *D. atripex*, Bali, McE32697; (*23*) *D. monieri*, Moorea, AM K.380298; (*24*) *D. ochrogaster*, New Caledonia, K.282803; (*25*) *D. schugi*, Samoa, K.356978; (*26*) *D. rarotongae*, Rarotonga, K.385584; (*27*) *D. phaeopleura*, Fiji, K.282923; (*28*) *D. pandora*, Lake Placid (near Cairns), ex iso-female strain CAQ425; (*29*) *D. ananassae*, Marquesas, K.380299; (*30*) *D. anomalata*, Townsville, ex type strain CHC221. Abbreviations, see Figs 13–20 caption.



Figures 31–33. *Drosophila bipectinata* Duda males, with detail of sex combs of male foreleg. Specimens in AM registered K.385867, K.385864 and K.385869.001 with label data: "COOK IS, Aitutaki | –18.8549° –159.7884° | 10.ii.2017 fruit | Michal Polak".

Drosophila bipectinata Duda, 1923:52

Figs 31–33

An easily recognizable small pale species with very distinctive sex combs (Figs 31–33). We have collected this species throughout the Tropical South Pacific (TSP) on the following islands: New Caledonia, Lifou, Efate (Vanuatu), Viti Levu, Upolu, Tutuila (American Samoa), Rarotonga, Aitutaki, Mangaia (Table 3), Bora Bora, Moorea, Nuku Hiva, Ua Pou and Hiva Oa (the latter three islands are in the Marquesas group) (Fig. 1).

Drosophila melanogaster Meigen, 1830:85

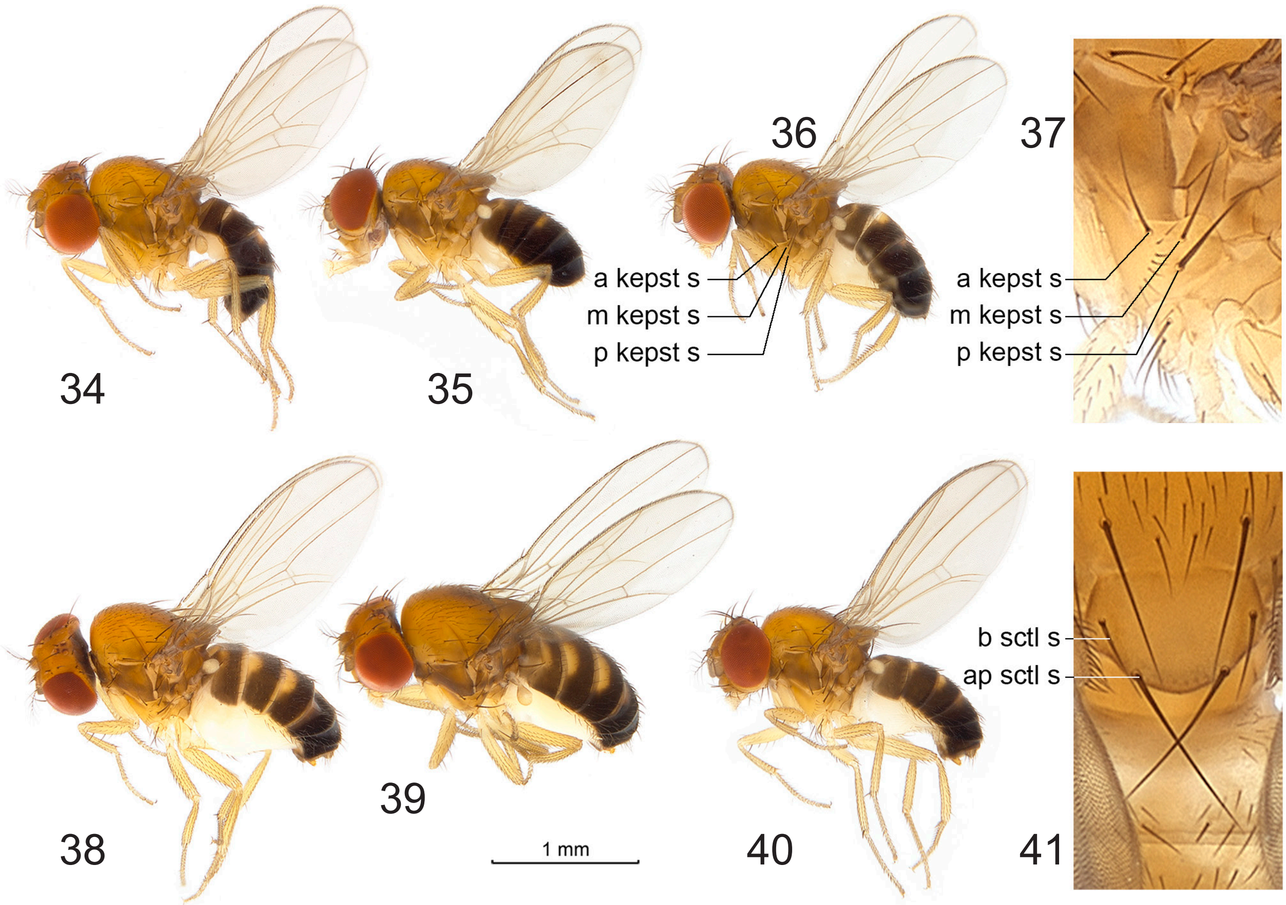
Drosophila melanogaster, generally less common than *D. simulans,* but nevertheless found on all three islands in the present survey (Table 3) and collected by us throughout the TSP (New Caledonia, Vanuatu, Fiji, Samoa, French Polynesia).

Drosophila simulans Sturtevant, 1919:153

A very widespread species in the Pacific region. Reported from 13 of the 16 sites surveyed during the present study (Table 3). Interestingly, we have seen no specimens and have seen no reports of this species (cf. *D. melanogaster*) from the Marquesas islands.

Drosophila kikkawai Burla, 1954:47

Not encountered on Mangaia, rare on Aitutaki, this species is present in small numbers at sites on Rarotonga. Brake & Bächli (2008) report this species from all zoogeographical regions of the world except Nearctic and Antarctic. Burla (1954) showed that the name *Drosophila montium* de Meijere, 1916, was incorrectly applied to a widespread species reported from Africa, the Oriental Region and across the Pacific to South America; in fact *D. montium* has a very restricted distribution in montane Java (Tjibodas, alternate spelling Cibodas, is the type locality), and the widespread species Burla named *D. kikkawai* using specimens from Brazil. *Drosophila kikkawai* and *D. montium* both possess a distinctive pair of longitudinal sex combs: one comb on the first tarsomere (metatarsus) the other on the second tarsomere, teeth densely packed and contiguous. The caudal margin of the gonocoxite is strongly convex and narrow, a key diagnostic character is the presence in *D. kikkawai* of a pair of very long spines arising at the tip of this narrow convexity, absent in *D. montium* and *D. serrata* Malloch, 1927 and the several other species of the complex in northern Australia and New Guinea. Many very similar species have been described from New Guinea and Australia (all lacking the long medial gonopodal setae) on the basis of differences in male terminalia (e.g., *D. serrata*; *D. birchii* Dobzhansky & Mather, 1961; *D. mayri* Mather & Dobzhansky, 1962; *D. dominicana* Ayala, 1965; *D. pseudomayri* Baimai, 1970; *D. pennae* Bock & Wheeler, 1972; *D. rhopaloa* Bock & Wheeler, 1972; *D. rhombura* Okada & Carson, 1983; and *D. bunnanda* Schiffer & McEvey, 2006) but apparently only *D. kikkawai* has dispersed into the TSP; the identity of the present sample has been confirmed by dissection (AM K.385605) and figured by Rodriguez-Exposito, Garcia-Gonzalez, & Polak (2020).



Figures 34–41. *Scaptodrosophila bryani* (Malloch), lateral views of males (*34–37,* K.393581–82, K.393583) and females (*38–40,* K.393585–87); anterior, middle, and posterior katepisternal setae (*kepst s*) indicated (*36–37*); detail of setae arising from scutellum (*ap sctl s,* apical scutellar seta, long; *b sctl s*, basal scutellar seta, short) and posterior part of scutum (*41*). All with label data: "COOK IS, Mangaia | –21.9531° –157.9148° | 7.ii.2017 ... fruit | Michal Polak" except Figs. 37 and 41: "NT Casuarina urban | 12.3731°S 130.8864°E | fruit compost 28.ix.2009 | S. McEvey & M. Braby". All in AM.

Genus *Scaptodrosophila* Duda, 1923

Scaptodrosophila Duda, 1923: 37. Type species: *Scaptodrosophila scaptomyzoidea* Duda, by monotypy. Current status as a genus-level name, see Grimaldi, 1990: 116.

Scaptodrosophila Duda, 1924: 180. Type species: *Scaptodrosophila scaptomyzoidea* Duda, by monotypy. Preoccupied by *Scaptodrosophila* Duda, 1923.

Pholadoris Sturtevant, 1942: 28 as subgenus of *Drosophila*. Type species: *Drosophila victoria* Sturtevant in *Drosophila* subgenus *Pholadoris* by original designation.

See additional synonymy of *Scaptodrosophila* Duda, 1923 as a genus-level name in Brake & Bächli (2008).

Scaptodrosophila bryani (Malloch, 1934:310)

Figs 34–41

Of the two *Scaptodrosophila* species known from the Cook Islands, this one—*S. bryani*—is by far the most abundant: absent at only one of the 16 sites surveyed and the second most common species overall (Table 2). Easily recognized by reference to the relative lengths of the scutellar setae: the basal pair are much shorter than the apical pair (Fig. 41); males and females are similar in general appearance (Figs 34–40); note that the katepisternal setae are large and subequal (indicated in Figs 36–37), a characteristic of many species of *Scaptodrosophila* but not one of *Drosophila*. Throughout the TSP reference to subequal katepisternal and unequal scutellar setae is an easy and reliable diagnostic for this species. However, Curran (1936) named a species that is, from a reading of his description, indistinguishable from *S. bryani.* Curran's species *Drosophila anuda* (which he recognized as belonging in *Paradrosophila* Duda = *Scaptodrosophila*] is known only from the very small "Anuda Island" [sic, possibly Anuta Island –11.6120° 169.8496°, Fig. 1] and from the "Nupani Reef Island" (–10.0483° 165.7211° or –10.2340° 166.3100°) in the Santa Cruz Group of the Solomon Islands. Years of collecting in the TSP allows the generalization that if drosophilids are found at all on any remote or small island, especially on low sparsely vegetated islands, they will be one of the three most common species often associated with humans in or near dwellings at sea level: *D. ananassae, D. sulfurigaster* or *S. bryani.* An examination of the *S. anuda* (Curran, 1936) types series (5♂♂, 5♀♀) in the Museum of the California Academy of Sciences (Entomology) would be necessary to settle the question of whether or not it is a junior synonym of *S. bryani*.

Scaptodrosophila marjoryae (Harrison, 1954:105)

Seventeen species of *Scaptodrosophila* are known from the Tropical South Pacific (TSP). During the present survey a pale brown *Scaptodrosophila* species with translucent or weakly pigmented setae and without thoracic vittae was collected on Aitutaki and Rarotonga. It has apical and basal scutellar setae subequal in length and is therefore not *S. bryani* or *S. anuda* (see above); it has C-index 2.11–2.23 (AM K.472185–88) and is therefore not *S. scaptomyzoidea* (Duda, 1923)—*S. scaptomyzoidea* has exceptionally high C-index in the range 4.0–4.7 (McEvey & Dizon, 2017). This is not a black species or a species with blackened thorax or blackened tergites, nor is it a species with any form of thoracic banding or thoracic vittae. This effectively eliminates 12 of the remaining 14 described TSP *Scaptodrosophila* species. The present species appears to be very close to *S. marjoryae* (Harrison, 1954) previously reported only from Samoa (Table 1, Fig. 1, 1500 km distant). *Scaptodrosophila marjoryae* closely resembles *S. concolor* (Bock, 1976) and *S. aurochaeta* (Bock, 1984) from Australia.

Specimens with very similar morphology, and awaiting determination in the AM, have been examined by us from Vanuatu (AM K.380057), Moorea (McE10215 CNRS/MNHN) (Table 1, Fig. 1) and Townsville, Australia (Schiffer's iso-female culture CBN17, AM K.357126–45 etc.). Unfortunately we have been unable to examine *S. marjoryae* from Samoa but our conclusion after a comparative study of male terminalia of these similar pale brown species with translucent setae from across the TSP and northern Australia is that at least four species exist; differences exist in specimens from Rarotonga, Port Vila, Moorea, and Townsville. Only three names are available (in the TSP and northern Australia), so types of *S. marjoryae, S. concolor* and *S. aurochaeta* must be examined before identifications can be made with confidence. In the interim, since we find no departure from Harrison's description, we have determined the present species from the Cook Islands to be *S. marjoryae* and we leave open the question of possible synonymies with Australian species until further study.

Supplementary data

The localities, collection dates and methods, registrations numbers and all other data relating to specimens and identifications are given in three spreadsheets published separately as Tables S1–S3, see McEvey & Polak (2021).

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