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The leaf-miner flies (Diptera: Agromyzidae) of Mitaraka, French Guiana

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Mitaraka study site MIT-E-savane roche 2 (Photo: Marc Pollet). In médaillon: *Nemorimyza maculosa* (Malloch, 1913) (Photo: Kenji Nishida).

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The leaf-miner flies (Diptera: Agromyzidae) of Mitaraka, French Guiana

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ABSTRACT

Preliminary data on the agromyzid fauna (Diptera: Agromyzidae) collected during the “Our Planet Reviewed” expedition in Mitaraka (French Guiana) is provided. A total of 138 specimens representing 10 genera and 50 morphospecies are recorded. *Melanagromyza* Hendel, 1920 and *Ophiomyia* Bra-schnikov, 1897 were the most diverse genera with 15 and 14 species respectively, followed by *Phytobia* Lioy, 1864 (five species), *Japanagromyza* Sasakawa, 1958 and *Calycomyza* Hendel, 1931 (four species each), *Liriomyza* Mik, 1894 (three species), *Nemorimyza* Frey, 1946 (two species), and *Agromyza* Fallén, 1810, *Cerodontha* Rondani, 1861, and *Phytoliriomyza* Hendel, 1931 (one species each). Except for *Liriomyza* and *Nemorimyza*, all of these genera are recorded from French Guiana for the first time. Nearly 90% of the specimens were collected with a 6 m long Malaise trap installed for eight days on a rocky outcrop (site “savane roche 2”) during the third phase of the expedition in August 2015. Prior to this expedition, only four species of Agromyzidae Fallén, 1823 were reported from French Guiana.

RÉSUMÉ

Les mouches mineuses (Diptera: Agromyzidae) de l'expédition du Mitaraka, Guyane.

Des données préliminaires sur la faune des agromyzides (Diptera : Agromyzidae) collectées dans le cadre du programme « La Planète revisitée », expédition Mitaraka (Guyane) sont fournies. Un total de 138 spécimens représentant 10 genres et 50 morpho-espèces sont répertoriés. *Melanagromyza* Hendel, 1920 et *Ophiomyia* Braschnikov, 1897 sont les genres les plus diversifiés avec respectivement 15 et 14 espèces, suivis par *Phytobia* Lioy, 1864 (cinq espèces), *Japanagromyza* Sasakawa, 1958 et *Calycomyza* Hendel, 1931 (quatre espèces chacun), *Liriomyza* Mik, 1894 (trois espèces), *Nemorimyza* Frey, 1946 (deux espèces), et *Agromyza* Fallén, 1810, *Cerodontha* Rondani, 1861, et *Phytoliriomyza* Hendel, 1931 (une espèce chacun). Tous ces genres, à l'exception de *Liriomyza* et *Nemorimyza*, sont recensés en Guyane pour la première fois. Près de 90 % des spécimens ont été récoltés avec un piège Malaise de 6 m de long, installé durant huit jours sur un affleurement rocheux (site « savane roche 2 ») lors de la troisième phase de l'expédition, en août 2015. Seules quatre espèces d'Agromyzidae Fallén, 1823 avaient auparavant été recensées de Guyane.

KEY WORDS

Diptera,
Agromyzidae,
Neotropical,
French Guiana,
Mitaraka,
savane-roche,
inselberg,
rain forest,
Amazon.

MOTS CLÉS

Agromyzidae,
diptères,
néotropical,
Guyane,
Mitaraka,
savane-roche,
inselberg,
forêt tropicale,
Amazonie.

INTRODUCTION

Approximately 18 000 insect species have been described from French Guiana, although about 100 000 species are estimated to occur there. About 75% of these described species belong to the order Lepidoptera Linnaeus, 1758 (moths and butterflies) and Coleoptera Linnaeus, 1758 (beetles) while Diptera Linnaeus, 1758 with only 577 species and two subspecies is listed among the most poorly known orders of French Guiana insects (Brûlé & Touroult 2014). The fly family Agromyzidae Fallén, 1823, commonly known as leaf-miner flies, includes nearly 3200 species worldwide (von Tschirnhaus 2021) and has been relatively well studied in some regions of the Neotropics with nearly 500 species recorded. The fauna of French Guiana, on the contrary, remains almost completely unknown with only four species previously recorded: *Liriomyza huidobrensis* (Blanchard, 1926); *L. trifolii* (Burgess, 1880); *L. sativae* Blanchard, 1938 and *Nemorimyza maculosa* (Malloch, 1913) (EPP0 2020; Martinez & Etienne 2002). These species are well known agromyzid pests and their presence in French Guiana has been reported by various agricultural or plant protection organisations (e.g. EPP0), rather than from biodiversity surveys.

During 2015, an expedition to the Mitaraka massif, a largely unexplored region of French Guiana, was organized to assemble information on the biodiversity of the area, with a focus on freshwater and terrestrial invertebrate biodiversity (Biotope 2014; Pascal *et al.* 2015). The expedition was part of a large-scale biodiversity program known as “Our planet Reviewed” (*La Planète revisitée*) led by the Muséum national d’Histoire naturelle (MNHN, France) and Pro-Natura International (Pollet *et al.* 2014; Muséum national d’Histoire naturelle 2016). The main objective of this program is to accelerate the discovery and description of new species by concentrating efforts in regions considered a priority for nature conservation (Muséum national d’Histoire naturelle 2016).

The Mitaraka massif is situated in the southwesternmost part of French Guiana directly bordering Surinam and Brazil (Fig. 1). It is part of the Guiana Amazonian Park, which forms one of the largest protected rain forest areas in the world, together with the adjacent Tumucumaque National Park in Brazil (Shelley 2013). The Mitaraka massif is a completely remote, uninhabited region consisting mainly of lowland tropical rain forest with scattered isolated rocky outcrops of Precambrian granite known as inselbergs (Fig. 2) (Touroult *et al.* 2018). Although these inselbergs are sometimes described as being part of a larger mountain range, known as Tumuc-Humac, the truth is that this mountain range does not exist, at least not as it was visualized by French explorers. Indeed, these “mountains” are no more than isolated inselbergs varying in size from 100 to 800 m (Hurault 1973, 2000; Chavance 2015).

Inselbergs (“Island mountains” in German) have recently received increased interest for biodiversity research as these “islands” are known to serve as refuges for unique flora and fauna (Vitt 1993; Porembski & Barthlott 2000; Vlasáková *et al.* 2008; Jocque & Giupponi 2012). The unique diversity

and structure of their plant communities have been studied in both tropical and temperate regions (Porembski & Barthlott 2000; Sarthou *et al.* 2003; Porembski 2007). Contrary to the rich flora of the surrounding moist forest, inselbergs are considered “micro-environmental deserts” (Phillips 1982) where vegetation grows on exposed granite rock with very little or no soil cover that is often exposed to extreme weather conditions. In French Guiana, the characteristic vegetation of inselbergs is called “savane-roche” (Gasc *et al.* 1998; Sarthou *et al.* 2003). More than 600 plant species have been reported from these savane-roche vegetations. Most of these species belong to the following plant families: Orchidaceae Juss., Rubiaceae Juss., Melastomataceae Juss., Poaceae Barnhart, Cyperaceae Juss., Bromeliaceae Juss., Araceae Juss., Myrtaceae Juss., and Euphorbiaceae Juss. (Gasc *et al.* 1998), with some variation from one inselberg to the other (Sarthou *et al.* 2003). In French Guiana, inselbergs are located in undisturbed rain forest and their flora includes some species that are rare and restricted to these rocky outcrops in this part of the Neotropics (Sarthou *et al.* 2003). Until recently, little was known about the insect fauna associated with inselbergs (Mares & Seine 2000). The recent expedition to the Mitaraka massif has produced some important new data on the insect fauna of the French Guiana inselbergs and surrounding rain forest habitats (e.g. Dalens & Touroult 2015; Touroult & Dalens 2015; Fleck 2017; Vicente & Robillard 2017; Mantilleri 2018; Campos & Desutter-Grandcolas 2020; Desutter-Grandcolas & Faberon 2020; Pocco & Cigliano 2020), including important progress on our knowledge of the Diptera fauna (Krolow *et al.* 2017; Brooks *et al.* 2018; Gomes & Carvalho 2018; Mortelmans & Pollet 2018; Runyon & Pollet 2018; Pollet *et al.* 2018; Ale-Rocha & Pollet 2019; Mederos & Pollet 2019; Pirani & Grimaldi 2019; Vieira *et al.* 2019; Marques *et al.* 2019; Curler 2020; Blagoderov & Pollet 2020; Silva & Pollet 2020).

The objective of this paper is to document on the diversity of agromyzid species collected during the Mitaraka expedition in a southern lowland rainforest with special attention to the fauna of a minor inselberg and to provide a first insight into the composition of French Guiana Agromyzidae.

MATERIALS AND METHODS

RESEARCH TEAM AND TIMEFRAME

Due to the dense vegetation and remote aspect of the Mitaraka massif, a landing area (the drop zone) was cleared by the French army prior to the arrival of the research crew by helicopter. A base camp was also established for the duration of the expedition. Three different teams of researchers were involved during three different sampling periods in 2015: February 23 to March 11, March 11-27 and August 12-20 (Touroult *et al.* 2018). The main mission was conducted during the rainy season (February-March 2015) by 32 researchers, each studying a specific taxonomical group, e.g. higher plants, earthworms, birds, fish, or particular insect taxa. A third shorter visit by a smaller team of 10 researchers to the site during the beginning of the dry season focused on insects only, and was organized

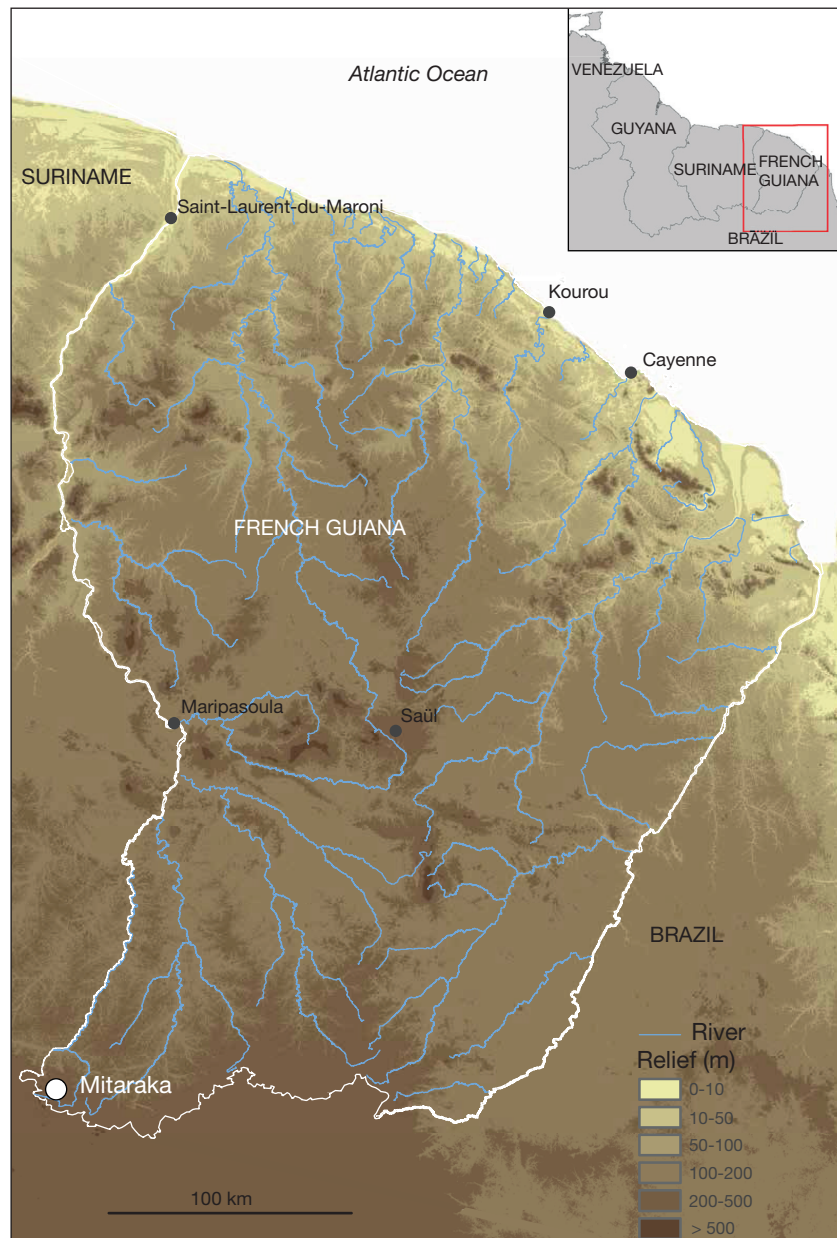


FIG. 1. — Map showing locality of Mitaraka study site (○), in southwest French Guiana. Map: L. Wilmé.

by the Entomological Society of Antilles-Guyane (SEAG). MP was the only Diptera worker involved in fieldwork and participated in the first sampling period.

COLLECTING SITES AND COLLECTING METHODS

The area under investigation consisted of the base camp, the drop zone and four main trails of approximately 3.5 km each, leaving in different directions from the base camp (Fig. 3). A total of 37 sampling sites were investigated (Pollet *et al.* 2018) but only a few of them produced agromyzid specimens, including a river bank forest (MIT-A-RBF1) (samples 186, 189), the drop zone (MIT-DZ) (sample 218), a minor inselberg with savane-roche vegetation (MIT-E- savane roche 2)

(Fig. 4) (sample 230), the base camp, and trails and other sites in tropical moist forest. Some samples were pooled from different sites and traps but were collected with the same method (samples 227, 229) (Table 1).

A wide array of methods was used to collect invertebrates (Pascal *et al.* 2015; Touroult *et al.* 2018) and multiple traps of particular types were employed e.g. 280 pan traps and 33 SLAM traps, but not all trapping methods were used during all three sampling periods of the expedition (e.g. pan traps only during the first sampling period). Among all techniques used, only a few were successful in collecting Agromyzidae: a 6 m long Malaise trap (MT(6M)) (Fig. 5C), the Sea and Land Air Malaise traps (SLAM) (Fig. 5B), and blue Polytrap



Fig. 2. — The Sommet-en-Cloche, an example of a major inselberg amid tropical lowland rain forest in the Mitaraka area (Photo: Xavier Desmier).

automatic light traps (PVB) (flight intercept trap using blue LED light, and suspended in the canopy) (Fig. 5A) (Table 1). Further details on sampling methods can be found in Touroult *et al.* (2018).

SPECIMEN PREPARATION AND IDENTIFICATION

All the specimens collected benefited from the Access and benefit sharing agreement of the Our Planet Reviewed program (APA 973-1). A total of 223 invertebrate samples were examined, with non-pan trap samples being sorted to insect orders and families at the SEAG office, and pan trap samples sorted by MP. This process produced nearly 2 200 subsamples, containing 28 Diptera families and superfamilies (Pollet *et al.* 2018) that were disseminated among experts worldwide, including the six samples of Agromyzidae (Table 1) sent to SB. The Agromyzidae samples were initially stored in 70% ethanol and subsequently dried using hexamethyldisilazane (HMDS), mounted and labelled (see Table 1). Morphospecies identifications were based on external morphological characters and male genitalic characters. Male genitalia were examined by detaching the abdomen from the remainder of the specimen, clearing it in 85% lactic acid heated in a microwave oven for 2-3 intervals of 30 seconds each, separated by a cooling period, or cleared outside the microwave (later in the project) following procedures outlined in Boucher (2019). The abdo-

men was subsequently transferred to a glycerin solution for further dissection and examination and was ultimately stored in a microvial pinned below the corresponding specimen. The format of the morphospecies names used here are: genus name + species number, preceded by the prefix Mit (for Mitaraka).

ABBREVIATIONS

MNHN	Muséum national d'Histoire naturelle, Paris;
MT(6M)	6 m long Maïaise trap;
PVB	Polytrap automatic light trap;
SEAG	Société entomologique Antilles-Guyane;
SLAM	Sea and Land Air Maïaise trap.

RESULTS

A total of 138 specimens of Agromyzidae from six samples (different collection events) were examined. Sample 230 was by far the largest sample with 123 specimens (Table 1) and was collected at the MIT-E-savane roche 2 site during the third period of the expedition (August 13-20, 2015) by researchers of SEAG. Sample 229 with six specimens was also collected during this period, resulting in a total of 129 specimens out of 138 specimens (93.5%) from this period (Fig. 6). Seven specimens (samples 186, 218, 227) were collected during the first period of the expedition (Feb. 23-March 11), and

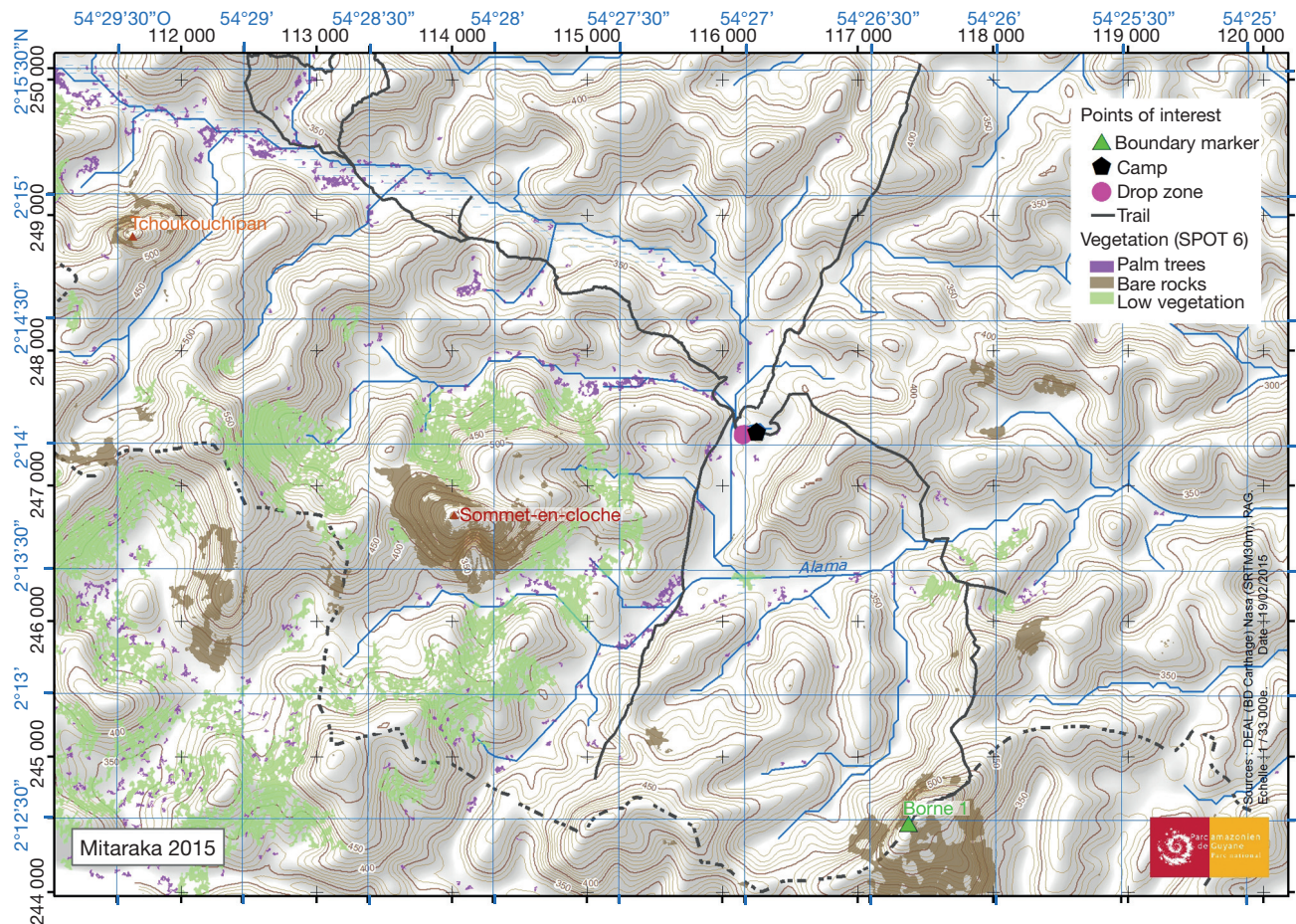


FIG. 3. — Mitaraka study site showing location of base camp, drop zone and main collecting trails (source: Maël Dewynter; Service géomatique du Parc amazonien de Guyane).

TABLE 1. — Labels of the six Agromyzidae Fallén, 1823 samples from Mitaraka with specimens and species number per sample. Collecting method for each sample is highlighted in bold.

Sample code	Label data	No. of specimens	No. of species
186	(FR-GU) Guyane, Mitaraka, nr MIT-A-RBF1, river, 02°14'11.4"N, 54°27'07.0"W, 306 m, 1-7.III.2015, MT(6m) , leg. Julien Tourout & Eddy Poirier (FR-GU/Mitaraka/2015) - sample code: MITARAKA/186 (sorted by Marc Pollet, 2015)	4	3
189	(FR-GU) Guyane, Mitaraka, nr MIT-A-RBF1, river, 02°14'11.4"N, 54°27'07.0"W, 306 m, 7-25.III.2015, MT(6m) , leg. Julien Tourout & Eddy Poirier (FR-GU/Mitaraka/2015) - sample code: MITARAKA/189 (sorted by Marc Pollet, 2015)	2	2
218	(FR-GU) Guyane, Mitaraka, MIT-DZ, 02°14'01.8"N, 54°27'01.0"W, 306 m, tropical moist forest (plateau-slope - cleared), 1.III.2015, SLAM , leg. Julien Tourout & Eddy Poirier (FR-GU/Mitaraka/2015) - sample code: MITARAKA/218 (sorted by Marc Pollet, 2015)	2	2
227	(FR-GU) Guyane, Mitaraka, different sites nr base camp and along trails, tropical moist forest (different sites), 3.III.2015, PVB , leg. Julien Tourout & Eddy Poirier (FR-GU/Mitaraka/2015) - sample code: MITARAKA/227 (sorted by Marc Pollet, 2015)	1	1
229	(FR-GU) Guyane, Mitaraka, different sites nr base camp and along trails, open / partially opened areas around base camp and dropzone, and in savane roche 2, 12.-20.VIII.2015, SLAM , leg. Pierre-Henri Dalens (FR-GU/Mitaraka/2015) - sample code: MITARAKA/229 (sorted by M. Pollet, 2015)	6	2
230	(FR-GU) Guyane, Mitaraka, MIT-E-savane roche 2, 02°13'59.8"N, 54°27'46.5"W, 471 m, open / partially opened areas on savane roche 2, 13-20.VIII.2015, MT(6m) , leg. Pierre-Henri Dalens (FR-GU/Mitaraka/2015) - sample code: MITARAKA/230 (sorted by Marc Pollet, 2015)	123	43



FIG. 4. — Mitaraka study site MIT-E-savane roche 2 (Photo: Marc Pollet).

only two specimens (sample 189) during the second period (March 11-27) (Fig. 6). Fifty morphospecies in 10 genera were recognized in these 138 specimens, with 43 males and 95 females (Table 2).

The following eight agromyzid genera are recorded for the first time from French Guiana: *Agromyza* Fallén, 1810; *Calycomyza* Hendel, 1931; *Japanagromyza* Sasakawa, 1958; *Melanagromyza* Hendel, 1920; *Ophiomyia* Braschnikov, 1897; *Phytobia* Lioy, 1864; *Cerodontha* Rondani, 1861; *Phytoliriomyza* Hendel, 1931.

The genus *Melanagromyza* with 67 specimens was by far the most abundant, followed by *Ophiomyia* (24 specimens), *Liriomyza* Mik, 1894 (15 specimens), *Japanagromyza* (11 specimens), *Calycomyza* (seven specimens), *Nemorimyza* Frey, 1946 and *Phytobia* (five specimens each), *Phytoliriomyza* (two specimens), and *Cerodontha* and *Agromyza* (one specimen each) (Fig. 7). The most abundant species was *Melanagromyza* Mit-2 (26 specimens), followed by *Melanagromyza* Mit-3 (13 specimens), *Liriomyza* Mit-1 (12 specimens), *Melanagromyza* Mit-6 (eight specimens), *Japanagromyza* Mit-1 (seven specimens), and *Melanagromyza* Mit-4 (five specimens) (Table 2).

The genus *Melanagromyza* and *Ophiomyia* were the most diverse with 15 and 14 species respectively, followed by the

genus *Phytobia* (five species), *Japanagromyza* and *Calycomyza* (four species each), *Liriomyza* (three species), *Nemorimyza* (two species) and *Phytoliriomyza*, *Cerodontha* and *Agromyza* (one species each) (Fig. 7).

Six species were collected during the first sampling period, two species during the second period, and most species (43 species out of 50) during the last period of the expedition (Fig. 6), with very little or no species overlap between the different periods (Fig. 9).

Only two species were represented in more than one sample: *Japanagromyza* Mit-1 was retrieved from samples 229 and 230, and *Melanagromyza* Mit-3 from samples 218, 229, and 230 (Table 2). Among the 50 species identified, 27 species were represented by females only and most species (38/50) were represented by only one or two specimens (Table 2).

Three collecting methods successfully caught Agromyzidae, but the 6 m long Malaise trap (MT(6M)) was by far the most successful with a total of 48 species (Fig. 8). Three agromyzid samples (186, 189, 230) were collected with this 6 m Malaise trap (Table 1), which was installed in tropical lowland rain forest over the Alama River (samples 186, 189) in February-March and on a minor inselberg in August (sample 230). The first two samples (1-25 March 2015)



FIG. 5. — Collecting techniques that yielded *Agromyzidae* Fallén, 1823 samples in Mitaraka: **A**, PVB light trap; **B**, SLAM traps; **C**, 6 m long Malaise trap (Photos: A, Julien Touroult; B, C, Stéphane Brulé).

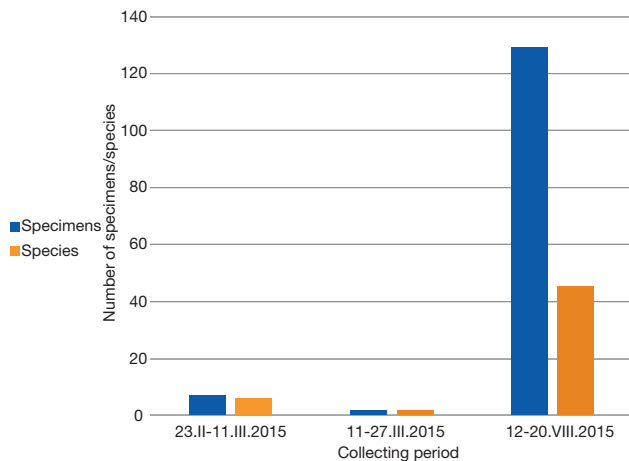


FIG. 6. — Number of Agromyzidae Fallén, 1823 specimens and species collected during the different periods of the expedition.

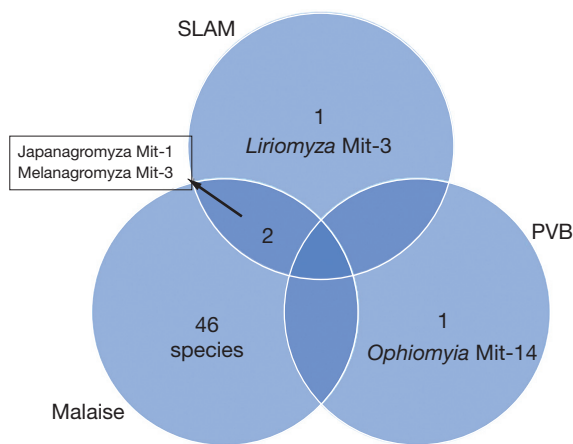


FIG. 8. — Venn diagram showing number of species collected with different trapping methods.

contained five different species (*Japanagromyza* Mit-4; *Melanagromyza* Mit-12; *Ophiomyia* Mit-8; *Phytobia* Mit-1; *Phytobia* Mit-2) while the latter eight day's sample encompassed an astonishing 43 agromyzid species (Table 2). The other two trapping methods, the SLAM (samples 218, 229) and blue polytrap automatic light traps (PVB) (sample 227) caught three (*Liriomyza* Mit-3; *Japanagromyza* Mit-1; *Melanagromyza* Mit-3) and one species (*Ophiomyia* Mit-14) respectively (Table 2; Fig. 8). The Malaise trap produced 46 unique species, while the SLAM and PVB traps collected one unique species each (*Liriomyza* Mit-3 and *Ophiomyia* Mit-14, respectively) (Fig. 8).

DISCUSSION

Given this relatively short survey (40 days total) and the low number of specimens examined (138 specimens), alpha diversity of Agromyzidae in Mitaraka appears quite high with

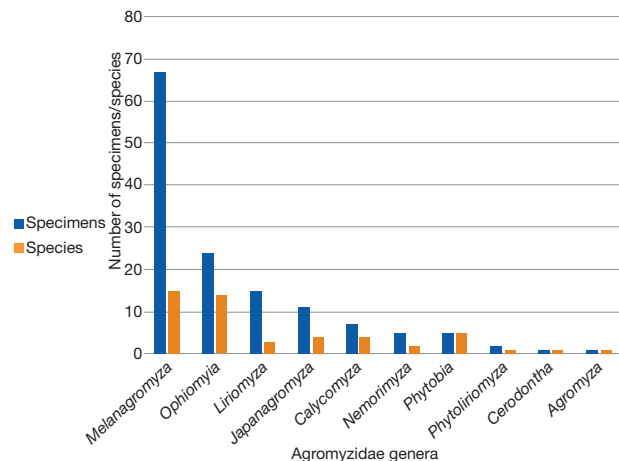


FIG. 7. — Abundance (number of specimens) vs diversity (number of species) for each Agromyzidae Fallén, 1823 genus collected during the Mitaraka expedition: *Melanagromyza* Hendel, 1920; *Ophiomyia* Braschnikov, 1897; *Liriomyza* Mik, 1894; *Japanagromyza* Sasakawa, 1958; *Calycomyza* Hendel, 1931; *Nemorimyza* Frey, 1946; *Phytobia* Lioy, 1864; *Phytoliriomyza* Hendel, 1931; *Cerodontha* Rondani, 1861; *Agromyza* Fallén, 1810.

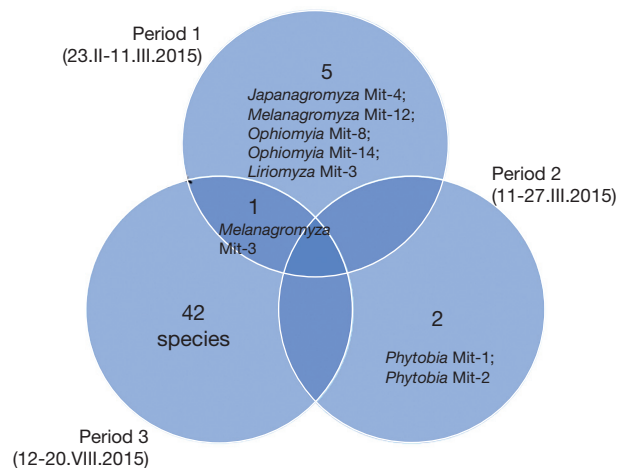


FIG. 9. — Venn diagram showing number of species collected during the different sampling periods.

a total of 50 species in 10 genera. Surprisingly, most of these agromyzids were collected with a Malaise trap set up for only eight days. A recent survey in a very small patch of cloud forest in Zurquí de Moravia, Costa Rica, yielded 812 specimens of 117 species of Agromyzidae in 12 genera, but this was the result of a whole year of sampling (Brown *et al.* 2018).

With 67 specimens and 15 species, *Melanagromyza* was the most abundant and most diverse genus in Mitaraka. It is also the second largest genus in the Neotropical region with 93 described species. Its diversity is substantially lower in temperate regions of the world. As an example, only 37 species are reported from the USA (Shi & Gaimari 2015). With only three species, *Liriomyza*, the most speciose Neotropical agromyzid genus with 105 described species, was not well represented in Mitaraka. The other most diverse genera in the Neotropical region are *Calycomyza* (73 described species) and

TABLE 2. — Agromyzidae Fallén, 1823 morphospecies list from Mitaraka with sample codes and number of specimens.

Species #	Sample code (s)	Morphospecies name	No. males	No. females	Total no. specimens
1	Mitaraka/229/230	<i>Japanagromyza</i> Mit-1	–	7	7
2	Mitaraka/230	<i>Japanagromyza</i> Mit-2	–	1	1
3	Mitaraka/230	<i>Japanagromyza</i> Mit-3	–	2	2
4	Mitaraka/186	<i>Japanagromyza</i> Mit-4	–	1	1
5	Mitaraka/230	<i>Agromyza</i> MIT-1	1	–	1
6	Mitaraka/230	<i>Melanagromyza</i> Mit-1	2	–	2
7	Mitaraka/230	<i>Melanagromyza</i> Mit-2	10	16	26
8	Mitaraka/218/229/230	<i>Melanagromyza</i> Mit-3	4	9	13
9	Mitaraka/230	<i>Melanagromyza</i> Mit-4	2	3	5
10	Mitaraka/230	<i>Melanagromyza</i> Mit-5	1	–	1
11	Mitaraka/230	<i>Melanagromyza</i> Mit-6	–	8	8
12	Mitaraka/230	<i>Melanagromyza</i> Mit-7	–	2	2
13	Mitaraka/230	<i>Melanagromyza</i> Mit-8	–	1	1
14	Mitaraka/230	<i>Melanagromyza</i> Mit-9	–	1	1
15	Mitaraka/230	<i>Melanagromyza</i> Mit-10	–	2	2
16	Mitaraka/230	<i>Melanagromyza</i> Mit-11	–	1	1
17	Mitaraka/186	<i>Melanagromyza</i> Mit-12	1	1	2
18	Mitaraka/230	<i>Melanagromyza</i> Mit-13	–	1	1
19	Mitaraka/230	<i>Melanagromyza</i> Mit-14	–	1	1
20	Mitaraka/230	<i>Melanagromyza</i> Mit-15	–	1	1
21	Mitaraka/230	<i>Ophiomyia</i> Mit-1	3	–	3
22	Mitaraka/230	<i>Ophiomyia</i> Mit-2	1	–	1
23	Mitaraka/230	<i>Ophiomyia</i> Mit-3	1	1	2
24	Mitaraka/230	<i>Ophiomyia</i> Mit-4	2	–	2
25	Mitaraka/230	<i>Ophiomyia</i> Mit-5	2	2	4
26	Mitaraka/230	<i>Ophiomyia</i> Mit-6	–	1	1
27	Mitaraka/230	<i>Ophiomyia</i> Mit-7	1	1	2
28	Mitaraka/186	<i>Ophiomyia</i> Mit-8	–	1	1
29	Mitaraka/230	<i>Ophiomyia</i> Mit-9	–	1	1
30	Mitaraka/230	<i>Ophiomyia</i> Mit-10	–	1	1
31	Mitaraka/230	<i>Ophiomyia</i> Mit-11	1	–	1
32	Mitaraka/230	<i>Ophiomyia</i> Mit-12	–	2	2
33	Mitaraka/230	<i>Ophiomyia</i> Mit-13	–	2	2
34	Mitaraka/227	<i>Ophiomyia</i> Mit-14	–	1	1
35	Mitaraka/230	<i>Calycomyza</i> Mit-1	1	1	2
36	Mitaraka/230	<i>Calycomyza</i> Mit-2	1	1	2
37	Mitaraka/230	<i>Calycomyza</i> Mit-3	–	2	2
38	Mitaraka/230	<i>Calycomyza</i> Mit-4	–	1	1
39	Mitaraka/230	<i>Cerodontha</i> Mit-1	1	–	1
40	Mitaraka/230	<i>Nemorimyza</i> Mit-1	1	2	3
41	Mitaraka/230	<i>Nemorimyza</i> Mit-2	–	2	2
42	Mitaraka/230	<i>Phytoliriomyza</i> Mit-1	1	1	2
43	Mitaraka/230	<i>Liriomyza</i> Mit-1	3	9	12
44	Mitaraka/230	<i>Liriomyza</i> Mit-2	–	2	2
45	Mitaraka/218	<i>Liriomyza</i> Mit-3	–	1	1
46	Mitaraka/189	<i>Phytobia</i> Mit-1	1	–	1
47	Mitaraka/189	<i>Phytobia</i> Mit-2	–	1	1
48	Mitaraka/230	<i>Phytobia</i> Mit-3	–	1	1
49	Mitaraka/230	<i>Phytobia</i> Mit-4	1	–	1
50	Mitaraka/230	<i>Phytobia</i> Mit-5	1	–	1
Total			43	95	138

Ophiomyia (50 species). The latter genus was represented in the Mitaraka samples with 14 species, the former with only four species.

The highest agromyzid specimen and species numbers were retrieved from a single sample (code 230), which was collected with a 6 m long Malaise trap on one of the minor inselbergs (site MIT-E- savane roche 2). This site was described as a rocky outcrop (471 m a.s.l.) covered with herbaceous vegetation (including *Pitcairnia* L'Hér.), scattered shrubs

and exposed rocks (Touroult *et al.* 2018; Pollet *et al.* 2018) (Fig. 4). *Pitcairnia* is a speciose genus of Bromeliaceae present mainly in Mexico, Central and South America and the Caribbean (Saraiva *et al.* 2015), with some species known to be restricted to inselbergs (Sarhou *et al.* 2001). This plant genus has never been recorded as host for any Agromyzidae, and only one species of Agromyzidae is known to feed on Bromeliaceae, *Melanagromyza rosales* Woodley, a leaf-miner in *Bromelia pinguin* L. in Costa Rica (Woodley & Janzen 1995).

However, none of the Mitaraka *Melanagromyza* specimens correspond to this species.

Only two species (*Melanagromyza* Mit-3 and *Japanagromyza* Mit-1) were present in more than one sample, with *Melanagromyza* Mit-3 collected in two distinct habitats (savane-roche and drop zone (cleared moist forest)). Surprisingly, other sites similar to the “MIT-E-savane roche 2” investigated at Mitaraka (including other minor rocky outcrops (390–470 m a.s.l.) and major rocky outcrops (540–570 m a.s.l.)), did not yield any Agromyzidae. This is most probably due to the fact that no 6 m Malaise trap was operational on these inselbergs, and that no agromyzids were actively searched for.

The success of the 6 m Malaise trap reflects previous knowledge that Malaise traps are an effective method for collecting flying insects, including flies (Lamarre *et al.* 2012; Borkent *et al.* 2018). But this method is also known to be female-biased for Agromyzidae (Scheirs *et al.* 1997), which concurs with the high proportion of agromyzid females collected during the expedition. As compared to the very productive Malaise trap on the minor inselberg in August 2015 (43 species, 123 specimens), the other habitat examined with this trap in March (samples 186, 189) proved much less species rich, with only five species and six specimens. Reasons for this difference might include: season, habitat type and host vegetation, position of the trap, or a combination of these factors. Among the other collecting methods used, the SLAM trap is not commonly applied for Agromyzidae, but when installed on land (as it was the case here) it works in a similar way as a Malaise trap, although being smaller (Touroult *et al.* 2018). This method collected few specimens and added only one unique species (*Liriomyza* Mit-3) (Fig. 8) in phase 1 of the project. The SLAM traps that were installed for nine days during the last sampling period (August) in a range of sites, including MIT-E-savane roche 2 (sample 229), were much less successful than the 6 m Malaise trap (sample 230) installed during the same period in the savane roche 2 site. The reasons for this difference remain unclear as this trap type was successful for collecting other Diptera families (Krolow *et al.* 2017; Pollet *et al.* 2018; Vieira *et al.* 2019). The PVB (automatic light trap with blue LED) also added one unique species (*Ophiomyia* Mit-14) (Fig. 8) represented by one female specimen. The automatic light traps were installed to collect nocturnal flying insects from various insect orders, but did not target Diptera (Touroult *et al.* 2018). Agromyzidae are known to be diurnal and are not normally collected by light traps so this specimen is possibly an accidental visitor to the trap. Despite being established as a successful device to collect Diptera, including Agromyzidae (Scheirs *et al.* 1997), the 280 pan traps used did not yield a single agromyzid in Mitaraka. This absence of Agromyzidae could be explained by the heavy rainfall which also affected yields of Dolichopodidae Latreille, 1809 (Pollet *et al.* 2018). Although savane roche 2 and at least 29 other sites were investigated by MP using a sweep net during the first phase of the expedition, no Agromyzidae were gathered because an on sight collecting approach was used to mainly target Dolichopodidae. Sweeping was also performed during the last phase of the expedition (Touroult *et al.* 2018), but

again this approach was unsuccessful for Agromyzidae, most probably for the same reason.

All species reported here are identified as morphospecies as a first step in the species recognition process. Species identification of small flies like the Agromyzidae (averaging 2–3 mm in wing length but sometimes as small as 1 mm) can be challenging, even for trained taxonomists. This is particularly true for species living in inadequately studied regions like French Guiana for which no reference work nor identification keys are available and where many undescribed species are expected. Although morphospecies identification is often performed by non-specialists (or “parataxonomists”) for rapid biodiversity assessment (Derraik *et al.* 2002), it was here performed by a trained agromyzid taxonomist (SB) using elaborate external non-genitalic and genitalic characters when possible, which certainly adds to the accuracy of the morphospecies determination. Nevertheless, females often remain difficult to differentiate from each other or to assign to a male morphospecies.

Further taxonomic work is in progress and will allow the assignment of some of the morphospecies to described species, while others will be confirmed as new species and will be described. Some morphospecies will remain unidentified until further material is available, and this will include most of the 27 species represented by female specimens only.

Although additional work is required for species level identification, we can confirm that the agromyzid species collected during the Mitaraka expedition do not correspond to any of the four species (*Nemorimyza maculosa*, *Liriomyza huidobrensis*, *L. trifolii*, *L. sativae*) previously recorded from French Guiana. The Mitaraka survey thus increases the known agromyzid fauna of this French Département d’Outre Mer to 54 (morpho)species.

These 50 morphospecies of Agromyzidae recorded from Mitaraka are a significant addition to the other Diptera species so far recorded from the Mitaraka survey. This list includes 24 species of Tabanidae Latreille, 1802 (Krolow *et al.* 2017), two species of Sciomyzidae Macquart, 1846 (Mortelmans & Pollet 2018), 244 species of Dolichopodidae (Pollet *et al.* 2018; Runyon & Pollet 2018), two species of Ropalomeridae Linder, 1930 (Ale-Rocha & Pollet 2019), 15 species of Pipunculidae Walker, 1834 (Marques *et al.* 2019), 44 species of Asilidae Latreille, 1802 (Vieira *et al.* 2019), three species of Lygistorrhinae Edwards, 1925 (Keroplastidae Rondani, 1856) (Blagoderov & Pollet 2020), and 11 species of Sepsidae Walker, 1833 (Silva & Pollet 2020), apart from the description of multiple new or extraordinary species (Gomes & de Carvalho 2018; Mederos & Pollet 2019; Pirani & Grimaldi 2019; Curler 2020).

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