

Diversity and altitudinal distribution of grasshoppers from the Parc National de Marojejy (Orthoptera: Tetrigoidea, Eumastacoidea, Acridoidea)

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Abstract

The list of grasshoppers and allied insects of the suborder Caelifera occurring in the Marojejy National Park is updated based on new material collected during two different field surveys in 2018 and 2021. A total of 56 species of Caelifera are now recorded from this protected area, 30 of which are only known from the site. More than half of these species occur at elevations ranging between 650 and 1150 m. Among the Caelifera species recorded from Marojejy, 15 are only known from a single specimen, suggesting that further sampling is needed to further advance the inventory of these insects in this national park.

Keywords: Orthoptera, Tetrigoidea, Eumastacoidea, Acridoidea, Madagascar, grasshoppers, endemism, singletons, altitudinal distribution

Résumé détaillé

La liste des criquets et groupes proches du sous-ordre Caelifera présents dans le parc national de Marojejy est mise à jour grâce au matériel collecté durant deux missions de terrain menées en 2018 et 2021. Jusqu'à 2018, 25 espèces de criquets étaient connus de ce parc national. Les nouvelles collectes permettent à présent d'y recenser un total de 56 espèces de Caelifera. Les Caelifera du Parc National de Marojejy appartiennent aux superfamilles suivantes : Acridoidea (24 espèces), Tetrigoidea (16 espèces), Eumastacoidea (10 espèces) et Pyrgomorphoidea (6 espèces). Les Tetrigoidea sont particulièrement diversifiés dans ce parc et représentent 22 % des espèces de cette superfamille à Madagascar. De ces 56 espèces, 21 ne sont pas encore nommées et seront décrites dans une prochaine publication. Plus de la moitié

de ces espèces (30/56) sont uniquement connues de cette aire protégée. Le maximum de diversité en Caelifera est rencontré entre 650 et 1150 m, altitudes auxquelles plus de la moitié des espèces (30/56) sont présentes. Parmi tous les Caelifera recensés à Marojejy, 15/56 correspondent à des singletons : ils ne sont connus que d'un seul spécimen, suggérant qu'un effort d'échantillonnage supplémentaire serait nécessaire pour compléter l'inventaire de ce sous-ordre dans ce parc national.

Mots clés : Orthoptera, Tetrigoidea, Eumastacoidea, Acridoidea, Madagascar, criquets, endémisme, singletons, distribution altitudinale

Introduction

Grasshoppers and allied insects belong to the suborder Caelifera, within the order Orthoptera. Two-thirds of the species of Orthoptera described from Madagascar belong to Caelifera. This unusual proportion likely results from the strong taxonomic attention towards Caelifera by previous authors (Hugel, 2022).

Humans have strong and ambiguous relationships with Caelifera since some species are serious crop pests, but this suborder is also a source of protein particularly appraised by Malagasy people. The diversity of edible Caelifera on the island is particularly high, and recent work recorded the consumption of 26 species (Van Itterbeeck *et al.*, 2019; Fisher & Hugel, 2022). Besides the anthropological importance of Malagasy Caelifera, these insects display particularly high levels of diversity and endemism (Hugel, 2022).

A compilation of the literature on Malagasy Caelifera indicated that until 2018, 25 species belonging to this suborder were known from the Parc National de Marojejy (Hancock, 1900; Finot, 1908; Bruner, 1910; Rehn, 1930, 1953; Bolivar, 1932; Rehn & Rehn, 1945; Günther, 1959, 1974; Dirsh, 1961, 1962, 1963a, 1963b, 1963c, 1966; Descamps, 1965, 1969, 1971, 1974; Descamps & Wintrebert, 1965, 1966a, 1966b, 1967; Dirsh & Descamps, 1968; Wintrebert, 1972). Specimens of most of these species were collected between 1958 and 1960 by Ernest Raharizonina and Pierre Soga, and some material by Paul Griveaud (Table 1). These

three individuals were entomological collaborators of the Institut de Recherche Scientifique de Madagascar (IRSM). Pierre Soga was affected to the Poste forestier of Manantenina in Marojejy. Ernest Raharizonina was a field assistant of Paul Griveaud and participated to surveys during this period. The present work aims at updating the species list in and around the Marojejy Massif based on new material collected during two different field surveys in 2018 and 2021.

Methods

Insect collecting

The new material cited herein was collected during two field inventories: 1) a survey conducted by the team of Insect and People of the South-Western Indian Ocean (IPSIO) project and by the author in February 2018 and 2) a survey conducted by Nicolas Cliquennois associated with an elevational transect organized by Association Vahatra in November 2021. Sampling permits for these collections were issued by the Malagasy authorities (permits N°012/18/MEEF/SG/DGF/DSAP/SCB.RE to S. Hugel and N°357/21/MEED/SG/DGGE/DAPRNE/SCBE.Re to Association Vahatra).

Most specimens were localized by sight during night using a headlamp and collected with a net. A few specimens were also obtained during daylight hours. These were localized either by sight or by shaking the vegetation or the leaf litter above a large umbrella turned upside down. For material collected in 2018, the code “2018MadaSHxxx” is used for all data associated with a given specimen, including notes on the field pad, pictures, pinned specimens, ethanol material, etc.

Collection repository

The new specimens cited in this work are temporarily held in the author’s collection. Holotypes, allotypes, and most paratypes of new species will be described in the near future and this material to be deposited in museum collections.

Identifications

Species were identified using the following literature: Hancock (1900), Finot (1908), Bruner (1910), Rehn (1930, 1953), Bolivar (1932), Rehn and Rehn (1945), Günther (1959, 1974), Dirsh (1961, 1962, 1963a, 1963b, 1963c), Descamps (1965, 1969, 1971, 1974), Descamps and Wintrebert (1965, 1966a, 1966b, 1967), Dirsh (1966), Dirsh and Descamps (1968),

Wintrebert (1972), and Devriese (1991, 1995). Since no new taxonomical designations are given in this paper, and to follow the spirit of Recommendation 16A of the International Code of Zoological Nomenclature (2023), undescribed species are referred to as “undescribed species” rather than “new species”. Each undescribed species is designated with a capital letter (from “A” to “U”) followed by “u. sp.”. If the genus is also undescribed, “u. gen.” is added before “u. sp.”. The taxonomic positions of these undescribed species are given in Table 1.

Results

New records from Marojejy

The two recent field surveys at Marojejy targeting orthopteroid insects conducted in 2018 and 2021 resulted in the collection of 152 adult specimens of Caelifera (146 by S. Hugel and 8 by N. Cliquennois). This new material added 31 species to Marojejy’s Caelifera list (Table 1, species with *). The total number of Caelifera species known to occur in Marojejy is now 56 (Table 1). This number corresponds to 12% of the Caelifera species described from Madagascar as a whole (Hugel, 2022).

Superfamilies of Caelifera recorded in Marojejy

Caelifera species recorded in Marojejy belong to the following superfamilies (Figure 1): Acridoidea (24 species), Tetrigoidea (16 species), Eumastacoidea (10 species), and Pyrgomorpoidea (6 species). Tetrigoidea are particularly diversified on the Marojejy Massif and the number of species recorded in the park correspond to 22% of the species belonging to this superfamily described from Madagascar (Hugel, 2022). This may also be due to collecting habits of Ernest Raharizonina and Pierre Soga, who appear to have particularly targeted these pygmy grasshoppers. No Tridactylidea has yet been recorded on Marojejy, but this superfamily is expected to occur at least along rivers at low elevations.

Species only known from Marojejy

The level of species endemism of Malagasy Caelifera is currently 94%, and most of these species are very narrowly distributed (Hugel, 2022). Therefore, there is a relatively low species overlap across sampling sites (Krištín *et al.*, 2019; Hugel, 2022). Consistent with this observation, 54% of Caelifera species recorded in the Parc National de Marojejy area have not been recorded elsewhere (Figure 2E). Accordingly, specimens from Marojejy are among the

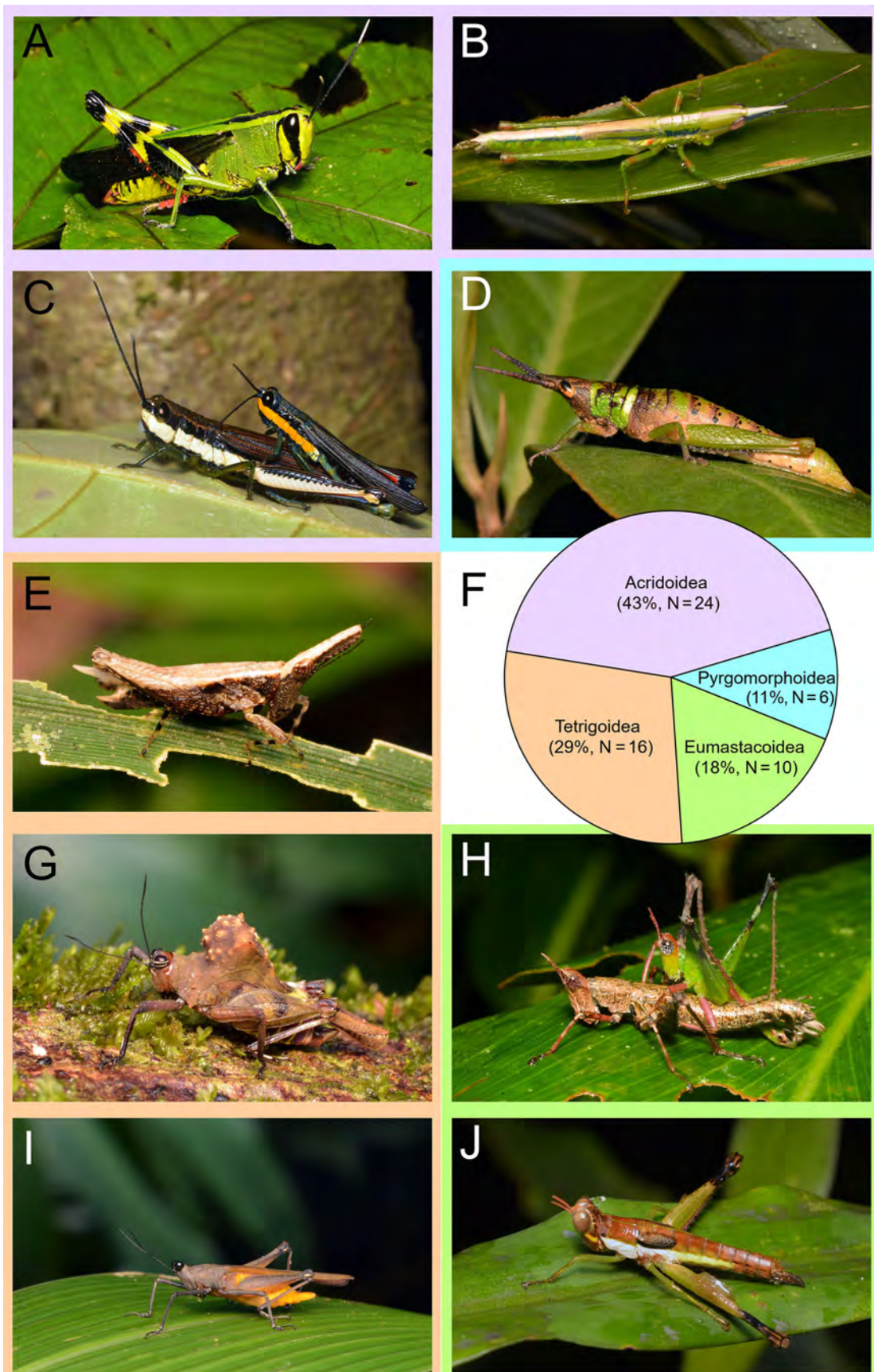


Figure 1. Example of Caelifera recorded in the Parc National de Marojejy. **A)** *Heteracris finoti* specimen 2018MadaSH126. **B)** *Galideus mocquersyi* specimen 2018MadaSH127. **C)** *Vohemara hysielloides* specimens 2018MadaSH432 and 2018MadaSH433. **D)** *Acanthopyrgus longicornis* specimen 2018MadaSH503. **E)** *Rhynchotettix rostratus* specimen 2018MadaSH091. **F)** Proportions of Caelifera superfamilies recorded in Marojejy. **G)** *Notocerus formidabilis* specimen 2018MadaSH543. **H)** *Acronomastax curvicercata* specimens 2018MadaSH084 and 2018MadaSH085. **I)** *Arexion suavis* specimen 2018MadaSH176. **J)** Undescribed species “G” u.sp. belonging to *Malagamastax*, specimen 2018MadaSH152.

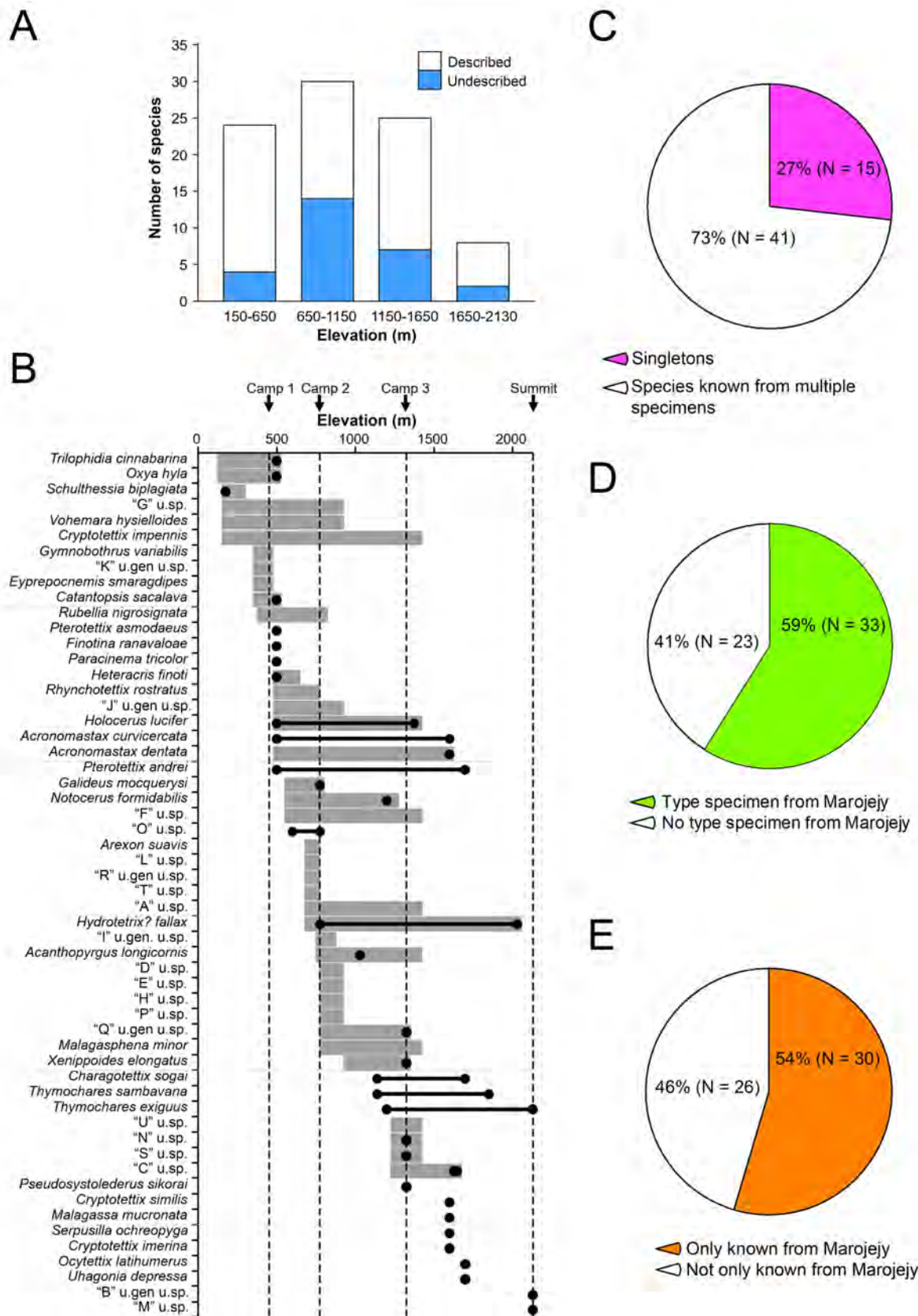


Figure 2. Caelifera species recorded in the Parc National de Marojejy. **A)** Number of species recorded per 500 m elevational class. Species that remain to be described are represented in blue within the bar of species count for each elevational band. **B)** Altitudinal distribution of Caelifera species recorded in the Parc National de Marojejy. When samples have been collected at a precise elevation, data are given in black, with maximal and minimal altitude represented with a dot. Data corresponding to elevation range rather than precise elevation are given as a gray bar. Species are sorted after their minimal elevation. **C)** Proportion of species only known by a single specimen (singletons) across Madagascar. **D)** Proportion of species including at least one specimen from the Parc National de Marojejy as a type specimen (holotype, allotype, paratype). **E)** Proportion of species only known from the Parc National de Marojejy with respect to species also recorded on other localities (more detailed information is given Table 1).

Table 1. List of species and specimens of Caelifera recorded from the Parc National de Marojejy.

TETRIGOIDEA

TETRIGIDAE

Pseudosystolederus sikorai Günther, 1939*

Camp 3, 1325 m, 13.II.2018, 2018MadaSH436, S. Hugel.

TETRIGIDAE, CLADONOTINAE

Thymochares exiguus Günther, 1974

Réserve naturelle XII, Beondroka, 1200 m, VI.1960, P. Soga, [in Günther, 1974], male holotype; Sommet, 2130 m, 11.II.2018, 2018MadaSH366, S. Hugel. Idem, 2018MadaSH367, S. Hugel.

Thymochares sambavana (Günther, 1974)

RN XII, Marojejy-Ouest, 1140 m, XI.1959, P. Soga [in Günther 1974], 1 male; RN XII, Marojejy-Ouest, 1850 m, II. 1960, P. Soga [in Günther 1974], 1 male; RN XII, Marojejy-Ouest, Col central, 1700 m, I. 1960, P. Soga [in Günther 1974], 4 males, 1 female (types).

TETRIGIDAE, METRODORINAE

Rhynchotettix rostratus Hancock, 1907*

Camp 1 vers Cascade Humbert, 500-580 m, 5.II.2018, 2018MadaSH091, S. Hugel (Figure 1E). Idem, 2018MadaSH092, S. Hugel. Idem, 2018MadaSH093, S. Hugel. Idem, 2018MadaSH094, S. Hugel. This species exists elsewhere on Madagascar (Antongil Bay in Günther, 1974).

Arexion suavis Rehn, 1929*

Bas Camp 2, 700-750 m, 8.II.2018, 2018MadaSH176, S. Hugel (Figure 1I).

This species exists elsewhere in Madagascar (northeast, center, east, in Günther, 1974).

Charagotettix sogai Günther, 1974

RN XII, Marojejy-Ouest, 1140 m, XI. 1959, P. Soga [in Günther, 1974], 1 male; RN XII, Marojejy-Ouest, 1600 m, XI. 1959, P. Soga [in Günther 1974], male female holotype and allotype, 3 paratypes. RN XII, Marojejy-Ouest, Col central, 1700 m, XI. 1959, P. Soga [in Günther, 1974], 2 males.

This species is only known from Marojejy.

Cryptotettix imerina Rehn, 1929

Marojejy Ouest, 1600 m, XI. 1959 [in Günther, 1974], 1 female.

This species exists in other regions of Madagascar (recorded in Maroantsetra, Périnet, Brickaville, Ste Marie, in Günther, 1974).

Cryptotettix impennis Günther, 1939*

Bas Camp 2, 700-750 m, 8.II.2018, 2018MadaSH200, S. Hugel. Camp 1 vers cascade Humbert, 500-580 m, 5.II.2018, 2018MadaSH095, S. Hugel. Idem, 2018MadaSH096, S. Hugel. Idem, 2018MadaSH097, S. Hugel. Camp 3 +/- 300 m, 1250-1400 m, 10-11.II.2018, 2018MadaSH375, S. Hugel. Idem, 2018MadaSH376, S. Hugel. Idem, 2018MadaSH379, S. Hugel. Entre Camp 2 et 3, 950-1150 m, 12.II.2018, 2018MadaSH386, S. Hugel. Entrée parc vers Camp 1, 175-275 m, 7.II.2018, 2018MadaSH146, S. Hugel. Haut Camp 2, 800-900 m, 9.II.2018, 2018MadaSH248, S. Hugel.

This species exists elsewhere on Madagascar (was previously only known from Antongil Bay in Günther, 1974).

Cryptotettix similis Günther, 1974

Marojejy Ouest, 1600 m, XI.1959, [in Günther, 1974], 1 male.

This species is only known from Marojejy area, the holotype is from Anjanaharibe [Sud] (Günther, 1974).

Holocerus lucifer (Serville, 1838)Ambatosoratra, 1000 m, VIII.1960, P. Soga [in Günther, 1974], 1 juv.; Ambinanitelo, 500 m XII.1958, E. Raharizonina [in Günther, 1974]. 14.437S, 49.742E, Rowe Becky, [ID Devriese in Skejo *et al.*, 2020]. Camp 1 vers Camp 2 mi-chemin, 575-625 m, 6.II.2018, 2018MadaSH133, S. Hugel, 1 male; Camp 3 +/- 300 m, 1250-1400 m, 10-11.II.2018, 2018MadaSH371, S. Hugel, 1 male; Idem, 2018MadaSH372, S. Hugel, 1 juv.; Camp 3, 1325 m, 26.X.2021, N. Cliquennois, 1 juv.; Idem, N. Cliquennois, 1 juv.This species exists elsewhere in the east of Madagascar (Günther, 1974; Skejo *et al.*, 2020).*Notocerus formidabilis* Günther, 1974

Réserve Naturelle XII, Beondroka, 1200 m VI.1960, P. Soga [in Günther, 1974], 1 male; bas Camp 2, 700-750 m, 12.II.2018, 2018MadaSH430, S. Hugel. Camp 1 vers Camp 2 mi-chemin, 575-625 m, 6.II.2018, 2018MadaSH147, S. Hugel, 1 female; Camp 2 ouest, 775-850 m, 15.II.2018, 2018MadaSH543, S. Hugel, 1 male (Figure 1G); Camp 2 vers 3, crête, 1150-1250 m, 15.II.2018, 2018MadaSH537, S. Hugel, 1 female.

This species exists elsewhere in northwestern Madagascar (Mathieu *et al.*, 2021).*Ocytettix latihumerus* Hancock, 1907

RN XII, Marojejy-Ouest, Col central, 1700 m, I.1960, P. Soga [in Günther, 1974], 5 males, 5 females.

This species exists elsewhere in Madagascar: it was described from Antongil Bay (Günther, 1974).

"A" u.sp. * genus *Oxytettix*

Bas Camp 2, 700-750 m, 8.II.2018, 2018MadaSH175, S. Hugel. Bas Camp 2, 700-750 m, 13.II.2018, 2018MadaSH448, S. Hugel. Camp 3 +/- 300 m, 1250-1400 m, 10-11.II.2018, 2018MadaSH373, S. Hugel. Idem, 2018MadaSH374, S. Hugel. Entre Camp 2 et 3, 950-1150 m, 12.II.2018, 2018MadaSH385, S. Hugel. Haut Camp 2, 800-900 m, 9.II.2018, 2018MadaSH249, S. Hugel. Idem, 13.II.2018, 2018MadaSH444, S. Hugel.

Pterotettix andrei Bolívar, 1887

Table 1. (continued)

Ambatosoratra, 1700 m, XI.1960, P. Soga [in Günther, 1974], 2 male; Ambinanitelo, 500 m, XII.1958, E. Raharizonina [in Günther, 1974], 1 male; Andapa, Camp 1, 740 m, Capuron [in Günther, 1974], 1 female; au-dessus du Camp 2, 775-850 m, 19.X.2021, N. Cliquennois. Bas Camp 2, 700-750 m, 13.II.2018, 2018MadaSH449, S. Hugel. Camp 1 vers cascade, 500-580 m, 5.II.2018, 2018MadaSH098, S. Hugel. Idem, 2018MadaSH099, S. Hugel. Idem, 2018MadaSH100, S. Hugel. Idem, 2018MadaSH101, S. Hugel. Idem, 2018MadaSH102, S. Hugel. Idem, 2018MadaSH103, S. Hugel.

This species exists in other regions of Madagascar (Nosy Be, Nosy Komba, Ananalava District, Günther, 1974).

Pterotettix asmodaeus (Serville, 1838)

Ambinanitelo, 500 m, XII.1958, E. Raharizonina [in Günther, 1974], 1 male.

This species exists in other regions of Madagascar (Toamasina and Ananalava District in Günther, 1974).

TETRIGIDAE, TETRIGINAE

Hydrotetrix? fallax Günther, 1974

RN XII, Marojejy-Ouest, Col central, 1700 m, I. 1960, P. Soga [in Günther, 1974], Holotype allotype; Matsabory du sommet, 2030 m, XII.58, P. Griveaud [in Günther, 1974], 2 femelles; Au-dessus du Camp 2, 775-850 m, 19.X.2021, N. Cliquennois. Bas Camp 2, 700-750 m, 13.II.2018, 2018MadaSH450, S. Hugel. Camp 2, 775 m, 10.II.2018, 2018MadaSH276, S. Hugel. Camp 2 vers 3, crête, 1150-1250 m, 15.II.2018, 2018MadaSH532, S. Hugel. Camp 3 +/- 300 m, 1250-1400 m, 10-11.II.2018, 2018MadaSH377, S. Hugel. Idem, 2018MadaSH378, S. Hugel. Idem, 2018MadaSH380, S. Hugel. Camp 3 vers sommet, 1400-1500 m, 11.II.2018, 2018MadaSH382, S. Hugel. Idem, 2018MadaSH383, S. Hugel. Idem, 2018MadaSH384, S. Hugel.

This species exists in other regions of Madagascar (Montagne d'Ambre and Périnet in Günther, 1974).

PYRGOMORPHOIDEA

PYRGOMORPHIDAE, ORTHACRIDINAE

Uhagonia depressa Dirsh, 1963

Sambava, Massif du Marojejy, Réserve Naturelle Intégrale XII, Ambatosoratra, 1700 m, XI. 1960, [in Dirsh & Descamps, 1968].

Malagasphena minor Kevan, Akbar & Singh 1964*

Camp 3 +/- 300 m, 1250-1400 m, 10-11.II.2018, 2018MadaSH345, S. Hugel, 1 female; haut Camp 2, 800-900 m, 13.II.2018, 2018MadaSH443, S. Hugel, 1 male.

This species exists elsewhere in Madagascar and was described from Toamasina (Dirsh & Descamps, 1968).

Acanthopyrgus longicornis Descamps & Wintrebert 1966

Massif du Marojejy, Betsakotsako, Anjanaharibe [Sud], sous-préfecture d'Andapa, 1030 m, XII. 1961, [in Dirsh & Descamps, 1968]. Camp 2 ouest, 775-850 m, 14.II.2018, 2018MadaSH503, S. Hugel, 1 female (Figure 1D); Camp 3 +/- 300 m, 1250-1400 m, 10-11.II.2018, 2018MadaSH346, S. Hugel, 1 male.

This species is only known from Marojejy area, the holotype is from Anjanaharibe [Sud] (Descamps & Wintrebert, 1966b; Dirsh & Descamps, 1968).

“B” u.gen u.sp. * family *Pyrgomorphidae*

Sommet, 2130 m, 11.II.2018, 2018MadaSH358, S. Hugel.

PYRGOMORPHIDAE, PYRGOMORPHINAE

Schulthessia biplagiata Bolívar, 1905*

Camp entrée Parc, 175 m, 16.II.2018, 2018MadaSH581, S. Hugel, 1 female; Idem, 2018MadaSH582, S. Hugel, 1 female; Entrée parc vers Camp 1, 175-275 m, 7.II.2018, 2018MadaSH153, S. Hugel, 1 female.

This species is widely distributed in other regions of Madagascar (Dirsh & Descamps, 1968).

Rubellia nigrosignata Stål, 1875

Massif du Marojejy, Réserve Naturelle Intégrale XII, Andrakata, II.1952, P. Soga [in Dirsh & Descamps, 1968].

This species occurs in most regions of Madagascar (Dirsh & Descamps, 1968; Braud *et al.*, 2014).

EUMASTACOIDEA

EPISACTIDAE, MIRACULINAE

Acronomastax curvicerca Descamps, 1965

Ambinanitelo, 500 m, XII.1958, E. Raharizonina [in Dirsh & Descamps, 1968]. Réserve Naturelle XII, Beondroka, 1200 m, VI. 1960, P. Soga [in Dirsh & Descamps, 1968]. Andapa, Anjanaharibe [Sud], 1600 m, IV.1960, P. Soga [in Dirsh & Descamps, 1968]. Camp 1 vers cascade, 500-580 m, 5.II.2018, 2018MadaSH076, S. Hugel, 1 male; Idem, 2018MadaSH077, S. Hugel, 1 male; Idem, 2018MadaSH078, S. Hugel, 1 male; Idem, 2018MadaSH079, S. Hugel, 1 female; Idem, 2018MadaSH080, S. Hugel, 1 female; Idem, 2018MadaSH082, S. Hugel. Idem, 2018MadaSH083, S. Hugel, 1 female; Idem, 2018MadaSH084, S. Hugel, 1 male (Figure 1H); Idem, 2018MadaSH085, S. Hugel, 1 female (Figure 1H).

This species is only known from the Parc National de Marojejy and Anjanaharibe-Sud localized nearby

Acronomastax dentata Descamps, 1965

Réserve naturelle XII, Marojejy ouest, 1600 m, XI. 1959, P. Soga [in Dirsh & Descamps 1968]; Camp 1 vers Cascade Humbert, 500-580 m, 5.II.2018, 2018MadaSH081, S. Hugel, 1 female.

This species is only known from the Parc National de Marojejy.

Malagassa mucronata Descamps, 1965

Réserve Naturelle XII, Marojejy ouest, 1600 m, XI. 1959, P. Soga [in Dirsh & Descamps 1968].

This species is only known from the Parc National de Marojejy.

Table 1. (continued)

“C” u.sp. * genus *Malagassa*

Autour du Camp 4, 1625 m, 29.X.2021, N. Cliquennois, 1 male; autour du Camp 4 1650 m, 29.X.2021, N. Cliquennois, 1 juv.; Camp 3 +/- 300 m, 1250-1400 m, 10-11.II.2018, 2018MadaSH351, S. Hugel, 1 female; Idem, 2018MadaSH355, S. Hugel. Idem, 2018MadaSH356, S. Hugel. Camp 3 ou 4, X.2021, ?, 1 female; Camp 3 ou 4, X.2021, ?, 1 juv.

EUSCHMIDTIIDAE, PSEUDOSCHMIDTIINAE

“D” u.sp. * genus *Acanthomastax*

Haut Camp 2, 800-900 m, 9.II.2018, 2018MadaSH247, S. Hugel, 1 female.

“E” u.sp. * genus *Sauromastax*

Haut Camp 2, 800-900 m, 9.II.2018, 2018MadaSH245, S. Hugel, 1 male.

“F” u.sp. * genus *Microlobia*

Camp 1 vers Camp 2 mi-chemin, 575-625 m, 6.II.2018, 2018MadaSH130, S. Hugel, 1 female; Camp 3 +/- 300 m, 1250-1400 m, 10-11.II.2018, 2018MadaSH354, S. Hugel, 1 male; haut Camp 2, 800-900 m, 13.II.2018, 2018MadaSH441, S. Hugel, 1 male.

“G” u.sp. * genus *Malagamastax*

Bas Camp 2, 700-750 m, 8.II.2018, 2018MadaSH198, S. Hugel, 1 male; Camp 1 bas chemin, 375-450 m, 5.II.2018, 2018MadaSH075, S. Hugel, 1 male; Camp 1 vers Camp 2 mi-chemin, 575-625 m, 6.II.2018, 2018MadaSH129, S. Hugel, 1 male; entrée parc vers Camp 1, 175-275 m, 7.II.2018, 2018MadaSH152, S. Hugel, 1 female (Figure 1J); haut Camp 2, 800-900 m, 9.II.2018, 2018MadaSH246, S. Hugel, 1 female.

“H” u.sp. * genus *Pseudoschmidtia*¹

Haut Camp 2, 800-900 m, 9.II.2018, 2018MadaSH442, S. Hugel, 1 male.

“I” u.gen. u.sp. * subfamily *Pseudoschmidtinae*

Camp 2 ouest, 775-850 m, 14.II.2018, 2018MadaSH514, S. Hugel, 1 male.

ACRIDOIDEA

ACRIDIDAE, ACRIDINAE

Gymnobothrus variabilis Bruner, 1910 *

Camp 1 bas, 375-450 m, 5.II.2018, 2018MadaSH061, S. Hugel, 1 female; Idem, 2018MadaSH065, S. Hugel, 1 female; Idem, 2018MadaSH066, S. Hugel, 1 male.

This species occurs in most regions of Madagascar and on islands of the Malagasy Region (Dirsh & Descamps, 1968; Parnaudeau *et al.*, 2013; Braud *et al.*, 2014).

ACRIDIDAE, CATANTOPINAE

Catantopsis sacalava (Brancsik, 1893)

Sambava, Massif du Marojejy, Ambinanitelo, 500 m, XII.1958 [in Dirsh & Descamps 1968]. Camp 1 bas, 375-450 m, 5.II.2018, 2018MadaSH062, S. Hugel, 1 male; Idem, 2018MadaSH063, S. Hugel, 1 male; Idem, 2018MadaSH064, S. Hugel, 1 male.

This species occurs in most regions of Madagascar and on islands of the Malagasy Region (Dirsh & Descamps, 1968; Parnaudeau *et al.*, 2013; Braud *et al.*, 2014).

Serpusilla ochreopyga ochreopyga Dirsh, 1962

Massif du Marojejy, Betsakotsako, Anjanaharibe [Sud], 1600 m, IV 1960, P. Soga [in Dirsh & Descamps 1968].

This species is only known by the holotype from the Marojejy region.

“J” u.gen u.sp.1 * subfamily *Catantopinae*

Bas Camp 2, 700-750 m, 8.II.2018, 2018MadaSH199, S. Hugel, 1 juv.; Camp 1 vers Cascade Humbert, 500-580 m, 5.II.2018, 2018MadaSH067, S. Hugel, 1 male; Idem, 2018MadaSH068, S. Hugel, 1 male; Idem, 2018MadaSH069, S. Hugel, 1 male; Idem, 2018MadaSH070, S. Hugel, 1 male; Idem, 2018MadaSH071, S. Hugel, 1 female; Idem, 2018MadaSH072, S. Hugel, 1 female; Idem, 2018MadaSH073, S. Hugel, 1 female; Camp 2 ouest, 775-850 m, 14.II.2018, 2018MadaSH513, S. Hugel, 1 juv.; haut Camp 2, 800-900 m, 9.II.2018, 2018MadaSH243, S. Hugel, 1 male; Idem, 2018MadaSH244, S. Hugel, 1 female.

“K” u.gen u.sp.2.* subfamily *Catantopinae*

Camp 1 bas, 375-450 m, 4.II.2018, 2018MadaSH059, S. Hugel, 1 male; Idem, 2018MadaSH060, S. Hugel, 1 male.

“L” u.sp. * genus *Perineta*

Bas Camp 2, 700-750 m, 12.II.2018, 2018MadaSH427, S. Hugel, 1 male.

“M” u.sp. * genus *Serpusiocris*

Sommet, 2130 m, 11.II.2018, 2018MadaSH359, S. Hugel, 1 male; Idem, 2018MadaSH360, S. Hugel, 1 male; Idem, 2018MadaSH361, S. Hugel, 1 male; Idem, 2018MadaSH362, S. Hugel, 1 female; Idem, 2018MadaSH363, S. Hugel, 1 female; Idem, 2018MadaSH364, S. Hugel, 1 female; Idem, 2018MadaSH365, S. Hugel, juvenile.

Vohemara hysiloides Dirsh, 1966 *

Bas Camp 2, 700-750 m, 12.II.2018, 2018MadaSH432, S. Hugel, 1 female (Figure 1C); Idem, 2018MadaSH433 (Figure 1C), S. Hugel, 1 male; Camp 1 vers Camp 2 mi-chemin, 575-625 m, 6.II.2018, 2018MadaSH131, S. Hugel, 1 male; Idem, 2018MadaSH132, S. Hugel, 1 juv.; Idem, 2018MadaSH086, S. Hugel, 1 juv.; entrée parc vers Camp 1, 175-275 m, 7.II.2018, 2018MadaSH154, S. Hugel, 1 male; Idem, 2018MadaSH155, S. Hugel, 1 male; Idem, 2018MadaSH161, S. Hugel, 1 female; haut Camp 2, 800-900 m, 9.II.2018, 2018MadaSH242, S. Hugel, 1 female.

This species was previously only known from the holotype collected at Vohémar (Dirsh, 1966; Dirsh & Descamps, 1968).

Finotina ranavaloeae (Finot, 1907)

Table 1. (continued)

Sambava, Massif du Marojejy, Ambinanitelo, 500 m, XII.1958, E. Raharizonina [in Dirsh & Descamps, 1968].
This species is known from other localities in the east of Madagascar (Dirsh & Descamps, 1968).

ACRIDIDAE, EYPREPOCNEMIDINAE

Eyprepocnemis smaragdipes Bruner, 1910 *

Camp 1 bas chemin, 375-450 m, 5.II.2018, 2018MadaSH074, S. Hugel, 1 male.

This species occurs in most regions of Madagascar, and in islands of the Malagasy Region (Dirsh & Descamps, 1968; Hugel, 2014).

Heteracris finoti (Bolívar, 1914)

Sambava, Massif du Marojejy, Ambinanitelo, 500 m, XII.1958, E. Raharizonina [in Dirsh & Descamps, 1968]. Camp 1 vers Camp 2 mi-chemin, 575-625 m, 6.II.2018, 2018MadaSH126, S. Hugel, 1 female (Figure 1A).

This species is known from other localities in the east of Madagascar (Dirsh & Descamps, 1968).

ACRIDIDAE, HEMIACRIDINAE

“N” u.sp.1 * genus *Gergis*

Camp 3, 1325 m, 15.II.2018, 2018MadaSH552, S. Hugel, 1 male; Camp 3 +/- 300 m, 1250-1400 m, 10-11.II.2018, 2018MadaSH347, S. Hugel, 1 male.

“O” u.sp.2 * genus *Gergis*

Camp 2, 775 m, 19.X.2021, N. Cliquennois, 1 male; entre Camp 1 et 2, 600 m, 18.X.2021, N. Cliquennois, 1 female.

“P” u.sp.3 * genus *Gergis*

Haut Camp 2, 800-900 m, 13.II.2018, 2018MadaSH440, S. Hugel, 1 male.

“Q” u.gen u.sp. * genus close to *Xenippacris*

Camp 3, 1325 m, 15.II.2018, 2018MadaSH553, S. Hugel, 1 male; haut Camp 2, 800-900 m, 13.II.2018, 2018MadaSH438, S. Hugel, 1 female; Idem, 2018MadaSH439, S. Hugel, 1 female.

Galideus mocquersyi Finot, 1908

Massif du Marojejy, Réserve Naturelle Intégrale XII, Androkata, II.1952, P. Soga [in Dirsh & Descamps, 1968]. Camp 1 vers Camp 2 mi-chemin, 575-625 m, 6.II.2018, 2018MadaSH127, S. Hugel, 1 female (Figure 1 B); Idem, 2018MadaSH128, S. Hugel, 1 female; Camp 2, 775 m, 15.II.2018, 2018MadaSH545, S. Hugel, 1 female.

This species is known from other localities in the east of Madagascar (Dirsh & Descamps, 1968).

“R” u.gen u.sp. * subfamily *Hemiacridinae*

Bas Camp 2, 700-750 m, 8.II.2018, 2018MadaSH178, S. Hugel, 1 male.

“S” u.sp. * genus *Hysiella*

Camp 3, 1325 m, 15.II.2018, 2018MadaSH551, S. Hugel, 1 female; Camp 3 +/- 300 m, 1250-1400 m, 10-11.II.2018, 2018MadaSH348, S. Hugel, 1 male; Idem, 2018MadaSH349, S. Hugel, 1 female.

“T” u.sp.2 * genus *Pseudoserpusia*

Bas Camp 2, 700-750 m, 8.II.2018, 2018MadaSH177, S. Hugel, 1 male; Idem, 2018MadaSH426, S. Hugel, 1 male.

Xenippoides elongatus Chopard, 1952 *

Camp 3, 1325 m, 15.II.2018, 2018MadaSH554, S. Hugel, 1 female; entre Camp 2 et 3, 950-1150 m, 12.II.2018, 2018MadaSH389, S. Hugel, 1 female.

This species was previously only known from Tsaratanàna mountain (Chopard, 1951; Dirsh & Descamps, 1968).

“U” u.sp. * genus *Xenippoides*

Camp 3 +/- 300 m, 1250-1400 m, 10-11.II.2018, 2018MadaSH357, S. Hugel.

ACRIDIDAE, OEDIPODINAE

Paracinema tricolor (Thunberg, 1815)

Massif du Marojejy, Ambinanitelo, 500 m, XII.1958, E. Raharizonina [in Dirsh & Descamps, 1968].

This species has a wide distribution in Madagascar, Africa, and elsewhere (Dirsh & Descamps, 1968).

Trilophidia cinnabarina Brancsik, 1893

Massif du Marojejy, Ambinanitelo, 500 m, XII.1958, E. Raharizonina [in Dirsh & Descamps, 1968]. Hors Parc, Mandena, cultures, 150-175 m, 16.II.2018, 2018MadaSH585, S. Hugel.

This species occurs in all regions of Madagascar (Dirsh & Descamps, 1968; Braud *et al.*, 2014).

Oxya hyla Serville, 1831

Massif du Marojejy, Ambinanitelo, 500 m, XII.1958, E. Raharizonina [in Dirsh & Descamps, 1968]. Hors Parc, Mandena, cultures, 150-175 m, 16.II.2018, 2018MadaSH584, S. Hugel.

This species has a wide distribution in Madagascar, Africa, and elsewhere (Cigliano *et al.*, 2020).

* : new record for Parc National de Marojejy.

Taxa endemic to Madagascar are in **boldface** type; taxa endemic to the Malagasy Region are underlined.

¹ *Pseudoschmidia tridens* Rehn & Rehn, 1945, is to our knowledge not known from Marojejy and the photo of it in Hugel (2022) was wrongly labelled as being from Marojejy, and was from the Réserve Naturelle Intégrale de Betampona.

type specimens of 59% of Caelifera species recorded from the protected area when both described and to-be-described species are considered (Figure 2D).

Among species only known from Marojejy, 21 do not correspond to any currently described species and these will be named in subsequent publications. This number of new species is quite large considering that on Madagascar, Caelifera is by far the best-known of the two Orthoptera suborders (Hugel, 2022). This elevated number of undescribed species may also be due to our collecting methods, targeting particularly night active species. It is important to note that this number of new species is not associated with a bias towards particular altitudes in sampling efforts: the proportion of Marojejy species occurring at each range of elevations being the same for described and undescribed species (Figure 2A).

Species only represented in the collections from Marojejy by a single specimen are termed “singletons”. The percentage of Caelifera singletons from Marojejy amounts to 27% of the recorded species on the massif (Figure 2C, Table 1). Insect collections from other tropical forests contain a similar proportion of singletons, ranging between 25 and 32% (Bickel, 1999; Novotný & Basset, 2000; Coddington *et al.*, 2009). Several ideas have been proposed to explain this considerable number, under sampling being probably the principal reason (Coddington *et al.*, 2009).

Distribution of species across elevation

The known elevational distribution of half of Caelifera species recorded on the Marojejy Massif is narrow, not exceeding 200 m in altitudinal width (Figure 2B). Since the number of singletons suggests an under sampling of Caelifera at Marojejy, interpretations of the elevational distribution of species should be considered as preliminary, especially for species with apparently narrow ranges. A few species displayed elevational ranges of over 1000 m (Figure 2B). Some of these species are associated with habitats occurring at a wide altitudinal gamut. For example, *Thymochares exiguus* occurs on large rocks at various altitudes and *Vohemara hysielloides* feeds on Nolinoidea plants (*Dracaena* sp. and relatives, Figure 1C) occurring from near the park entrance to the upper limit of the forest.

On the Marojejy Massif, more than half of Caelifera species occur at elevations ranging between 650 and 1150 m, the zone that holds the highest species diversity of this suborder (Figure 2A). About 15% of Marojejy Caelifera species occur

in montane ericoid thickets and montane grasslands (Figure 2A). This distribution in species richness is similar to that reported for this suborder in the Mascarenes (Hugel, 2014, 2015).

Species associated with specific habitats or food plants

The collection of multiple specimens of a given species allows some insight into their microhabitat usage and preferred food plants. For example, *Rhynchotettix rostratus* (Figure 1E) and *Galideus mocquersyi* (Figure 1B), have only been observed on Bambusoidea plants, the former on small plants near the ground and the latter at 1 to 3 m off the ground.

The undescribed “Q” u.gen u.sp. (close to *Xenippacris*) has only been observed feeding on palm leaves. *Vohemara hysielloides* and species “S” u.sp. (genus *Hysiella*) are only known to feed on Nolinoideae plants at 50 cm to 2 m off the ground (Figure 1C). The species “A” u.sp. (genus *Oxytettix*) appear to be restricted to tree trunks and *Cryptotettix impennis* to leaf litter. The Miraculinae *Acronomastax curvicerca* (Figure 1H) and the undescribed Catantopinae “J” u.gen u.sp. occur in low vegetation below 1 m. The two specimens of the pyrgomorphid *Acanthopyrgus longicornis* were observed on leaves 5 m off the ground (Figure 1D).

Conclusion

The number of new species of Caelifera discovered on the Marojejy Massif in 2018 and 2021, as well as the high rate of taxa only known from a single specimen, suggest that more work is needed to comprehensively inventory grasshoppers from the park. Notwithstanding these limitations, the Caelifera fauna of the Parc National de Marojejy is particularly rich, representing at least 12% of the number of species belonging to this suborder described from Madagascar as a whole. Moreover, the large number of species only known from Marojejy underlines the particular importance of this protected area in the conservation of Malagasy Caelifera.

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