

1 **A new species of aposematic grasshopper of the**
2 **Bolivian genus *Pseudoutanacris* (Caelifera:**
3 **Gomphocerinae) ~~discovered from~~in the Andean cloud**
4 **forest of the Ecuadorian Amazon basin**

5
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14 **Abstract**

15 The lack of knowledge about the diversity of insects, especially in the tropics, is a significant gap
16 that we aim to address in this study focusing on Orthoptera. Our research contributes to the
17 identification of poorly understood species within the genus *Pseudoutanacris* and provides
18 insights into related species. We have identified a new grasshopper species belonging to this
19 genus in the montane forests of the eastern Andes in Ecuador. This discovery expands the known
20 distribution of the genus, previously limited to a single species in the Bolivian tropics, by over
21 2,000 kilometers. The newly described species, *Pseudoutanacris grilla* sp. nov., shares a unique
22 coloration pattern with its congener, *Pseudoutanacris chromobapta* (Jago, 1971), setting them
23 apart from other members of the Amblytropidini tribe. During our study, we also observed *P.*
24 *grilla* sp. nov. on the same plant as *Megacheilacris graminicola* (Descamps & Amédégnato,
25 1971) (Bactrophorinae: Romaleidae), a species with similar chromatic characteristics. This
26 finding also marks the first formal documentation of the new geographical records of *M.*
27 *graminicola* in Ecuador.

28 **Introduction**

29 Despite being insects of relatively large size, striking colors, interesting shapes, and economic
30 importance in agriculture, the Orthoptera group has been relatively understudied in the
31 neotropics, and Ecuador is no exception. With a total of approximately 30,000 species known
32 worldwide, of which 40% correspond to short-horned diurnal grasshoppers (Caelifera), the
33 country's diversity is only about 2% of the world's total (Cigliano et al., 2025). In well-known
34 groups such as vertebrates, plants, butterflies, or certain families of beetles, the percentage of
35 diversity reaches values greater than 5% (Campos et al., 2020). This disparity highlights the

39 limited research efforts directed towards orthopterans, particularly in a diverse country like
40 Ecuador, where vast areas such as the páramos-Páramos and montane forests of the Andes
41 remain largely unexplored.

42
43 The Amblytropidini tribe, mainly distributed in the Neotropical region, is one of the 19
44 recognized tribes of the Gomphocerinae subfamily found almost worldwide, except in Oceania
45 and certain circumpolar areas. Amblytropidiini is formed by nine genera and about 39 species
46 (Cigliano et al., 2025). In Ecuador, the presence of the tribe is limited to just two species:
47 *Fenestra platyceps* (Hebard, 1924^[gt1]); and *Peruvia nigromarginata* (Scudder, 1875^[gt2]);
48 (Buzzetti & Carotti, 2008; Cigliano et al., 2025). This low diversity value likely indicates
49 undersampling, suggesting that the country's biodiversity of this group may increase in the
50 future.

51
52 The genus *Pseudoutanacris* (Jago, 1971) is currently composed of a single described species
53 found in the tropical zone southeast of Bolivia, in the Department of Santa Cruz de la Sierra.
54 Other photographic records extend its distribution to the southeast of Peru, in the Department of
55 Madre de Dios (Bay, 2015). At first glance, *Pseudoutanacris* differs from all species of the tribe
56 Amblytropidiini and even from the subfamily Gomphocerinae by its coloration, which is
57 composed of bright tones and striking alternating colors, unlike the brown, cream, and orange
58 tones that dominate in other species of the group (Jago, 1971).- The type species of the genus,
59 *Pseudoutanacrisnautia* *chromobapta* (Jago, 1971), is known only from males, and its name
60 reflects the colorful nature of a related genus^[gt3]. *Utanacris* (Miller, 1934^[gt4]), of the subfamily
61 Catantopinae from the Malay Peninsula.

62
63 At In the end, this study marks the beginning of a series on the acridoid grasshoppers of Ecuador.
64 The National Institute of Biodiversity of Ecuador has been investigating these grasshoppers for
65 the past years, building on the research conducted by a French mission from the Museum of
66 Natural History of Paris in the late 20th century.

68 Materials & Methods

69
70 All the specimens cited in this work are deposited in the scientific collection of invertebrates at
71 the National Biodiversity Institute (INABIO) in Ecuador, representing the MECN (Ecuadorian
72 Museum of Natural Sciences) collections. Labels of type material are quoted separately, line
73 breaks are indicated by a backslash (/), and additional information is given between brackets ([
74]).
75 The specimens studied were collected under research permits No. MAAE-DBI-CM-2022-0228
76 and MAATE-DBI-CM-2023-0309 issued by the Ministry of Environment of Ecuador.

78 Specimens of the new species were compared with published descriptions of the species *P.*
79 *chromobapta* (Jago, 1971), and photographs of the type specimen, available in the Orthoptera
80 Species File (Cigliano et al., 2025). Measurements of the study material (holotype, and
81 paratypes) were taken with a digital caliper (accuracy \pm 0.1 mm). The total body length refers to
82 the insect's body length, from the head to the tip of the abdomen. The width of the head was
83 measured between the two outermost points of the head, ~~in the case of males the eyes; the eyes, in~~
84 ~~the case of males~~, while in females, the measurement was taken from the posterior edge of the
85 head.

86
87 The male genitalia were prepared following the procedure proposed by Hubbell (1932). The
88 process begins by softening the entire animal in hot water for a short period (30 seconds) and
89 focusing on the tip of the abdomen for a slightly longer time. ~~Using a stereo microscope, an~~
90 ~~incision is made on the left side between the distal tergites and sternites.~~ [gt5] The membrane
91 connecting the ventral surfaces of the paraprocts to the sclerotized plate at the cephalic end is
92 then cut. The caudal end of the genital mass is carefully slid outward to expose the penis. The
93 pallium is separated from the subgenital plate, and the entire genital apparatus is removed. ~~A~~
94 ~~treatment with 10% KOH in a water bath~~ [gt6] ~~for 2 minutes is performed~~ ~~To~~ ~~to~~ study the genitals,
95 ~~a treatment with 10% KOH in a water bath for 2 minutes is performed~~, followed by soaking the
96 sample in distilled water. If necessary, soft tissues are cleaned, and the structures are preserved in
97 ~~70% alcohol.~~ [gt7] A Zeiss Stemi 2000-C microscope and a Canon G10 camera were used for the
98 genital study. Photographs of live animals were captured using a Nikon D3300 camera with a
99 Nikkor 105mm macro lens and a Sony Alpha7 camera with a Sigma 105mm macro lens.

100
101 For molecular species identification, we amplified the classical animal DNA barcode, a fragment
102 of the mitochondrial cytochrome oxidase I (COI) gene, in collaboration with the Canadian
103 Centre for DNA Barcoding (CCDB). We used the C_LepFolF and C_LepFolR primers and
104 ~~following~~ ~~followed~~ the standard protocols of the Biodiversity Institute of Ontario at Guelph
105 University (Ratnasingham et al., 2024). [gt8]

106
107 To genetically identify the male and female specimens of *Pseudoutanacris grilla* sp. nov., we
108 compared the acquired DNA barcodes of specimens (MECN-FC1987 (♂), MECN-FC1988 (♀),
109 and MECN-FC1992 (♂)) using the BIN code. BOLD Systems assigns unique alphanumeric
110 codes called "Barcode Index Numbers" (BINs) to define distinct genetic clusters in the entire
111 BOLD Systems database (Ratnasingham & Hebert, 2013). NJ trees were generated in BOLD
112 Systems based on Kimura two-parameter distances, and were viewed and edited using the
113 software MEGA X and FigTree v1.4.4. For the outgroup, we use ~~to~~ *Peruvia nigromarginata*
114 (~~(Seudder, 1875)~~ published in this paper) and *Amblytropidia mysteca* (Saussure, 1861) [gt9]
115 (~~Kumar et al., 2018; Ratnasingham & Hebert, 2013~~) [gt10]. Sequences are available in GenBank
116 under the accession numbers PV173915, PV173916, PV173917, PV173918 in the BOLD
117 Systems database (www.boldsystems.org/). [gt11]

118
119 The electronic version of this article in Portable Document Format (PDF) will represent a
120 published work according to the International Commission on Zoological Nomenclature (ICZN),
121 and hence the new names contained in the electronic version are effectively published under that
122 Code from the electronic edition alone. This published work and the nomenclatural acts it
123 contains have been registered in ZooBank, the online registration system for the ICZN. The
124 ZooBank LSIDs (Life Science Identifiers) can be resolved and the associated information viewed
125 through any standard web browser by appending the LSID to the prefix <http://zoobank.org/>. The
126 LSID for this publication is: [urn:lsid:zoobank.org:act:1EE26CD7-7B6F-4894-8971-
127 374CF07F9214]. The online version of this work is archived and available from the following
128 digital repositories: PeerJ, PubMed Central SCIE and CLOCKSS.

129

130 **Results**

131

132 ***Pseudoutanacris grilla* sp. nov.**
133 <https://zoobank.org/NomenclaturalActs/1ee26cd7-7b6f-4894-8971-374cf07f9214>

134

135 Type material.-

136

137 Holotype: Ecuador. Morona Santiago, / M. El Tigrillo, road Macas- / Guamote 1920 m. /
138 -2,217458, -78,224425 / 25-ago-2023 F. Campos²²; " ; [Depository:] MECN-FC-1687²²; "
139 HOLOTYPE / *Pseudoutanacris grilla*²²; " ; DNA voucher specimen / CCDB Lab
140 code / Process ID / ORTEC164-24²².

141

142 Paratypes: 4♂, 1♀ (nymph): Same data as holotype; [Depository:] MECN-FC-1691-4,
143 MECN-FC-1688²²; " ; PARATYPE / *Pseudoutanacris grilla*²²; " ; data of DNA
144 voucher specimen is same as holotype, ORTEC160-24, ORTEC168-24²².

145

146 Etymology

147

148 The word "grilla" is derived from the Spanish word "grillo," which refers to the female of an
149 orthoptera species known as "grillo" (Genus *Gryllus*) and taxonomically belongs to the
150 infraorder Gryllidea. In Ecuador, most orthoptera are commonly referred to as "grillos"
151 (crickets). The term is also used as an Ecuadorianism to describe a person who seeks attention,
152 exhibiting in Ecuadorianism to describe a person who seeks attention and exhibits behavior
153 similar to that of the species.

154

155 Description.-

156

157 Male. Small to medium-medium-sized insect with quite rough tegument.

158

159 Coloration: The insect has a predominantly green and red color ~~schema~~pattern (Fig. 1A). The
160 head, pronotum disc, and wings are olive green, while the face also features yellowish tones
161 (Figs. 1A; 2A-C). ~~Red~~The red coloring is visible on the proximal half of the posterior femurs, as
162 well as on the sides of the thorax and pronotum (Figs. 1A; 2A, C). The eyes appear blue in life
163 (Fig. 1A). The antennae are black with a cream apex, light blue peduncle, and pedicel (Figs. 1A;
164 2A-C). The tibiae and tarsi of all legs are a faint turquoise color, with the femurs of the front and
165 middle legs displaying a jade green hue with brown flecks. The distal half of the posterior femurs
166 ~~showcase~~haves two faint green and cream bands near the black ~~knees~~genicular lobes. The
167 abdomen is orange on the sides and dorsally, with a yellowish ~~lower part~~gt13 (Fig. 1A). The
168 cerci are black, and the posterior tip of the abdomen ~~features is~~ light blue, white, and yellow
169 tones (see Figs. 1A-3A-C).

170

171 Head: Slightly wider than long with prominent, almost oval eyes. The frontal costa ~~is very~~
172 ~~pronounced, extending~~s from the tip of the fastigium to below the middle ocellus, ~~a distance~~
173 ~~similar to the width of the scape~~gt14, and then ~~disappearing~~disappears. Along its length, it
174 is marked by small but deep subcircular points, arranged in two parallel rows in the holotype and
175 more disordered in the paratypes (Fig. 2C-D). The fastigium of the vertex ~~of the fastigium~~ is
176 truncated in front, with strong lateral and middle carinae, the latter extending moderately along
177 the entire occiput (Fig. 2A-B). Antennae are less than 2.2 times the size length of the head and
178 pronotum combined, with 22 segments slightly narrower at their proximal end.

179

180 Thorax: The pronotum is rough on the dorsal and lateral surfaces, with three moderately marked
181 sulci. The middle carina is evident throughout its entire length, while the lateral carinae are
182 almost absent, except at the posterior end of the metazone. The posterior edge of the pronotum is
183 angular and rounded, with a posterior projection of 25 degrees (Fig. 2A). The lateral
184 lobessurfaces of the pronotum have a straight anterior edge, a slightly obtuse lower anterior
185 angle, and a sinuous lower edge that is concave in the prozone and convex in the metazone. The
186 posteroinferior angle is barely obtuse and appears subcircular. The posterior edge is barely
187 sinuous, concave below, and convex at the upper end (Fig. 2C). The tegmina have very marked
188 venation and are abbreviated with an extension that varies between the 8th tergite and the tip of
189 the supra-anal plate. The hindwings are approximately the same size length as the tegmina.

190

191 Legs: Long, with middle and forelegs almost as long as the hind femur extension, and the hind
192 femur is $\frac{1}{4}$ longer than the tip of the abdomen. The hind leg has 10 internal and external tibial
193 spines, with the inner ones approximately twice the size of the outer ones. The inferior inner lobe
194 of the knee has an apical tip (Fig. 1A).

195

196 Abdomen: The abdomen ~~features has~~conical cerci that are robust and~~robust~~conical cerci that
197 project directly backward. The triangular epiproct has a slightly rounded posterior angle. In ~~top~~

198 dorsal view, the subanal^[gt15] plate is subtriangular with a rounded tip at the posterior end. In
199 lateral view, it does not extend beyond the lateral edge (Fig. 3A-C).
200
201 Phallic complex⁺ characterized by very long, straight, and narrow aedeagal valves. The
202 epiphallus has a narrow and elongated bridge, spiniform anchorae with inward-directed tips, a
203 triangular anterior process with a rounded outward-directed apex, and a dilated posterior process
204 (Fig. 4A-D).^[gt16]
205
206 Female: The only female we have is an immature^[gt17] specimen, but we are including its
207 description as it adds to the knowledge of the species. This is particularly significant as it is the
208 first female description for this genus.
209
210 The female is twice the size of the male and has a wider overall appearance, especially in the
211 head and thorax, giving it a fusiform shape. Compared to the male, the female has smaller
212 antennae and posterior femurs. The antennae are 1.5 times the length of the head and pronotum,
213 while the posterior femurs are 57% of the body size, whereas in males, this value is 88%. The
214 female shares most anatomical features with the male, except for the presence of a prominent
215 lateral carina on the entire pronotum. The most noticeable difference is the female's cryptic
216 coloration, which is olive green with brown hues on the head, thorax, and extremities. The hind
217 legs have black areas on the femur internally and externally, as well as on the knees genicular
218 lobes and the proximal part of the tibias. The rest of the tibias and tarsi are deep red. The
219 antennae are mustard yellow with black spots towards the distal end and yellow in the last
220 segments.
221
222 We obtained 3 complete COI sequences from three Pseudoutanaeris P. grilla sp. nov. specimens
223 from Ecuador. The barcode analysis results^s for specimens MECN-FC1987 (♂), MECN-FC1988
224 (♀), and MECN-FC1992 (♂) support their genetic similarity between the female and the males.
225 Confirm these specimens are of the same species even though their colors and morphology are
226 somewhat different. The Molecular clustering is available in supplementary file number 1^[gt18].
227
228 **Comparative diagnosis**
229
230 Pseudoutanaeris P. grilla sp. nov. is distinguished from P. chromobapta (Jago, 1971) (the only
231 known species of the genus) primarily by its coloration. P. grilla sp. nov. has a green head and
232 red basal half of the posterior femurs and lateral area of the thorax (Fig. 5A), while P.
233 chromobapta has a blue head, a red band on the second basal quarter of the posterior femurs,
234 yellowish-green sides of the thorax, and a black dorsal-lateral band that extends from the anterior
235 edge of the pronotum to the tip of the tegm~~e~~inaes (Figure 5B).
236

237 Anatomically, *P. grilla* sp. nov. has a rougher integument compared to *P. chromobapta*, with
238 deeper punctures-punctuations on the thorax and head. The lateral carinae on the pronotum are
239 more pronounced in the female (nymph)[gt19] of *P. grilla* sp. nov., while in the male, they are
240 mainly visible at the posterior end, unlike the Bolivian species where they are absent.
241 Additionally, the posterior edge of the pronotum has a slightly more angular shape in the
242 Ecuadorian species. The frontal costa in *P. chromobapta* is sulcate, whereas, in *P. grilla* sp.
243 nov., it appears punctuated by two parallel lines of consecutive dots. The antennae size in *P.*
244 *grilla* sp. nov. is slightly smallershorter than the total body length, while in *P. chromobapta*, it is
245 slightly largerlonger. The male terminalia shape, when viewed from the topdorsum, is rounded in
246 the Ecuadorian species and more angular in the Bolivian species.
247

248 In life, males of the two species of *Pseudoutanacris* typically stand upright with their front legs
249 extended, hind legs poised to jump, and heads raised, displaying their antennae (Fig. 5A-B). In
250 contrast, females, with more camouflaged colors, tend to adopt a flattened posture with their legs
251 bent.
252

253 **Distribution and habitat**

254 This species is only known from the type locality in the montane forest ecosystem of the
255 Amazonian Andean foothills of the Province of Morona Santiago, in the Ecuadorian Amazon.
256 The collection site is a disturbed area dominated by grass, bushes, and remaining patches of
257 forest, which are part of the buffer zone of the Sangay National Park. The exact collection point
258 corresponds to an area of tall grass surrounded by bushes.
259

260 **Behavior**

261 In a small patch of tall grass measuring three to four square meters, we observed around a dozen
262 red grasshoppers perched on the upper leaves of the kikuyuKikuyu grass (*Cenchrus*
263 *clandestinus*), an invasive species from Africa. Upon closer inspection for photography and
264 collection, we identified two different species, *Pseudoutanacris**P. grilla* sp. nov. and
265 *Megacheilacris graminicola* (Romaleidae), both coexisting in the same habitat. The individuals
266 of *Pseudoutanacris* were more spread out compared to those of *Megacheilacris*. When we
267 collected specimens, we only found male individuals of *Pseudoutanacris*, while *Megacheilacris*
268 was represented by males, females, and juveniles. Locating *Pseudoutanacris* females was
269 challenging, as they were well camouflaged in the lower part of the vegetation, blending in
270 seamlessly with the dense grass. We were only able to collect one female in a juvenile state[gt20],
271 prompting initial doubts about whether it belonged to the same species.
272

273 This episode highlights interesting aspects of *P. grilla* sp. nov. Firstly, there is the marked
274 sexual dimorphism, which is not only related to size, shape, and color but also to the
275 differentiated behavior between both sexes. While the males are exposed in a characteristic

278 raised position in the upper zone of the vegetation, the females hide among the low stems in a
279 flattened position. A second aspect is related to communication, not only in terms of
280 aposematism, which is present, in its own way, in both sexes, since in the case of females, these
281 colors remain hidden until the moment of maximum danger, when they extend their legs and
282 expose the red tibias and the inner surfaces of the hind femurs to deter predators in the foliage. In
283 the case of males, their colors are evident to aerial predators. However, also related to
284 communication is the presence of antennae of considerable length, adorned with white at the tip,
285 like a flag. This characteristic is shared with *Megacheilacris*, evidencing a probable elaborate
286 communication mechanism in both species (Klaus Riede, pers. comm.). Finally, a third element
287 of great interest is undoubtedly related to convergent evolution, expressed in the coloration of the
288 males of two different groups, in which two independent species acquire similar characteristics
289 as a survival strategy. There are undoubtedly several questions that remain that we would like to
290 clarify in future behavioral studies; however, these are aspects that position this genus and this
291 species as interesting subjects of study in the field of sexual evolution, adaptability, and inter and
292 intraspecific communication.

293

294 **Etymology**

295

296 ~~The word "grilla" is derived from the Spanish word "grillo," which refers to the female of an~~
297 ~~orthoptera species known as "grillo" (Genus *Gryllus*) and taxonomically belongs to the~~
298 ~~infraorder Gryllidea. In Ecuador, most orthoptera are commonly referred to as "grillos"~~
299 ~~(crickets). The term is also used as an Ecuadorianism to describe a person who seeks attention,~~
300 ~~exhibiting behavior similar to that of the species.~~

301

302 **New geographical records**

303

304 ***Megacheilacris graminicola* (Descamps & Amédégnato, 1971) (Fig. 5D)**

305

306 **Type Locality:** Colombia, Departamento de Putumayo, entre El Mirador y pepino, altitud
307 1.500m, 1♂ Holotype, 1♀ Allotype, 22♂ and 18♀ paratypes, 8 larves, 8-XI-1968. Lg. M.
308 Descamps, E. Lagos, R. Restrepo y H. Salazar. Depository: Museum of Paris.

309

310 **New records:** “[♂] Ecuador. Morona Santiago, / M. El Tigrillo, road Macas- / Guamote 1920 m.
311 / -2,217458, -78,224425 / 25-ago-2023 F. Campos”; “[Depository:] MECN-FC-1700”

312

313 “[1♂, 1♀] Ecuador. Napo / Baeza, junto Río Quijos / -0.457873, -77.89381 / 17-11-2021 1800m
314 / Manual F. Campos”; “[Depository:] MECN-FC-0094; MECN-FC-0100”

315

316 **Distribution:** Piemontane and Lower Montane Forest (500 to 2,000 m) between the Department
317 of Putumayo, Colombia, to the Province of Zamora Chinchipe, in southern Ecuador.

318

319 **Discussion**

320

321 Our study has identified a new species of grasshopper, *Pseudoutanacris-P. grilla* sp. nov., in the
322 montane forests of the eastern Andes in Ecuador. This discovery expands the known distribution
323 of the genus *Pseudoutanacris*, previously limited to Bolivia, by more than 2,000 kilometers. The
324 distinct coloration pattern of *P. grilla* sp. nov., shared with *P. chromobapta*, underscores the
325 uniqueness of this genus within the Amblytropidini tribe.

326

327 The co-occurrence of *P. grilla* and *Megacheilaeris-M. graminicola* in the same habitat suggests
328 potential ecological interactions or convergent evolutionary traits, particularly in coloration and
329 behavior. This raises intriguing questions about the adaptive strategies and communication
330 mechanisms of these species, warranting further investigation.

331

332 Our findings also establish new geographical records for *M. graminicola* in Ecuador,
333 contributing to a better understanding of Orthoptera diversity in the region. Differences in sexual
334 dimorphism and behavior between male and female *P. grilla* sp. nov. offer insights into their
335 ecological roles and reproductive strategies.

336

337 However, our study is limited by a small sample size and the absence of mature female
338 specimens, hindering a comprehensive description of sexual dimorphism and reproductive
339 biology. Future research should focus on expanding the sample size, exploring additional
340 habitats, and conducting detailed behavioral studies to address these gaps.

341

342 **Conclusions**

343

344 In conclusion, our research has identified a new species, *Pseudoutanacris-P. grilla* sp. nov.,
345 which significantly expands the known distribution of the genus *Pseudoutanacris*. This
346 discovery highlights the rich biodiversity of the Ecuadorian Andes and emphasizes the
347 importance of ongoing exploration and documentation of Orthoptera in the region.

348

349 Our findings shed light on the unique coloration and behavior of *P. grilla* sp. nov., suggesting
350 potential ecological interactions and convergent evolution with other grasshopper species. The
351 new geographical records for *M. graminicola* further contribute to our understanding of
352 Orthoptera diversity in Ecuador.

353

354 Future studies should focus on addressing the limitations of our research by increasing sample
355 sizes, exploring additional habitats, and conducting comprehensive behavioral analyses. These
356 efforts will deepen our knowledge of the ecological roles, adaptive strategies, and evolutionary
357 relationships of these intriguing insects.

358

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369

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