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BatFly: A database of Neotropical bat-fly interactions

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Complete List of Authors:	Zapata-Mesa, Natalya; Universidade de Sao Paulo, Montoya-Bustamante, Sebastian; Universidade de Sao Paulo Instituto de Biociencias, Department of Ecology Hoyos, Juliana; University of Georgia Odum School of Ecology Peña, Daniela; Universidad Veracruzana Galindo-González, Jorge; Universidad Veracruzana Chacón-Pacheco, Julio Javier; Institución Educativa José María Córdoba, ; Universidad de Córdoba, Colombia, Ballesteros-Correa, Jesús; Universidad de Córdoba, Colombia, Pastrana-Montiel, Maria; Universidad de Córdoba, Colombia, Graciolli, Gustavo; Universidade Federal de Mato Grosso do Sul, Nogueira, Marcelo Rodrigues; State University of Northern Rio de Janeiro Mello, Marco; Universidade de Sao Paulo Instituto de Biociencias, Department of Ecology
Substantive Area:	Community Ecology < Substantive Area, Species Interactions < Community Ecology < Substantive Area, Parasitism < Species Interactions < Community Ecology < Substantive Area, Data paper < Data < Substantive Area
Organism:	Bats < Mammals < Vertebrates < Animals, Flies, Mosquitoes < Insects < Arthropods < Invertebrates < Animals
Habitat:	
Geographic Area:	South America < Geographic Area, Central America < Geographic Area, Mexico < North America < Geographic Area, Puerto Rico < United States < North America < Geographic Area, Southeast US (DC, DE, FL, GA, MD, NC, SC, WV, VA) < United States < North America < Geographic Area, Southcentral US (AL, AR, KS, KY, LA, MO, MS, OK, TN, TX) < United States < North America < Geographic Area, Southwest US (AZ, CA, CO, NM, NV, UT) < United States < North America < Geographic Area
Key words/phrases:	Antagonism, bats, bat flies, Chiroptera, diseases, ectoparasites, hematophagy, Nycteribiidae, Streblidae, specialization, species interactions, zoonosis
Abstract:	Global changes have increased the risk of emerging infectious diseases, which can be prevented or mitigated by studying host-parasite interactions, among other measures. Bats and their ectoparasitic flies of the families Streblidae and Nycteribiidae are an excellent study model,

	<p>but so far, our knowledge is restricted to fragmented records at a local scale. To help boost research, we have assembled a data set of bat-fly interactions from 174 studies published between 1904 and 2022, plus three original data sets. Altogether, these studies were carried out at 650 sites in the Neotropics, mainly distributed in Mexico, Brazil, Argentina, southern USA and Colombia, among other countries. In total, our data set contains 3,984 interaction records between 237 bat species and 255 fly species. The bat species with the largest number of recorded interactions were <i>Carollia perspicillata</i> (357), <i>Artibeus jamaicensis</i> (263), and <i>Artibeus lituratus</i> (228). The fly species with the largest number of recorded interactions were <i>Trichobius joblingi</i> (256), <i>Megistopoda aranea</i> (235), and <i>Megistopoda proxima</i> (215). The interaction data were extracted, filtered, taxonomically harmonized, and made available in a tidy format together with linked data on bat population, fly population, study reference, sampling methods and geographic information from the study sites. This interconnected structure enables the expansion of information for each interaction record, encompassing where and how each interaction occurred, as well as the number of bats and flies involved. We expect BatFly to open new avenues for research focused on different levels of ecological organization and spatial scales. It will help consolidate knowledge about ecological specialization, resource distribution, pathogen transmission, and the drivers of parasite prevalence over a broad spatial range. It may also help answer key questions, such as: are there differences in fly prevalence or mean infestation across Neotropical ecoregions? What ecological drivers explain those differences? Or how do specialization patterns vary among fly species in the Neotropics? Furthermore, we expect BatFly to inspire research aimed at understanding how climate and land-use changes may impact host-parasite interactions and disease outbreaks. This kind of research may help us reach Sustainable Development Goal 3, Good Health and Wellbeing, outlined by the United Nations.</p>
Note: The following files were submitted by the author for peer review, but cannot be converted to PDF. You must view these files (e.g. movies) online.	
Data_S1.zip	

1 BatFly: A database of Neotropical bat-fly interactions

2 Natalya Zapata-Mesa^{1,2*}, Sebastián Montoya-Bustamante^{1,2}, Juliana Hoyos³, Daniela
3 Peña⁴, Jorge Galindo-González⁵, Julio J. Chacón-Pacheco⁶, Jesús Ballesteros-Correa⁶,
4 María Raquel Pastrana-Montiel⁶, Gustavo Graciolli⁷, Marcelo R. Nogueira⁸, Marco A. R.
5 Mello²

6 ¹ Programa de Pós-graduação em Ecologia, Instituto de Biociências, Universidade de São
7 Paulo, São Paulo, SP, Brazil.

8 ² Departamento de Ecología, Instituto de Biociências, Universidade de São Paulo, São
9 Paulo, SP, Brazil.

10 ³ Odum School of Ecology, University of Georgia, Athens, GA 30602, USA

11 ⁴ Universidad Veracruzana, Xalapa, Veracruz, Mexico.

12 ⁵ Instituto de Biotecnología y Ecología Aplicada, Universidad Veracruzana, Xalapa,
13 Veracruz, Mexico.

14 ⁶ Departamento de Biología, Grupo Investigación Biodiversidad Unicórdoba, Universidad
15 de Córdoba, Montería, Colombia

16 ⁷ Instituto de Biociências, Universidade Federal de Mato Grosso do Sul, Campo Grande,
17 MS, Brazil

18 ⁸ Universidade Federal Rural do Rio de Janeiro. Instituto de Biología, Laboratório de
19 Mastozoología. Seropédica, RJ, Brazil.

20 **Abstract:** Global changes have increased the risk of emerging infectious diseases,
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50 *Key words/phrases:* Antagonism, bats, bat flies, Chiroptera, diseases, ectoparasites,
51 hematophagy, Nycteribiidae, Streblidae, specialization, species interactions, zoonosis.

52 Open Research: The complete data set is available as Supporting Information at: [to be
53 completed at proof stage]. Associated data is also available at: BatFly: A database of
54 Neotropical bat-fly interactions <https://doi.org/10.5281/zenodo.10019756>

55
56 * Corresponding Author E-mail: zapatamesan@gmail.com

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4 Raquel Pastrana-Montiel⁶, Gustavo Graciolli⁷, Marcelo R. Nogueira⁸, Marco A. R. Mello²

5 ¹ *Programa de Pós-graduação em Ecologia, Instituto de Biociências, Universidade de São*

6 *Paulo, São Paulo, SP, Brazil.*

7 ² *Departamento de Ecologia, Instituto de Biociências, Universidade de São Paulo, São Paulo,*

8 *SP, Brazil.*

9 ³ *Odum School of Ecology, University of Georgia, Athens, GA 30602, USA*

10 ⁴ *Universidad Veracruzana, Xalapa, Veracruz, Mexico.*

11 ⁵ *Instituto de Biotecnología y Ecología Aplicada, Universidad Veracruzana, Xalapa,*

12 *Veracruz, Mexico.*

13 ⁶ *Departamento de Biología, Grupo Investigación Biodiversidad Unicórdoba, Universidad*

14 *de Córdoba, Montería, Colombia*

15 ⁷ *Instituto de Biociências, Universidade Federal de Mato Grosso do Sul, Campo Grande,*

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17 ⁸ *Universidade Federal Rural do Rio de Janeiro. Instituto de Biologia, Laboratório de*

18 *Mastozoologia. Seropédica, RJ, Brazil.*

19 * Correspondence and requests for materials should be addressed to Natalya Zapata-Mesa

20 (zapatamesan@gmail.com).

21 **METADATA**

22 **CLASS I. DATA SET DESCRIPTOR**

23 **A. Data set identity**

24 **Title:** BatFly: A database of Neotropical bat-fly interactions

25 **B. Data set identification**

26 **Data set identity codes:**

27 BatFly_References.csv

28 BatFly_Sites.csv

29 BatFly_Sampling.csv

30 BatFly_Bat_Pop.csv

31 BatFly_Fly_Pop.csv

32 Batfly_Species.csv

33 **C. Data set description**

34 **Principal Investigator(s):**

35 1. Natalya Zapata-Mesa. Programa de Pós-graduação em Ecologia, Instituto de
36 Biociências, Universidade de São Paulo, São Paulo, SP, Brazil.

37 2. Marco A. R. Mello. Departamento de Ecologia, Instituto de Biociências,
38 Universidade de São Paulo, São Paulo, SP, Brazil.

39 **Abstract:**

40 Global changes have increased the risk of emerging infectious diseases, which can be
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42 Bats and their ectoparasitic flies of the families Streblidae and Nycteribiidae are an
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69 Wellbeing, outlined by the United Nations.

70 **D. Keywords**

71 Antagonism, bats, bat flies, Chiroptera, diseases, ectoparasites, hematophagy, Nycteribiidae,
72 Streblidae, specialization, species interactions, zoonosis.

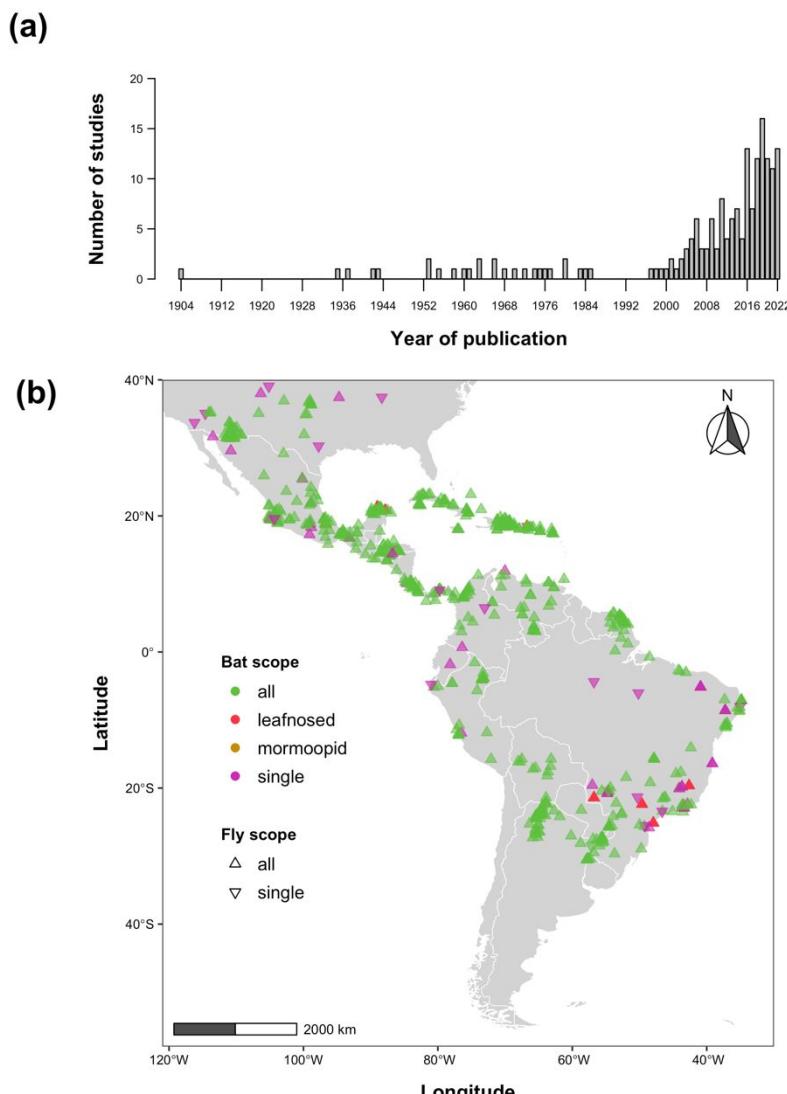
73 **E. Description**

74 Our world faces urgent problems related to global changes caused by human activities,
75 which we strive to solve by following the United Nation's 17 Sustainable Development Goals
76 (UN 2015). Goal 3, "Good Health and Wellbeing", is the focus of research by scientists from
77 many areas under a transdisciplinary approach known as One Health (OHITF 2008). Under
78 this approach, it is of paramount importance to understand the interactions between hosts and
79 their parasites to prevent disease transmission and spillover (Giraudoux et al. 2022).

80 Bats play a crucial role in the dynamics of emerging infectious diseases because of
81 their huge ecological diversity (Wilson and Reeder 2005), which includes a myriad of
82 interactions with endo and ectoparasites (Kliment and Mehlhorn 2016) that carry pathogens
83 associated with zoonosis (Szentiványi et al. 2018). The most important bat ectoparasites are
84 dipterans of the families Streblidae and Nycteribiidae, also known as bat flies (Dick and
85 Patterson 2006). Bat flies (hereafter just flies) share a tight evolutionary history with bats, as
86 they are found exclusively on them (Dick and Dittmar 2014). Consequently, both fly families
87 exhibit intricate morphological and ecological adaptations for living on bats (Dittmar et al.
88 2015). In addition, they are considered host-specific, with most fly species parasitizing from
89 one to three bat species□ only (Pilosof et al. 2012).

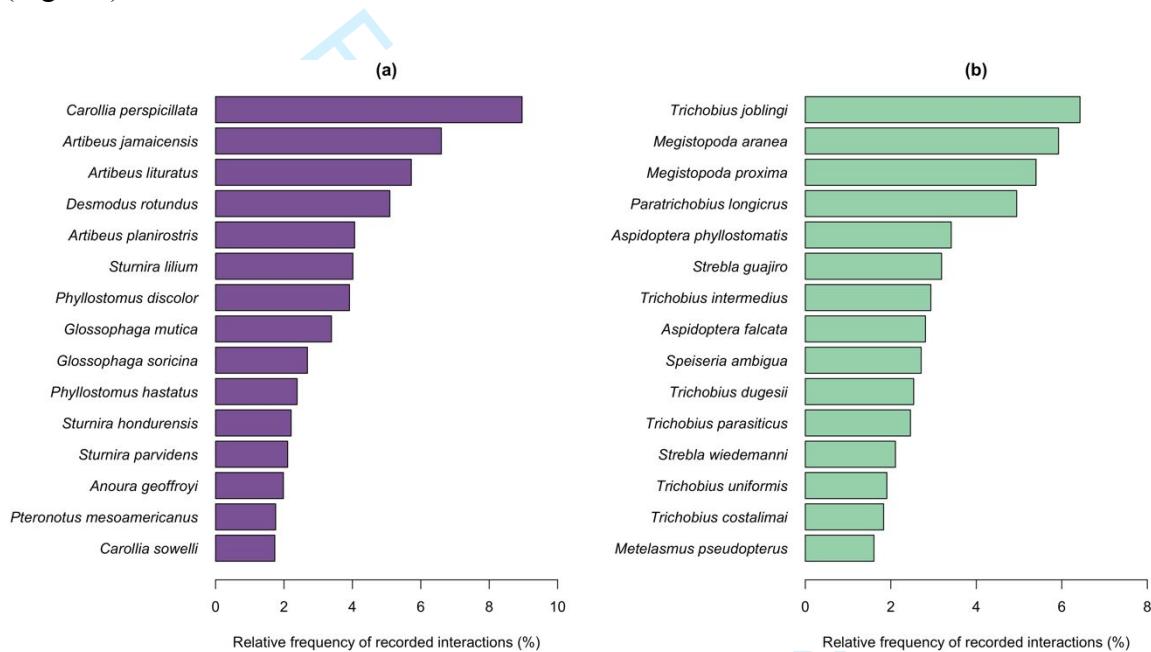
90 Host specificity has received large attention in the ecological literature, being used as
91 a model to study ecological specialization (Hiller et al. 2021), resource distribution (Hiller et
92 al. 2018), pathogen transmission (Szentiványi et al. 2018), and the drivers of parasite
93 prevalence (Frank et al. 2016). Despite this remarkable effort to study the ecology of flies
94 (Patterson, Dick, and Dittmar 2007), so far knowledge is restricted to fragmented interaction
95 records at a local scale. Therefore, we need synthesis aimed at compiling information and
96 publishing it in data papers that filter, organize, and curate large data sets, opening avenues
97 for addressing a broader range of questions.

98 In the present data paper, we compiled information on bat-fly interactions derived
99 from 174 studies with multiple scopes, including taxonomic reviews, checklists, and
100 assessments of species interactions, and we have also included three original data sets. These
101 reference studies were published between 1904 and 2022, with most being published after
102 the year 2000 (Fig. 1A). Overall, our database contains information recorded at 650 sites
103 spanning from the northern limit of the Neotropics to southern South America (Fig. 1B).
104 Those sites are primarily located in Mexico (143 sites from published studies and 3 sites from
105 original datasets), Brazil (89), Argentina (62), southern USA (62), Peru (55), Cuba (32), the
106 Dominican Republic (32), Honduras (26), and Colombia (19 sites from published studies and
107 15 sites from original datasets), among other countries (Fig. 1B). For 95% of the sites, there
108 is information on entire assemblages of bats and flies. The remaining 5% report parasites
109 collected from a single bat species (Fig. 1B).



110
111 **Figure 1.** Temporal and spatial distribution of the references included in BatFly. (A) Number
112 of studies published per year in the time range (1904 – 2022) included in BatFly. (B)
113 Distribution of the sampling sites included in BatFly. Triangles represent sampling sites.
114 Colors represent the taxonomic scope of sampling for bats, and triangle orientation (up/down)
115 represents the taxonomic scope of sampling for flies. “Single” represents studies focused on
116 a single fly species. “All” represents studies that assessed all fly species found at the site.
117 Our database comprises interactions made by bats of nine families, 76 genera, and
118 237 species. For flies, it comprises two families, 29 genera, and 255 species. The 15 most

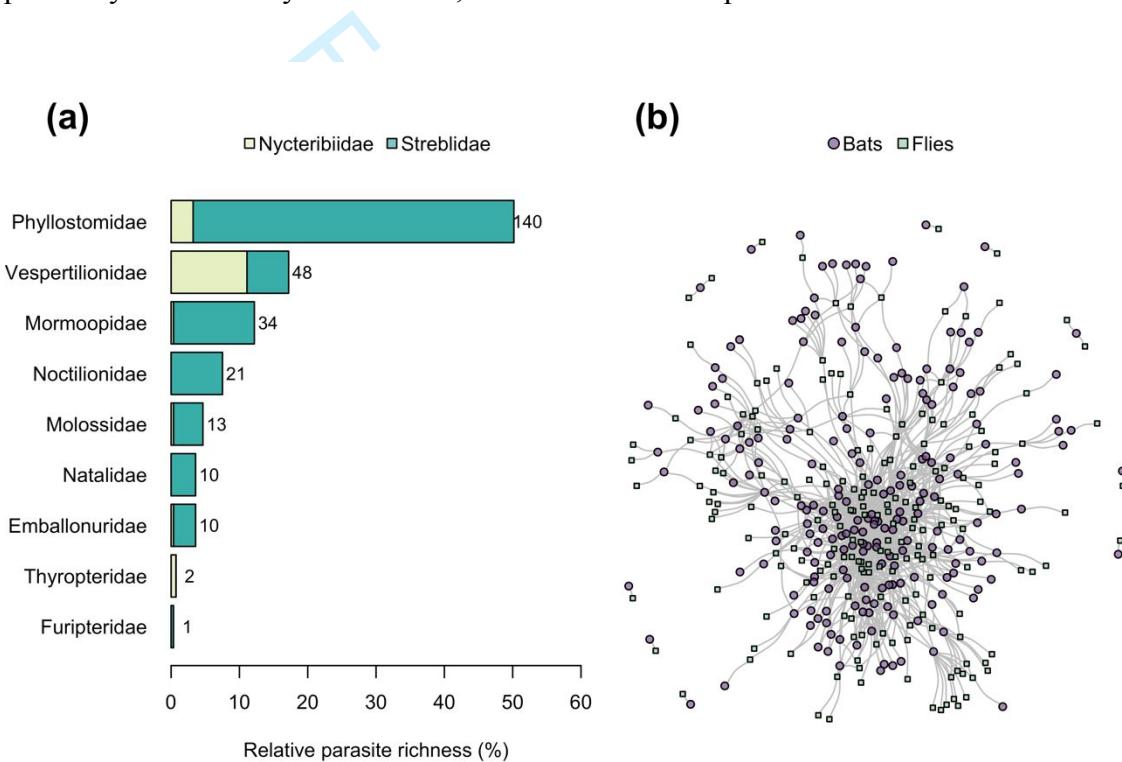
119 frequently recorded bat species made 57% of all interactions, with *Carollia perspicillata* as
 120 the species with most records (357), followed by *Artibeus jamaicensis* (263) and *Artibeus*
 121 *lituratus* (228) (Fig. 2A), all of which are members of the Phyllostomidae (Fleming et al.
 122 2020). Over 57 bat species were shown to have only one interaction (singletons). Half of the
 123 interactions were made by 15 fly species, with *Trichobius joblingi* having the highest number
 124 of records (256), followed by *Megistopoda aranea* (235) and *Megistopoda proxima* (215)
 125 (Fig. 2B).



126
 127 **Figure 2.** Relative frequency of interactions made by the top 15 (A) bat species and (B) fly
 128 species with most records.

129 In summary, BatFly has a total of 3,984 interaction records between bat and fly
 130 species. Among bats, the family Phyllostomidae shows the richest set of interactions (140 fly
 131 species), followed by Vespertilionidae (48 fly species), and Mormoopidae (36 fly species).
 132 Most bat families within our records interact more frequently with fly species of the family
 133 Streblidae, except for Vespertilionidae and Thyropteridae, which interact more frequently
 134 with the Nycteribiidae. Furthermore, in the bat families Furipteridae, Noctilionidae, and

135 Natalidae no interaction with Nycteribiidae species was recorded (Fig. 3A). Those
 136 interactions between bat and fly species form a densely connected network, in which a large
 137 group of interconnected bat and fly species (giant component of the network) can be
 138 observed. This kind of structure was unexpected due to the high specificity that these
 139 interactions are assumed to have (Fig. 3B). However, this network was made with all
 140 interactions included in BatFly, even uncommon interactions, which may mask the true host
 141 specificity in the bat-fly interactions, so it should be interpreted with caution.

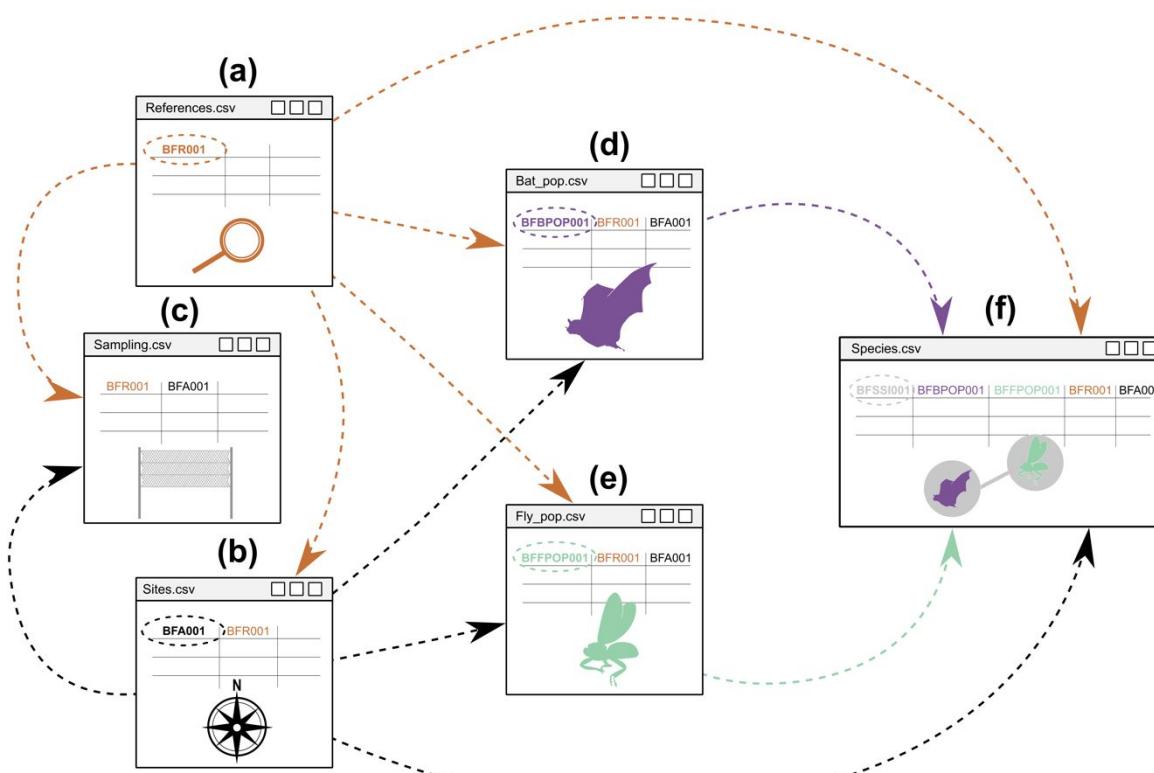


142
 143 **Figure 3.** Overview of bat-fly interactions included in BatFly. (A) Relative richness of fly
 144 families (Nycteribiidae and Streblidae) per bat family. The number in front of the bars depicts
 145 the total number of fly species found parasitizing each bat family. (B) Bat-fly network built
 146 for the entire Neotropical region with all records included in our data set, even uncommon
 147 associations. Lines depict interactions between bat species (purple circles) and fly species
 148 (green squares). Most nodes belong to the giant component (largest subgroup of
 149 interconnected species) and there are also ten minor components (dyads).

150 BatFly represents the largest dataset of antagonistic interactions made by bats in both
151 geographical and taxonomic terms. All records were taxonomically harmonized, i.e., bat and
152 fly scientific names were checked and updated. In addition to interaction records, our
153 database includes information about references, study sites, sampling methods, and bat and
154 fly populations organized in six linked data sheets (Fig. 4): “references”, “sites”, “sampling”,
155 “bat population”, “fly population”, and “species interactions”. The “references” data sheet
156 (Fig. 4A) contains information on the original sources from which the data were obtained.
157 Each reference study was assigned a unique reference code (e.g., BFR001), enabling
158 identification of each reference study in all other data sheets. The data sheets “sites” (Fig.
159 4B) and “sampling” (Fig. 4C) contain information about where, when and how the data were
160 collected at each site, including study sites characteristics (e.g., mean annual temperature,
161 annual rainfall, and vegetation type) which are known to influence bat-fly interactions
162 (Pilosof et al. 2012). Each study site was assigned a unique site code (e.g., BFA001), with
163 which each study site can be identified in within “sites”, “sampling”, “bat population”, “fly
164 population” and “species interactions” data sheets.

165 The “bat population” (Fig. 4E) and “fly population” (Fig. 4F) data sheets contain
166 taxonomic identification and information about the populations of interacting species. Also,
167 we included bat species traits, such as the roost types used by bats, which are important
168 drivers of parasite dynamics (Patterson, Dick, and Dittmar 2007). Each population was
169 assigned a unique population code for bats (e.g., BFBPOP000) and flies (e.g., BFFPOP000),
170 allowing its identification of each population in the “species interactions” data sheets.
171 Finally, the “species interactions” data sheet (Fig. 4F) contains the species-species interaction
172 records, and information about number of infested bats, prevalence, mean fly intensity, and

173 mean fly abundance. Each interaction record was assigned an interaction code (e.g.,
 174 BFSSI000) associated to bat population and fly population codes, and also associated to site,
 175 and references codes shared between data sheets (foreign keys). This interconnected structure
 176 enables the expansion of information for each interaction record encompassing where and
 177 how the interaction was collected, as well as the number of bats and flies involved in a
 178 specific record.



179
 180 **Figure 4.** Structure of the BatFly database. BatFly is integrated by six interconnected
 181 datasheets. (a) References data sheet. (b) Site data sheet. (c) Sampling data sheet. (d) Bat
 182 population data sheet. (e) Fly population data sheet. (f) Species interaction data sheet. Each
 183 interaction record has a unique interaction code (primary key) associated to reference, site,
 184 bat and fly population codes shared between datasheets (foreign keys). In the graphical
 185 representation, dashed ovals indicate the first appearance of a code within the database.

186 Dashed lines illustrate the relationships between BatFly's datasheets. Each code is designated
187 with a distinct color. For example, the reference code (colored orange), which first appears
188 on the reference datasheet (a), can be found on all other datasheets, denoted by five orange
189 lines.

190 BatFly was designed to boost the use of bat-fly interactions as a model for addressing
191 questions at different levels of ecological organization and spatial scales. We expect BatFly
192 to inspire researchers to continue consolidating knowledge about ecological specialization,
193 resource distribution, pathogen transmission, and the drivers of parasite prevalence over a
194 broader spatial range. It may also help answer key questions, such as: are there differences
195 in fly prevalence or mean infestation across Neotropical ecoregions? What ecological drivers
196 explain those differences? Or how do specialization patterns vary among fly species in the
197 Neotropics? We also expect to inspire research aimed at understanding how bat-fly
198 interactions can be affected by climate and landscape changes. Ultimately, we expect BatFly
199 to help understand host-parasite interactions, facilitate predicting zoonotic outbreaks, and
200 provide information to address the UN's SDG 3 Good Health and Wellbeing.

201 CLASS II. RESEARCH ORIGIN DESCRIPTORS

202 A. Overall project description

203 **Identity:** A compilation of bat-fly interactions.

204 **Period of study:** Data of publication reported in the references range from 1904 to
205 2022.

206 **Objective:** We aimed to summarize and make available all bat-fly interaction records
207 found in the literature plus three new data sets in a tidy format, to be used in studies on

208 community ecology, interaction networks, and macroecology, and disease spillover,
209 among other topics.

210 **Abstract:** Global changes have increased the risk of emerging infectious diseases,
211 which can be prevented or mitigated by studying host-parasite interactions, among
212 other measures. Bats and their ectoparasitic flies of the families Streblidae and
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240 **Sources of funding:** NZM, SMB, and JH were funded by Ministerio de Ciencia,
241 Tecnología e Innovación de Colombia (MinCiencias, Convocatoria Doctorados en el
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243 the Improvement of Higher Education Personnel (CAPES, 88887.467879/2019-00 and
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247 and Technological Development (CNPq, 304498/2019-0), São Paulo Research
248 Foundation (FAPESP, 2018/20695-7 and 2023/02881-6), and Dean of Research of the
249 University of São Paulo (PRP-USP, 18.1.660.41.7).

250 **B. Specific subproject descriptions**

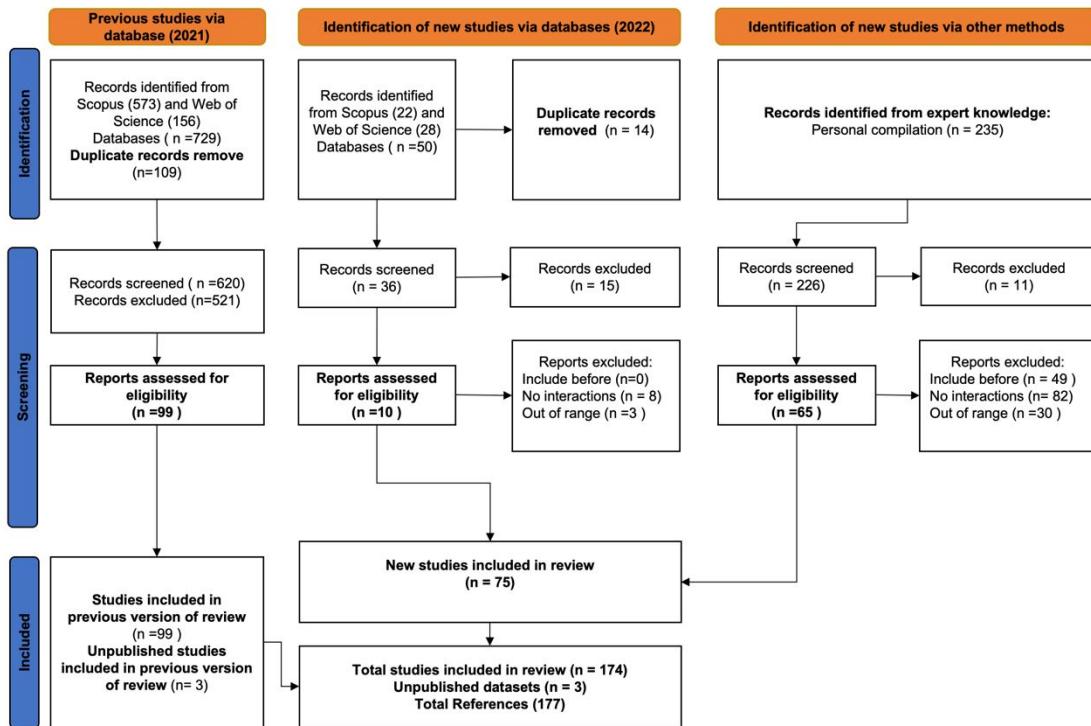
251 **Data compilation:** We performed a comprehensive systematic review of the literature,
252 following the Preferred Reporting Items for Systematic review and Meta-Analyses
253 (PRISMA) protocol designed as a guide to improve clarity and transparency in the
254 reporting of systematic reviews (Page et al. 2021). We also added information from

255 papers that did not appear in our systematic search, but which we were aware of, and
256 invited authorities to contribute with their unpublished data (Fig. 5).

257 The systematic search was conducted utilizing the Web of Knowledge and
258 Scopus databases. There were no date restrictions, and the search was performed in
259 2021. The search utilized keywords in three languages: English, Portuguese, and
260 Spanish. The following keywords were employed: "bat*" OR "murciélagos*" OR
261 "morcego*" OR "chiroptera" OR "chiroptero" OR "quiropeta" OR "quiroptero" AND
262 "bat fly" OR "bat flies" OR "streblid*" OR "streblidae" OR "nycteribiid*" OR
263 "nycteribiidae" OR "parasite*" OR "parásito*" OR "ectoparasite*" OR
264 "ectoparásito*" OR "ectoparasita*" OR "diptera*" OR "díptero" OR "mosca". With
265 the results from this naive-term search we extracted potential keywords using the Rapid
266 Automatic Keyword Extraction (RAKE) algorithm (Grames et al. 2019). Those
267 automatic extracted keywords underwent manual verification, filtering, and sorting.
268 Subsequently, a search was performed using the following refined keywords: "tropical
269 bat" OR "tropical bats" OR "bat" OR "bats" OR "neotropical bats" OR "neotropical
270 bat" OR "chiroptera" OR "chiropteran hosts" OR "chiropteran species" AND "blood-
271 sucking flies" OR "blood-sucking fly" OR "diptera" OR "dipterans" OR "nycteribiidae"
272 OR "streblidae" OR "streblid*" OR "bat flies" OR "bat fly" OR "ectoparasite*" OR
273 "nycteribiid*" OR "bat parasite*" OR "bloodsucking diptera" OR "bloodsucking
274 dipterans" OR "batfly" OR "batflies" AND "parasitizing" OR "interaction*" OR
275 "interacted" OR "interact" OR "parasitological" OR "association*" OR "host-parasite"
276 OR "system*" OR "vertebrate-parasite" OR "network*" "parasite assemblage*" OR
277 "intensity" OR "infection" OR "infestation" OR "load*" "host potential" OR
278 "parasitism" OR "prevalence" OR "parasited" OR "hematophagous" OR

279 "relationship*" OR "specificity" OR "specialization" OR "specialisation" OR
280 "inhabiting" OR "fly-host" OR "host-specific" OR "parasitology" OR "bat-parasite"
281 OR "specialized" OR "specialised" OR "specialize" OR "specialise" OR "host" OR
282 "hosted" OR "hosting" OR "hosts". We compiled information on bat fly interactions
283 from a total of 102 references, 99 studies found in this systematic search and 3
284 unpublished data sets collected by the authors. As we did our first systematic search in
285 2021, we did an update with additional search restricted to studies published in 2022,
286 with keywords: "streblid*" OR "streblidae" OR "nycteribiid*" OR "nycteribiidae",
287 adding ten references for 2022 year. Finally, we included 65 references provided by
288 one of the authors, Gustavo Graciolli (Fig. 5). These 65 references did not come up in
289 the search due to most of them are not indexed in the databases used.

290 For a study to be included in our database, it had to meet the following inclusion
291 criteria: (1) be a primary study, so we discarded literature reviews or compilations of
292 interactions from other studies; (2) contain naturally occurring interactions, so we
293 ignored host preference studies carried out under controlled conditions; and (3) contain
294 spatial information of where the interactions were recorded, as coordinates, country
295 and locality. Finally, with the studies found in the first systematic search done in 2021
296 (99), the studies found in the second systematic search (update, 10) and 65 studies
297 provided by one of the authors, BatFly contains 174 published studies and 3 original
298 datasets (177 references in total; Fig. 5).



299
300 **Figure 5.** Workflow of the updated systematic review carried out to acquire data, which
301 included database searches, additional records, and other sources, following PRISMA
302 2020 (Page et al. 2021).

303 **Research methods:** We included only studies that reported bat-fly interactions
304 recorded from wild assemblages. Their scopes range from new fly records and
305 community ecology and endosymbiont diversity in bat flies (bacteria and fungi), along
306 with information on bat hosts. Information on sampling methods and host population
307 was also extracted. We also included geographical information from study sites
308 (latitude, longitude, locality, municipality, state, and country), and site characteristics
309 (ecoregion, type of vegetation, height, average annual temperature). Missing
310 information was coded as “NA”.

311 We compiled information on bat-fly interactions published between 1904 and
312 2022 from 174 references: Brues 1904; Curran 1935; Guimarães 1937; 1966; 1972;

313 1977; E. Dias et al. 1942; Augustson 1943; Fox and Stabler 1953; Hoffmann 1953;
314 Parmalee 1955; Zeve 1958; Peterson 1960; 1963; Bradshaw and Ross 1961; Tonn and
315 Arnold 1963; Uberlaker 1966; Maa 1968; Peterson and Maa 1970; Peterson and Hürka
316 1974; Whitaker and Easterla 1975; Reisen, Kennedy, and Reisen 1976; Hoffmann,
317 Palacios-Vargas, and Morales-Malacara 1980; Overal 1980; Fritz 1983; Coimbra jr,
318 Guimarães, and Mello 1984; Peterson and Lacey 1985; Caplonch et al. 1997; Komeno
319 and Linhares 1999; Claps, Autino, and Barquez 2000; 2005; Chavez 2001; Ritzi et al.
320 2001; Azevedo and Linardi 2002; Guzmán-Cornejo et al. 2003; Moura, Bordignon, and
321 Graciolli 2003; Autino and Claps 2004; González D., Santos M, and Miranda 2004; ter
322 Hofstede, Fenton, and Whitaker, Jr. 2004; Bertola et al. 2005; Villegas-Guzman,
323 López-González, and Vargas 2005; Dick and Gettinger 2005; Anderson and Ortencio
324 Filho 2006; Dick and Wenzel 2006; Oscherov, Chatellenaz, and Milano 2006;
325 Oscherov, Idoeta, and Milano 2012; Graciolli et al. 2006; Graciolli, Zortéa, and
326 Carvalho 2010; Graciolli, Guerrero, and Catzeflis 2019; Voigt and Kelm 2006;
327 Shockley and Murray 2006; Graciolli and Bianconi 2007; Dick, Gettinger, and Gardner
328 2007; Kurta et al. 2007; Rojas et al. 2008; Sebastián Tello, Stevens, and Dick 2008; P.
329 A. Dias et al. 2009; Autino et al. 2009; 2011; Autino, Claps, and Barquez 2014; Autino
330 et al. 2016; 2018; 2020; Dittmar et al. 2009; 2011; Valdez, Ritzi, and Whitaker 2009;
331 Santos et al. 2009; 2013; Graciolli and Dick 2009; 2012; Almeida et al. 2011; Camilotti
332 et al. 2010; Aguiar and Antonini 2011; Eriksson, Graciolli, and Fischer 2011; Muñoz-
333 Romo, Burgos, and Kunz 2011; J. R. R. da Silva and Ortêncio Filho 2011; Lourenço
334 and Esbérard 2011; Esbérard et al. 2012; 2014; Morse et al. 2012; Dick 2013; Moras
335 et al. 2013; Saldaña-Vázquez et al. 2013; Soares et al. 2013; 2016; 2017; França et al.
336 2013; Urbieta and Torres 2014; Moreno Valdés 1998; Camacho et al. 2014; Lourenço

337 et al. 2014; 2020; Velazco, Autino, and Claps 2014; Tarquino-Carbonell et al. 2015;
338 Tlapaya-Romero et al. 2015; Tlapaya-Romero, Ibáñez-Bernal, and Santos-Moreno
339 2019; Tlapaya-Romero, García-Méndez, and Ramírez-Martínez 2022; Cuxim-Koyoc
340 et al. 2015; 2016; 2018; Judson, Frank, and Hadly 2015; Patrício and Lourenço 2016;
341 de Vasconcelos et al. 2016; Hernández-Arciga, Herrera M., and Morales-Malacara
342 2016; Frank et al. 2016; Reeves et al. 2016; Barbier and Graciolli 2016; Bezerra, de
343 Vasconcelos, and Bocchiglieri 2016; Zarazúa-Carbajal et al. 2016; Barbier, Prado-
344 Neto, and Bernard 2016; Barbier et al. 2017; 2018; 2019; Barbier, Graciolli, and
345 Bernard 2019; Barbier et al. 2020; Barbier, Falcão, and Bernard 2021; Fagundes,
346 Antonini, and Aguiar 2017; Dornelles and Graciolli 2017; Rivera-García et al. 2017;
347 Cordero-Schmidt et al. 2017; Walker et al. 2018; Abundes-Gallegos et al. 2018;
348 Bolívar-Cimé et al. 2018; Colín-Martínez, Morales-Malacara, and García-Estrada
349 2018; Salinas-Ramos et al. 2018; Calonge-Camargo and Pérez-Torres 2018; Estrada-
350 Villegas et al. 2018; do Amaral et al. 2018; Bezerra and Bocchiglieri 2018; 2022;
351 Hrycyna, Martins, and Graciolli 2019; S. S. P. da Silva, Guedes, et al. 2019; S. S. P. da
352 Silva et al. 2021; Torres et al. 2019; Hernández-Martínez et al. 2019; Trujillo-Pahua
353 and Ibáñez-Bernal 2019; 2020; Smit and Miller 2019; Durán et al. 2019; S. S. P. da
354 Silva, Neves, et al. 2019; Vieira et al. 2019; Liévano-Romero, Rodríguez-Posada, and
355 Cortés-Vecino 2019; Orta-Pineda et al. 2019; Ribas, Batista, and Aranha 2020;
356 Ascuntar-Osnas, Montoya-Bustamante, and González-Chávez 2020; Bonifaz, Mena,
357 and Oporto 2020; Raigosa Álvarez et al. 2020; Zamora-Mejías et al. 2020; Ikeda et al.
358 2020; Palheta et al. 2020; de Groot et al. 2020; Oliveira et al. 2020; Menezes Júnior et
359 al. 2021; Minaya, Mendoza, and Iannacone 2021; Vidal, Bernardi, and Talamoni 2021;
360 Urbíeta, Graciolli, and Vizentin-Bugoni 2021; Hiller et al. 2021; Lira-Olguin, Guzmán-

361 Cornejo, and León-Paniagua 2021; Mello et al. 2021; Ramalho, Diniz, and Aguiar
362 2021; Gómez-Corea et al. 2022; Alcantara et al. 2022; Speer et al. 2022; da Silva Biz
363 et al. 2021; Castillo-Urbina et al. 2022; Carvalho et al. 2022; Herrera and Jara 2008;
364 González-Ávalos et al. 2014; Bellizzi et al. 2022; Almeida et al. 2010; Dornelles et al.
365 2017; Ramírez-Martínez et al. 2016; Mello et al. 2022; da Silva Reis et al. 2022.

366 For already included references, if applicable, we accommodated studies that
367 partially or totally used the same data sets as “Associated References”, assuring not to
368 duplicate interaction records (see Table 1).

369 **Taxonomic information:** All records were taxonomically harmonized. Scientific
370 names were checked and updated. For bats, taxonomic harmonization was performed
371 by Marcelo Nogueira. The main reference for bat taxonomic arrangement and
372 nomenclature adopted here was Simmons and Cirranello (2023). However, when
373 considering the taxonomy of *Glossophaga* we followed Diaz et al. (2021). Also, in the
374 case of *Dermanura*, we followed Cirranello et al. (2016) in treating this taxon as a
375 subgenus of *Artibeus*. Diaz et al. (2021) and Gardner (2008) were the general
376 references for the geographic distribution of each species, but we also consulted
377 country-wide compilations (e.g., York et al. 2019; Martínez-Fonseca et al. 2020;
378 Turcios-Casco et al. 2020; Mora, López, and Espinal 2021; Velazco et al. 2021;
379 Garbino et al. 2022) and primary references (e.g., species descriptions and systematic
380 revisionary works), and species accounts, including Solari and Baker (2006);
381 Genoways and Baker (1996); McDonough et al. (2008); Velazco, Gardner, and
382 Patterson (2010); Velazco and Simmons (2011); Moratelli et al. (2011); Mantilla-
383 Meluk (2014); Mantilla-Meluk and Muñoz-Garay (2014); Pavan and Marroig (2016);
384 Pavan, Bobrowiec, and Percequillo (2018); Velazco and Patterson (2019); Basantes et

385 al. (2020); Loureiro, Engstrom, and Lim (2020); Rodríguez-Posada et al. (2021);
386 Velazco et al. (2021); Calahorra-Oliart, Lira-Noriega, and León-Paniagua (2022);
387 Calderón-Acevedo, Bagley, and Muchhalá (2022); Esquivel et al. (2022). When there
388 was a situation in which more than one species could be associated to a previous species
389 record within the same bat assembly, as *Platyrrhinus helleri* and *Pteronotus parnellii*—
390 please refer to Velazco, Gardner, and Patterson (2010) and Pavan, Bobrowiec, and
391 Percequillo (2018) for newly described taxa related to these species—the updated
392 identification was retained at genus level.

393 For flies, taxonomic harmonization was performed by Gustavo Graciolli.
394 Taxonomic changes in the current name of species were made following Alcantara,
395 Graciolli, and Nihei (2019); Hrycyna et al. (2022); Tlapaya-Romero, García-Méndez,
396 and Ramírez-Martínez (2023); Graciolli and Dick (2012); Graciolli, Santos, and
397 Rebêlo (2022). In the records that were not identified to the species level, whenever
398 possible, the taxonomic complex or group to which they belong was reported.

399 **Bat roost information:** We report the roost type used by each bat species included in
400 the database. Bat roost play an important role in fly species lifecycle due to fly species
401 pupal development is carried out in these places (Dittmar et al. 2009). All possible roost
402 types were classified into eight categories: cave (hot caves, caverns, and crevices), tree
403 cavity (hollow trees, fallen trees, and loose bark), human-made structure (buildings,
404 bridges, tunnels, and culverts), foliage (branches and leaves), tent, termite nest, rocky
405 cliff, and river cliff. We compiled this information from the literature (Kunz and
406 Lumsden 2003; Rodríguez-Durán 2020). □

407 **C. Data limitations and potential enhancements**

408 BatFly has limitations related to the scope of the studies used as data sources and how
409 information was reported in them. There are many gaps in information in the references
410 used, as unfortunately commonly observed in studies on species interactions (see
411 another paper with recommendations to solve this problem: Kita et al. 2022)

412 First, there are sampling information limitations. As several references are
413 checklists of fly species also reporting their hosts, most studies do not provide
414 information about the methods used for capturing bats, e.g., the number of sampling
415 hours or the number of mist nets used, hindering the estimation of sampling effort.
416 Only 117 study sites (18%) informed their sampling effort following the widely used
417 method of Straube and Bianconi (2002).

418 Second, there are geographical information limitations. Sixteen site studies
419 (2.5%) report interactions accumulated from several locations, hindering the use of
420 their data at smaller spatial scales. In those cases, we recorded all data available from
421 the locations of the study in the observation column (see Table 2). A single SiteCode
422 was assigned with the coordinates of the centroid of the polygon formed by the
423 coordinates reported in the study (see Table 2).

424 Third, there are interaction information limitations. Not all studies have
425 information that allows quantifying the interaction, 490 (12%) interactions were
426 recorded only as occurrence (binary information), hindering the use of their data in
427 studies that aim to analyze the interaction by incidence of fly species on bat species.
428 Furthermore, information provided by most studies is limited to the number of
429 individuals of a given fly species found on a given bat species, excluding other key
430 information useful to quantify the interaction such as prevalence, mean intensity, and

431 mean abundance. Only 978 (25%) of the interaction records provide us with
432 information on prevalence.

433 Four, there are representativeness limitations. Our database is biased by the
434 method through which bats are sampled, since most studies were based on mist-netting,
435 and different bat species have different capturability (Francis 1989). Mist nets are much
436 more efficient for capturing phyllostomids than bats from other families (Tschapka
437 1998). So, potential users of BatFly should have this in mind, for example when
438 carrying out studies aimed at analyzing fly incidence in different bat families or species
439 from different bat families.

440 CLASS III. DATA SET STATUS AND ACCESSIBILITY

441 A. Status

442 **Latest update:** October 2023.

443 **Latest archive date:** October 2023.

444 **Metadata status:** Last updated in October 2023, version submitted.

445 **Data verification:** Data were compiled as presented in the sources. We corrected
446 transcription errors, checked the geographic coordinates of the study sites, and made
447 taxonomic harmonization of species names.

448 B. Accessibility

449 **Storage location and medium:** The complete data set (in .CSV format) and scripts to
450 replicate the figures of this metadata are available on
451 <https://doi.org/10.5281/zenodo.10019756>

452 **Contact persons:** Natalya Zapata-Mesa (zapatamesan@gmail.com) & Marco A. R.
453 Mello (marmello@usp.br).

454 **Copyright restrictions:** Creative Commons Attribution 4.0 International License.

455 **Proprietary restrictions:** Please cite this data paper, if the data are used in any kind
456 of publication related to research, outreach, and teaching activities, such as papers,
457 books, book chapters, monographs, bibliographies, reports, patents, posters, talks,
458 keynotes, and lectures.

459 **Costs:** None.

460 CLASS IV. DATA STRUCTURAL DESCRIPTORS

461 A. Data set file

462 Identity and size:

463 BatFly_References.csv 66KB

464 BatFly_Sites.csv 142KB

465 BatFly_Sampling.csv 46KB

466 BatFly_Bat_Pop.csv 334KB

467 BatFly_Fly_Pop.csv 303KB

468 Batfly_Species_Interactions.csv 585KB

469 **Format and storage mode:** Data frames with comma-separated values (.csv).

470 **Header information:** See variable description in Variable information section.

471 **Alphanumeric attributes:** Mixed.

472 **Special characters/fields:** Each table contains a column named “Observations”. This
473 column may have additional information or comments. For example, in Table 2,
474 Observations column may have additional information about the study site reported by
475 the reference, as a pool of coordinates from a study site. “NA” indicates no information
476 available for a given cell.

477 **B. Variable information**

478 **Table 1.** BatFly_References: Information of the references used as data sources in our
479 database.

Variable	Description	Levels	Example
RefCode	Identification code of each reference	BFR001 – BFR179	BFR002
Author	Short name of the author(s); if there are three or more authors, we use <i>et al.</i>		Graciolli <i>et al.</i>
Year	Year of publication of each reference		2010
Type	Type of reference	Article, Book, Unpublished data	Article
Reference	Full bibliographic reference		Graciolli G., Zortéa M., Carvalho L. F. A. C. (2010) Bat flies (Diptera, Streblidae and Nycteribiidae) in a Cerrado area of Goiás state, Brazil. Revista Brasileira de Entomologia 54: 511-514. https://doi.org/10.1590/S0085-56262010000300025
BatVouchers	Name of the biological collection where voucher bat specimens were deposited		Chiroptera Collection of “Universidade Federal de Goiás, Campus Jataí” (CCUFG)

FlyVoucher s	Name of the biological collection where voucher fly specimens were deposited	Zoological Collection of "Universidade Federal do Mato Grosso do Sul"
Associated References	Full bibliographic reference of studies that fully or partially uses the same data of the Reference	Pedro, W.A., Passos F.C. & B.K Lim. 2001. Morcegos (Chiroptera; Mammalia) da Estação Ecológica dos Caetetus, Estado de São Paulo. Chiroptera Neotropical, Brasília, 7: 136-140

480

481

482 **Table 2.** BatFly_Sites: Information of the study sites from the references included in our
 483 database.

Variable	Description	Levels	Example
SiteCode	Identification code of each study site. A single publication may contain multiple study sites. Different studies could share the same study site and consequently the same SiteCode	BFA001 – BFA653	BFA002
RefCode	Identification code of each reference	BFR001 – BFR179	BFR002
Country	English name of the country where the study was carried out		Brazil
State	State, Province or Department of the study site as described in the source or identified from its geographic coordinates		Goiás
Municipality	Municipality of the study site as described in the reference or identified from its geographic coordinates		Serranópolis
Locality	Local name of the study site as described in the reference or identified from its geographic coordinates		Reserva Particular do Patrimônio Natural Pousada das Araras
Latitude	Corrected and transformed coordinates of the latitude in decimal degrees (Datum WGS84)		-20.772227
Longitude	Corrected and transformed coordinates of the longitude in decimal degrees (Datum WGS84)		-54.785154
PrecisionClass	Coordinate precision classes of the study site. Precise: coordinates of the grid, transect or vegetation patch are reported in the reference. Not precise: coordinates of	precise, not precise	precise

	the municipality are reported, or the coordinates do not match the information provided in the reference		
Vegetation	Vegetation type as described in the reference		Tropical rainforest
VegType	Vegetation type according to Oliveira-Filho (2017)		Rainforest
Ecoregion	Ecological region according to Oliveira-Filho (2017)		Cauca Valley montane forests
Domain	Tectonic domain according to Oliveira-Filho (2017)		Northern Andean
Elevation	Elevation above sea level in meters (m) reported in the reference		700
DatasetElevation	Elevation above sea level in meters (m), extracted from the GTOPO30 dataset (United States Geological Survey – USGS, 2001. Global 30 arc-seconds Elevation)		700
MeanAnnTemp	Mean annual temperature in Celsius degrees (°C) from WorldClim 2.1 with 30 arc seconds resolution.		23.3
MeanAnnRain	Mean annual rainfall in millimeters (mm) from WorldClim 2.1 with 30 arc seconds resolution.		1429
Observations	Additional information or comments		

485 **Table 3.** BatFly_Sampling: Information on the sampling methods used to record interactions
 486 included in our database.

Variable	Description	Levels	Example
SiteCode	Identification code of each study site from each reference. A single publication may contain multiple study sites.	BFA001 – BFA653	BFA002
RefCode	Identification code of each reference	BFR001 – BFR179	BFR002
YearStart	Year of the beginning of sampling		2000
YearFinish	Year of the end of sampling		2001
Duration	Unstandardized duration of sampling (in months)		11
SamplingEffort	Sampling effort, accounting for the area of the mist nets used and the duration of the survey, in hours*square meters (following Straube and Bianconi 2002). Since many studies do not report mist net size or model, this standardized measure is common for comparing bat inventories		13608
BatEcologicalScale	Reported bat assemblage. all: the whole bat species captured was reported. leafnosed: only leaf-nosed bats (Phyllostomidae) were reported. mormoopid: only mormoopid bats (Mormoopidae) were reported. single: a single bat species was reported	all, leafnosed, mormoopid, single	all
FlyEcologicalScale	Reported fly assemblage. all: the whole fly species capture was reported. Single: a single fly species was reported.	all, single	all
BatSamplingMethod	Method used to capture bats. Direct refers to collection by hand or devices such as hand nets or harp traps.	direct, harp traps, mist nets, hand net	mist nets

SamplingNights	Total number of capture nights	0 to 36	10
SamplingHours	Duration of capture per night, i.e., the number of hours the mist nets were kept open each night	1 to 12	1
SamplingMistnets	Number of mist nets used, regardless of manufacturer, type, size, mesh, or material	1 to 14	1
SamplingStrata	Vertical strata of the habitat where bats were captured: understory, from canopy to understory, below canopy, canopy	U, UC, BC, C	U
SamplingSeason	Sampling season reported in the reference	dry, wet, both	wet
Observations	Additional information or comments		

488 **Table 4.** BatFly_Bat_Pop: Information on the bat populations sampled, which were involved
 489 in the recorded interactions included in our database.

Variable	Description	Levels	Example
BatPopulationCode	Identification code of each bat population	BFBPOP001 – BFBPOP2187	BFBPOP001
RefCode	Identification code of each reference	BFR001 – BFR179	BFR001
SiteCode	Identification code of each study site in each reference	BFA001 – BFA653	BFA001
BatFamily	Current scientific name of the bat family		Noctilionidae
BatGenus	Current scientific name of the bat genus		<i>Noctilio</i>
BatSpecies	Scientific name of the bat species as reported in the reference		<i>Noctilio leporinus</i>
CurrentBatSpecies	Current scientific name of the bat species according to Simmons and Cirranello (2023)		<i>Noctilio leporinus</i>
BatSubspecies	Scientific subspecies name of the Bat as reported in the reference (checked and updated)		
BatRoost	Roosting site of the bat species reported in Kunz and Lumsden (2003) and Rodríguez-Durán (2020)	cave, tree cavity, foliage, tent, termite nest, human-made structure	caves
BatCaptureNumber	Total number of captured bats of the population	1 to 3173	25
BatMarks	Whether or not captured bats were marked. For studies where no marks were used, BatCaptureNumber might include recaptured	yes, no	no

	individuals		
BatFemales	Number of captured bats that are females of the population	0 to 235	11
BatMales	Number of captured bats that are males of the population	0 to 182	21
BatJuvenile	Number of captured bats that are juveniles of the population	0 to 290	41
BatAdult	Number of captured bats that are adults of the population	0 to 127	5
BatLactatingFemales	Number of captured bats that are lactating females of the population. Bats can be lactating and pregnant at the same time	0 to 21	20
BatNonreproductiveFemales	Number of captured bats that are nonreproductive females of the population	0 to 34	3
BatPregnantFemales	Number of captured bats that are pregnant females of the population	0 to 18	4
BatNonreproductiveMales	Number of captured bats that are nonreproductive males of the population	0 to 37	6
BatScrotalTestesMales	Number of captured bats that are males with scrotal testes of the population	0 to 32	30
Observations	Additional information or comments		

491 **Table 5.** BatFly_Fly_Pop: Information on the fly populations sampled, which were involved
 492 in the recorded interactions included in our database.

Variable	Description	Levels	Example
FlyPopulationCode	Identification code of each bat fly population	BFFPOP001 – BFFPOP2969	BFFPOP001
RefCode	Identification code of each reference	BFR001 – BFR179	BFR001
SiteCode	Identification code of each study site in each reference	BFA001 – BFA653	BFS001
FlyFamily	Current scientific name of the fly family	Streblidae, Nycteribiidae	Streblidae
FlyGenus	Current scientific name of the fly genus		<i>Megistopoda</i>
FlySpecies	Scientific name of the fly as reported in the reference		<i>Megistopoda aranea</i>
CurrentFlySpecies	Current scientific name of the fly		<i>Megistopoda aranea</i>
FlySubspecies	Scientific subspecies name of the fly as reported in the reference (checked and updated)		
FlyCaptureNumber	Total number of captured flies of the population	1 to 2197	2
FlyFemales	Total number of flies that are females of the population	0 to 1105	20
FlyMales	Total number of flies that are males of the population	0 to 2042	4
FlyUndetermined	Total number of flies that were not sex identified		

493

494 **Table 6.** Batfly_Species_Interactions: Information on the bat-fly species-species interactions
 495 recorded in our database.

Variable	Description	Levels	Example
InteractionSpeciesCode	Identification code of each species-species interaction record	BFSSI00 01 – BFSSI40 14	BFSSI00 01
BatPopulationCode	Identification code of each bat population	BFBPOP 001 – BFBPOP 2187	BFBPOP 0010
FlyPopulationCode	Identification code of each fly population	BFFPOP 001 – BFFPOP 2969	BFFPOP 0015
RefCode	Identification code of each reference	BFR001 – BFR179	BFR004
SiteCode	Identification code of each study site in each reference	BFA001 – BFA653	BFA051
CurrentBatSpecies	Current scientific name of the bat species according to Simmons and Cirranello (2023)		<i>Noctilio leporinus</i>
BatSubspecies	Scientific subspecies name of the bat as reported in the reference (checked and updated)		
CurrentFlySpecies	Current scientific name of the fly		<i>Megistopoda aranea</i>
Flysubspecies	Scientific subspecies name of the fly as reported in the reference (checked and updated)		
TransientInteractionorError	Uncommon association. It may be an association that will not last over time (transient) or the researcher's error in the collection or identification	yes, no	no
NumberInteractions	Number of flies captured on	0 to 2197	2197

	the bat species		
NumberInteractionsByFlyFemales	Number of female flies captured on the bat species	0 to 1105	291
NumberInteractionsByFlyMales	Number of male flies captured on the bat species	0 to 1091	351
NumberInteractionsByFlyUndetermined	Number of undetermined flies captured on the bat species	0 to 2042	781
BatInfested	Number of bats infested with one or more individuals of the fly species	0 to 278	201
BatInfestedFemales	Number of female bats infested with one or more individuals of the fly species	0 to 40	21
BatInfestedMales	Number of male bats infested with one or more individuals of the fly species	0 to 33	33
Prevalence	Prevalence (Number of bats infested divided by the total number of bat captures) as reported in the reference	0 to 100	80
PrevalenceOnBatFemales	Prevalence (Number of female bats infested divided by the total number of bat captures) as reported in the reference	0 to 100	50
PrevalenceOnBatMales	Prevalence (Number of male bats infested divided by the total number of bat captures) as reported in the reference	0 to 100	20
MeanFlyIntensity	The total number of flies of the species parasitizing the bat species divided by the number of individual bats infested with the fly	1 to 4.66	1
MeanFlyIntensityOnBatFemales	The total number of flies of the species parasitizing females of the bat species divided by the number of individual female bats infested with the fly	1 to 8	4
MeanFlyIntensityOnBatMales	The total number of flies of the species parasitizing males of the bat species divided by the number of individual male bats infested	1 to 2.53	2.1

	with the fly		
MeanFlyAbundance	The total number of flies of the species parasitizing the bat species divided by the number of individual bats (including non-infested individuals)	0 to 24.1	24.1
MeanFlyAbundanceOnBatFemales	The total number of flies of the species parasitizing females of the bat species divided by the number of individual female bats (including non-infested individuals)	0 to 2.6	1.5
MeanFlyAbundanceOnBatMales	The total number of flies of the species parasitizing males of the bat species divided by the number of individual male bats (including non-infested individuals)	0 to 1.6	1
Observations	Information about reference or comments		

496

497 **C. Data anomalies:** If there is no information available for a specific cell in a given
 498 datasheet, it is indicated as “NA”.

499 **CLASS V. SUPPLEMENTAL DESCRIPTORS**

500 **A. Data acquisition**

501 **Data entry/verification procedures:** Screening and data extraction were always
 502 performed by the same person. The information included in BatFly’s sheets, such as
 503 codes and scientific names, was validated with logical and set tests implemented in R
 504 to reduce typing errors.

505 **B. Publications and results**

506 Partial data of unpublished reference BFR102 (see Table 1) was used in Pastrana-
507 Montiel, M. R., Ballesteros-Correa, J., & Chacón-Pacheco, J. (2019). First record of
508 the parasite bat fly *Basilia mimoni* Theodor & Peterson, 1964 (Diptera: Nycteribiidae)
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510 <https://doi.org/10.4257/oeco.2019.2303.27>

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1 **BatFly: A database of Neotropical bat-fly interactions**

2 Natalya Zapata-Mesa^{1,2*}, Sebastián Montoya-Bustamante^{1,2}, Juliana Hoyos³, Daniela Peña⁴,

3 Jorge Galindo-González⁵, Julio J. Chacón-Pacheco⁶, Jesús Ballesteros-Correa⁶, María

4 Raquel Pastrana-Montiel⁶, Gustavo Graciolli⁷, Marcelo R. Nogueira⁸, Marco A. R. Mello²

5 ¹ Programa de Pós-graduação em Ecologia, Instituto de Biociências, Universidade de São
6 Paulo, São Paulo, SP, Brazil.

7 ² Departamento de Ecologia, Instituto de Biociências, Universidade de São Paulo, São Paulo,
8 SP, Brazil.

9 ³ Odum School of Ecology, University of Georgia, Athens, GA 30602, USA

10 ⁴ Universidad Veracruzana, Xalapa, Veracruz, Mexico.

11 ⁵ Instituto de Biotecnología y Ecología Aplicada, Universidad Veracruzana, Xalapa,
12 Veracruz, Mexico.

13 ⁶ Departamento de Biología, Grupo Investigación Biodiversidad Unicórdoba, Universidad
14 de Córdoba, Montería, Colombia

15 ⁷ Instituto de Biociências, Universidade Federal de Mato Grosso do Sul, Campo Grande,
16 MS, Brazil

17 ⁸ Universidade Federal Rural do Rio de Janeiro. Instituto de Biología, Laboratório de
18 Mastozoologia. Seropédica, RJ, Brazil.

19 **Abstract:** Global changes have increased the risk of emerging infectious diseases, which

20 can be prevented or mitigated by studying host-parasite interactions, among other measures.

21 Bats and their ectoparasitic flies of the families Streblidae and Nycteribiidae are an excellent
22 study model, but so far, our knowledge is restricted to fragmented records at a local scale. To
23 help boost research, we have assembled a data set of bat-fly interactions from 174 studies
24 published between 1904 and 2022, plus three original data sets. Altogether, these~~These~~
25 studies were carried out at 650 sites in the Neotropical regions, mainly distributed in Mexico
26 (~~146~~), Brazil (~~89~~), Argentina (~~62~~), southern USA (~~62~~), and Colombia~~Peru~~ (~~55~~), among other
27 countries. In total, our data set contains 3,984 interaction records between 237 bat species
28 and 255 fly species. The bat species with the largest number of recorded interactions were
29 *Carollia perspicillata* (357), *Artibeus jamaicensis* (263), and *Artibeus lituratus* (228). The
30 fly species with the largest number of recorded interactions were *Trichobius joblingi* (256),
31 *Megistopoda aranea* (235), and *Megistopoda proxima* (215). The interaction data were
32 extracted, filtered, taxonomically harmonized, and made available in a tidy format together
33 with linked data on bat population, fly population, study reference, sampling methods and
34 geographic information from the study sites. This interconnected structure enables the
35 expansion of information for each interaction record, encompassing where and how each
36 interaction occurred, as well as the number of bats and flies involved. We expect BatFly to
37 open new avenues for research focused on different levels of ecological organization and
38 spatial scales. It will help consolidate knowledge about ecological specialization, resource
39 distribution, pathogen transmission, and the drivers of parasite prevalence over a broad
40 spatial range. It may also help answer key questions, such as: are there differences in fly
41 prevalence or mean infestation across Neotropical ecoregions? What ecological drivers
42 explain those differences? Or how do specialization patterns vary among fly species in the
43 Neotropics? Furthermore, we expect BatFly to inspire research aimed at understanding how
44 climate and land-use changes may impact host-parasite interactions and disease outbreaks.

45 This kind of research may help us reach Sustainable Development Goal 3, Good Health and
46 Wellbeing, outlined by the United Nations.~~The data were organized, taxonomically~~
47 ~~harmonized, and made available in a tidy format together with rich metadata on bats, flies,~~
48 ~~and sites. We expect BatFly to open new avenues for research focused on different levels of~~
49 ~~ecological organization and spatial scales.~~

50 ***Key words/phrases:*** Antagonism, bats, bat flies, Chiroptera, diseases, ectoparasites,
51 hematophagy, Nycteribiidae, parasitism, Streblidae, specialization, species interactions,
52 zoonosis.

53 Open Research: The complete data set is available as Supporting Information at: [to be
54 completed at proof stage]. Associated data is also available at: BatFly: A database of
55 Neotropical bat-fly interactions <https://doi.org/10.5281/zenodo.10019756>

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57 * Corresponding Author E-mail: zapatamesan@gmail.com
58

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77 * Correspondence and requests for materials should be addressed to Natalya Zapata-Mesa
78 (zapatamesan@gmail.com).

79 **INTRODUCTION**

80 Our world faces urgent problems related to global changes caused by human activities,
81 which we strive to solve by following the United Nation's 17 Sustainable Development Goals
82 (UN 2015). The third goal, Good Health and Wellbeing, is the focus of research by scientists
83 from many areas under a transdisciplinary approach known as One Health (OHITF 2008).
84 Under this approach, it is of paramount importance to understand the interactions between
85 hosts and their parasites to prevent emerging diseases (Giraudoux et al. 2022).

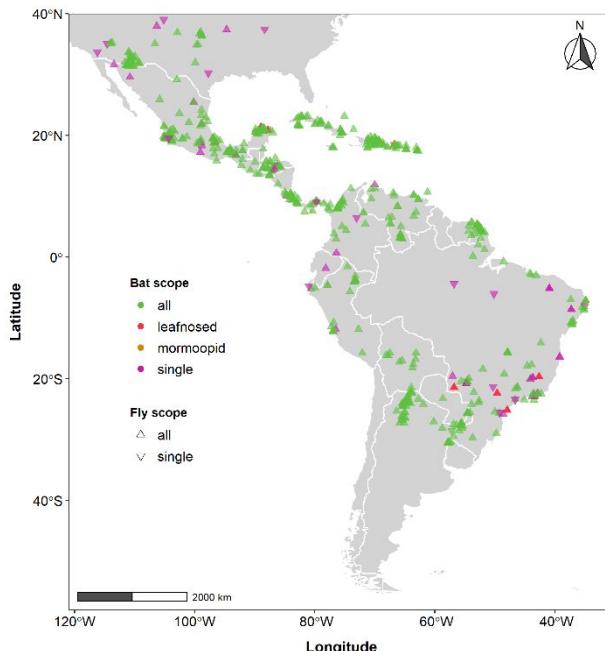
86 Bats play a crucial role in emerging diseases because of their huge ecological diversity
87 (Wilson and Reeder 2005)□□, which includes a myriad of interactions with endo- and
88 ectoparasites □□(Klimpel and Mehlhorn 2016) that carry pathogens associated with
89 zoonoses (Szentiványi et al. 2018).□ The most important bat ectoparasites are dipterans of
90 the families Streblidae and Nycteribiidae, also known as bat flies (Dick and Patterson 2006).
91 Bat flies share a tight evolutionary history with bats, as they are found exclusively on them
92 □(Dick and Dittmar 2014). Consequently, both streblids and nycteribiids exhibit intricate
93 morphological and ecological adaptations for living on bats (Dittmar et al. 2015). In addition,
94 they are considered host specific, with most fly species parasitizing from one to three bat
95 species□ only (Pilosof et al. 2012).

96 Host specificity has received large attention in the ecological literature, being used as
97 a model to study ecological specialization □□(Hiller et al. 2021), resource distribution
98 (Hiller et al. 2018)□, pathogen transmission (Szentiványi et al. 2018), and the drivers of
99 parasite prevalence (Frank et al. 2016). Despite this remarkable effort to study the ecology
100 of bat flies (Patterson, Dick, and Dittmar 2007), so far knowledge is restricted to fragmented
101 interaction records at a local scale. Therefore, we need syntheses aimed at compiling

102 information and publishing it in data papers that filter, organize, and curate large data sets,
103 opening avenues for addressing a broader range of questions.

104 In the present data paper, we compiled information on bat–fly interactions derived
105 from 177 studies with multiple scopes, including taxonomic reviews, checklists, and
106 assessments of species interactions. Altogether, our database comprises information recorded
107 at 650 sites distributed from the northern frontier of the Neotropics (including Mexico,
108 southern USA, and the Caribbean), until southern South America (Fig. 1). Summarizing a
109 total of 3,984 interaction records between 237 bat species and 255 fly species, BatFly
110 represents the largest dataset of antagonistic interactions made by bats in both geographical
111 and taxonomic terms.

112 Most interaction records compiled in BatFly came from published data, and we have
113 also included three original data sets. All records were taxonomically harmonized, i.e., bat
114 and fly scientific names were checked and updated. In addition, our database includes
115 additional information about study sites characteristics (e.g., mean annual temperature,
116 annual rainfall, and vegetation type). Also, we included bat species traits, such as the roost
117 types used, which is considered an important driver of parasite dynamics (Patterson, Dick,
118 and Dittmar 2007). BatFly was designed to boost the use of bat–fly interactions as a model
119 for addressing questions at different levels of ecological organization and spatial scales.



120
121 **Figure 1. Distribution of the sampling sites included in BatFly. Triangles represent sampling**
122 **sites. Colors represent the taxonomic scope of sampling for bats, and triangle orientation**
123 **(up/down) represents the taxonomic scope of sampling for flies. "Single" represents studies**
124 **focused on one bat species. "All" represents studies that assessed all bat species found at the**
125 **sampling site.**

126 **METADATA**

127 **CLASS I. DATA SET DESCRIPTOR**

128 **A. Data set identity**

129 **Title:** BatFly: A database of Neotropical bat-fly interactions

130 **B. Data set identification**

131 **Data set identity codes:**

132 BatFly_References.csv

133 BatFly_Sites.csv

134 BatFly_Sampling.csv

135 BatFly_Bat_Pop.csv

136 BatFly_Fly_Pop.csv

137 Batfly_Species.csv

138 **C. Data set description**

139 **Principal Investigator(s):**

140 1. Natalya Zapata-Mesa. Programa de Pós-graduação em Ecologia, Instituto de
141 Biociências, Universidade de São Paulo, São Paulo, SP, Brazil.

142 2. Marco A. R. Mello. Departamento de Ecologia, Instituto de Biociências,
143 Universidade de São Paulo, São Paulo, SP, Brazil.

144 **Abstract:**

145 Global changes have increased the risk of emerging infectious diseases, which can be
146 prevented or mitigated by studying host-parasite interactions, among other measures.

147 Bats and their ectoparasitic flies of the families Streblidae and Nycteribiidae are an
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153 other countries. In total, our data set contains 3,984 interaction records between 237
154 bat species and 255 fly species. The bat species with the largest number of recorded
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192 D. Keywords

193 Antagonism, bats, bat flies, Chiroptera, diseases, ectoparasites, hematophagy, ectoparasites,
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195 E. Description

196 Our world faces urgent problems related to global changes caused by human activities,
197 which we strive to solve by following the United Nation's 17 Sustainable Development Goals
198 (UN 2015). Goal 3, "Good Health and Wellbeing", is the focus of research by scientists from
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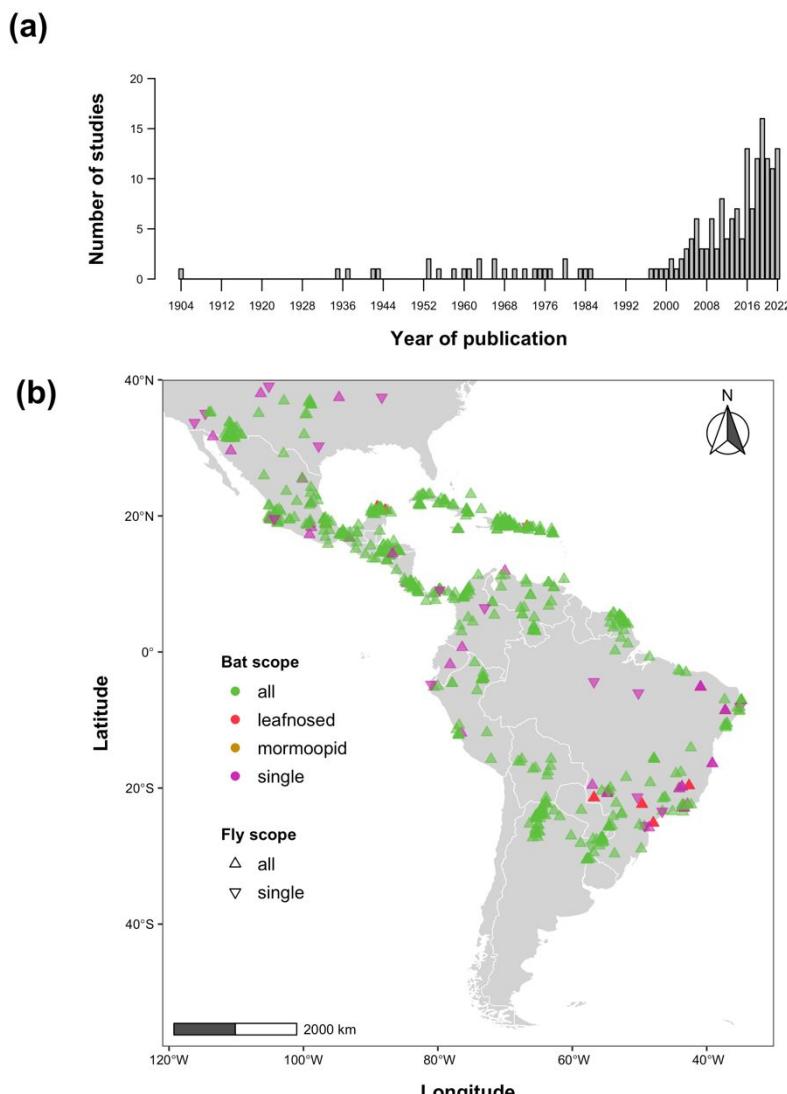
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223 database includes references published between 1904 and 2022 (Fig. 2). These reference
224 studies were published between 1904 and 2022, with most being published after the year
225 2000 (Fig. 1A). Overall, our database contains information recorded at 650 sites spanning
226 from the northern limit of the Neotropics to southern South America (Fig. 1B). Those sites
227 are primarily located in Mexico (143 sites from published studies and 3 sites from original

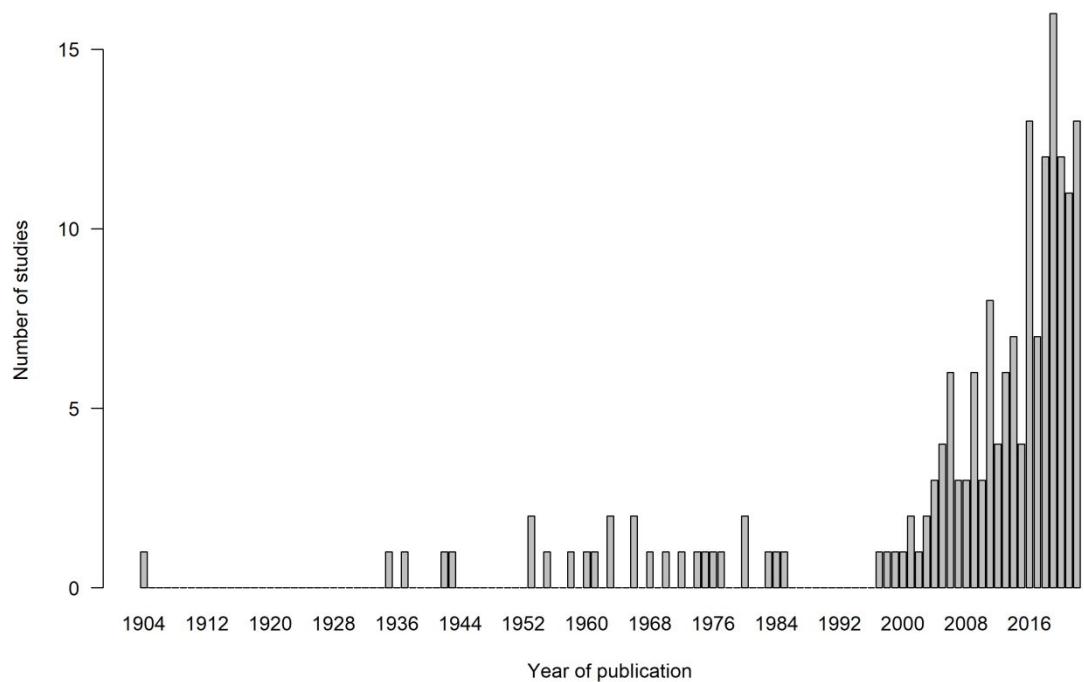
228 datasets), Brazil (89), Argentina (62), southern USA (62), Peru (55), Cuba (32), the
229 Dominican Republic (32), Honduras (26), and Colombia (19 sites from published studies and
230 15 sites from original datasets), among other countries (Fig. 1B). For 95% of the study sites,
231 we havethere is information on entire communities-assemblages of bats and- flies. The
232 remaining 5% report parasites collected from a single bat species (Fig. 1B). Information
233 gathered here came from 650 study sites, located mainly in Mexico (146), Brazil (89),
234 Argentina (62), southern USA (62), Peru (55), Cuba (32), Dominican Republic (32), and
235 Honduras (26) (Fig. 1). On average, each reference contributed to the database with
236 information from one study site. However, there are 19 references that contain information
237 from over 10 study sites, which represent studies focused on recording all fly species and
238 their hosts from a country or state (e.g., bat flies of Paraguay).



239
240 **Figure 1.** Temporal and spatial distribution of the references included in BatFly. (A) Number
241 of studies published per year in the time range (1904 – 2022) included in BatFly. (B)
242 Distribution of the sampling sites included in BatFly. Triangles represent sampling sites.
243 Colors represent the taxonomic scope of sampling for bats, and triangle orientation (up/down)
244 represents the taxonomic scope of sampling for flies. “Single” represents studies focused on
245 a single fly species. “All” represents studies that assessed all fly species found at the site.

246 The BatFly database contains 3,984 interaction records compiled and curated from
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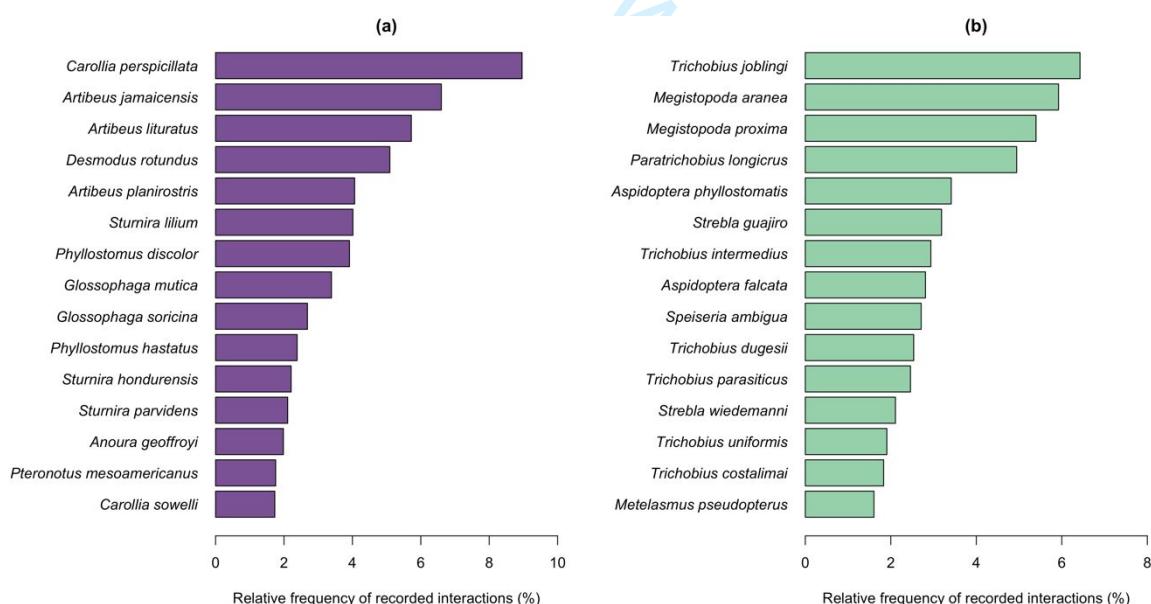
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253 are 19 references that contain information from over 10 study sites, which represent studies
254 focused on recording all fly species and their hosts from a country or state (e.g., bat flies of
255 Paraguay). The database includes references published between 1904 and 2022 (Fig. 2).



256
257 **Figure 2.** Growth in the number of studies on bat-fly interactions over the years (1904–
258 2022).

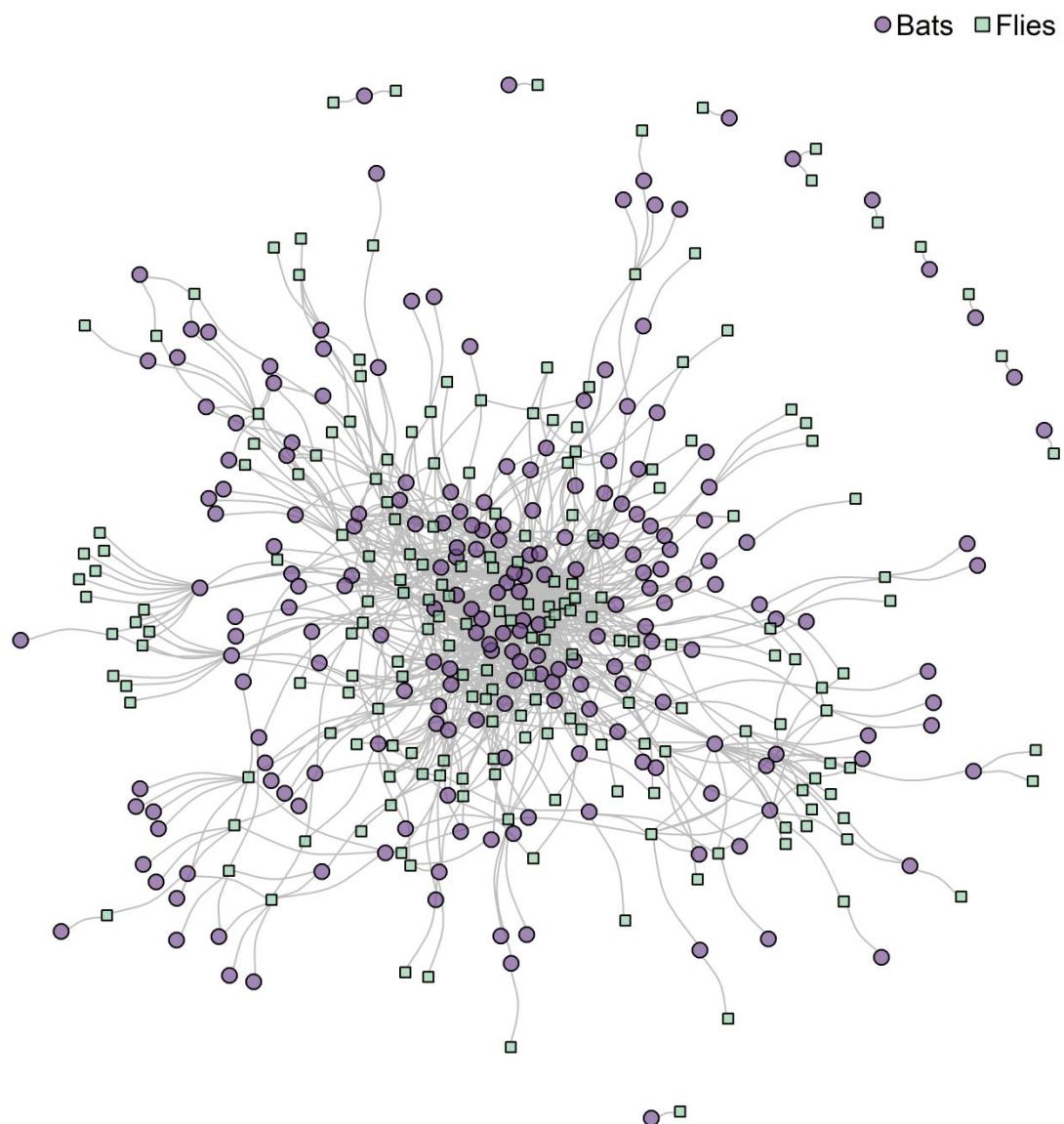
259 Our database comprises interactions made by bats ~~belonging to~~ nine families, 76
 260 genera, and 237 species. For flies, it comprises two families, 29 genera, and 255 species.
 261 ~~Those interactions form a highly connected network, in which a giant component can be~~
 262 ~~observed. This kind of structure was unexpected due to the high specificity that these~~
 263 ~~interactions are assumed to have (Fig. 3).~~

264 The 15 most frequently recorded bat species made 57% of all interactions, with
 265 *Carollia perspicillata* (357) as the species with most records (357), followed by *Artibeus*
 266 *jamaicensis* (263) and *Artibeus lituratus* (228) (Fig. 24A), ~~all of which are all three~~ members
 267 of ~~the the~~ Phyllostomidae (Fleming et al. 2020)□. Over 57 bat species were shown to have
 268 only one interaction (singletons). Half of the interactions were made by 15 fly species, with
 269 *Trichobius joblingi* having the highest number of records (256), followed by *Megistopoda*
 270 *aranea* (235) and *Megistopoda proxima* (215) (Fig. 24B).

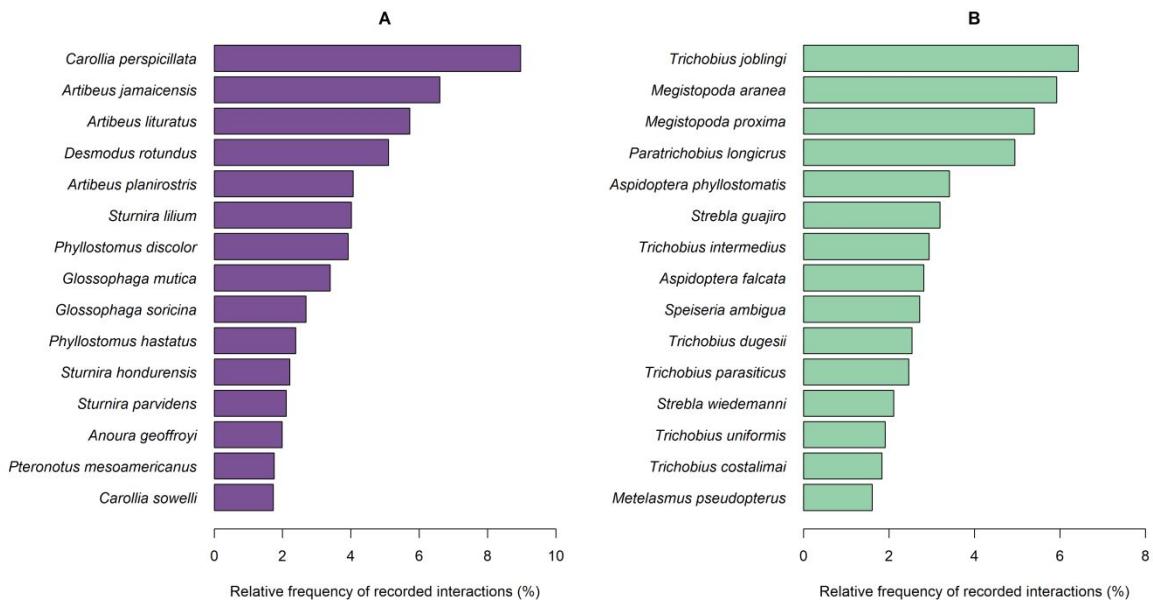


271
 272 **Figure 2.** Relative frequency of interactions made by the top 15 (A) bat species and (B) fly
 273 species with most records.

274 In summary, BatFly has a total of 3,984 interaction records between bat and fly
275 species.

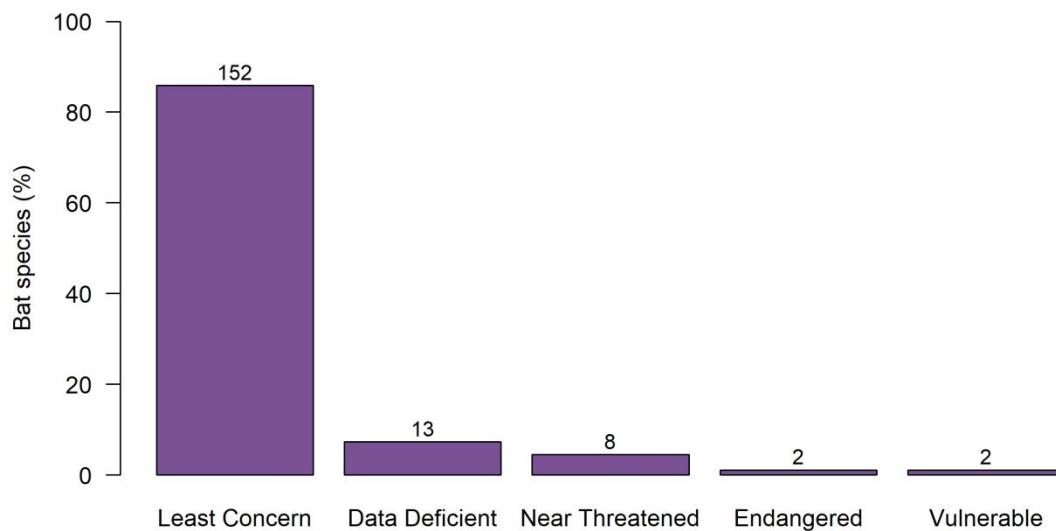


276
277 Figure 3. The bat-fly network built for the entire Neotropical region with all records included
278 in our data set. Lines depict interactions between bat species (purple circles) and bat-fly
279 species (green squares). Most nodes belong to a giant component and there are also ten minor
280 components.



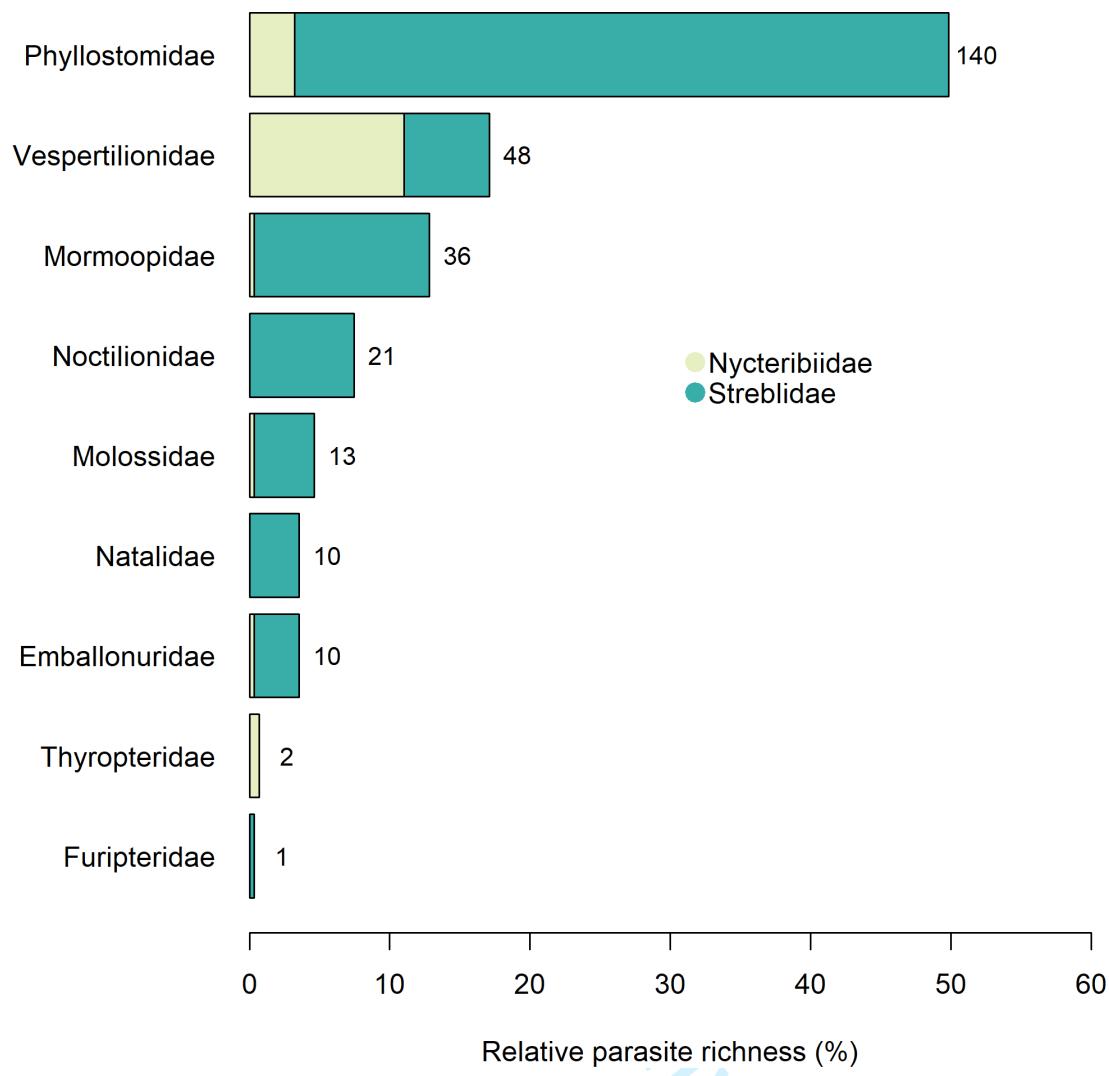
281
282 **Figure 4. Relative frequency of interactions made by the top 15 (A) bat species and (B) fly**
283 **species with most records.**

284 Those interactions form a highly connected network, in which a giant component can
285 be observed. This kind of structure was unexpected due to the high specificity that these
286 interactions are assumed to have (Fig. 3). Most bat species recorded in our data set, according
287 to the IUCN Red List of Threatened Species (<https://www.iucnredlist.org>), are categorized
288 as least concern (152 species). However, two of them are considered vulnerable, while the
289 species *Leptonycteris nivalis* and *Lonchophylla dekeyseri* are considered endangered (Fig. 5)

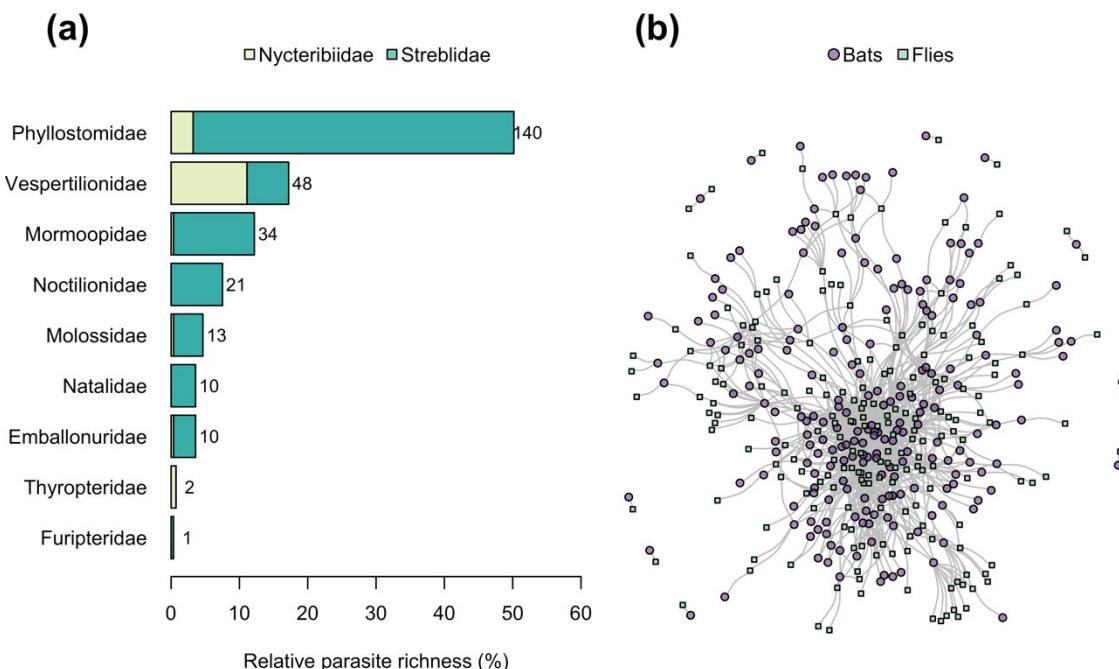


290
291 **Figure 5. IUCN conservation status of the bat species.**

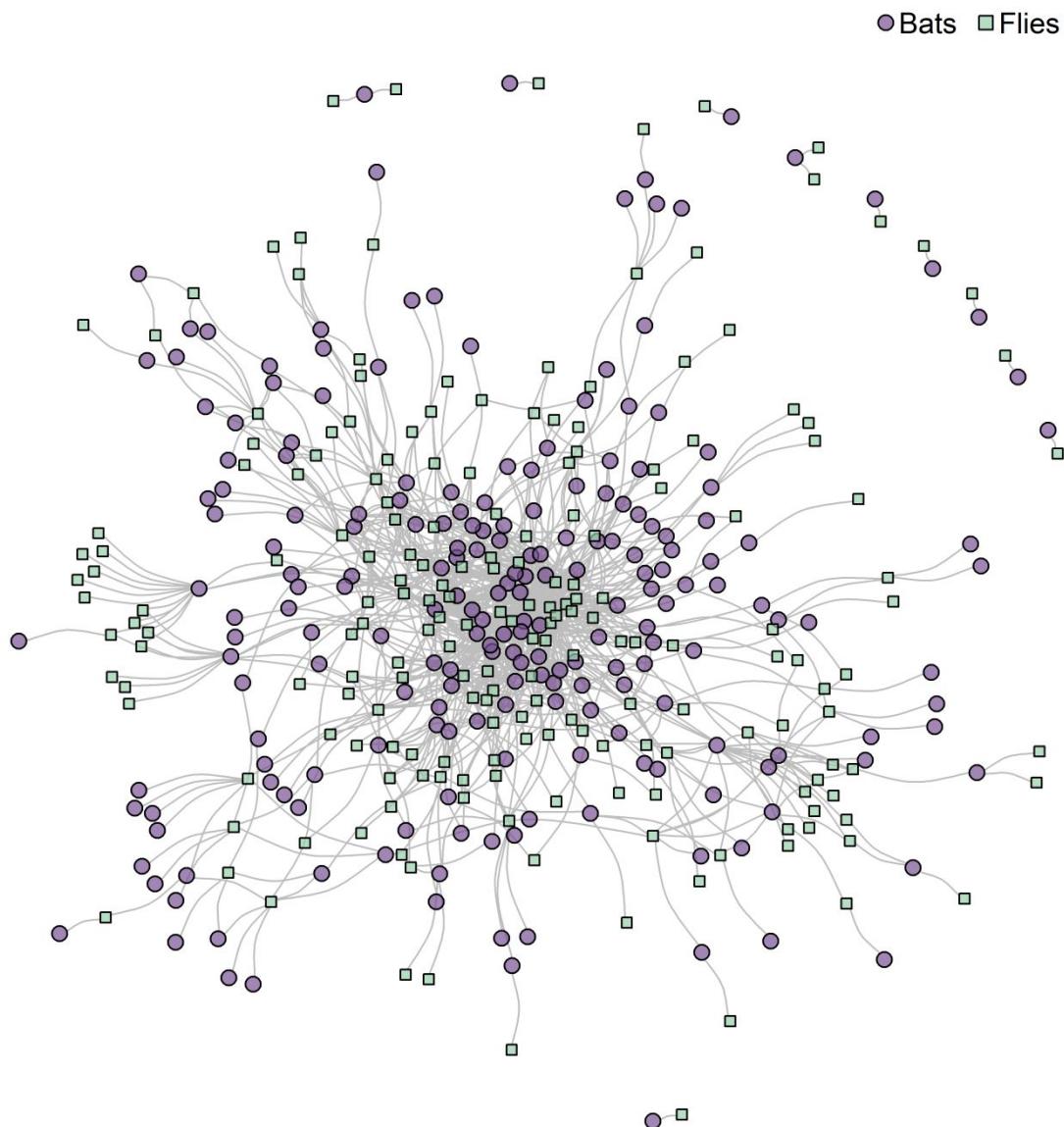
292 Among bats, Species within the family Phyllostomidae shows the richest set of
293 interactions (140 fly species), followed by Vespertilionidae (48 fly species), and
294 Mormoopidae (36 fly species). Most bat families within our records interact more frequently
295 with fly species belong to of the family Streblidae, except for Vespertilionidae and
296 Thyropteridae, which that interact more frequently with the the Nycteribiidae. Furthermore,
297 in the bat families Furipteridae, Noctilionidae, and Natalidae no interaction with species of
298 Nycteribiidae species was recorded (Fig. 3A6). Those interactions between bat and fly
299 species form a densely connected network, in which a large group of interconnected bat and
300 fly species (giant component of the network) can be observed. This kind of structure was
301 unexpected due to the high specificity that these interactions are assumed to have (Fig. 3B).
302 However, this network was made with all interactions included in BatFly, even uncommon
303 interactions, which may mask the true host specificity in the bat-fly interactions, so it should
304 be interpreted with caution.



305



306
307 **Figure 36.** Overview of bat-fly interactions included in BatFly. **(A)** Relative richness of bat
308 fliesfly families (Nycteribiidae and Streblidae) per bat family. The number in front of the
309 bars depicts the total number of bat fly species found parasitizing each bat family. **(B)** Bat-
310 fly network built for the entire Neotropical region with all records included in our data set,
311 even uncommon associations. Lines depict interactions between bat species (purple circles)
312 and fly species (green squares). Most nodes belong to the giant component (largest subgroup
313 of interconnected species) and there are also ten minor components (dyads).



314
315

Figure 3. The bat–fly network built for the entire Neotropical region with all records included

316
317
318

in our data set. Lines depict interactions between bat species (purple circles) and bat–fly species (green squares). Most nodes belong to a giant component and there are also ten minor components.

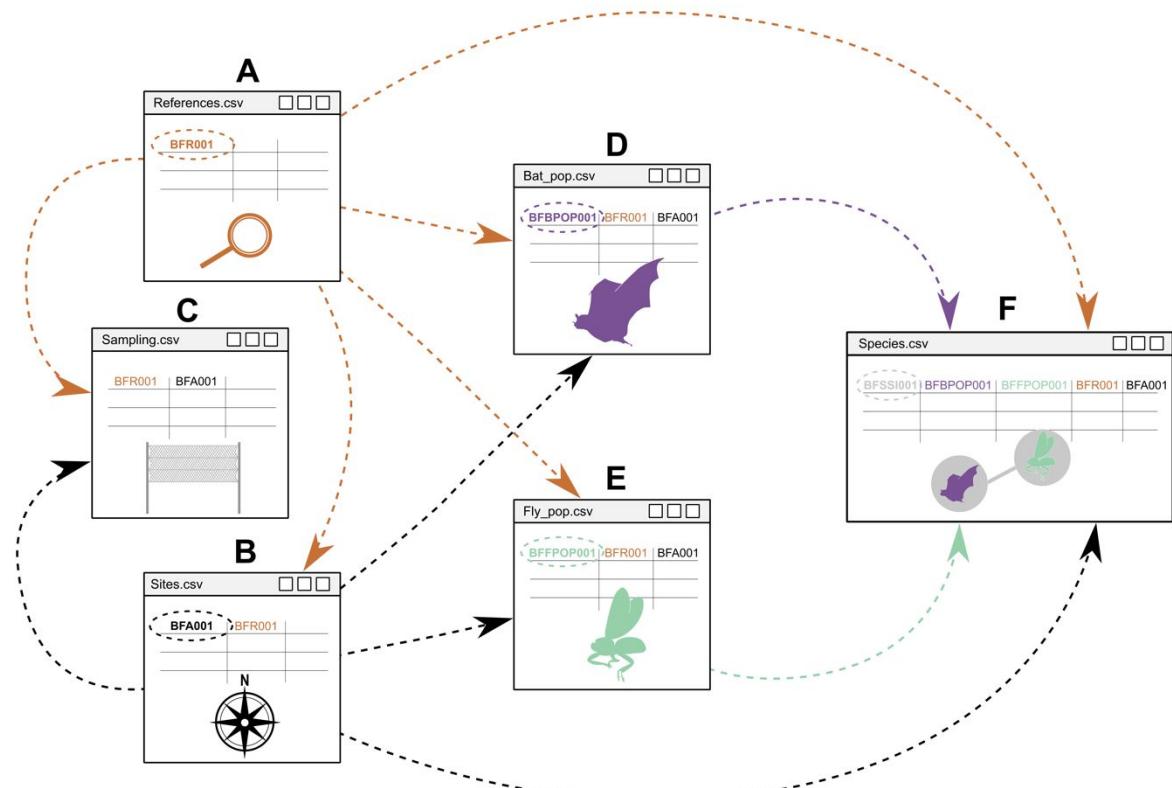
319
320
321

BatFly represents the largest dataset of antagonistic interactions made by bats in both geographical and taxonomic terms. All records were taxonomically harmonized, i.e., bat and fly scientific names were checked and updated. In addition to interaction records, our

322 database includes information about references, study sites, sampling methods, and bat and
323 fly populations organized in six linked data sheets (Fig. 4): “references”, “sites”, “sampling”,
324 “bat population”, “fly population”, and “species interactions”. The “references” data sheet
325 (Fig. 4A) contains information on the original sources from which the data were obtained.
326 Each reference study was assigned a unique reference code (e.g., BFR001), enabling
327 identification of each reference study in all other data sheets. The data sheets “sites” (Fig.
328 4B) and “sampling” (Fig. 4C) contain information about where, when and how the data were
329 collected at each site, including study sites characteristics (e.g., mean annual temperature,
330 annual rainfall, and vegetation type) which are known to influence bat-fly interactions
331 (Pilosof et al. 2012). Each study site was assigned a unique site code (e.g., BFA001), with
332 which each study site can be identified in within “sites”, “sampling”, “bat population”, “fly
333 population” and “species interactions” data sheets.

334 The “bat population” (Fig. 4E) and “fly population” (Fig. 4F) data sheets contain
335 taxonomic identification and information about the populations of interacting species. Also,
336 we included bat species traits, such as the roost types used by bats, which are important
337 drivers of parasite dynamics □(Patterson, Dick, and Dittmar 2007). Each population was
338 assigned a unique population code for bats (e.g., BFBPOP000) and flies (e.g., BFFPOP000),
339 allowing its identification of each population in the “species interactions” data sheets.
340 Finally, the “species interactions” data sheet (Fig. 4F) contains the species-species interaction
341 records, and information about number of infested bats, prevalence, mean fly intensity, and
342 mean fly abundance. Each interaction record was assigned an interaction code (e.g.,
343 BFSSI000) associated to bat population and fly population codes, and also associated to site,
344 and references codes shared between data sheets (foreign keys). This interconnected structure

345 enables the expansion of information for each interaction record encompassing where and
 346 how the interaction was collected, as well as the number of bats and flies involved in a
 347 specific record.



348
 349 **Figure 4.** Structure of the BatFly database. BatFly is integrated by six
 350 interconnected datasheets. (a) References data sheet. (b) Site data sheet. (c)
 351 Sampling data sheet. (d) Bat population data sheet. (e) Fly population data sheet. (f) Species
 352 interaction data sheet. Each interaction record has a unique interaction code (primary key)
 353 associated to reference, site, bat and fly population codes shared between datasheets (foreign
 354 keys). In the graphical representation, dashed ovals indicate the first appearance of a code
 355 within the database. Dashed lines illustrate the relationships between BatFly's datasheets.
 356 Each code is designated with a distinct color. For example, the reference code (colored

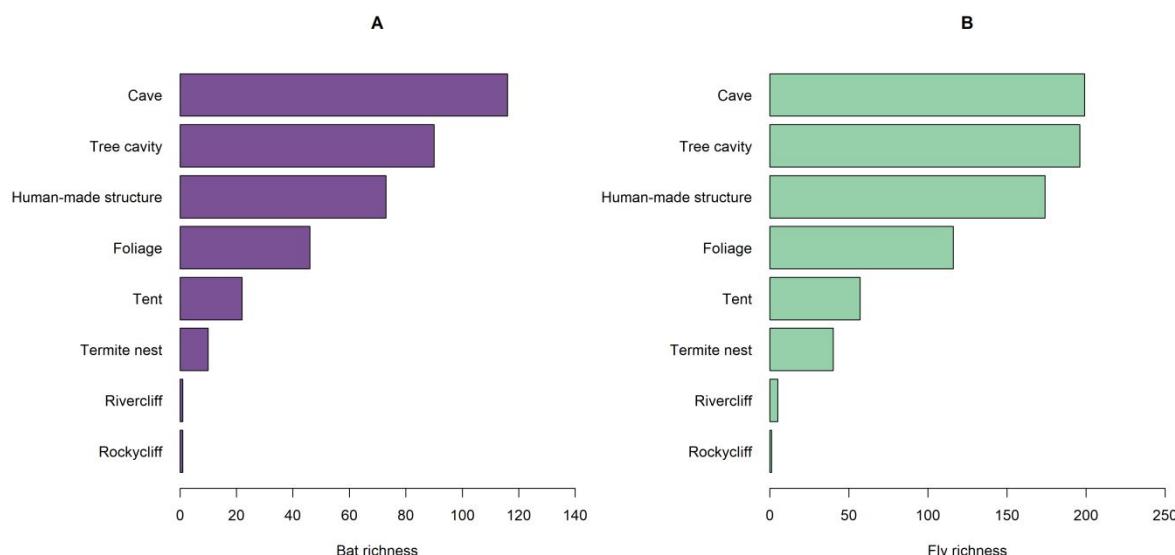
357 orange), which first appears on the reference datasheet (aA), can be found on all other
358 datasheets, denoted by five orange lines.

359 In the graphical representation, dashed ovals indicate the first appearance of a code within a
360 specific datasheet. Dashed lines depict the relationships between BatFly's datasheets,
361 showing where each code first appears (indicated by the start of the dashed line) and in which
362 datasheets it is shared (indicated by the dashed line arrow). Each code is assigned a different
363 color. For instance, the reference code (colored orange), which initially appears on the
364 reference datasheet (A), can be located on all other datasheets, represented by five orange
365 lines.

366
367 BatFly was designed to boost the use of bat-fly interactions as a model for addressing
368 questions at different levels of ecological organization and spatial scales. We expect BatFly
369 to inspire researchers to continue consolidating knowledge about ecological specialization,
370 resource distribution, pathogen transmission, and the drivers of parasite prevalence over a
371 broader spatial range. It may also help answer key questions, such as: are there differences
372 in fly prevalence or mean infestation across Neotropical ecoregions? What ecological drivers
373 explain those differences? Or how do specialization patterns vary among fly species in the
374 Neotropics? We also expect to inspire research aimed at understanding how bat-fly
375 interactions can be affected by climate and landscape changes. Ultimately, we expect BatFly
376 to help understand host-parasite interactions, facilitate predicting zoonotic outbreaks, and
377 provide information to address the UN's SDG 3 Good Health and Wellbeing.

378 Bat species included here use different types of roosts, mainly caves, tree cavities,
379 human-made structures, and foliage. Most bat species use caves and tree cavities (32 and

380 25%, respectively) (Fig. 7A). Others use termite nests as roosts, mainly bats that belong to
 381 the genera *Lophostoma*, *Phyllostomus*, and *Tonatia*. In addition, *Sturnira tildae* and
 382 *Nyctinomops laticauda* were the only species reported using river cliff roosts and rocky cliff
 383 roosts, respectively. The highest species richness of flies was found to be linked to bat species
 384 inhabiting caves (25%) and tree cavities (25%) (Fig. 7B).



385
 386 **Figure 7.** (A) Bat richness according to the type of roost used. (B) Fly richness according to
 387 the type of roost used by their bat hosts. Considering that the same bat species might use
 388 more than one type of roost, the sum of bar values does not match the total number of bat
 389 and fly species included in our data set.

390 CLASS II. RESEARCH ORIGIN DESCRIPTORS

391 A. Overall project description

392 **Identity:** A compilation of bat-fly interactions.

393 **Period of study:** Data of collection-publication reported in the references range from
 394 19044 to 2022.

395 **Objective:** We aimed to summarize and make available all bat-fly interaction records
396 found in the literature plus three new data sets in a tidy format, to be used in studies on
397 community ecology, interaction networks, and macroecology, and disease spillover,
398 among other topics.

399 **Abstract:** Global changes have increased the risk of emerging infectious diseases,
400 which can be prevented or mitigated by studying host-parasite interactions, among
401 other measures. Bats and their ectoparasitic flies of the families Streblidae and
402 Nycteribiidae are an excellent study model, but so far, our knowledge is restricted to
403 fragmented records at a local scale. To help boost research, we have assembled a data
404 set of bat-fly interactions from 174 studies published between 1904 and 2022, plus
405 three original data sets. Altogether, these studies were carried out at 650 sites in the
406 Neotropics, mainly distributed in Mexico, Brazil, Argentina, southern USA and
407 Colombia, among other countries. In total, our data set contains 3,984 interaction
408 records between 237 bat species and 255 fly species. The bat species with the largest
409 number of recorded interactions were *Carollia perspicillata* (357), *Artibeus*
410 *jamaicensis* (263), and *Artibeus lituratus* (228). The fly species with the largest number
411 of recorded interactions were *Trichobius joblingi* (256), *Megistopoda aranea* (235),
412 and *Megistopoda proxima* (215). The interaction data were extracted, filtered,
413 taxonomically harmonized, and made available in a tidy format together with linked
414 data on bat population, fly population, study reference, sampling methods and
415 geographic information from the study sites. This interconnected structure enables the
416 expansion of information for each interaction record, encompassing where and how
417 each interaction occurred, as well as the number of bats and flies involved. We expect
418 BatFly to open new avenues for research focused on different levels of ecological

419 organization and spatial scales. It will help consolidate knowledge about ecological
420 specialization, resource distribution, pathogen transmission, and the drivers of parasite
421 prevalence over a broad spatial range. It may also help answer key questions, such as:
422 are there differences in fly prevalence or mean infestation across Neotropical
423 ecoregions? What ecological drivers explain those differences? Or how do
424 specialization patterns vary among fly species in the Neotropics? Furthermore, we
425 expect BatFly to inspire research aimed at understanding how climate and land-use
426 changes may impact host-parasite interactions and disease outbreaks. This kind of
427 research may help us reach Sustainable Development Goal 3, Good Health and
428 Wellbeing, outlined by the United Nations.

429 Same as above.

430 **Sources of funding:** NZM, SMB, and JH were funded by Ministerio de Ciencia,
431 Tecnología e Innovación de Colombia (MinCiencias, Convocatoria Doctorados en el
432 Exterior 860 and 906). NZM and SMB were funded by the Brazilian Coordination for
433 the Improvement of Higher Education Personnel (CAPES, 88887.467879/2019-00 and
434 88887.388097/2019-00). GG was funded by National Council for Scientific and
435 Technological Development (CNPq# 308119/2022-3). MARM was funded by the
436 Alexander von Humboldt Foundation (AvH~~_~~~~, 3.2-BRA/~~1134644 ~~and 3.4-1134644-~~
437 ~~BRA-GA~~), National Council for Scientific and Technological Development (CNPq,
438 304498/2019-0), São Paulo Research Foundation (FAPESP, 2018/20695-7 and
439 2023/02881-6), and Dean of Research of the University of São Paulo (PRP-USP,
440 18.1.660.41.7).

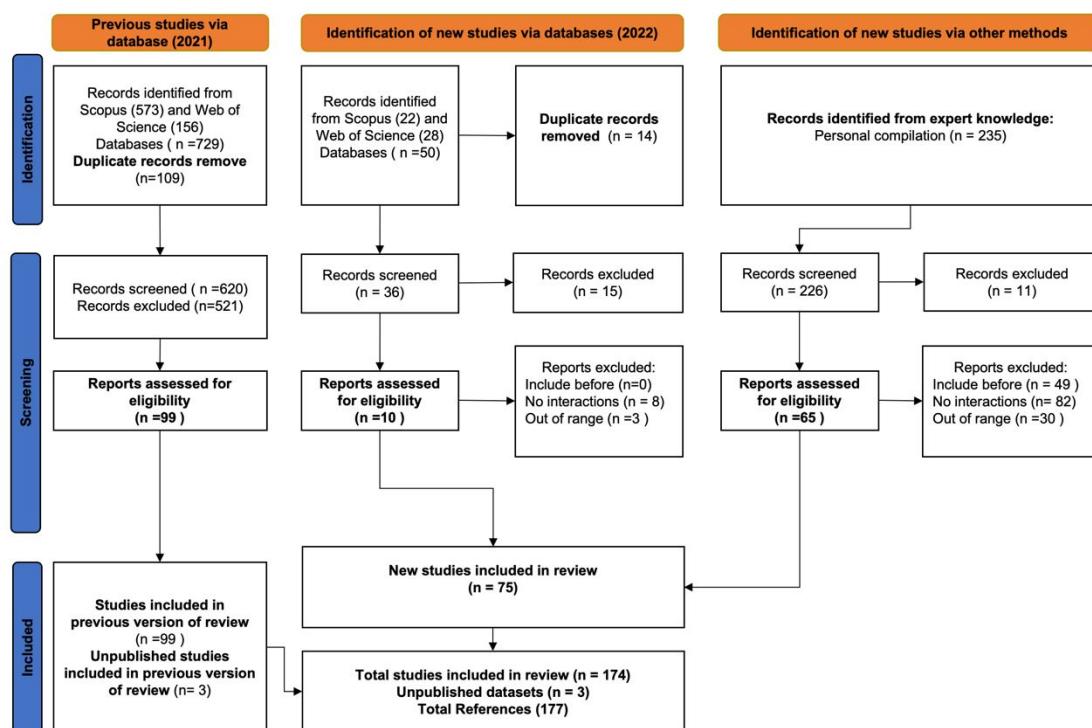
441 **B. Specific subproject descriptions**

442 **Data compilation:** We performed a comprehensive systematic review of the literature,
443 following the Preferred Reporting Items for Systematic review and Meta-Analyses
444 (PRISMA) protocol designed as a guide to improve clarity and transparency in the
445 reporting of systematic reviews protocol (Page et al. 2021). We also added information
446 from articles papers that did not appear in our systematic search, but which we were
447 aware of, and invited authorities to contribute with their unpublished data (Fig. 58).

448 The systematic search was conducted in three languages: English, Portuguese,
449 and Spanish, utilizing the Web of Knowledge and Scopus databases. There were no
450 date restrictions, and the search was performed in 2021The systematic search was
451 conducted across three languages English, Portuguese, and Spanish, on the Web of
452 Knowledge and Scopus databases. The search utilized keywords in three languages:
453 English, Portuguese, and Spanish. The following keywords were employed: The
454 systematic search was made on the databases Web of Knowledge and Scopus, using the
455 following search terms: “bat*” OR “murciélagos*” OR “morcego*” OR “chiroptera”
456 OR “chiroptero” OR “quiroptera” OR “quiroptero” AND “bat fly” OR “bat flies” OR
457 “streblid*” OR “streblidae” OR “nycteribiid*” OR “nycteribiidae” OR “parasite*” OR
458 “parásito*” OR “ectoparasite*” OR “ectoparásito*” OR “ectoparasita*” OR “diptera*”
459 OR “díptero” OR “mosca”. With the results from this ese naive-term search we
460 extracted potential keywords using the Rapid Automatic Keyword Extraction (RAKE)
461 algorithm (Grames et al. 2019). We performed an additional search based on tThose
462 automatic extracted keywords underwent manual verification, filtering, and sorting.
463 Subsequently, a search was performed using the following se refined keywords:
464 "tropical bat" OR "tropical bats" OR "bat" OR "bats" OR "neotropical bats" OR

465 "neotropical bat" OR "chiroptera" OR "chiropteran hosts" OR "chiropteran species"
466 AND "blood-sucking flies" OR "blood-sucking fly" OR "diptera" OR "dipterans" OR
467 "nycteribiidae" OR "streblidae" OR "streblid*" OR "bat flies" OR "bat fly" OR
468 "ectoparasite*" OR "nycteribiid*" OR "bat parasite*" OR "bloodsucking diptera" OR
469 "bloodsucking dipterans" OR "batfly" OR "batflies" AND "parasitizing" OR
470 "interaction*" OR "interacted" OR "interact" OR "parasitological" OR "association*"
471 OR "host-parasite" OR "system*" OR "vertebrate-parasite" OR "network*" "parasite
472 assemblage*" OR "intensity" OR "infection" OR "infestation" OR "load*" "host
473 potential" OR "parasitism" OR "prevalence" OR "parasited" OR "hematophagous" OR
474 "relationship*" OR "specificity" OR "specialization" OR "specialisation" OR
475 "inhabiting" OR "fly-host" OR "host-specific" OR "parasitology" OR "bat-parasite"
476 OR "specialized" OR "specialised" OR "specialize" OR "specialise" OR "host" OR
477 "hosted" OR "hosting" OR "hosts"~~hoste automatically extracted keywords.~~ We
478 compiled information on bat fly interactions from a total of 10277 references.~~+99174~~
479 ~~papers studies found and 3 unpublished data sets) in this systematic search and 3~~
480 ~~unpublished data sets collected by the authors in a first source of information.~~ As we
481 did our first systematic search in 2021, we did an update with additional search
482 restricted to ~~works studies~~ published in 2022, with keywords: "streblid*" OR
483 "streblidae" OR "nycteribiid*" OR "nycteribiidae", adding ten references for 2022
484 year. Finally, we included 65 references provided by one of the authors, Gustavo
485 Graciolli (Fig. 58).~~These 65 references did not come up in the search due to most of~~
486 ~~them are not indexed in the databases used.~~

487 For a study to be included in our database, it had to meet the following inclusion
 488 criteria: (1) be a primary study, so we discarded literature reviews or compilations of
 489 interactions from other studies; (2) contain naturally occurring interactions, so we
 490 ignored host preference studies carried out under controlled conditions; and (3) contain
 491 spatial geographic information of where the interactions were recorded, as coordinates,
 492 country and locality. Finally, with the studies found in the first systematic search done
 493 in 2021 (99), the studies found in the second systematic search (update, 10) and 65
 494 studies provided by one of the authors, BatFly contains 174 published studies and 3
 495 original datasets (177 references in total; Fig. 5). Finally, with three sources (previous



496 review, update, and personal compilation) BatFly contains 174 studies and 3 original
 497 datasets (Fig. 8).

498

499 **Figure 58.** Workflow of the updated systematic review carried out to acquire data,
500 which included database searches, additional records, and other sources, following
501 PRISMA 2020 (Page et al. 2021).

502 **Research methods:** We included only studies that reported bat-fly interactions
503 recorded from wild assemblages. Their scopes range from new fly records and
504 community ecology and endosymbiont diversity in bat flies (bacteria and fungi), along
505 with information on bat hosts. Information on sampling methods and host population
506 was also extracted. We also included geographical information from study sites
507 (latitude, longitude, locality, municipality, state, and country), and site characteristics
508 (ecoregion, type of vegetation, height, average annual temperature). Missing
509 information was coded as “NA”.

510 We compiled information on bat-fly interactions published between 1904 and
511 2022 from 174 references: Brues 1904; Curran 1935; Guimarães 1937; 1966; 1972;
512 1977; E. Dias et al. 1942; Augustson 1943; Fox and Stabler 1953; Hoffmann 1953;
513 Parmalee 1955; Zeve 1958; Peterson 1960; 1963; Bradshaw and Ross 1961; Tonn and
514 Arnold 1963; Uberlaker 1966; Maa 1968; Peterson and Maa 1970; Peterson and Hürka
515 1974; Whitaker and Easterla 1975; Reisen, Kennedy, and Reisen 1976; Hoffmann,
516 Palacios-Vargas, and Morales-Malacara 1980; Overal 1980; Fritz 1983; Coimbra jr,
517 Guimarães, and Mello 1984; Peterson and Lacey 1985; Caplonch et al. 1997; Komeno
518 and Linhares 1999; Claps, Autino, and Barquez 2000; 2005; Chavez 2001; Ritzi et al.
519 2001; Azevedo and Linardi 2002; Guzmán-Cornejo et al. 2003; Moura, Bordignon, and
520 Graciolli 2003; Autino and Claps 2004; González D., Santos M, and Miranda 2004; ter
521 Hofstede, Fenton, and Whitaker, Jr. 2004; Bertola et al. 2005; Villegas-Guzman,
522 López-González, and Vargas 2005; Dick and Gettinger 2005; Anderson and Ortencio

523 Filho 2006; Dick and Wenzel 2006; Oscherov, Chatellenaz, and Milano 2006;
524 Oscherov, Idoeta, and Milano 2012; Graciolli et al. 2006; Graciolli, Zortéa, and
525 Carvalho 2010; Graciolli, Guerrero, and Catzeflis 2019; Voigt and Kelm 2006;
526 Shockley and Murray 2006; Graciolli and Bianconi 2007; Dick, Gettinger, and Gardner
527 2007; Kurta et al. 2007, n.d.; Rojas et al. 2008; Sebastián Tello, Stevens, and Dick
528 2008; P. A. Dias et al. 2009; Autino et al. 2009; 2011; Autino, Claps, and Barquez
529 2014; Autino et al. 2016; 2018; 2020; Dittmar et al. 2009; 2011; Valdez, Ritzi, and
530 Whitaker 2009; Santos et al. 2009; 2013; Graciolli and Dick 2009; 2012; Almeida et
531 al. 2011; Camilotti et al. 2010; Aguiar and Antonini 2011; Eriksson, Graciolli, and
532 Fischer 2011; Muñoz-Romo, Burgos, and Kunz 2011; J. R. R. da Silva and Ortêncio
533 Filho 2011; Lourenço and Esbérard 2011; Esbérard et al. 2012; 2014; Morse et al. 2012;
534 Dick 2013; Moras et al. 2013; Saldaña-Vázquez et al. 2013; Soares et al. 2013; 2016;
535 2017; França et al. 2013; Urbíeta and Torres 2014; Moreno Valdés 1998; Camacho et
536 al. 2014; Lourenço et al. 2014; 2020; Velazco, Autino, and Claps 2014; Tarquino-
537 Carbonell et al. 2015; Tlapaya-Romero et al. 2015; Tlapaya-Romero, Ibáñez-Bernal,
538 and Santos-Moreno 2019; Tlapaya-Romero, García-Méndez, and Ramírez-Martínez
539 2022; Cuxim-Koyoc et al. 2015; 2016; 2018; Judson, Frank, and Hadly 2015; Patricio
540 and Lourenço 2016; de Vasconcelos et al. 2016; Hernández-Arciga, Herrera M., and
541 Morales-Malacara 2016; Frank et al. 2016; Reeves et al. 2016; Barbier and Graciolli
542 2016; Bezerra, de Vasconcelos, and Bocchiglieri 2016; Zarazúa-Carbajal et al. 2016;
543 Barbier, Prado-Neto, and Bernard 2016; Barbier et al. 2017; 2018; 2019; Barbier,
544 Graciolli, and Bernard 2019; Barbier et al. 2020; Barbier, Falcão, and Bernard 2021;
545 Fagundes, Antonini, and Aguiar 2017; Dornelles and Graciolli 2017; Rivera-García et
546 al. 2017; Cordero-Schmidt et al. 2017; Walker et al. 2018; Abundes-Gallegos et al.

547 2018; Bolívar-Cimé et al. 2018; Colín-Martínez, Morales-Malacara, and García-
548 Estrada 2018; Salinas-Ramos et al. 2018; Calonge-Camargo and Pérez-Torres 2018;
549 Estrada-Villegas et al. 2018; do Amaral et al. 2018; Bezerra and Bocchiglieri 2018;
550 2022; Hrycyna, Martins, and Graciolli 2019; S. S. P. da Silva, Guedes, et al. 2019; S.
551 S. P. da Silva et al. 2021; Torres et al. 2019; Hernández-Martínez et al. 2019; Trujillo-
552 Pahua and Ibáñez-Bernal 2019; 2020; Smit and Miller 2019; Durán et al. 2019; S. S.
553 P. da Silva, Neves, et al. 2019; Vieira et al. 2019; Liévano-Romero, Rodríguez-Posada,
554 and Cortés-Vecino 2019; Orta-Pineda et al. 2019; Ribas, Batista, and Aranha 2020;
555 Ascuntar-Osnas, Montoya-Bustamante, and González-Chávez 2020; Bonifaz, Mena,
556 and Oporto 2020; Raigosa Álvarez et al. 2020; Zamora-Mejías et al. 2020; Ikeda et al.
557 2020; Palheta et al. 2020; de Groot et al. 2020; Oliveira et al. 2020; Menezes Júnior et
558 al. 2021; Minaya, Mendoza, and Iannaccone 2021; Vidal, Bernardi, and Talamoni 2021;
559 Urbieta, Graciolli, and Vizentin-Bugoni 2021; Hiller et al. 2021; Lira-Olguin, Guzmán-
560 Cornejo, and León-Paniagua 2021; Mello et al. 2021; Ramalho, Diniz, and Aguiar
561 2021; Gómez-Corea et al. 2022; Alcantara et al. 2022; Speer et al. 2022; da Silva Biz
562 et al. 2021; Castillo-Urbina et al. 2022; Carvalho et al. 2022; Herrera and Jara 2008;
563 González-Ávalos et al. 2014; Bellizzi et al. 2022; Almeida et al. 2010; Dornelles et al.
564 2017; Ramírez-Martínez et al. 2016; Mello et al. 2022; da Silva Reis et al. 2022).

565 For already included references, if applicable, we accommodated studies that
566 partially or totally used the same data sets as “Associated References”, assuring not to
567 duplicate interaction records (see Table 1).

568 **Taxonomic information:** All records were taxonomically harmonized. Scientific
569 names were checked and updated. For bats, taxonomic harmonization was performed
570 by Marcelo Nogueira. The main reference for bat taxonomic arrangement and

571 nomenclature adopted here was Simmons and Cirranello (2023). HWe, however, when
572 considering the taxonomy of *Glossophaga* we followed Diaz et al. (2021). Also, in the
573 case of *Dermanura*, we followed Cirranello et al. (2016) in treating this taxon as a
574 subgenus of *Artibeus*. followed Diaz et al. (2021) when considering the taxonomy of
575 *Glossophaga*. In the case of *Dermanura*, we followed Cirranello et al. (2016) in treating
576 this taxon as a subgenus of *Artibeus*. Diaz et al. (2021) and Gardner (2008) were the
577 general references for the geographic distribution of each species, but we also consulted
578 country-wide compilations (e.g., York et al. 2019; Martínez-Fonseca et al. 2020;
579 Turcios-Casco et al. 2020; Mora, López, and Espinal 2021; Velazco et al. 2021;
580 Garbino et al. 2022) and primary references (e.g., species descriptions and systematic
581 revisionary works), and species accounts, including Solari and Baker (2006);
582 Genoways and Baker (1996); McDonough et al. (2008); Velazco, Gardner, and
583 Patterson (2010); Velazco and Simmons (2011); Moratelli et al. (2011); Mantilla-
584 Meluk (2014); Mantilla-Meluk and Muñoz-Garay (2014); Pavan and Marroig (2016);
585 Pavan, Bobrowiec, and Percequillo (2018); Velazco and Patterson (2019); Basantes et
586 al. (2020); Loureiro, Engstrom, and Lim (2020); Rodríguez-Posada et al. (2021);
587 Velazco et al. (2021); Calahorra-Oliart, Lira-Noriega, and León-Paniagua (2022);
588 Calderón-Acevedo, Bagley, and Muchhal (2022); Esquivel et al. (2022). When there
589 was a situation in which more than one species could be associated to a previous species
590 record within the same bat community assembly, as *Platyrrhinus helleri* and *Pteronotus*
591 *parnellii*—please refer to Velazco, Gardner, and Patterson (2010) and Pavan,
592 Bobrowiec, and Percequillo (2018) for newly described taxa related to these species—
593 When more than one species could be associated to a previous record, as was the case
594 for *Platyrrhinus helleri* and *Pteronotus parnellii*—see Velazco, Gardner, and Patterson

595 (2010) and Pavan, Bobrowiec, and Percequillo (2018) for new taxa related to these
596 species—the updated identification was retained at genus level.

597 For flies, taxonomic harmonization was performed by Gustavo Graciolli.
598 Taxonomic changes in the current name of species were made following Alcantara,
599 Graciolli, and Nihei (2019); Hrycyna et al. (2022); Tlapaya-Romero, García-Méndez,
600 and Ramírez-Martínez (2023); Graciolli and Dick (2012); Graciolli, Santos, and
601 Rebêlo (2022). In the records that were not identified to the species level, whenever
602 was possible, the taxonomic complex or group to which they belong was reported.

603 **Bat roost information:** We report the roost type used by each bat species included in
604 the database. Bat roost play an important role in fly species lifecycle due to fly species
605 pupal development is carried out in these places (Dittmar et al. 2009). All possible roost
606 types were classified into eight categories: cave (hot caves, caverns, and crevices), tree
607 cavity (hollow trees, fallen trees, and loose bark), human-made structure (buildings,
608 bridges, tunnels, and culverts), foliage (branches and leaves), tent, termite nest, rocky
609 cliff, and river cliff. We compiled this information from the literature (Kunz and
610 Lumsden 2003; Rodríguez-Durán 2020). □

611 C. Data limitations and potential enhancements

612 BatFly has limitations related to the scope of the studies used as data sources and how
613 information was reported in them. There are many gaps in information in the references
614 used, as unfortunately commonly observed in studies on species interactions (see
615 another paper with recommendations to solve this problem: (Kita et al. 2022))

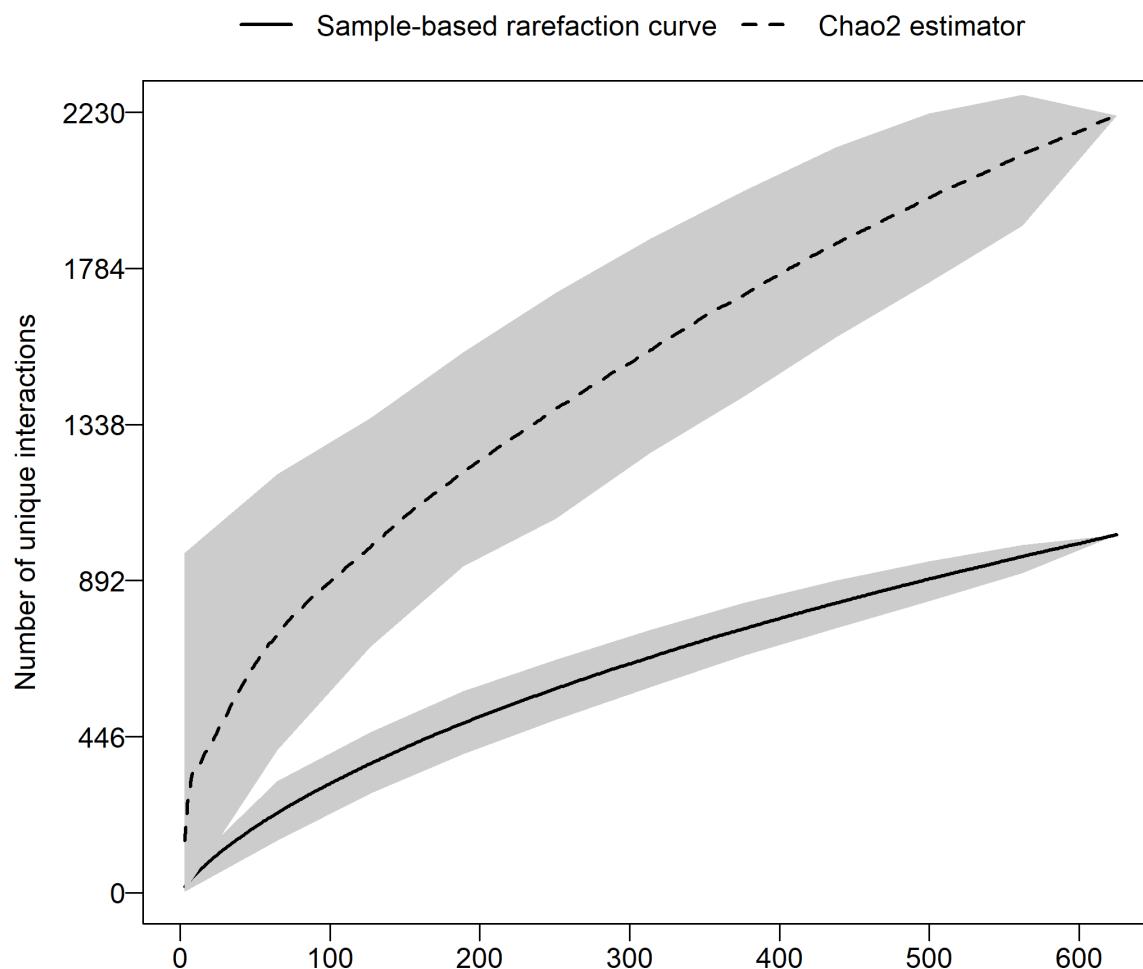
616 BatFly has limitations related to the scope of the studies used as data sources.
617 First, there are sampling information limitations. As several references are checklists
618 of fly species also reporting their hosts, many lack information on bat sampling

619 ~~methods. most studies do not provide information about the methods used for capturing~~
620 ~~bats, e.g., the number of sampling hours or the number of mist nets used, hindering the~~
621 ~~estimation of sampling effort. Only 117 study sites (18%) informed their sampling~~
622 ~~effort following the widely used method of Straube and Bianconi (2002).~~

623 Second, there are geographical information limitations. Sixteen site studies
624 (2.5%) report interactions accumulated from several locations, hindering the use of
625 their data ~~in studies~~ at smaller spatial scales. In those cases, we recorded all ~~the data~~
626 available ~~data~~ from the locations of the study in the observation column (see Table 2).
627 A single SiteCode was assigned with the coordinates of the centroid of the polygon
628 formed by the coordinates reported in the study (see Table 2).

629 Third, there are sampling interaction information limitations. ~~Most studies do~~
630 ~~not provide information about the methods used for capturing bats, e.g., the number of~~
631 ~~sampling hours or the number of mist nets used, hindering the estimation of sampling~~
632 ~~effort. Only one hundred and seventeen (18%) studies informed their sampling effort~~
633 ~~following (Straube and Bianconi 2002). Fourth, Not all studies have information that~~
634 ~~allows quantifying the about interaction weight, and~~ 490 (12%) interactions were
635 recorded only as incidence occurrence (binary information), hindering the use of their
636 data in studies that aim to analyze the interaction by incidence of fly species on bat
637 species. Furthermore, information provided by most studies is limited to the number
638 of individuals of a given fly species found on a given bat species, excluding other key
639 information useful to quantify the interaction such as prevalence, mean intensity, and
640 mean abundance. Only 978 (25%) of the interaction records provide us with
641 information on prevalence.

642 ~~Our fifth~~, there are representativeness limitations. Our database is biased by the
643 method through which bats are sampled, since most studies were based on mist-netting,
644 and different bat species have different capturability (Francis 1989). Mist nets are much
645 more efficient for capturing phyllostomids than bats ~~of from~~ other families (Tschapka
646 1998). So, potential users of BatFly should have this in mind, for example when
647 carrying out studies aimed at analyzing fly incidence in different bat families or species
648 from different bat families. ~~Thus, our database with 1,023 unique interactions represents~~
649 ~~only a small subset of all bat-fly interactions that probably occur in nature. The~~
650 ~~rarefaction curve is far from reaching an asymptote despite being based on 3,984~~
651 ~~interactions records and 1,023 unique interactions, made at 650 study sites (Fig. 9).~~



652
653 **Figure 9.** Number of unique interactions estimated by the Chao2 non-parametric estimator.
654

655 Plotted values for Chao2 are means of 1,000 permutations per sampling site, with the gray
656 area along the line representing 95% confidence intervals. 95% confidence intervals are also
657 showed for the sample-based rarefaction curve. When all sampling sites are pooled (1,023
658 unique interactions detected), the estimator suggests that 1,198 unique interactions remain
659 undetected.

660 CLASS III. DATA SET STATUS AND ACCESSIBILITY**661 A. Status**

662 **Latest update:** November October 20232.

663 **Latest archive date:** November October 20232.

664 **Metadata status:** Last updated in OctoNovember 20232, version submitted.

665 **Data verification:** Data were compiled as presented in the sources. We corrected
666 transcription errors, checked the geographic coordinates of the study sites, and made
667 taxonomic harmonization of species names.

668 B. Accessibility

669 **Storage location and medium:** The complete data set (in .CSV format) and scripts to
670 replicate the figures of this metadata are available on
671 <https://doi.org/10.5281/zenodo.10019756> <https://doi.org/10.5281/zenodo.7814543>.

672 **Contact persons:** Natalya Zapata-Mesa (zapatamesan@gmail.com) & Marco A. R.
673 Mello (marmello@usp.br).

674 **Copyright restrictions:** Creative Commons Attribution 4.0 International License.

675 **Proprietary restrictions:** Please cite this data paper, if the data are used in any kind
676 of publication related to research, outreach, and teaching activities, such as papers,
677 books, book chapters, monographs, bibliographies, reports, patents, posters, talks,
678 keynotes, and lectures.

679 **Costs:** None.

680 CLASS IV. DATA STRUCTURAL DESCRIPTORS**681 A. Data set file**

682 **Identity and s and size:**

683 BatFly_References.csv 66KB

684 BatFly_Sites.csv 14~~22~~KB

685 BatFly_Sampling.csv 46KB

686 BatFly_Bat_Pop.csv 334KB

687 BatFly_Fly_Pop.csv 303KB

688 Batfly_Species Interactions.csv 58~~55~~KB

689 **Format and storage mode:** Data frames with comma-separated values (.csv).

690 **Header information:** See variable description in Variable information section.

691 **Alphanumeric attributes:** Mixed.

692 **Special characters/fields:** Each table contains a column ~~of named “Observations”~~.

693 ~~This column may have additional information or comments. For example, in Table 2,~~

694 ~~Observations column may have additional information about the study site reported by~~

695 ~~the reference, as a pool of coordinates from a study site. This column may have~~

696 ~~additional information or comments. For example, a pool of coordinates from a study~~

697 ~~site.~~ “NA” indicates no information available for a given cell.

698 B. Variable information

699 **Table 1. BatFly References:** Information ~~about of~~ the references used as data sources in our
700 database.

Variable	Description	Levels	Example
RefCode	Identification code of each reference	BFR001 – BFR179	BFR002
Author	Short name of the author(s); if there are three or more authors, we use <i>et al.</i>		Graciolli <i>et al.</i>
Year	Year of publication of each reference		2010
Type	Type of reference	Article, Book, Unpublished data	Article

Reference	Full bibliographic reference For Review Only	Graciolli G., Zortéa M., Carvalho L. F. A. C. (2010) Bat flies (Diptera, Streblidae and Nycteribiidae) in a Cerrado area of Goiás state, Brazil. Revista Brasileira de Entomologia 54: 511-514. https://doi.org/10.1590/S0085-56262010000300025
BatVouchers	Name of the biological collection where voucher bat specimens were deposited	Chiroptera Collection of “Universidade Federal de Goiás, Campus Jataí” (CCUFG)
FlyVouchers	Name of the biological collection where voucher fly specimens were deposited	Zoological Collection of “Universidade Federal do Mato Grosso do Sul”
Associated References	Full bibliographic reference of studies that fully or partially uses the same data of the Reference	Pedro, W.A., Passos F.C. & B.K Lim. 2001. Morcegos (Chiroptera; Mammalia) da Estação Ecológica dos Caetetus, Estado de São Paulo.

Chiroptera
Neotropical,
Brasilia, 7: 136-
140

701

702

For Review Only

703 **Table 2.** BatFly_Sites: Information about_of the study sites from the references included in our
 704 database.

Variable	Description	Levels	Example
SiteCode	Identification code of each study site. A single publication may contain multiple study sites. Different studies could share the same study site and consequently the same SiteCode	BFA001 – BFA653	BFA002
RefCode	Identification code of each reference	BFR001 – BFR179	BFR002
Country	English name of the country where the study was carried out		Brazil
State	State, Province or Department of the study site as described in the source or identified from its geographic coordinates		Goiás
Municipality	Municipality of the study site as described in the reference or identified from its geographic coordinates		Serranópolis
Locality	Local name of the study site as described in the reference or identified from its geographic coordinates		Reserva Particular do Patrimônio Natural Pousada das Araras
Latitude	Corrected and transformed coordinates of the latitude in decimal degrees (Datum WGS84)		-20.772227
Longitude	Corrected and transformed coordinates of the longitude in decimal degrees (Datum WGS84)		-54.785154
Precision <u>Class</u>	Coordinate precision <u>classes</u> of the study site. Precise: coordinates of the grid, transect or vegetation patch are reported <u>in the reference</u> . Not precise: coordinates of	precise, not precise	precise

	the municipality are reported, or the coordinates do not match the information provided in the reference		
Vegetation	Vegetation type as described in the reference		Tropical rainforest
VegType	Vegetation type according to Oliveira-Filho (2017)		Rainforest
Ecoregion	Ecological region according to Oliveira-Filho (2017)		Cauca Valley montane forests
Domain	Tectonic domain according to Oliveira-Filho (2017)		Northern Andean
Elevation	Elevation above sea level in meters (m) reported in the reference		700
<u>DatasetElevationfromElevation</u>	<u>Meters</u> <u>Elevation</u> above sea level <u>in meters (m)</u> , <u>extracted</u> from the GTOPO30 dataset (United States Geological Survey – USGS, 2001. Global 30 arc-seconds Elevation)		700
MeanAnnTemp	Mean annual temperature in Celsius degrees (°C) from WorldClim 2.1 with 30 arc seconds resolution.		23.3
MeanAnnRain	Mean annual rainfall in millimeters (mm) from WorldClim 2.1 with 30 arc seconds resolution.		1429
Observations	Additional information or comments		

706 **Table 3.** BatFly Sampling: Information on the sampling methods used to record interactions
 707 included in our database
 708 information about the sampling and methods in our database.

Variable	Description	Levels	Example
SiteCode	Identification code of each study site from each reference. A single publication may contain multiple study sites.	BFA001 – BFA653	BFA002
RefCode	Identification code of each reference	BFR001 – BFR179	BFR002
YearStart	Year of the beginning of sampling		2000
YearFinish	Year of the end of sampling		2001
Duration	Unstandardized duration of sampling (in months)		11
SamplingEffort	Sampling effort, accounting for the area of the mist nets used and the duration of the survey, in hours*square meters (following Straube and Bianconi 2002). Since many studies do not report mist net size or model, this standardized measure is common for comparing bat inventories		13608
BatEcologicalScale	Reported bat assemblage. all: the whole bat species captured was reported. leafnosed: only leaf-nosed bats (Phyllostomidae) were reported. mormoopid: only mormoopid bats (Mormoopidae) were reported. single: a single bat species was reported	all, leafnosed, mormoopid, single	all
FlyEcologicalScale	Reported fly assemblage. All: the whole fly species capture was reported. Single: a single fly species was reported.	all, single	all
BatSamplingMethod	Method used to capture bats. Direct refers to collection by	direct, harp traps, mist	mist nets

	hand or devices such as hand nets or harp traps.	nets, hand net	
SamplingNights	Total number of capture nights	0 to 36	10
SamplingHours	Duration of capture per night, i.e., the number of hours the mist nets were kept open each night	1 to 12	1
SamplingMistnets	Number of mist nets used, regardless of manufacturer, type, size, mesh, or material	1 to 14	1
SamplingStrata	Vertical strata of the habitat where bats were captured: understory, from canopy to understory, below canopy, canopy	U, UC, BC, C	U
SamplingSeason	Sampling season reported in the reference	dry, wet, both	wet
Observations	Additional information or comments		

710 **Table 4.** [BatFly_Bat_Pop: Information on the bat populations sampled, which were involved in the](#)
 711 [recorded interactions included in our database](#)[Information about the bat populations sampled in](#)
 712 [the references included in our database.](#)

Variable	Description	Levels	Example
BatPopulationCode	Identification code of each bat population	BFBPOP001 – BFBPOP2187	BFBPOP001
RefCode	Identification code of each reference	BFR001 – BFR179	BFR001
SiteCode	Identification code of each study site in each reference	BFA001 – BFA653	BFA001
BatFamily	Current scientific name of the bat family		Noctilionidae
BatGenus	Current scientific name of the bat genus		<i>Noctilio</i>
BatSpecies	Scientific name of the bat species as reported in the reference		<i>Noctilio leporinus</i>
CurrentBatSpecies	Current scientific name of the bat species according to <u>Simmons and Cirnello (2023)</u>		<i>Noctilio leporinus</i>
BatSubspecies	Scientific subspecies name of the Bat as reported in the reference (checked and updated)		
BatRoost	Roosting site of the bat species reported in Kunz and Lumsden (2003) and Rodríguez-Durán (2020)	cave, tree cavity, foliage, tent, termite nest, human-made structure	caves
BatCaptureNumber	Total number of captured bats of the population	1 to 3173	25
BatMarks	Whether or not captured bats were marked. For studies where no marks were used,	yes, no	no

	BatCaptureNumber might include recaptured individuals		
BatFemales	Number of captured bats that are females of the population	0 to 235	11
BatMales	Number of captured bats that are males of the population	0 to 182	21
BatJuvenile	Number of captured bats that are juveniles of the population	0 to 290	41
BatAdult	Number of captured bats that are adults of the population	0 to 127	5
BatLactatingFemales	Number of captured bats that are lactating females of the population. Bats can be lactating and pregnant at the same time	0 to 21	20
BatNonreproductiveFemales	Number of captured bats that are nonreproductive females of the population	0 to 34	3
BatPregnantFemales	Number of captured bats that are pregnant females of the population	0 to 18	4
BatNonreproductiveMales	Number of captured bats that are nonreproductive males of the population	0 to 37	6
BatScrotalTestesMales	Number of captured bats that are males with scrotal testes of the population	0 to 32	30
Observations	Additional information or comments		

714 **Table 5.** BatFly_Fly_Pop: Information on the fly populations sampled, which were involved in the
 715 recorded interactions included in our database. Information about the fly populations sampled in
 716 the references included in our database.

Variable	Description	Levels	Example
FlyPopulationCode	Identification code of each bat fly population	BFFPOP001 – BFFPOP2969	BFFPOP001
RefCode	Identification code of each reference	BFR001 – BFR179	BFR001
SiteCode	Identification code of each study site in each reference	BFA001 – BFA653	BFS001
FlyFamily	Current scientific <u>name</u> of the fly family	Streblidae, Nycteribiidae	Streblidae
FlyGenus	Current scientific <u>name</u> of the fly genus		<i>Megistopoda</i>
FlySpecies	Scientific name of the fly as reported in the reference		<i>Megistopoda aranea</i>
CurrentFlySpecies	<u>Current s</u> Scientific name of the bat fly		<i>Megistopoda aranea</i>
Flysubspecies	Scientific subspecies name of the fly as reported in the reference (checked and updated)		
FlyCaptureNumber	Total number of captured flies of the population	1 to 2197	2
FlyFemales	Total number of flies that are females of the population	0 to 1105	20
FlyMales	Total number of flies that are males of the population	0 to 2042	4
FlyUndetermined	Total number of flies that were not <u>sex</u> identified		

717

718 **Table 6.** Batfly_Species_Interactions: Information ~~about on~~ the bat-fly species-species interactions
 719 recorded in our database.

Variable	Description	Levels	Example
InteractionSpeciesCode	Identification code of each species-species interaction record	BFSSI00 01 – BFSSI40 14	BFSSI00 01
BatPopulationCode	Identification code of each bat population	BFBPOP 001 – BFBPOP 2187	BFBPOP 0010
FlyPopulationCode	Identification code of each bat fly population	BFFPOP 001 – BFFPOP 2969	BFFPOP 0015
RefCode	Identification code of each reference	BFR001 – BFR179	BFR004
SiteCode	Identification code of each study site in each reference	BFA001 – BFA653	BFA051
CurrentBatSpecies	Current scientific name of the bat species according to Simmons and Cirranello (2023)		<i>Noctilio leporinus</i>
BatSubspecies	Scientific subspecies name of the bat as reported in the reference (checked and updated)		
CurrentFlySpecies	Current scientific name of the bat fly		<i>Megistopoda aranea</i>
Flysubspecies	Scientific subspecies name of the fly as reported in the reference (checked and updated)		
TransientInteractionorError	Uncommon association. It may be an association that will not last over time (transient) or the researcher's error in the collection or identification	yes, no	no
NumberInteractions	Number of bat -flies captured on the bat species	0 to 2197	2197

NumberInteractionsByFlyFemales	Number of female bat-flies captured on the bat species	0 to 1105	291
NumberInteractionsByFlyMales	Number of male bat-flies captured on the bat species	0 to 1091	351
NumberInteractionsByFlyUndetermined	Number of undetermined bat flies captured on the bat species	0 to 2042	781
BatInfested	Number of bats infested with one or more individuals of the fly species	0 to 278	201
BatInfestedFemales	Number of female bats infested with one or more individuals of the fly species	0 to 40	21
BatInfestedMales	Number of male bats infested with one or more individuals of the fly species	0 to 33	33
Prevalence	Prevalence (Number of bats infested divided by the total number of bat captures) as reported in the reference	0 to 100	80
PrevalenceOnBatFemales	Prevalence (Number of female bats infested divided by the total number of bat captures) as reported in the reference	0 to 100	50
PrevalenceOnBatMales	Prevalence (Number of male bats infested divided by the total number of bat captures) as reported in the reference	0 to 100	20
MeanFlyIntensity	The total number of flies of the species parasitizing the bat species divided by the number of individual bats infested with the fly	1 to 4.66	1
MeanFlyIntensityOnBatFemales	The total number of flies of the species parasitizing females of the bat species divided by the number of individual female bats infested with the fly	1 to 8	4
MeanFlyIntensityOnBatMales	The total number of flies of the species parasitizing males of the bat species divided by the number of individual male bats infested with the fly	1 to 2.53	2.1

MeanFlyAbundance	The total number of flies of the species parasitizing the bat species divided by the number of individual bats (including non-infested individuals)	0 to 24.1	24.1
MeanFlyAbundanceOnBatFemales	The total number of flies of the species parasitizing females of the bat species divided by the number of individual female bats (including non-infested individuals)	0 to 2.6	1.5
MeanFlyAbundanceOnBatMales	The total number of flies of the species parasitizing males of the bat species divided by the number of individual male bats (including non-infested individuals)	0 to 1.6	1
Observations	Information about reference or comments		

720

721 **C. Data anomalies:** If there is no information available for a specific cell in a given
 722 datasheet, it is indicated as if there is no information available for a given cell, this is indicated
 723 as "NA".

724

725 CLASS V. SUPPLEMENTAL DESCRIPTORS

726 A. Data acquisition

727 **Data forms or acquisition methods:** The full data set is composed of six data sheets:
 728 references, sites, sampling, bat population, fly population, and interactions species-
 729 species. The references data sheet has the information of the original sources from the
 730 data was obtained. The data sheets sites and sampling contain information about where,
 731 when and how the data were collected on each site. The data sheets bat population and

732 ~~fly population contain taxonomic identification and information about the populations~~
733 ~~of interacting species. Finally, the interaction data sheet contains interaction records~~
734 ~~linked to bat population and fly population, and information about number of bats~~
735 ~~infested, prevalence, mean fly intensity, and mean fly abundance.~~

736 **Data entry/verification procedures:** Screening and data extraction were always
737 performed by the same person. The information included in BatFly's the tablesheets,
738 such as codes and scientific names, was validated with logical and set tests
739 implemented in R to reduce typing errors.

740 **B. Publications and results**

741 Partial data of unpublished reference BFR102 (see Table 1) was used in Pastrana-
742 Montiel, M. R., Ballesteros-Correa, J., & Chacón-Pacheco, J. (2019). First record of
743 the parasite bat fly *Basilia mimoni* Theodor & Peterson, 1964 (Diptera: Nycteribiidae)
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