Data Paper

The InBIO Barcoding Initiative Database: DNA barcodes of Portuguese Diptera 01

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Abstract

Background

The InBIO Barcoding Initiative (IBI) Diptera 01 dataset contains records of 203 specimens of Diptera. All specimens have been morphologically identified to species level, and belong to 154 species in total. The species represented in this dataset correspond to about 10% of continental Portugal dipteran species diversity. All specimens were collected north of the Tagus river in Portugal. Sampling took place from 2014 to 2018, and specimens are deposited in the IBI collection at CIBIO, Research Center in Biodiversity and Genetic Resources.
New information

This dataset contributes to the knowledge on the DNA barcodes and distribution of 154 species of Diptera from Portugal and is the first of the planned IBI database public releases, which will make available genetic and distribution data for a series of taxa. All specimens have their DNA barcodes made publicly available in the Barcode of Life Data System (BOLD) online database and the distribution dataset can be freely accessed through the Global Biodiversity Information Facility (GBIF).

Keywords

Diptera, occurrence records, continental Portugal, DNA barcode, COI

Introduction

Diptera is one of the most diverse, abundant and widespread insect orders, with more than 158,000 described species, and many more still to be described (Pape et al. 2009; Evenhuis and Pape 2019). Dipterans are ubiquitous in many terrestrial ecosystems and larval stages of some species can also been found in aquatic ecosystems. They play important ecological roles in ecosystems, including those of pollinators, detritivores and parasites. Some species are also important disease vectors (Merritt et al. 2009) and crop pests (Skuhravá et al. 2010).

In continental Portugal, 1,475 species of Diptera were recorded, a sizable diversity, but small when compared to the 5,800 species known to occur in continental Spain (Carles-Tolrá 2002). Since the seminal work of Carles-Tolrá (2002), further increments to the Portuguese dipteran fauna have been made (e.g. Andrade and Gonçalves 2014; Ebejer and Andrade 2015; Pollet et al. 2019), but much remains to be known about its diversity and distribution patterns in the country. The huge diversity of this order, the shortage of specialised taxonomists and the difficulties in identifying many species are the main obstacles to overcome this lack of knowledge.

DNA barcoding is a method that aims to identify organisms based on a short DNA sequence previously sequenced from morphologically identified specimens (Hebert et al. 2003). This requires the construction of comprehensive reference collections of DNA sequences that represent the existing biodiversity (Baird et al. 2011, Kress et al. 2005, Ferreira et al. 2018). DNA barcoding can also be used as a first step in new species discovery and, as such, can be used as a tool to help address the taxonomic impediment problem (e.g. Kekkonen and Hebert 2014).

The striking scarcity of genetic data associated with the high biodiversity found in Portugal instigated the creation of a DNA barcoding initiative by the Research Network in Biodiversity and Evolutionary Biology - InBIO (Associate Laboratory). The InBIO Barcoding Initiative (IBI) makes use of Next Generation Sequencing technologies (NGS) to develop a
reference collection of DNA barcoding sequences, focusing on Portuguese invertebrate taxa. Within the project, a special focus is afforded to insects, given their relevance to food webs and ecosystems functioning (e.g., Weisser and Siemann 2004; Mata et al. 2016; Silva et al. 2019). Furthermore, for many insect species occurring in Portugal, there are no barcodes available in public databases (Corley and Ferreira 2017; Corley et al. 2017; Weigand et al. 2019), and those that exist often show high distances to sequences obtained in Portugal, which may indicate cryptic diversity (Corley et al. 2019, Corley et al. 2019; Ferreira et al. 2018).

The IBI Diptera 01 dataset contains records of 203 specimens of Diptera collected in continental Portugal, all of which were morphologically identified to species level, for a total of 154 species. This is the first IBI dataset to be released to the Global Biodiversity Information Facility (GBIF) and all specimens have their DNA barcodes made publicly available in the Barcode of Life Data System (BOLD). We have included in this dataset the barcodes of all identified Diptera specimens in IBI up to December 2019, except those from the families Tipulidae and Limoniidae, for which we will provide a more detailed treatment in a future paper, due to the detection of new species and the need for further research. Overall, this paper is a contribution to sharing and publicly disseminating the distribution records and DNA barcodes of specimens from our reference collection to increase the available information on Portuguese Diptera fauna.

General description

Purpose: This dataset aims to provide a first contribution to an authoritative DNA barcode sequences library for Portuguese Diptera. Such a library should facilitate DNA-based identification of species for both traditional molecular studies and DNA-metabarcoding studies and constitute a valuable resource for taxonomic research on Portuguese Diptera and its distribution.

Additional information: A total of 203 specimens of dipterans were collected and DNA barcoded (Suppl. material 2). Fig. 1 illustrates examples of the diversity of species that are part of the dataset of distribution data and DNA barcodes of Portuguese Diptera 01. All sequences of cytochrome c oxidase I (COI) DNA barcodes are 658 bp long. From the 154 species barcoded, twenty nine (19%) from 16 families are new to the DNA barcode database BOLD at the moment of the release (marked with * in Species field of Table 2). Forty-two additional species (27%) from 24 families were previously represented in BOLD, but with less than 10 DNA barcode sequences at the moment of the release (marked with ” in Species field of Table 2). Therefore, this dataset represents a significant contribution to enhance the species and genetic diversity of Diptera fauna represented in public libraries.
Figure 1.
Examples of the diversity of species that are part of the dataset of distribution data and DNA barcodes of Portuguese Diptera 01. All photos by Rui Andrade.

a: Lucilia caesar, Lordelo do Ouro - Porto, BOLD: IBIDP083-19, GenBank: MN868752
b: Hydrotaea dentipes, Campo - Valongo, BOLD: IBIDP136-19, GenBank: MN868754
c: Trigonometopus frontalis, Canelas - Estarreja, BOLD: IBIDP099-19, GenBank: MN868863
d: Episyphus balteatus, Vale de Algoso - Vimioso, BOLD: IBIDP015-19, GenBank: MN868781
e: Ceratitis capitata, Gilmonde - Barcelos, BOLD: IBIDP140-19, GenBank: MN868854
Table 1.
Number of specimens collected per Portuguese district and corresponding percentage. The number of recorded specimens also corresponds to the number of species recorded per district, as each species was collected only once in each district.

| District      | Specimens (n) | Specimens (%) |
|---------------|---------------|---------------|
| Bragança      | 79            | 38.9%         |
| Aveiro        | 51            | 25.1%         |
| Porto         | 38            | 18.7%         |
| Braga         | 21            | 10.3%         |
| Vila Real     | 6             | 3.0%          |
| Castelo Branco| 4             | 2.0%          |
| Viana do Castelo | 2 | 1.0%        |
| Guarda        | 1             | 0.5%          |
| not known     | 1             | 0.5%          |
| **Total**     | **203**       | **100%**      |

Table 2.
List of species that were collected and DNA barcoded within this project. * Indicate species without DNA barcode prior to this study, '' indicates species with less than 10 sequences prior to this study.

| Family          | Species                  | IBI code | BOLD code   | BOLD BIN | GenBank   |
|-----------------|--------------------------|----------|-------------|----------|-----------|
| Anisopodidae    | Sylvicola cinctus        | INV04902 | IBIDP034-19 | BOLD:AAG1996 | MN868840  |
| Anthomyiidae    | Anthomyia imbrida        | INV00551 | IBIDP006-19 | BOLD:ABX9294 | MN868736  |
| Anthomyiidae    | Anthomyia pluvialis      | INV00817 | IBIDP144-19 | BOLD:ADH9310 | MN868903  |
| Anthomyiidae    | Subhylemyia longula      | INV00555 | IBIDP007-19 | BOLD:AAP8836 | MN868762  |
| Asilidae        | Molobratia teutonus      | INV07407 | IBIDP391-19 | BOLD:ADF9805 | MN868906  |
| Bibionidae      | Dilophus febrilis        | INV04935 | IBIDP055-19 | BOLD:ACI4790 | MN868809  |
| Bombyliidae     | Anthrax anthrax          | INV04944 | IBIDP063-19 | BOLD:ADR8193 | MN868791  |
| Family            | Species                        | IBI code          | BOLD code       | BOLD BIN        | GenBank          |
|-------------------|-------------------------------|-------------------|---------------|----------------|-----------------|
| Bombyliidae       | *Exhyalanthrax afer* (Fabricius, 1794) | INV04951         | IBIDP151-19    | BOLD:ADU1899   | MN868734        |
| Bombyliidae       | *Hemipenthes morio* (Linnaeus, 1758) | INV04959         | IBIDP070-19    | BOLD:ACS6268   | MN868882        |
| Calliphoridae     | *Calliphora vicina* Robineau-Desvoidy, 1830 | INV00609, INV01920, INV05001, INV05029 | IBIDP009-19, IBIDP018-19, IBIDP087-19, IBIDP167-19 | BOLD:AAB6579 | MN868831, MN868732, MN868823, MN868797 |
| Calliphoridae     | *Calliphora vomitoria* (Linnaeus, 1758) | INV00176, INV02884, INV05036, INV07378 | IBIDP001-19, IBIDP024-19, IBIDP107-19, IBIDP381-19 | BOLD:AAA8931 | MN868884, MN868856, MN868898, MN868853 |
| Calliphoridae     | *Chrysomya albiceps* (Wiedemann, 1819) | INV05008, INV05075 | IBIDP092-19, IBIDP125-19 | BOLD:ABX6432 | MN868731, MN868796 |
| Calliphoridae     | *Lucilia caesar* (Linnaeus, 1758) | INV04986          | IBIDP083-19    | BOLD:AAA7470   | MN868868        |
| Calliphoridae     | *Lucilia sericata* (Meigen, 1826) | INV04987, INV05048 | IBIDP084-19, IBIDP112-19 | BOLD:AAA6618 | MN868905, MN868854 |
| Canacidae         | *Canace nasica* (Haliday, 1839) | INV04995          | IBIDP161-19    | BOLD:ADT0044   | MN868786        |
| Canacidae         | Tethina illota (Haliday, 1838) | INV05007          | IBIDP091-19    | BOLD:ABA8670   | MN868899        |
| Chloropidae       | *Camarota curvipennis* (Latreille, 1805) | INV04955          | IBIDP152-19    | BOLD:ACP6247   | MN868844        |
| Chloropidae       | *Cryptonevra flavitarsis* (Meigen, 1830) | INV04994          | IBIDP086-19    | BOLD:ACB6675   | MN868783        |
| Chloropidae       | *Diploptera messoria* (Fallen, 1820) | INV05017, INV05081 | IBIDP098-19, IBIDP127-19 | BOLD:ACD3417 | MN868807, MN868793 |
| Chloropidae       | *Elachiptera bimaculata* (Loew, 1845) | INV04990          | IBIDP158-19    | BOLD:ADU0665   | MN868888        |
| Family        | Species                                      | IBI code    | BOLD code                 | BOLD BIN   | GenBank          |
|--------------|----------------------------------------------|-------------|---------------------------|------------|------------------|
| Chloropidae  | Elachiptera megaspis (Loew, 1858)            | INV05080,   | IBIDP174-19,IBIDP374-19   | BOLD:ADU0581 | MN868842, MN868711 |
|              |                                              | INV07368    |                           |            |                  |
| Chloropidae  | Eutropha albibipila (Becker, 1908)*          | INV04991    | IBIDP159-19                | BOLD:ADS5005 | MN868764         |
| Chloropidae  | Eutropha fulvifrons (Haliday, 1833)*         | INV04992    | IBIDP160-19                | BOLD:ADT0252 | MN868855         |
| Chloropidae  | Lasiochaeta pubescens                        | INV05082    | IBIDP175-19                | BOLD:ACP6247 | MN868876         |
|              | Thalhammer, 1898*                            |             |                           |            |                  |
| Chloropidae  | Polyodaspis sulcicollis (Meigen, 1838)*      | INV04989    | IBIDP157-19                | BOLD:ADS6761 | MN868863         |
| Chloropidae  | Thaumatomyia elongatula                      | INV05083    | IBIDP176-19                | BOLD:ADV5221 | MN868862         |
|              | (Becker, 1910)*                              |             |                           |            |                  |
| Chloropidae  | Trachysphonella ruficeps                     | INV04996    | IBIDP162-19                | BOLD:ACP4572 | MN868766         |
|              | (Macquart, 1835)*                            |             |                           |            |                  |
| Conopidae    | Conops flavipes                              | INV05010    | IBIDP164-19                | BOLD:AAJ7146 | MN868871         |
|              | Linnaeus, 1758"                              |             |                           |            |                  |
| Diastatidae  | Diastata adusta                              | INV05066    | IBIDP172-19                | BOLD:ADS5309 | MN868880         |
|              | Meigen, 1830"                                |             |                           |            |                  |
| Dolichopodida| Campsicnemus scambus (Fallen, 1823)"        | INV04938    | IBIDP058-19                | BOLD:ACP5225 | MN868902         |
| Dolichopodida| Campsicnemus umbripennis                     | INV07394    | IBIDP387-19                | BOLD:ACQ9843 | MN868739         |
|              | Loew, 1856"                                 |             |                           |            |                  |
| Dolichopodida| Gymnopternus cupreus (Fallen, 1823)"        | INV04909    | IBIDP147-19                | BOLD:AAZ8613 | MN868838         |
| Dolichopodida| Machaerium maritimae                         | INV05105    | IBIDP179-19                | BOLD:ADT1791 | MN868724         |
|              | Haliday, 1832"                               |             |                           |            |                  |
| Family            | Species                            | IBI code | BOLD code   | BOLD BIN      | GenBank       |
|-------------------|------------------------------------|----------|-------------|---------------|---------------|
| Dolichopodidae    | Sciapus platypterus (Fabricius, 1805) | INV04907 | IBIDP037-19 | BOLD:ABU9505  | MN868817      |
| Drosophilidae     | Drosophila suzukii (Matsumura, 1931) | INV05107 | IBIDP135-19 | BOLD:AAC2499  | MN868726      |
| Drosophilidae     | Leucophenga maculata (Dufour, 1839) | INV05006 | IBIDP090-19 | BOLD:ACC9004  | MN868775      |
| Drosophilidae     | Phortica variegata (Fallen, 1823)   | INV04906 | IBIDP036-19 | BOLD:ADP2209  | MN868851      |
| Ephydridae         | Discomyza incurva Fallen, 1823      | INV04956 | IBIDP069-19 | BOLD:ABA8754  | MN868839      |
| Ephydridae         | Hecamede albicans (Meigen, 1830)    | INV04993 | IBIDP085-19 | BOLD:ABA8686  | MN868716      |
| Ephydridae         | Psilopa nitidula (Fallen, 1813)     | INV04984 | IBIDP081-19 | BOLD:AAG6948  | MN868834      |
| Fanniidae          | Fannia canicularis (Linnaeus, 1761) | INV00177, INV04943 | IBIDP002-19, IBIDP062-19 | BOLD:AAF7101 | MN868723, MN868818 |
| Fanniidae          | Fannia lustrator (Harris, 1780)     | INV07364 | IBIDP372-19 | BOLD:ACB3656  | MN868758      |
| Heleomyzidae       | Suillia variegata (Loew, 1862)      | INV00970, INV04948 | IBIDP011-19, IBIDP065-19 | BOLD:ABY1201 | MN868749, MN868727 |
| Hippoboscidae      | Hippobosca equina Linnaeus, 1758    | INV07388 | IBIDP385-19 | BOLD:AAX0882  | MN868873      |
| Hybotidae          | Hybos culiciformis (Fabricius, 1775) | INV01283, INV01808, INV05078 | IBIDP013-19, IBIDP014-19, IBIDP173-19 | BOLD:ACD8518  | MN868781, MN868800, MN868846 |
| Lauxaniidae        | Calliopum simillimum (Collin, 1933) | INV07387 | IBIDP384-19 | BOLD:ACP8933  | MN868801      |
| Lauxaniidae        | Minettia longipennis (Fabricius, 1794) | INV04908 | IBIDP038-19 | BOLD:ACB3141  | MN868788      |
| Family          | Species                          | IBI code   | BOLD code       | BOLD BIN       | GenBank   |
|-----------------|----------------------------------|------------|-----------------|----------------|-----------|
| Lauxaniidae     | *Prosopomyia pallida* Loew, 1856* | INV04946   | IBIDP150-19     | **BOLD:ADV2313** | MN868794  |
|                 |                                  |            |                 |                |           |
| Lauxaniidae     | *Trigonometopus frontalis* (Meigen, 1830)*                           | INV05019   | IBIDP099-19     | **BOLD:ACS3478** | MN868881  |
| Lonchaeidae     | *Lamprolonchaea smaragdi* (Walker, 1849)*                           | INV05120   | IBIDP184-19     | **BOLD:ACO9728** | MN868843  |
|                 |                                  |            |                 |                |           |
| Lonchaeidae     | *Silba fumosa* (Egger, 1862)*                           | INV04985   | IBIDP082-19     | **BOLD:ACQ9578** | MN868841  |
| Micropezidae    | *Micropeza lateralis* Meigen, 1826*                           | INV01282   | IBIDP145-19     | **BOLD:ADC0694** | MN868910  |
| Muscidae        | *Coenosia atra* Meigen, 1830                          | INV04968, INV05090 | IBIDP075-19, IBIDP131-19 | **BOLD:ACP3222** | MN868737, MN868850 |
|                 |                                  |            |                 |                |           |
| Muscidae        | *Coenosia attenuata* Stein, 1903                           | INV05122   | IBIDP142-19     | **BOLD:AAD7633** | MN868861  |
| Muscidae        | *Coenosia tigrina* (Fabricius, 1775)                           | INV04928   | IBIDP052-19     | **BOLD:AAB5609** | MN868826  |
| Muscidae        | *Dasyphora albofasciata* (Macquart & Berthelot, 1839)*                  | INV05100   | IBIDP178-19     | **BOLD:ADS1325** | MN868827  |
| Muscidae        | *Graphomya maculata* (Scopoli, 1763)                           | INV04919   | IBIDP046-19     | **BOLD:ABV4895** | MN868806  |
| Muscidae        | Helina evecta (Harris, 1780)                             | INV05054   | IBIDP115-19     | **BOLD:ACB3279** | MN868729  |
| Muscidae        | *Hydrotaea dentipes* (Fabricius, 1805)                           | INV05110   | IBIDP136-19     | **BOLD:AAI8769** | MN868883  |
| Muscidae        | *Lispe kowarzi* Becker, 1903*                           | INV04975   | IBIDP155-19     | **BOLD:ACA1246** | MN868872  |
| Muscidae        | *Lispocephala mikii* (Strobl, 1893)*                           | INV04918   | IBIDP148-19     | **BOLD:ADT6256** | MN868912  |
| Family         | Species                        | IBI code | BOLD code    | BOLD BIN     | GenBank  |
|----------------|--------------------------------|----------|--------------|--------------|----------|
| Muscidae       | *Musca autumnalis* De Geer, 1776 | INV04936 | IBIDP056-19  | BOLD:AAA3187 | MN868877 |
| Muscidae       | *Musca domestica* Linnaeus, 1758 | INV05087 | IBIDP130-19  | BOLD:AAA6020 | MN868773 |
| Muscidae       | *Musca tempestiva* Fallen, 1817* | INV04974 | IBIDP154-19  | BOLD:ACO3332 | MN868751 |
| Muscidae       | *Musca levida* (Harris, 1780)   | INV04940 | IBIDP059-19  | BOLD:AAB8817 | MN868769 |
| Muscidae       | *Musca pascuorum* (Meigen, 1826) | INV04941 | IBIDP060-19  | BOLD:AAG1714 | MN868746 |
| Muscidae       | *Musca stabulans* (Fallen, 1817) | INV05015, INV05106 | IBIDP096-19, IBIDP134-19 | BOLD:AAF6582 | MN868720, MN868760 |
| Muscidae       | *Neomyia cornicina* (Fabricius, 1781) | INV04922 | IBIDP048-19  | BOLD:AAH3032 | MN868811 |
| Muscidae       | *Orchisia costata* (Meigen, 1826) | INV05022 | IBIDP101-19  | BOLD:ABX0213 | MN868830 |
| Muscidae       | *Phaonia fuscata* (Fallen, 1825) | INV04952 | IBIDP067-19  | BOLD:ACB5198 | MN868753 |
| Muscidae       | *Phaonia pallida* (Fabricius, 1787) | INV05045 | IBIDP110-19  | BOLD:ABW3852 | MN868712 |
| Muscidae       | *Polistes meridionalis* (Peris & Llorente, 1963) | INV04964, INV05055 | IBIDP072-19, IBIDP116-19 | BOLD:AAY2766 | MN868770, MN868865 |
| Muscidae       | *Pyrellia vivida* Robineau-Desvoidy, 1830* | INV04970 | IBIDP153-19  | BOLD:ADT8849 | MN868828 |
| Muscidae       | *Schoenomyza litorella* (Fallen, 1823) | INV02961, INV04969 | IBIDP029-19, IBIDP076-19 | BOLD:ABW5574 | MN868787, MN868835 |
| Nemestrinidae  | *Fallenia fasciata* (Fabricius, 1805)* | INV07404 | IBIDP390-19  | BOLD:ADR9796 | MN868810 |
| Opetiidae      | *Opetia nigra* Meigen, 1830* | INV04942 | IBIDP061-19  | BOLD:ACD2824 | MN868780 |
| Opomyzidae     | *Opomyza petrei* Mesnil, 1934  | INV04953, INV05077 | IBIDP068-19, IBIDP126-19 | BOLD:AAG1210 | MN868887, MN868745 |
| Family         | Species                  | IBI code   | BOLD code       | BOLD BIN      | GenBank     |
|---------------|--------------------------|------------|-----------------|---------------|-------------|
| Pallopteridae | *Toxoneura muliebris* (Harris, 1780) | INV05115   | IBIDP139-19     | BOLD:ACQ9316  | MN868763    |
| Periscelidae  | *Periscelis fugax*       | INV05109   | IBIDP181-19     | BOLD:ADU2556  | MN868715    |
| Platystomatidae | *Rivellia syngenesiae* (Fabricius, 1781) | INV04931, INV07385 | IBIDP054-19, IBIDP383-19 | BOLD:AAX8866 | MN868768, MN868792 |
| Psychodidae   | *Clogmia albibiculata* (Williston, 1893) | INV05093   | IBIDP177-19     | BOLD:ACS5395  | MN868879    |
| Ptychopteridae | *Ptychoptera albimana* (Fabricius, 1787) | INV07376   | IBIDP379-19     | BOLD:ACL4516  | MN868771    |
| Rhiniidae     | *Rhyncomya columbina* (Meigen, 1824) | INV04981   | IBIDP156-19     | BOLD:ADU6456  | MN868859    |
| Rhiniidae     | *Rhyncomya felina* (Fabricius, 1794) | INV05057   | IBIDP171-19     | BOLD:ADV4310  | MN868896    |
| Rhiniidae     | Stomorhina lunata (Fabricius, 1805) | INV04929, INV05044 | IBIDP053-19, IBIDP109-19 | BOLD:ACD9536 | MN868816, MN868892 |
| Rhinophoridae | *Melanophora roralis* (Linnaeus, 1758) | INV04949   | IBIDP066-19     | BOLD:AAG6862  | MN868885    |
| Rhinophoridae | *Oplisa aterrima* (Strobi, 1899) | INV04926   | IBIDP149-19     | BOLD:ADU0356  | MN868890    |
| Sarcophagidae | *Sarcophaga crassipalpis* Macquart, 1839 | INV00698   | IBIDP010-19     | BOLD:AAC1709  | MN868822    |
| Sarcophagidae | *Sarcophaga longestylata* Strobi, 1906 | INV05116   | IBIDP182-19     | BOLD:ADV1383  | MN868891    |
| Scathophagidae | *Norellia tipularia* (Fabricius, 1794) | INV07396   | IBIDP388-19     | BOLD:ACE2160  | MN868870    |
| Scathophagidae | *Norellisoma spinimanum* (Fallen, 1819) | INV04924   | IBIDP049-19     | BOLD:ACD3336  | MN868721    |
| Family       | Species                  | IBI code          | BOLD code                                      | BOLD BIN            | GenBank                  |
|-------------|--------------------------|-------------------|------------------------------------------------|---------------------|--------------------------|
| Scathophagidae | *Scathophaga stercoraria* (Linnaeus, 1758) | INV00527, INV02883, INV04913, INV07377 | IBIDP004-19, IBIDP023-19, IBIDP041-19, IBIDP380-19 | BOLD:AAD0853 | MN868858, MN868799, MN868719, MN868829 |
| Sciomyzidae   | *Euthycera alaris* Vala, 1983* | INV01287          | IBIDP146-19                                    | BOLD:ADV6563        | MN868813                 |
| Sciomyzidae   | *Euthycera cribrata* (Rondani, 1868)* | INV05031          | IBIDP168-19                                    | BOLD:ADU4073        | MN868789                 |
| Sciomyzidae   | *Ilione trifaria* (Loew, 1847)* | INV05084, INV05024 | IBIDP128-19, IBIDP102-19                       | BOLD:ADR6909        | MN868748, MN868717       |
| Sciomyzidae   | *Pherbellia cinerella* (Fallen, 1820) | INV05004          | IBIDP089-19                                    | BOLD:ACB5604        | MN868757                 |
| Sciomyzidae   | *Pherbellia dorsata* (Zetterstedt, 1846)* | INV05061          | IBIDP119-19                                    | BOLD:ACD6777        | MN868901                 |
| Sciomyzidae   | *Pherbina mediterranea* Mayer, 1953* | INV05117          | IBIDP183-19                                    | BOLD:ADU0215        | MN868714                 |
| Stratiomyidae | *Chloromyia formosa* (Scopoli, 1763) | INV04925, INV07375 | IBIDP050-19, IBIDP378-19                       | BOLD:ABU9940        | MN868798, MN868735       |
| Stratiomyidae | *Hermetia illucens* (Linnaeus, 1758) | INV01259, INV04643, INV05003, INV05035 | IBIDP012-19, IBIDP032-19, IBIDP088-19, IBIDP106-19 | BOLD:AAG3698, BOLD:AAD0622 | MN868718, MN868889, MN868825, MN868864 |
| Syrphidae     | *Chalcosyrphus nemorum* (Fabricius, 1805) | INV05104          | IBIDP133-19                                    | BOLD:AAG6762        | MN868908                 |
| Syrphidae     | *Chrysotoxum intermedium* Meigen, 1822 | INV05041          | IBIDP108-19                                    | BOLD:AEE9233        | MN868747                 |
| Syrphidae     | *Dasysyrphus albostriatus* (Fallen, 1817) | INV07391          | IBIDP386-19                                    | BOLD:AAL1242        | MN868722                 |
| Syrphidae     | *Episyrphus balteatus* (De Geer, 1776) | INV01909, INV07402 | IBIDP015-19, IBIDP389-19                       | BOLD:AAC6833        | MN868761, MN868738       |
| Family   | Species                  | IBI code             | BOLD code            | BOLD BIN            | GenBank       |
|----------|--------------------------|----------------------|----------------------|---------------------|---------------|
| Syrphidae | Eristalis aeneus         | INV05013             | IBIDP095-19          | BOLD::AAF3600       | MN868802      |
|          | (Scopoli, 1763)          |                      |                      |                     |               |
| Syrphidae | Eristalis sepulcralis    | INV05025, INV05072   | IBIDP103-19, IBIDP123-19 | BOLD::AAZ5387      | MN868777, MN868819 |
|          | (Linnaeus, 1758)         |                      |                      |                     |               |
| Syrphidae | Eristalis taeniops       | INV01912, INV04912   | IBIDP017-19, IBIDP040-19 | BOLD::ACL5309      | MN868857, MN868779 |
|          | (Wiedemann, 1818)        |                      |                      |                     |               |
| Syrphidae | Eristalis arbustorum     | INV01948, INV02915, INV04917, INV05071 | IBIDP021-19, IBIDP027-19, IBIDP045-19, IBIDP122-19 | BOLD::AAA8223 | MN868782, MN868832, MN868878, MN868875 |
|          | (Linnaeus, 1758)         |                      |                      |                     |               |
| Syrphidae | Eristalis pertinax       | INV04965             | IBIDP073-19          | BOLD::AAQ3585      | MN868733      |
|          | (Scopoli, 1763)          |                      |                      |                     |               |
| Syrphidae | Eristalis similis        | INV01910, INV04915   | IBIDP016-19, IBIDP043-19 | BOLD::AAY9892      | MN868866, MN868894 |
|          | (Fallen, 1817)           |                      |                      |                     |               |
| Syrphidae | Eristalis tenax          | INV01937, INV02914, INV04916 | IBIDP019-19, IBIDP026-19, IBIDP044-19 | BOLD::AAB0391 | MN868900, MN868756, MN868909 |
|          | (Linnaeus, 1758)         |                      |                      |                     |               |
| Syrphidae | Ferdinandea cuprea      | INV05021             | IBIDP100-19          | BOLD::AAJ0402      | MN868897      |
|          | (Scopoli, 1763)          |                      |                      |                     |               |
| Syrphidae | Helophilus pendulus      | INV04914             | IBIDP042-19          | BOLD::AAl6747      | MN868765      |
|          | (Linnaeus, 1758)         |                      |                      |                     |               |
| Syrphidae | Melanostoma mellinum    | INV04977             | IBIDP078-19          | BOLD::AAB2866      | MN868833      |
|          | (Linnaeus, 1758)         |                      |                      |                     |               |
| Syrphidae | Milesia crabroniformis   | INV04153, INV05016   | IBIDP031-19, IBIDP097-19 | BOLD::ADS0144      | MN868804, MN868904 |
|          | (Fabricius, 1775)        |                      |                      |                     |               |
| Syrphidae | Myathropa florea         | INV01938, INV04963   | IBIDP020-19, IBIDP071-19 | BOLD::AAP9713, BOLD::ADQ8445 | MN868821, MN868847 |
|          | (Linnaeus, 1758)         |                      |                      |                     |               |
| Syrphidae | Paragus quadrifasciatus  | INV00560             | IBIDP008-19          | BOLD::ACG5063      | MN868744      |
|          | Meigen, 1822             |                      |                      |                     |               |
| Family       | Species                        | IBI code                  | BOLD code                        | BOLD BIN             | GenBank          |
|--------------|--------------------------------|---------------------------|----------------------------------|----------------------|------------------|
| Syrphidae    | *Platycerus rosarum* (Fabricius, 1787) | INV04911, INV05074       | IBIDP039-19, IBIDP124-19         | BOLD:AAG4683         | MN868812, MN868740 |
| Syrphidae    | *Scaeva pyrastr* (Linnaeus, 1758) | INV05070                  | IBIDP121-19                      | BOLD:AAF2374         | MN868785         |
| Syrphidae    | *Sphaerophoria rupeppeli* (Wiedemann, 1830)* | INV05058                  | IBIDP117-19                      | BOLD:AAA7374         | MN868820         |
| Syrphidae    | *Sphaerophoria scripta* (Linnaeus, 1758) | INV02901, INV04900       | IBIDP025-19, IBIDP033-19         | BOLD:AAA7374         | MN868774, MN868784 |
| Syrphidae    | *Syrphus flaviventris* Macquart, 1842 | INV04973                  | IBIDP077-19                      | BOLD:AAG4663         | MN868803         |
| Syrphidae    | *Syrphus pipiens* (Linnaeus, 1758) | INV04937, INV05042, INV05097 | IBIDP057-19, IBIDP170-19, IBIDP132-19 | BOLD:AAC6291 | MN868778, MN868754, MN868869 |
| Syrphidae    | *Syrphus vitripennis* Meigen, 1822 | INV07372                  | IBIDP377-19                      | BOLD:AAB5577         | MN868776         |
| Syrphidae    | *Volucella zonaria* (Poda, 1761) | INV04979                  | IBIDP080-19                      | BOLD:AAH7785         | MN868837         |
| Tabanidae    | *Chrysops caecutiens* (Linnaeus, 1758) | INV07371                  | IBIDP376-19                      | BOLD:ADZ0489         | MN868849         |
| Tabanidae    | *Chrysops viduatius* (Fabricius, 1794)* | INV04978                  | IBIDP079-19                      | BOLD:ACB5910         | MN868728         |
| Tabanidae    | *Haematopota ocelligera* (Krober, 1922)* | INV05023                  | IBIDP166-19                      | BOLD:ADU0467         | MN868772         |
| Tachinidae   | *Besseria dimidiata* (Zetterstedt, 1844)* | INV04998                  | IBIDP163-19                      | BOLD:ADT0080         | MN868755         |
| Tachinidae   | *Compsilura concinnata* (Meigen, 1824) | INV05119                  | IBIDP141-19                      | BOLD:ADK6725         | MN868913         |
| Family    | Species                                      | IBI code            | BOLD code                     | BOLD BIN          | GenBank       |
|-----------|----------------------------------------------|---------------------|-------------------------------|-------------------|---------------|
| Tachinidae| *Cylindromyia bicolor* (Olivier, 1811)       | INV02245, INV04921  | IBIDP022-19, IBIDP047-19     | BOLD:AAN3295      | MN868867,     |
|           |                                              |                     |                               |                   | MN868808      |
| Tachinidae| *Cylindromyia rufipes* (Meigen, 1824)        | INV05014            | IBIDP165-19                   | BOLD:AAU6684      | MN868795      |
| Tachinidae| *Dexia rustica* (Fabricius, 1775)"           | INV04945            | IBIDP064-19                   | BOLD:ACD9618      | MN868850      |
| Tachinidae| *Ectophasia crassipennis* (Fabricius, 1794)" | INV05026            | IBIDP104-19                   | BOLD:ADJ6473      | MN868852      |
| Tachinidae| *Eloceria delecta* (Meigen, 1824)"           | INV04905            | IBIDP035-19                   | BOLD:ACA9834      | MN868895      |
| Tachinidae| *Frontina laeta* (Meigen, 1824)"             | INV05027            | IBIDP105-19                   | BOLD:ABW4362      | MN868874      |
| Tachinidae| *Leskia aurea* (Fallen, 1820)"               | INV05011            | IBIDP094-19                   | BOLD:AAV7830      | MN868759      |
| Tachinidae| *Microphthalmia europaea* Egger, 1860        | INV05111            | IBIDP137-19                   | BOLD:AAU6726      | MN868814      |
| Tachinidae| *Mintho rufiventris* (Fallen, 1817)          | INV05053            | IBIDP114-19                   | BOLD:AAX3938      | MN868730      |
| Tachinidae| *Nemoraea pellucida* (Meigen, 1824)"         | INV05108            | IBIDP180-19                   | BOLD:ACD9580      | MN868848      |
| Tachinidae| *Peleteria rubescens* (Robineau-Desvoidy, 1830)" | INV05113  | IBIDP138-19                   | BOLD:AAZ5252      | MN868713      |
| Tachinidae| *Peribaea tibialis* (Robineau-Desvoidy, 1851) | INV07382  | IBIDP382-19                   | BOLD:ACB1892      | MN868907      |
| Tachinidae| *Periscepsia carbonaria* (Panzer, 1798)      | INV05046, INV05085  | IBIDP111-19, IBIDP129-19     | BOLD:ACD9481      | MN868815,     |
|           |                                              |                     |                               |                   | MN868767      |
| Tachinidae| *Phasia pusilla* Meigen, 1824                | INV07360            | IBIDP371-19                   | BOLD:AAY2270      | MN868790      |
| Family          | Species                                      | IBI code       | BOLD code                     | BOLD BIN          | GenBank         |
|-----------------|----------------------------------------------|----------------|-------------------------------|-------------------|----------------|
| Tachinidae      | *Tachina lurida* (Fabricius, 1781)*          | INV07369       | IBIDP375-19                   | **BOLD:ACA9827**  | MN868845       |
|                 | *Tachina magnicornis* (Zetterstedt, 1844)    | INV04967, INV05052 | IBIDP074-19, IBIDP113-19     | **BOLD:AAN9512**  | MN868752, MN868741 |
|                 | *Triarthria setipennis* (Fallen, 1810)       | INV00529       | IBIDP005-19                   | **BOLD:ADK0727**  | MN868911       |
| Tachinidae      | *Zophomyia temula* (Scopoli, 1763)*          | INV04927       | IBIDP051-19                   | **BOLD:ACD1492**  | MN868886       |
| Tephitidae      | *Ceratitis capitata* (Wiedemann, 1824)       | INV05118       | IBIDP140-19                   | **BOLD:AAA3297**  | MN868742       |
| Trichiceridae   | *Trichocera saltator* (Harris, 1776)         | INV06188       | IBIDP143-19                   | **BOLD:ACQ9998**  | MN868805       |
| Ulidiidae       | *Ceroxys urticae* (Linnaeus, 1758)*          | INV05059       | IBIDP118-19                   | **BOLD:AAI7007**  | MN868893       |
| Ulidiidae       | *Myennis octopunctata* (Coquebert, 1798)*    | INV00518       | IBIDP003-19                   | **BOLD:AAG7348**  | MN868824       |
| Ulidiidae       | *Physiphora alceae* (Preyssler, 1791)        | INV03580       | IBIDP030-19                   | **BOLD:ABA5170**  | MN868875       |
| Ulidiidae       | *Ulidia apicalis* Meigen, 1826*             | INV02952, INV05037, INV07366 | IBIDP028-19, IBIDP169-19, IBIDP373-19 | **BOLD:ABX4821**  | MN868743, MN868836, MN868860 |

**Project description**

**Title:** The name “DNA barcodes of Portuguese Diptera 01” refers to the first data release of DNA barcodes and distribution data of dipterans within the InBIO Barcoding Initiative.

**Personnel:** Pedro Beja (project coordinator), Nuno Fonseca (project chair), Sónia Ferreira (taxonomist and IBI manager), Joana Paupério (IBI manager), Pedro Sousa (project technician), all affiliated to CIBIO-InBIO, University of Porto; Rui Andrade (taxonomist) independent researcher and Ana Rita Gonçalves (taxonomist) cE3c, Faculty of Science, University of Lisbon.

**Study area description:** North of the Tagus river in Portugal (Fig. 2).
Design description: Dipteran specimens were collected in the field, morphologically identified and DNA barcoded.

Funding: This project is funded by the European Union’s Horizon 2020 Research and Innovation programme under grant agreement No 668981 and by the project PORBIOTA—Portuguese E-Infrastructure for Information and Research on Biodiversity (POCI-01-0145-FEDER-022127), supported by Operational Thematic Program for Competitiveness and Internationalization (POCI), under the PORTUGAL 2020 Partnership Agreement, through the European Regional Development Fund (FEDER), by EDP Biodiversity Chair, and is part of research conducted at the Long Term Research Site of Baixo Sabor (LTER_EU_PT_002). P.S. was funded by the project ECOLIVES – Fostering sustainable management in Mediterranean olive farms: pest control services provided by wild species as incentives for biodiversity conservation (PTDC/AAG-REC/6480/2014/), supported by Portuguese national funds by FCT/MCTES and co-financed by Fundo Europeu de Desenvolvimento Regional (FEDER) throughout COMPETE – Programa Operacional Factores de Competitividade (POFC).

Sampling methods

Study extent: North of the Tagus river in Portugal

Sampling description: The studied material was collected in 59 different localities from the northern half of continental Portugal (Fig. 2, Table 1). Sampling was conducted between 2014 and 2018 on a wide range of habitats, using mainly hand-held sweep-nets or direct search for specimens. Collected specimens were examined both dry and in alcohol using a binocular stereoscopic microscope (Optika ST-30-2LR, 20x-40x) and stored in 96% ethanol.
for downstream molecular analysis. Morphological identification was performed, based on keys and descriptions from literature (Suppl. material 1).

DNA extraction and sequencing followed the general pipeline used in the InBIO Barcoding Initiative. Briefly, genomic DNA was extracted from leg tissue using EasySpin Genomic DNA Tissue Kit (Citomed) following manufacturer’s protocol. The cytochrome c oxidase I (COI) barcoding fragment was amplified as two overlapping fragments (LC and BH), using two sets of primers: LCO1490 (Folmer et al. 1994) + III_C_R (Shokralla et al. 2015) and III_B_F Shokralla et al. 2015) + HCO2198 (Folmer et al. 1994), respectively. The COI mitochondrial gene (Folmer region), was then sequenced in a MiSeq benchtop system. OBITools (https://git.metabarcoding.org/obitools/obitools) was used to process the initial sequences which were then assembled into a single 658 bp fragment using Geneious 9.1.8. (https://www.geneious.com).

Quality control: All DNA barcodes sequences were compared against the BOLD database and the 99 top hits were inspected in order to detect possible issues due to contaminations or misidentifications. Prior submission to GBIF, data was checked for errors and inconsistencies with OpenRefine 3.2 (http://openrefine.org).

Step description: Specimens were collected in 59 different localities of continental Portugal. Sampling was conducted from 2014 to 2018, and consisted of direct search of specimens (e.g. Hecamede albicans, Eutropha fulvifrons, Canace nasica), the use of entomological nets to intercept specimens flight (e.g. Hemipenthes morio, Sphaerophoria scripta) or to sweep the vegetation (e.g. Opetia nigra, Trigonometopus frontalis). Specimens collected were stored in 96% ethanol. A tissue sample was removed, from which DNA was extracted and the COI DNA barcode fragment was sequenced. Data generated were submitted to BOLD, GenBank and GBIF.

Geographic coverage

Description: Continental Portugal

Coordinates: 40.054 and 42.002 Latitude; 6.274 and -8.774 Longitude.

Taxonomic coverage

Description: This dataset is composed of data relating to 203 Diptera specimens. All specimens were determined to species level. Overall, 154 species are represented in the dataset. These species belong to 41 families. Five families account for 56% of the total collected specimens, Syrphidae, Muscidae, Tachinidae, Calliphoridae and Chloropidae (Fig. 3). These five families account for 54% of the total species represented (Fig. 3). Nineteen families are represented by a single species.
Figure 3. 

Distribution of specimens (A) and species (B), in percentage, per Diptera family present in the dataset. Families representing less than 2% of specimens/species were lumped together.

Temporal coverage

Data range: 2014-5-27 - 2018-7-07.

Notes: The sampled material was collected in the period from 27 May 2014 to 07 July 2018

Collection data

Collection name: InBIO Barcoding Initiative

Collection identifier: 4ec2b246-f5fa-4b90-9a8d-ddafc2a3f970

Specimen preservation method: “Alcohol”

Curatorial unit: Voucher tube - 1 to 203, DNA extractions - 1 to 203

Usage rights

Use license: Creative Commons Public Domain Waiver (CC-Zero)
Data package title: The InBIO Barcoding Initiative Database: Diptera 01

Resource link: dx.doi.org/10.5883/DS-IBIDP01

Number of data sets: 1

Data set name: DS-IBIDP01 IBI Diptera 01

Download URL: http://www.boldsystems.org/index.php/Public_SearchTerms?query=DS-IBIDP01

Data format: dwc, xml, tsv, fasta

Description: The InBIO Barcoding Initiative Database: Diptera 01 dataset can be downloaded from the Public Data Portal of BOLD (dx.doi.org/10.5883/DS-IBIDP01) in different formats (data as dwc, xml or tsv, and sequences as fasta files). Alternatively, BOLD users can log-in and access the dataset via the Workbench platform of BOLD. All records are also searchable within BOLD, using the search function of the database.

The InBIO Barcoding Initiative will continue sequencing Diptera for the BOLD database, with the ultimate goal of comprehensive coverage. The version of the dataset, at the time of writing the manuscript, is included as Suppl. materials 2, 3, 4 in the form of two text files for record information as downloaded from BOLD, one text file with the collecting and identification data in Darwin Core Standard format (downloaded from GBIF) and of a fasta file containing all sequences as downloaded from BOLD.

It should be noted that, as the BOLD database is not compliant with the Darwin Core Standard format, the Darwin Core formatted file (dwc) that can be downloaded from BOLD is not strictly Darwin Core formatted. For a proper Darwin Core formatted file, see http://ipt.gbif.pt/ipt/resource?r=ibi_diptera_i&v=1.0 (Suppl. material 3).

Column labels below follow the labels downloaded in the tsv format. Columns with no content in our dataset are left out in the list below.

| Column label          | Column description                                           |
|-----------------------|--------------------------------------------------------------|
| processid             | Unique identifier for the sample                             |
| sampleid              | Identifier for the sample being sequenced, i.e. IBI catalogue number at Cibio-InBIO, Porto University. Often identical to the "Field ID" or "Museum ID" |
| recordID              | Identifier for specimen assigned in the field                |
| catalognum            | Catalogue number                                             |
| fieldnum              | Field number                                                 |
| institution_storing   | The full name of the institution that has physical possession of the voucher specimen |
| Field                  | Description                                                                 |
|------------------------|-----------------------------------------------------------------------------|
| bin_uri                | Barcode Index Number system identifier                                      |
| phylum_taxID           | Phylum taxonomic numeric code                                                 |
| phylum_name            | Phylum name                                                                  |
| class_taxID            | Class taxonomic numeric code                                                  |
| class_name             | Class name                                                                   |
| order_taxID            | Order taxonomic numeric code                                                  |
| order_name             | Order name                                                                   |
| family_taxID           | Family taxonomic numeric code                                                 |
| family_name            | Family name                                                                  |
| subfamily_taxID        | Subfamily taxonomic numeric code                                              |
| subfamily_name         | Subfamily name                                                                |
| genus_taxID            | Genus taxonomic numeric code                                                  |
| genus_name             | Genus name                                                                   |
| species_taxID          | Species taxonomic numeric code                                                |
| species_name           | Species name                                                                  |
| identification_provided_by | Full name of primary individual who assigned the specimen to a taxonomic group |
| identification_method  | The method used to identify the specimen                                       |
| voucher_status         | Status of the specimen in an accessioning process (BOLD controlled vocabulary) |
| tissue_type            | A brief description of the type of tissue or material analysed                 |
| collectors             | The full or abbreviated names of the individuals or team responsible for collecting the sample in the field |
| lifestage              | The age class or life stage of the specimen at the time of sampling           |
| sex                    | The sex of the specimen                                                       |
| lat                    | The geographical latitude (in decimal degrees) of the geographic centre of a location |
| lon                    | The geographical longitude (in decimal degrees) of the geographic centre of a location |
| elev                   | Elevation of sampling site (in metres above sea level)                        |
| country                | The full, unabbreviated name of the country where the organism was collected  |
| province_state         | The full, unabbreviated name of the province ("Distrito" in Portugal) where the organism was collected |
| region                 | The full, unabbreviated name of the municipality ("Concelho" in Portugal) where the organism was collected |
| exactsite              | Additional name/text description regarding the exact location of the collection site relative to a geographic relevant landmark |
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Supplementary materials

Suppl. material 1: References used for morphological identification

Authors: Rui Andrade
Data type: References
Brief description: References used for morphological identification
Download file (10.80 kb)

Suppl. material 2: IBI- Diptera 01 library - Specimen details

Authors: Sónia Ferreira, Rui Andrade, Ana Rita Gonçalves, Pedro Sousa, Pedro Beja
Data type: Record information - specimen data
Brief description: The file includes information about all records in BOLD for the IBI-Diptera 01 library. It contains collecting and identification data. The data are as downloaded from BOLD, without further processing.
Download file (79.85 kb)

Suppl. material 3: IBI- Diptera 01 library - Specimen details - Darwin Core Standard

Authors: Sónia Ferreira, Rui Andrade, Ana Rita Gonçalves, Pedro Sousa, Pedro Beja
Data type: Record information - specimen data in Darwin Core Standard format
Brief description: The file includes information about all records in BOLD for the IBI-Diptera 01 library. It contains collecting and identification data. The data are downloaded from GBIF, without further processing.
Download file (246.19 kb)

Suppl. material 4: IBI- Diptera 01 library - DNA sequences

Authors: Sónia Ferreira, Rui Andrade, Ana Rita Gonçalves, Pedro Sousa, Pedro Beja
Data type: Genomic data, DNA sequences
Brief description: COI sequences in fasta format. Each sequence is identified by the BOLD ProcessID, species name, marker and GenBank accession number, separated by pipe. The data are as downloaded from BOLD.
Download file (140.61 kb)