An introduction to the Lepidoptera Iranica project*

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CHAPTER 1

An introduction to the Lepidoptera Iranica project*

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Up-to-date checklists of living organisms are an essential and inescapable tool for research, habitat management and conservation, pest control and biodiversity monitoring. However, such organized and trustable baseline data are missing for many groups of animals in Iran, including Lepidoptera (butterflies and moths). Several lists published in the past have contributed to our understanding of Iranian Lepidoptera (e.g., Rothschild 1921; Sutton 1963; Barou 1967; Hashemi 1966; Mirzayans & Kalali 1970; Modarres Awal 1994, 1997, 2012; Nazari 2003; Naderi 2012; Koçak & Kemal 2014; Tshikolovets et al. 2014). However, most of these checklists covered either a narrow geographic range (e.g., Rothschild 1921; Kalali 1976) or only few taxonomic groups (e.g., Eckweiler & Hofmann 1980; Nazari 2003), or suffered from a limited examination of collections (e.g., Barou 1967; Mirzayans & Kalali 1970). The only published list with national scope and broader taxonomic (at the order level) coverage, published by Koçak & Kemal (2014), is unfortunately full of errors and misleading data, suffers from structural problems and is useless for most purposes (see last section of Rajaei et al. 2023b).

Unfortunately, due to a lack of sufficiently trained lepidopterists in Iran, to the low number of amateur lepidopterists and collectors and to the extremely low number of research collections and active projects in Iran, a large part of the Lepidoptera fauna of the country is estimated as still undiscovered (see Landry et al. 2023). The only well-organized research initiative, "Association Lepidoptera Iranica" or A.L.I., which started in 2004, laid the foundations for boosting and centralizing lepidopterological activities in the country (see Rajaei et al. 2023b). During the course of three A.L.I. symposiums in Karlsruhe and Tehran, a large number of lepidopterists from around the world focused their efforts on the identification of Iranian Lepidoptera for a few years. However, the A.L.I. initiative did not receive enough attention in Iran and ended too soon, after just three years.

The present catalogue is the first modern catalogue of Iranian Lepidoptera with national coverage for the whole order. In it, we tried to combine all presently-known phylogenetic, systematic, taxonomic, nomenclatural and geographic information on the Lepidoptera of Iran. Our main target was to present the data in a useful, easy-to-use and compact format.

Iran, a country of great diversities

With an area of 1,648,195 km^2, Iran is located in the Middle East and stretches between 44–64° east and 25–40° north. It borders with Afghanistan and Pakistan to the east, with Turkmenistan, Armenia and Azerbaijan to the north and with Turkey and Iraq to the west. The country is confined by two water bodies: the Persian Gulf and Sea of Oman to the south and the Caspian Sea to the north (Fig. 1).

Except for the southern coasts of the Caspian Sea and the southwestern lowlands, most of Iran's territory forms the Iranian Plateau. This geological formation is part of the Eurasian plate, situated between the Indian plate to the east and the Arabian plate to the west. Five major mountain ranges are restricted to the Iranian Plateau: the Alborz Mts. (north), the Kopet-Dagh Mts. (northeast), the Azerbaijan Plateau (northwest), the Zagros Mts. (from northeast through northwest to south) and the Makran Mts. (southeast). The average altitude of the Iranian Plateau is 900 m (Djamali 2008). The lowest point of the country is Chale Lut, at 56 m below sea level, whereas the highest point is the Damavand summit, 5,610 m above sea level (Matov et al. 2008). Two large deserts, the Dasht-e Kavir and the Dasht-e Lut, which occupy the central, eastern and south-eastern regions of the country, contain evaporite deposits from the Tethys Ocean. Climatologically, Iran is a semi-arid to arid country, with less than 250 mm mean annual precipitation. Annual precipitation decreases from the northern part of the Alborz range to the southern parts of the country (Raziei et al. 2008).

Two main mountain ranges, the Alborz Mts. (north) and the Zagros Mts. (northwest to southeast) are home to a high diversity of plants and animals. The western part of the Zagros Mts. is covered by open woodland dominated

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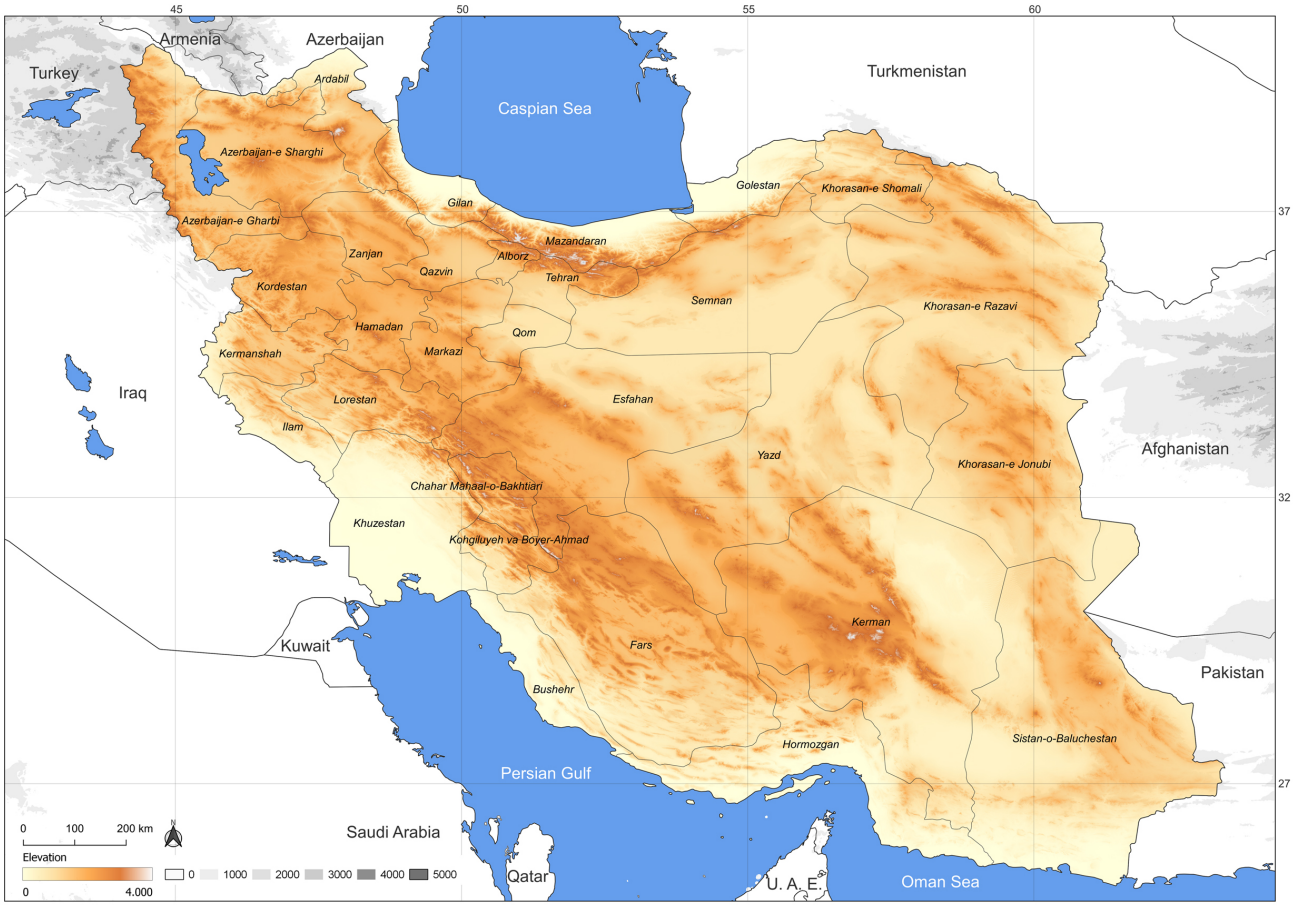


Fig. 1. Map of Iran, showing provinces and neighbouring countries.

by deciduous oak, sometimes mixed with wild pistachio and almond scrubs. The vegetation of the eastern part of the Zagros Mts. is comparable to that of Africa and Arabia, with a pseudo-savanna vegetation containing many Saharo-Sindian elements (Jones et al. 2013). The Central Iranian Plateau contains saline plains mainly covered by *Artemisia* steppes and highly diverse halophytic plant communities, mostly in the family Chenopodiaceae (Jones et al. 2013). The Hyrcanian forests on the northern slopes of the Alborz range are temperate to subtropical humid forests with many relictual species from the Last Glacial Maximum (LGM) (Jones et al. 2013).

Three different zoogeographic realms meet in Iran: the Palearctic Realm, which covers the main part of the country; the Saharo-Arabian Realm, which covers the southern part of the country along the coasts of the Persian Gulf; and the Oriental Realm, which touches only the southeasternmost part of the country. Due to this unique position, Iran is home to highly complex and diverse floral and faunal elements.

Iran is part of both the Irano-Anatolian and Caucasus biodiversity hotspots, two of the 35 areas of the planet with the highest species diversity (Myers et al. 2000; Mittermeier et al. 2011; Noroozi et al. 2021). With a terrestrial surface area of 1,648,195 km^2, Iran has an equivalent surface area to France, Germany, Spain and the United Kingdom combined. However, Iran has over 50% more endemic species of vascular plants and vertebrates than those four countries combined (Jowkar et al. 2016). At least 8,000 plant species are known from Iran, with an endemism rate of 30% (Noroozi et al. 2019).

The Iranian flora was documented primarily in the monumental work "Flora Iranica" (Rechinger 1963–2010) and in several regional and phytogeographic works (Zohary 1973; Akhani et al. 1997, 2010; Akhani 1998, 2005; Noroozi et al. 2013, 2019). Phytogeographically, Iran is part of the Euro-Siberian Region in the north, the Irano-Turanian Region, which covers most parts of the country, and the Saharo-Sindian Region in the south (Zohary 1963).

The Iranian vertebrate fauna is well studied (Firouz 2005). In total, 1,310 vertebrate species are known from the country, including 192 species of mammals (Yusefi et al. 2019), 534 species of birds (Kaboli et al. 2016; Khaleghizadeh et al. 2017), 265 species of reptiles (Safaei-

Mahroo 2019), 22 species of amphibians (Safaei-Mahroo et al. 2016) and 297 species of freshwater fish (Esmaeili et al. 2018).

In contrast, many invertebrate groups have only been fragmentarily catalogued in Iran (Khayrandish et al. 2017; Enayatnia et al. 2018; Drogvalenko & Ghahari 2021), but at least the class Arachnida is very well catalogued and has been regularly updated by Zamani et al. (2022), who listed 1,146 species including 906 Araneae, 1 Amblypygi, 28 Opiliones, 65 Pseudoscorpiones, 77 Scorpiones and 69 Solifugae.

Recent studies confirmed that the Azerbaijan Mts. and Alborz, Kopet-Dagh and Zagros Mts. played a crucial role as refugia during the Last Glacial Maximum (LGM) (Seddon et al. 2002; Volodicheva 2002; Ahmadzadeh et al. 2012; Rajaei et al. 2013). Many relictual species (e.g., the Persian ironwood *Parrotia persica*), which were widely distributed in all of Europe before the LGM, occur today only in Iran (Adroit et al. 2018).

Complex climatic and topographic contrasts have been considered important factors contributing to this high plant diversity (Zohary 1973). Noroozi et al. (2019) showed that roughly 75% of the endemic species are restricted to mountains and that the rate of endemism increases along the elevational gradient (Noroozi et al. 2019).

Combining the distributional data of selected animal and plant groups with global zoogeographic, biotic, geological and climate data, the Earth's terrestrial habitats have been subdivided into 14 terrestrial biomes and 846 ecoregions, seven and 16 of which, respectively, are recognized in Iran (Olson et al. 2001; Dinerstein et al. 2017).

Threats to Iranian biodiversity

Roughly 10% of Iran's territories are protected (Jowkar et al. 2016), including 30 national parks, 167 protected areas, 44 wildlife refuges and 35 national natural monuments. Still, the biodiversity of Iran is seriously threatened by multiple environmental crises. Two charismatic Iranian carnivorous species, the Caspian tiger and the Asiatic lion, became extinct by the end of the 1950s, and two others, the Asiatic cheetah and the Persian leopard, are ranked as critically endangered by the International Union for the Conservation of Nature (IUCN), along with over a hundred vertebrate species regarded as vulnerable or already endangered (Mazák 1981; Jowkar et al. 2016).

Natural and anthropogenic climate change and drought, inefficient water management, human population growth, air and soil pollution, traditional agriculture (especially in natural habitats) and the side effects of industry, overgrazing and lack of enforcement of environmental regulations are some of the major environmental threats in Iran (Jowkar et al. 2016; Mansouri Daneshvar et al. 2019; AghaKouchak et al. 2021; Ashraf et al. 2021). From a global perspective, over 40 years of economic sanctions by the most industrialized countries against Iran have further exacerbated the above-listed threats to the biodiversity of the country (Tahbaz 2016).

New climate predictions show an increase of extreme maximum temperatures, especially in the southern parts of Iran, in the coming decades (Ashraf Vaghefi et al. 2019), and this is regarded as a major threat to the biodiversity of these regions (Yousefi et al. 2019).

Human population growth, which has more than tripled in the last 150 years (from about 25 million in 1865 to about 84 million in 2022), has directly increased anthropogenic pressure on the natural habitats and biodiversity of Iran (Jowkar et al. 2016).

The rate of soil erosion in Iran (25 tonnes per hectare) is 4.3 times more than the global average (Amiraslani & Dragovich 2011). This reduces soil productivity and results in frequent sandstorms (Jowkar et al. 2016).

According to data from 2008, almost half of the 124 million livestock in Iran are sheep (about 52 million individuals), which is the fifth largest population in the world (Valizadeh 2010). Most of the natural habitats of Iran, especially the protected areas located in arid and sub-arid regions, are under extreme pressure from overgrazing, which directly increases the vulnerability of these areas (Jowkar et al. 2016).

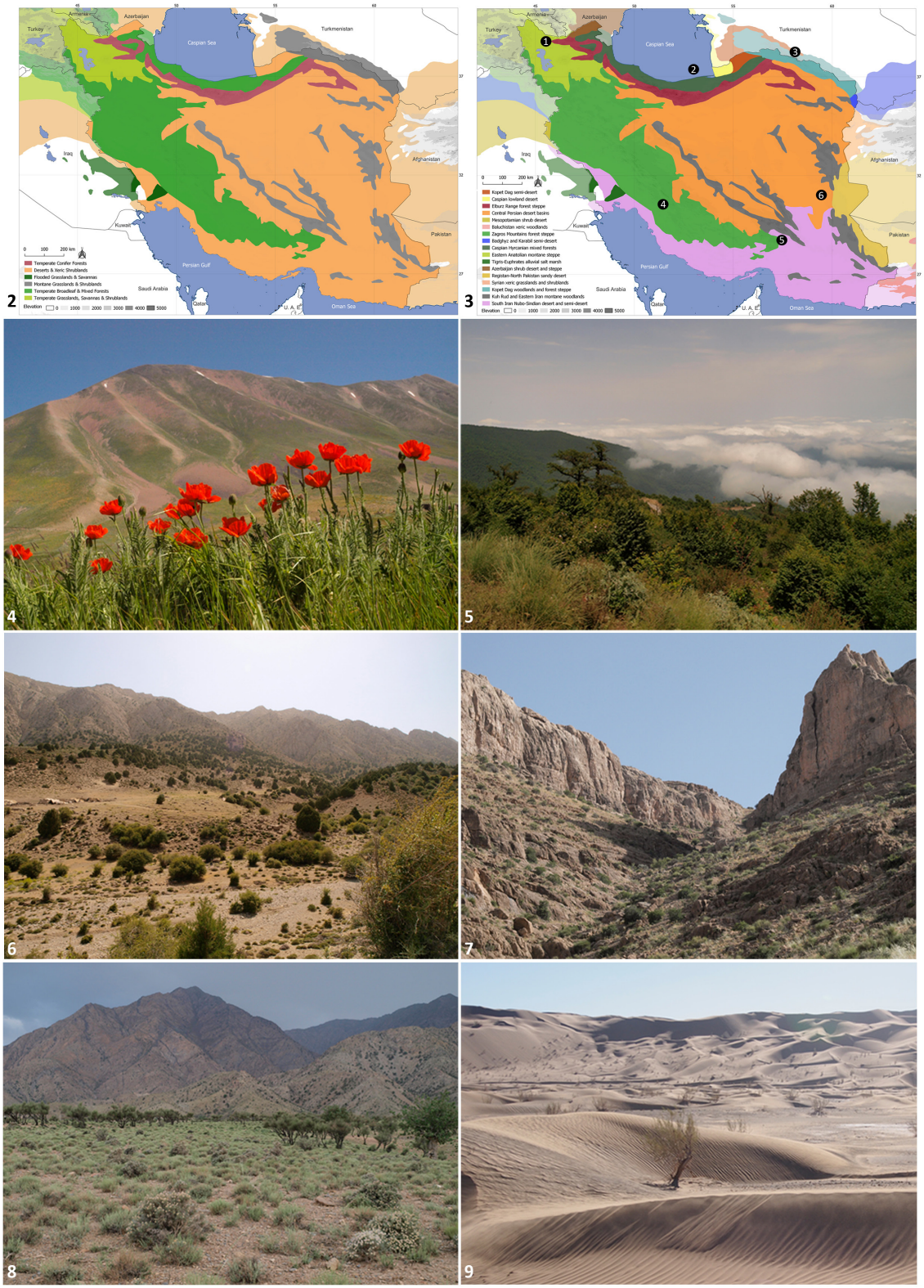
Increasing our taxonomic knowledge, and understanding the diversity and distribution patterns, of the organisms of an area are crucial first steps towards the conservation of both habitats and species.

On the knowledge of the Lepidoptera of Iran

Since the description of the first Iranian moth species (*Zygaena cuvieri* Boisduval, [1828]), a wealth of knowledge on the order Lepidoptera has been accumulated. This knowledge is often imbalanced, however, and some more charismatic groups, like the butterflies and zygaenid moths, are much better studied than others.

The taxonomic study of most Iranian Microlepidoptera families was largely neglected in the past. This is mostly due to a lack of sufficient collecting activities in Iran and to the extremely low number of Microlepidoptera specimens in collections. However, several families are much better studied, for example Cossidae (Alipanah et al. 2021), Sesiidae (de Freina 1997; Kallies & Špatenka 2003, 2004), Zygaenidae (Keil 2014), Coleophoridae (Baldizzone et al. 2006) and Pterophoridae (Alipanah & Ustjuzhanin 2005, 2007, 2013; Alipanah & Gielis 2010).

The butterflies (superfamily Papilionoidea) are the best studied group of Lepidoptera in Iran. They have been thoroughly covered by several detailed studies, large monographs and books (e.g., Nazari 2003; Tshikolovets et al. 2014). A popular field guide on Iranian butterflies was published by Naderi (2012, 2019), including a revised checklist.



Figs. 2–9. Biomes, ecoregions and habitats of Iran. **2**. Map of biomes. **3**. Map of ecoregions. **4–9.** Habitats in selected ecoregions. – **4**. Sahand Mt., 2,431 m. **5**. Alborz Mts., between Gorgan and Shahrud, 2,455 m. **6**. Bajgiran, between Bardar and Namanlu, 1,922 m. **7**. Zagros Mts., Baghak Mt., between Hanna and Komehr, 2,355 m. **8**. Dehbakri, Shir Mt., 1,940 m. **9**. Lut Desert, SW Rig-e Yalan, towards Fahradj, 289 m.

The superfamily Pyraloidea (especially the family Pyralidae) is one of the lesser-known superfamilies of Lepidoptera in Iran. Still, there are several major works that can be used as a baseline for the study of Pyralidae and Crambidae in Iran (e.g., Amsel 1949a, 1949b, 1950, 1951, 1954, 1958, 1959, 1961; Roesler 1973; Alipanah 2017; Slamka 2019; Leraut 2021).

In the clade Macrolepidoptera, several families are better studied. For example, Lasiocampidae (e.g., Zolotuhin & Zahiri 2008), Brahmaeidae and Saturniidae (e.g., Nässig 1980, 1981; Zolotuhin et al. 2011) and Sphingidae (e.g., de Freina & Witt 1987; Daniel 1961, 1971; Kitching & Zahiri 2007; Lehmann & Zahiri 2011).

The family Geometridae has been under intensive revision by Rajaei and collaborators over the last decade (e.g., Rajaei et al. 2011, 2012, 2022; Rajaei 2012; Wanke et al. 2019, 2020).

In the superfamily Noctuoidea, some groups are better studied, especially where major taxonomic revisions on the Palearctic Realm have been published. For example, the family Notodontidae was revised in the framework of a project on Palearctic members of the family (Schintlmeister 2008). The family Erebidae was partially revised as part of various projects, most of all in "The Bombycidae and Sphingidae of the West Palearctic" (e.g., de Freina & Witt 1987, 1991, 2001; de Freina 1997). The family Nolidae of Eurasia was revised by László et al. (2007).

Lots of data on the family Noctuidae have been published in a number of monographs. For example, Ebert & Hacker (2002) provided a great baseline for faunistic studies on this family in the country. Later, the Witt Catalogue and Fibigeriana book series, written by various authors (Ronkay et al. 2008, 2011, 2014a, 2014b, 2017; Ronkay & Ronkay 2009; Behounek et al. 2010; Lödl et al. 2013, 2015; Pekarsky et al. 2019), provided further taxonomic and faunistic details on this family in Iran.

Iranian Lepidoptera have also been listed as part of general books on agricultural (Behdad 1988, 1997; Modarres Awal 1994, 1997, 2012) and forest (Abai 2000) pests, with additional information on the biology and host plants of various economically important species.

Material and methods

Data sources

Taxonomic publications. In total, 1,694 taxonomic publications were examined, including all historical and recent research papers, books, short communications, congress reports and abstracts with a focus on the fauna of Iran or neighbouring countries (see Rajaei et al. 2023a). The faunistic literature from all countries adjacent to Iran, but also Europe, the Russian Federation, the Arabian Peninsula and central Asia was reviewed for Iranian records as far as available. All extracted data were entered in a master Excel sheet and separated into taxonomic data (higher classification, taxon name, author and year of publication) and distributional data, including province, precise locality, altitude, date of collection and name(s) of collector(s). Biological and ecological data were also collected where available. Data quality was thoroughly assessed by the first editor (HR), with help from Dominic Wanke for parts of the families Zygaenidae and Geometridae. The cut-off date for examination of new literature for this version of the catalogue was 31 December 2022.

Scientific collections. As far as available and accessible within the time frame of this project, specimens from scientific collections were examined and their data extracted by the authors of each taxonomic section of the catalogue (Rajaei et al. 2023a) as an additional source of information. In total, 48 Lepidoptera collections, both institutional and private, were examined (see Table 1). Priority was given to identified but not yet published specimens, which were added to the catalogue as previously unpublished data. Much Iranian material in these collections remains to be identified.

Updating the data

The collected data were then thoroughly vetted by the authors of each section of the catalogue (Rajaei et al. 2023a), all of which are internationally renowned Lepidoptera experts with a high degree of authority on their taxonomic group(s). Each specialist received the raw data concerning his or her taxonomic groups(s) of interest and was asked to carry out the following checks:

- verify whether each taxon was valid at the species or subspecies level;
- verify whether any names had since been synonymized;
- check for any ambiguities with gender agreement or misspellings;
- assign a status to each taxon for Iran, as follows: "resident", "unconfirmed", "erroneous" or "erroneous but probable" (see below for details);
- where necessary, add explanatory notes on the status of the taxon in Iran, unpublished localities, new records, DNA barcoding, classification, phylogeny, nomenclature, misidentifications, etc.

Finally, each collaborator was asked to provide a list of species based on the data provided, sort them systematically and add the higher classification.

Most records from recent taxonomic revisions were accepted without any further systematic verification.

Systematics, taxonomy and nomenclature

To avoid taxonomic and nomenclatural errors in the catalogue, a comprehensive list of standard literature sources on Lepidoptera names at all classification levels was used.

For the higher classification (superfamily and family level), we mainly referred to Nieukerken et al. (2011). Subfamily classifications are mainly according to Kristensen (1998), in combination with updated and recently published phylogenies (see Table 2).

In the case of conflicting phylogenetic hypotheses and different classifications by different authors, we referred to the most recent publications and explained details in the notes.

Only published names are listed in the catalogue, except four undescribed species (listed with the genus name followed by "sp. n."), one undescribed subspecies ("ssp. n.") and a number of unidentified species (listed with the genus name followed by "sp.").

We followed the International Code of Zoological Nomenclature (ICZN 1999) in not recognizing informal taxonomic levels (e.g., forms, varieties or aberrations), which in some cases, however, were included as synonyms.

Table 1. List of examined collections and their abbreviations.

Collection name, city, country	Abbreviation
Collection Alexander Schintlmeister, Dresden, Germany	CAS
Collection Jean Haxaire Laplume, Paris, France	CJHL
Collection of Plant Protection Department, Faculty of Agriculture, University of Birjand, Birjand, Iran	ICB
Collection Stefan Naumann, Berlin, Germany	CSNB
Finnish Museum of Natural History, Helsinki, Finland	MZH
Hayk Mirzayans Insect Museum, Tehran, Iran	HMIM
Landesmuseum für Kärnten, Klagenfurt, Austria	NHMK
Museum für Naturkunde, Berlin, Germany (also known as Museum für Naturkunde der Humboldt Universität)	MFNB
Museum für Tierkunde, Dresden, Germany	MTD
Muséum national d'Histoire naturelle, Paris, France	MNHN
Museum Witt Munich (now in ZSM), Munich, Germany	MWM
National Museum Prague, Prague, Czechia	NMPC
Natural History Museum, London, UK	NHMUK
Naturalis Biodiversity Center, Leiden, The Netherlands	RMNH
Naturhistorisches Museum Wien, Vienna, Austria	NHMW
Naturhistoriska Riksmuseet, Stockholm, Sweden	NRM
Private collection of Dirk Stadie, Eisleben, Germany	PCDS
Private collection of Alireza Naderi, Tehran, Iran	PCAN
Private collection of Arthur Lingenhöle, Biberach, Germany	PCAL
Private collection of Axel Kallies, Berlin, Germany	PCAK
Private collection of Bernd Müller, Berlin, Germany	PCBM
Private collection of Jörg Gelbrecht, Königs Wusterhausen, Germany	PCJG
Private collection of Péter Gyulai, Budapest, Hungary	PCPG
Private collection of Francesco Fentoni, Pavia, Italy	PCFF
Private collection of Günter Müller, Freising, Germany	PCGM
Private collection of H. Christof Zeller, Thalgau, Austria	PCCZ
Private collection of Jarosław Buszko, Toruń, Poland	PCJB
Private collection of Jörg-Uwe Meineke, Kippenheim, Germany	PCJM
Private collection of Manfred Sommerer, Munich, Germany	PCMS
Private collection of Norbert Pöll, Bad Ischl, Austria	PCNP
Private collection of Payam Zehzad, Tehran, Iran	PCPZ
Private collection of Peder Skou, Ollerup, Denmark	PCPS
Private collection of Thomas Keil, Dresden, Germany	PCTK
Private collection of Thomas Sobczyk, Hoyerswerda, Germany	PCTS
Private collection of Wilfried Arnscheid, Bochum, Germany	PCWA
Research collection of Josef Mooser, Freising, Germany	RCJM
Senckenberg Deutsches Entomologisches Institut, Müncheberg, Germany	SDEI
Sphingidae Museum, Příbram, Czechia	SMCR
Staatliches Museum für Naturkunde Karlsruhe, Karlsruhe, Germany	SMNK
Staatliches Museum für Naturkunde Stuttgart, Stuttgart, Germany	SMNS
Tiroler Landesmuseum Ferdinandeum, Innsbruck, Austria	TLMF
Zentrum für Biodokumentation Reden, Saarland, Germany	ZfB
Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russian Federation	ZISP
Zoological Museum of Moscow State University, Moscow, Russian Federation	ZMMU
Zoologisches Forschungsinstitut und Museum Alexander König, Bonn, Germany	ZFMK
Zoological State Collection, Munich, Germany	ZSM/SNSB
Zoological Museum, Taras Shevchenko National University, Kyiv, Ukraine	ZMKU
Zoological Museum, Natural History Museum of Denmark, Copenhagen, Denmark	ZMUC

Table 2. List of phylogenetic references for each family treated in this catalogue.

Family	Reference(s)	Family	Reference(s)
Nepticulidae	Puplesis & Diškus (2003); Nieukerken et al. (2016)	Lypusidae	Heikkilä & Kaila (2009)
Heliozelidae	Milla et al. (2017, 2019)	Depressariidae	Heikkilä et al. (2014)
Adelidae	Milla et al. (2019)	Cosmopterigidae	Sinev (2002); Koster & Sinev (2003)
Tischeriidae	Puplesis & Diškus (2003)	Gelechiidae	Karsholt et al. (2013); Huemer & Karsholt (2020)
Meessiidae	Regier et al. (2014)	Pterolonchidae	Heikkilä et al. (2014)
Psychidae	Sobczyk (2011); Arnscheid & Weidlich (2017)	Elachistidae	Heikkilä et al. (2014); Wang & Li (2020)
Eriocottidae	Zagulajev (1988)	Coleophoridae	Baldizzone et al. (2006)
Tineidae	Robinson (2009)	Batrachedridae	Sinev (2002); Koster & Sinev (2003); Heikkilä et al. (2014)
Gracillariidae	De Prins & De Prins (2005, 2006–2022)	Stathmopodidae	Sinev (2015)
Bedelliidae	Sohn et al. (2013); Heikkilä et al. (2015)	Blastobasidae	Sinev (1992); Heikkilä et al. (2014)
Heliodinidae	Hsu & Powell (2004)	Momphidae	Sinev (1992); Koster & Sinev (2003); Heikkilä et al. (2014)
Lyonetiidae	Sohn et al. (2013); Heikkilä et al. (2015)	Alucitidae	Gielis (2003); Heikkilä et al. (2015); Hobern (2022a)
Argyresthiidae	Sohn et al. (2013)	Pterophoridae	Gielis (2003); Alipanah & Gielis (2010); Hobern (2022b)
Yponomeutoidea	Sohn et al. (2013)	Carposinidae	Diakonoff (1989)
Ypsolophidae	Kyrki (1990)	Papilionoidea	Nieukerken et al. (2011); Heikkilä et al. (2012); Kawahara & Breinholt (2014); Espeland et al. (2018); Chazot et al. (2019)
Plutellidae	Sohn et al. (2013)	Epermeniidae	Dugdale et al. (1998)
Glyphipterigidae	Sohn et al. (2013)	Pyralidae	Regier et al. (2012); Léger et al. (2020)
Douglasioidea	Karsholt & Nielsen (2013)	Crambidae	Regier et al. (2012); Mally et al. (2019); Léger et al. (2019, 2020)
Ustyrtiidae	Kaila et al. (2020)	Cimeliidae	Yen & Minet (2007)
Choreutidae	Rota (2011); Rota & Wahlberg (2012)	Drepanidae	László et al. (2007)
Galacticoidea	Heikkilä et al. (2015); Mey (2022)	Lasiocampidae	Zolotuhin (2015); Hamilton et al. (2019); Kawahara et al. (2019)
Tortricidae	Regier et al. (2012); Fagua et al. (2017)	Brahmaeidae	Zwick (2008); Paukstadt & Paukstadt (2021)
Cossidae	Bazinet et al. (2013); Heikkilä et al. (2015)	Bombycidae	Zwick et al. (2010); Hamilton et al. (2019)

Family	Reference(s)	Family	Reference(s)
Sesiidae	McKern et al. (2008)	Sphingidae	Kitching et al. (2018); Kitching (2022)
Brachodidae	Kallies (2016)	Geometridae	Yamamoto & Sota (2007); Sihvonen et al. (2011); Heikkilä et al. (2015); Rajaei et al. (2015); Brehm et al. (2019); Murillo-Ramos et al. (2019); Sihvonen et al. (2020)
Zygaenidae	Efetov & Tarmann (2017); Hofmann & Tremewan (2020)		
Limacodidae	Epstein (1996)		
Epipyropidae	Krampl & Dlabola (1983); Epstein (1996)		
Lecithoceridae	Gozmány (1978)	Notodontidae	Schintlmeister (2013)
Autostichidae	Gozmány (2008); Heikkilä et al. (2014)	Erebidae	Zahiri et al. (2012)
		Euteliidae	Zahiri et al. (2022)
Ocophoridae	Heikkilä et al. (2014)	Noctuidae	Zahiri et al. (2011, 2012, 2013); Keegan et al. (2021)
Saturniidae	Rougerie et al. (2022)		

For the taxonomy and nomenclature at the genus and species level, we mainly relied on the most updated publications, including checklists and taxonomic revisions (e.g., Błeszyński 1965; Sattler 1967; Roesler 1973, 1993; Gozmány 1978; Razowski 1984; Diakonoff 1986; Karsholt & Razowski 1996; Bengtsson 1997; Huemer & Karsholt 1999, 2010, 2020; Scoble 1999; Hacker & Hreblay 2002; Gielis 2003; Goater et al. 2003; Koster & Sinev 2003; Brown et al. 2005; De Prins & De Prins 2005; Baldizzone et al. 2006; László et al. 2007; Scoble & Hausmann 2007; Ronkay et al. 2008, 2011, 2014b, 2017; Schintlmeister 2008; Fibiger et al. 2009, 2010; Ronkay & Ronkay 2009; Zilli et al. 2009; Varga et al. 2013, 2015, 2020; Pekarsky et al. 2019; Alipanah et al. 2021).

An additional check of taxonomic, nomenclatural and distributional data was carried out in the following, broadly accepted online portals and databases:

- Funet web portal (https://www.funet.fi/pub/sci/bio/life/insecta/lepidoptera/);
- Lepiforum e.V. Bestimmung von Schmetterlingen und ihren Präimaginalstadien (https://lepiforum.org/);
- Barcode of Life Data System (Ratnasingham & Hebert 2007) (https://www.boldsystems.org/);
- Global Information System on Pyraloidea (Nuss et al. 2003–2022);
- T@RTS: Online World Catalogue of the Tortricidae (Gilligan et al. 2018);
- Global Taxonomic Database of Gracillariidae (De Prins & De Prins 2006–2022).

Structure of the catalogue

The structure of this catalogue is largely adopted from Pohl et al. (2018), a major difference being the numbering system and species statuses (four categories instead of the eleven used by them).

Systematics

As far as possible, we tried to sort all taxa systematically based on the most updated phylogenies. This was not an easy task, and the arrangement remains somewhat provisional for some families (e.g., Pyralidae) in need of more in-depth taxonomic revisions.

Section introductions

Each family or superfamily starts with a brief introduction as a footnote, with general information on, e.g., diagnostic characters, classification, species diversity in the world and in Iran and biological data. Introductions vary in length according to the group.

Unique identifiers for taxa

We developed a numbering system that provides a unique identifier for each species and that will not change in future versions of the catalogue.

Each species was assigned a unique identifier consisting of six digits in three parts, each separated by a dot. The first two digits (from 01 to 70) designate the family, the next three digits designate the species and the last digit designates the catalogue version (1 for the present version). In this way, additional species can be inserted between any two species in future versions without affecting the identifiers of the other species.

Subspecies recognized in Iran were not assigned a unique identifier but were marked with a lowercase letter (a, b, c, etc.), and their distribution is given.

Synonymies are listed below the valid name, preceded by "=".

We assigned a different identifier to erroneously reported taxa, retaining the two-digit family identifier followed by an "E", a two-digit number and a last digit (1) after a full stop. These numbers start from 1 in each family, therefore the last erroneous number shows how many erroneously reported taxa are in each family.

Status of species in Iran

We classified each species and subspecies into one of four statuses with regard to their presence in the country, after careful evaluation of the available data, as follows:

R = confirmed resident. The presence of these taxa is also designated by abbreviations for each province from which they have been recorded.

U = unconfirmed presence. These are mostly taxa reported in the older literature, for which no vouchers were available or whose determination remains uncertain or unverified. We used the same system of unique identifiers for these taxa as for taxa with status R, as these species may be confirmed in the future. Province abbreviations are given in brackets "[ ]" to reflect this degree of uncertainty. We added a note for each of these taxa explaining why they could not be confirmed.

EP = erroneous but probable. This status indicates taxa erroneously recorded in Iran but whose presence in the country is expected. We added a note for each of these taxa.

E = erroneous. Taxa whose records have been documented as incorrect in a reliable publication, have been redetermined as referring to another species by an expert, or are thought to be so unlikely that an error is the only reasonable explanation. We added a note for all erroneous records.

Taxa with type locality in Iran

Taxa, including synonyms, whose type locality is in Iran are marked with an asterisk (*), both in front of the taxon name and next to the province abbreviation.

Endemic taxa

Taxa endemic to Iran based on current knowledge are denoted by a lowercase "e" before the name.

New country records

In total, 182 species are reported as new to the Iranian list in this work, indicated by an arrow (→) in front of the name. Four undescribed species in the genera *Agonopteryx*, *Ectoedemia*, *Ptilophora* and *Zygaena* and a new subspecies of *Phaselia erika* are listed as "sp. n." and "ssp. n.", respectively, and will be described elsewhere.

New locality records

A large number (1,489) of previously unpublished localities for known species are supplemented with collection dates and depositories.

Distributional data

To keep the catalogue as compact as possible, we provided distributional data at the province level only, with provinces listed at the top of each page. Province abbreviations are listed after each taxon with confirmed records from that province. Provinces are ordered geographically from North-West to East, South and South-East.

Synonyms

Synonyms were listed only where at least one Iranian record under the synonymous name was found in the literature.

Gender agreement

Contrary to common practice among most lepidopterists (see Sommerer 2002; Nieukerken et al. 2019), some published works on the fauna of Iran have followed gender agreement for specific and subspecific names (Lederer 1871; Rothschild 1921; Bigot 1968; Arenberger 1999,

Table 3. List of Iranian provinces and their abbreviations as used in this catalogue.

Province	Abbreviation	Province	Abbreviation
Alborz	al	Khorasan-e Razavi	km
Ardabil	ar	Khorasan-e Shomali	ks
Azerbaijan-e Gharbi	ag	Khuzestan	kh
Azerbaijan-e Sharghi	as	Kohgiluyeh va Boyer-Ahmad	kb
Bushehr	bu	Kordestan	ko
Chahar Mahaal-o-Bakhtiari	cb	Lorestan	lo
Esfahan	es	Markazi	mk
Fars	fa	Mazandaran	ma
Gilan	gi	Qazvin	qa
Golestan	go	Qom	qo
Hamadan	ha	Semnan	se
Hormozgan	ho	Sistan-o-Baluchestan	sb
Ilam	il	Tehran	te
Kerman	ke	Yazd	ya
Kermanshah	kr	Zanjan	za
Khorasan-e Jonubi	kj		

Table 4. Other abbreviations used in this catalogue.

East	E
Hossein Rajaei	HR
metres above sea level	m
Mountain/Mountains	Mt./Mts.
North	N
North-East	NE
North-West	NW
Ole Karsholt	OK
South	S
South-East	SE
South-West	SW
West	W

2002; Alipanah & Ustjuzhanin 2005, 2013; Nematollahi 2005; Alipanah 2014, 2017; Alipanah et al. 2021). We maintain that following gender agreement is destructive for the stability of taxonomic names, especially in the digital era (see Nieukerken et al. 2019), and have chosen not to follow it here. Any corrections of gender-agreement variants found in the literature are detailed in the notes.

Abbreviations

Abbreviations of province names used in the catalogue are listed in Table 3. Other abbreviations are listed in Table 4.

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