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A newly available database of an important family of phytophagous mites: Tenuipalpidae Database

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Abstract

This paper announces a database on the taxonomy, distribution and host plants of mites of the family Tenuipalpidae Berlese (Acari: Tetranychoidea), available online at https://www.tenuipalpidae.ibilce.unesp.br/. In the Tenuipalpidae Database the recorded world distribution and range of host plants are provided for each tenuipalpid species, including synonyms, with a list of all relevant publications.

Key words: flat mites, false spider mites, Tetranychoidea, Prostigmata, taxonomy, distribution, host plant

Introduction

The flat mites (Acari: Tenuipalpidae) have a worldwide distribution and include several economically important plant feeding species (Gerson 2008; Mesa *et al.* 2009; Beard *et al.* 2012). For example, species of the genus *Brevipalpus* Donnadieu are associated with the transmission of plant viruses that can cause diseases in important crops around the world (Childers *et al.* 2003; Beard *et al.* 2015; Roy *et al.* 2015). In addition, the red palm mite, *Raoiella indica* Hirst, has recently received great attention due to its rapid spread and economic impact on palm crops in the New World (Flechtmann & Etienne 2004; Dowling *et al.* 2008; Beard *et al.* 2018; Mendes *et al.* 2018).

The first catalogue of world species of Tenuipalpidae was published by Mesa *et al.* (2009). It provided taxonomic information on 891 known species belonging to 34 genera, a key to the genera of the world and the zoogeographical distributions of the species listed. Mesa *et al.* (2009) synonymized three genera: *Rarosiella* Rimando and *Neoraoiella* Mohanasundaram with *Raoiella* Hirst, and *Meyeraepalpus* Smiley, Frost & Gerson with *Aegyptobia* Sayed. They also erected three new genera: *Magdalenapalpus* Mesa, Welbourn & Evans, *Chaudhripalpus* Mesa, Welbourn & Evans and *Urigersonus* Mesa, Ochoa & Evans. Several taxonomic changes have taken place since the publication of this catalogue. Beard & Ochoa (2011) erected two genera, *Cyperacarus* Beard & Ochoa and *Gahniacarus* Beard & Ochoa, while Beard *et al.* (2014) erected the new genus *Palpipalpus* Beard & Seeman. Three genera were reinstated: *Colopalpus* Pritchard & Baker, *Extenuipalpus* Reck and *Meyeraepalpus*, while *Urigersonus* was synonymized with *Ultratenuipalpus* Mitrofanov (Beard *et al.* 2014, 2016; Castro *et al.* 2015). Additionally, several species were moved to different genera, many new species were described, and new geographical and host plant records were made.

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In this paper, we report the availability of a new database that contains updated information about the taxonomy, distribution records and host plant associations for all species of the family Tenuipalpidae.

Material and methods

As for the databases of the families Ascidae, Blattisociidae and Melicharidae (Santos *et al*. 2018, 2020a, 2020b, 2020c), the computational framework used for the Tenuipalpidae catalogue was adapted from that of the Phytoseiidae Database (Demite *et al.* 2014, 2020). This structure, and the necessary adaptation for the new database, were made by the company "E-client Information Technology", Piracicaba, state of São Paulo, Brazil.

The genera and species considered valid in the database and in this publication follow those listed by Mesa *et al.* (2009), and includes the subsequently described taxa. Synonymies, reinstatements, new combinations and corrections in species identification (e.g. the *Brevipalpus phoenicis* species complex) are also considered. The searching tools provided in the database are the same as those available in the previously mentioned databases: *Species*, *Advanced*, *Tree* and *References*. When searching for species, the presence of the symbol "*" indicates that the species is a junior synonym.

The information for each flat mite species is organized and categorized to match the Phytoseiidae Database, i.e.: *Classification*, *Holotype*, *Synonyms*, *Other Names*, *Distribution*, *Hosts/Substrates*, *Catalogue*, *Redescription* and *Notes*. Information about Hosts/Substrates includes all records of tenuipalpid species on host plants (scientific or common name) available in the literature. The database also informs the institution where the holotype was deposited (Type Depository).

The information about the *Holotype*, *Type Depository*, *Other Names* (Species Designation in the catalogue), *Synonyms* and *Redescription* was obtained from Mesa *et al.* (2009), with the addition of references published subsequently. Information about geographic distribution and hosts/substrates were obtained directly from the references listed in the database (Castro *et al.* 2020). Additional references were obtained by general searches of the National Agricultural Library (USDA, USA), ESALQ Library (University of São Paulo, Brazil), The Smithsonian Library, websites of scientific journals and contacts with researchers around the world.

Junior synonyms are mentioned immediately after the information corresponding to the senior synonym. Searches for geographic distribution and host plants should consider the information available for both senior and junior synonyms.

Territories and possessions of a country (e.g., Azores, Galapagos, Hawaii, Martinique etc.) were mentioned separately from the corresponding country in the database and in this publication. For Australia, Brazil, Canada, China, India, Russia and the United States of America (countries with the largest geographical areas), the distribution is given in relation to the first level of political division where the species has been reported.

The acronym OBS after some of the references in the text indicates the presence of explanatory notes. By positioning the cursor over that acronym, the note will be shown on the screen.

The correct spelling of scientific names of host plants and the determination of their respective families was derived from the site "The Plant List" available online at http://www.theplantlist.org/.

Results and discussion

Since the publication of the tenuipalpid catalogue (Mesa *et al.* 2009), over 120 other tenuipalpid species have been described. About 80% of these are from five countries: Australia (34), Iran (29), Brazil (12), Saudi Arabia (12) and South Africa (7) (Ueckermann *et al.* 2010; Khanjani *et al.* 2012; Beard *et al.* 2018; Castro *et al.* 2018; Khan *et al.* 2019). Thus, the Tenuipalpidae currently comprises 1013 valid species (Table 1), in addition to 70 synonyms and three *Incertae Sedis*, placed in 39 genera.

Approximately 200 papers on tenuipalpids have been published since 2009, including new descriptions, redescriptions, revisions, new distribution and host plant records, and changes in the generic placement of some species. The database is intended to include all information on distribution and host plants reported in the literature. The inclusion of this new information in the database has increased the number of references indicated by Mesa *et al.* (2009) by about 50%, as their citations only included distribution and host plant data for the holotype of each species.

TABLE 1. Number of described and valid species of Tenuipalpidae, including three species of uncertain generic placement (Castro *et al.* 2020).

	Species	
Genus	**Described**	**Valid**
Acaricis	5	5
Aegyptobia	110	104
Afronychus	4	4
Amblypalpus	5	5
Australopalpus	1	1
Brevipalpus	318	292
Capedulia	4	4
Cenopalpus	71	70
Chaudhripalpus	2	2
Coleacarus	1	1
Colopalpus	5	5
Crossipalpus	4	4
Cyperacarus	2	2
Dolichotetranychus	28	26
Extenuipalpus	3	3
Gahniacarus	2	2
Inserta sedis	3	-
Krugeria	2	2
Larvacarus	2	2
Lisaepalpus	1	1
Macfarlaniella	1	1
Magdalenapalpus	3	3
Meyeraepalpus	1	1
Obdulia	3	3
Obuloides	8	8
Palpipalpus	1	1
Pentamerismus	24	23
Philippipalpus	4	4
Phyllotetranychus	4	4
Phytoptipalpus	23	22
Priscapalpus	2	2
Prolixus	6	6
Pseudoleptus	13	13
Raoiella	32	22
Raoiellana	1	1
Tegopalpus	1	1
Tenuilichus	2	2
Tenuipalpus	351	328
Terminalichus	8	8
Ultratenuipalpus	25	25
Total for the 39 genera	**1086**	**1013**

TABLE 2. Number of valid species of Tenuipalpidae by geographic location (no political connotation) (Castro *et al.* 2020).

Locality	**Valid Species**
Mexico	171
USA	157
South Africa	136
Pakistan	121
India	99
Iran	77
Greece	76
Australia	63
China	60
Brazil	38
Honduras	33
New Zealand	32
Turkey	31
Ukraine	30
Saudi Arabia	28
Egypt	27
Georgia	25
Costa Rica, Jamaica	24
Hungary, Israel	23
Iraq, Trinidad	22
Philippines, Puerto Rico	21
Italy	18
Cuba, Japan	16
Armenia	15
Spain	14
France, Guyana, Taiwan	13
Syria	12
Dominican Republic, Portugal	10
Chile, Hawaii (USA), Tajikistan, Thailand	9
Namibia, South Korea	8
Argentina, Colombia, Morocco, Netherlands, New Caledonia, Tunisia	7
Angola, Lybia, Zimbabwe	6
Algeria, Bermuda, Congo, Cook Islands, Germany, Guadeloupe, Guatemala, Indonesia, Malawi, Mauritius, Poland	5
Bulgaria, Cameroon, Canada, Cyprus, England, Fiji, Kazakhstan, Lebanon, Nigeria, Palestine, Uzbekistan, Venezuela	4
Austria, Azerbaijan, Azores (Portugal), Ethiopia, Jordan, Malaysia, Mozambique, Panama, Paraguay, Peru, Rwanda, Sri Lanka, Sudan, Uganda, United Arab Emirates	3
DR Congo, Ecuador, Hong Kong, Java (Indonesia), Kenya, Kyrgyztan, Madeira Islands (Portugal), Martinique (France), Myanmar, Nepal, Norfolk Island (Australia), Oman, Reunion Island, Saint Martin, Samoa, Singapore, Tahiti, Tanzania	2
Afghanistan, Antigua, Aruba, Bangladesh, Barbados, Belgium, Cambodia, Canary Islands (Spain), Croatia, Dominica, El Salvador, Gaza Strip, Guam, Haiti, Kuwait, Les Saintes, Malta, Marie Galante, Mauritania, Monaco, Papua New Guinea, Saint Croix, Saint Helena, Saint Lucia, Saint Thomas, Senegal, Switzerland, Tonga, Turks and Caicos Islands, Uruguay	1

The genera with the largest number of valid species are *Tenuipalpus* (328), *Brevipalpus* (292), *Aegyptobia* (104) and *Cenopalpus* (70). These four genera alone represent 80% (794 species) of the valid tenuipalpid species around the world. The following genera have between 13 and 26 species: *Dolichotetranychus* (26), *Ultratenuipalpus* (25), *Pentamerismus* (23), *Phytoptipalpus* (22), *Raoiella* (22) and *Pseudoleptus* (13); and 29 genera have less than ten species, including eight monospecific genera (Table 1). The pattern of a few genera comprising a large number of species and of several genera having few species had also been mentioned by Mesa *et al*. (2009).

The countries with the largest number of recorded species are Mexico (171), USA (157), South Africa (136), Pakistan (121) and India (99) (Table 2). Several countries have less than 15 tenuipalpid species recorded, and many others have not recorded any species. This information indicates the regions where the tenuipalpid fauna is still not well known. Countries with the greatest diversity of genera are Australia (22 genera), followed by South Africa (16), India and Iran (14) (Table 3). Furthermore, Australia presents the highest endemicity at the generic level, with 11 endemic genera.

TABLE 3. Number of genera of Tenuipalpidae by geographic location (no political connotation) (Castro *et al.* 2020).

Locality	**Genus**
Australia	22
South Africa	16
India, Iran	14
China	11
Greece, Mexico, Pakistan, Saudi Arabia	10
Egypt, Iraq, Israel, Philippines, USA	9
Turkey	8
Namibia, New Zealand	7
Brazil, Japan, Taiwan, Tajikistan, Ukraine	6
France, Honduras, Hungary, Georgia, Thailand	5
Armenia, Colombia, Cook Islands, Cuba, England, Hawaii (USA), Indonesia, Italy, Poland, Puerto Rico, South Korea, Spain, Syria, Trinidad, Tunisia	4
Algeria, Angola, Argentina, Canada, Chile, Costa Rica, Dominican Republic, Germany, Guadeloupe, Guatemala, Guyana, Jamaica, Jordan, Lybia, Mauritius, Morocco, Netherlands, New Caledonia, Palestine, Paraguay, Portugal, Sudan	3
Austria, Azerbaijan, Bermuda, Bulgaria, Cameroon, Congo, Cyprus, Ecuador, Fiji, Hong Kong, Java (Indonesia), Kazakhstan, Madeira Islands (Portugal), Malawi, Martinique (France), Nigeria, Oman, Panama, Reunion Islands, Saint Martin, Singapore, Sri Lanka, Tahiti, United Arab Emirates, Uzbekistan, Venezuela, Zimbabwe.	2
Afghanistan, Antigua, Aruba, Azores (Portugal), Bangladesh, Barbados, Belgium, Cambodia, Canary Islands (Spain), Croatia, Denmark, Dominica, DR Congo, El Salvador, Ethiopia, Gaza Strip, Guam, Haiti, Kenya, Kuwait, Kyrgyztan, Lebanon, Les Saintes, Malaysia, Malta, Marie Galante, Mauritania, Monaco, Mozambique, Myanmar, Nepal, Norfolk Island (Australia), Papua New Guinea, Peru, Rwanda, Saint Croix, Saint Helena, Saint Lucia, Saint Thomas, Samoa, Senegal, Switzerland, Tanzania, Tonga, Turks and Caicos Islands, Uganda, Uruguay	1

The Tenuipalpidae Database is hosted at the site of Instituto de Biociências, Letras e Ciências Exatas (IBILCE), Universidade Estadual Paulista (UNESP), São José do Rio Preto, state of São Paulo, Brazil, at following address: http://www.tenuipalpidae.ibilce.unesp.br. The availability of the database with updated information about taxonomy, distribution and host plants of the flat mites facilitates the work of taxonomists around the world. It is our intention to update the database periodically.

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