

M. Fennane, M. Ibn Tattou, J. El Oualidi, M. S. Taleb, O. Benkhniq, H. Khamar & C. Moujahdi

Floristic research in Morocco: achievements and future trends

Abstract

Fennane, M., Ibn Tattou, M., El Oualidi, J., Taleb, M. S., Benkhniq, O., Khamar, H. & Moujahdi, C.: Floristic research in Morocco: achievements and future trends. — *Fl. Medit.* 33: 5-16. 2023. — ISSN: 1120-4052 printed, 2240-4538 online.

The main lines of the history of knowledge about the vascular flora of Morocco are presented. Names of some famous authors and notable publications are indicated.

The report drawn up shows that the general floristic inventory is fairly well known; but for many species, there are still more or less big taxonomic and/or chorological gaps.

Moroccan floristic research is currently in a bad situation. While waiting for better days, there is a way to keep the flame of this research alive by benefiting from the advantages of computer tools; efforts should be directed towards the creation and development of databases and electronic flora. The aim is to capitalize existing information, update it and disseminate it to the widest possible public, in particular researchers, students and biodiversity managers.

Key words: botanical history, Flora, checklist, database, North Africa.

Introduction

The data and reflections, shared in this work, are concerning the fields that are mainly related to taxonomy (i.e., description and delimitation of taxa) and to floristics, in particular the inventory aspects (i.e., catalogs), identification keys (i.e., Floras) and geographical distribution of species.

In this context, we could say that the second decade of the twenty-first century was marked by the completion of three major syntheses on the vascular flora of Morocco, viz the “Flore pratique du Maroc” (Fennane & al. 1999-2014), the “Index Synonymique de la Flore d’Afrique du Nord” (Dobignard & Chatelain 2010-2013) and the “Livre Rouge de la flore vasculaire du Maroc” (Fennane & al. 2021).

In our opinion, these three references present the end of a stage and should open the way to another one that is certainly part of the continuity, and that must imperatively be different and innovative in order to: on the one hand capitalize, develop and further clarify the scientific knowledge acquired, and on the other hand, exploit better, protect and conserve the national phytodiversity.

We discuss the future of research on the vascular flora of Morocco with great caution viewing the bad position in which it currently finds itself and viewing the little hope for a change of trend in the short term, or even in the medium term. We have discussed this subject fifteen years ago (Fennane 2008), and unfortunately today, we believe that the situation is more than gloomy.

From now on, in the digital era, there is no doubt that the study, management / valorization and protection / conservation of flora cannot be developed without the precious support of databases and electronic flora. The challenge is great for the country, especially since on the scientific level, research activities continue to decline. Worse still, the training of young specialists is almost absent.

Since the dawn of time, thanks to the efforts of many generations of researchers and practitioners (professional or amateur managers), we have been able to:

- 1) know the national plant heritage better and better;
- 2) take advantage of its goods for our physical and moral comfort;
- 3) protect / conserve the flora for our daily needs, but also as a sustainable resource towards future generations.

Today, we believe that a page has been turned in the study of our vascular flora and another is on the way to be opened. For the first page, what are the major achievements? For the second one, what are the possible expectations? These are the main questions presented and discussed in this article.

Historical overview and current context

Under no circumstances, we cannot pretend here to give a complete list of the authors and/or previous works on Moroccan flora. This is simply an impossible mission for some obvious reasons: many historical documents have disappeared over time and those that have come down to us are not always easily accessible. Only few researchers have taken the time and trouble to search the archives to shed light on the past. Therefore, today we have a good knowledge of authors and works that present the most important benchmarks, especially during the second millennium. Below is a selection of these benchmarks. For further details, the interested reader may consult the following references: Renaud (1935), Sauvage (1954), Sauvage (1975), Ibn Tattou & Fennane (1989), Bellakhdar (1991), García & Carabaza (2009), Valdés (2021).

Pre-Linnaean period

Ninth - Eleventh centuries

- Abou-Hanifa Dinawari (820 - 895): “Grand Dictionnaire des Plantes”, about 50 new species are described.
- Ibn Wahchiya (??? - 930): translated and enriched the book “L’Agriculture nabatéenne”; the first classification trial.
- Ibn Djoljol, Andalus: published in 982 a work on the plants studied by Dioscorides and on other news.
- Ibn Wafid (1008 - 1075), Andalus: brilliant agronomist; responsible of the Botanical Garden of Toledo.
- Ibn Bassal (11th century), Toledo: agronomist; author of the book “Diwan al filaha”.

- Ibn Al Hajjaj (11th century), Córdoba: author of several books on agriculture.
- Abulcassis (936 - 1013), Córdoba: surgeon, author of “Kitabet-tesrif” that includes several volumes on medicinal plants.
- Ibn Beklarech (11th century), Zaragoza: author of the book “Al mustaâni” that discusses the materia medica with a large focus on plants of Spain and the Maghreb.
- Al Bekri (1014 - 1094), Córdoba: good expert of Maghreb plants, cited extensively by Ibn Al Baytar.

Twelfth and Thirteenth centuries

- At-Tighnari (1073 - 1118), Andalus: Book “Zahrat Al Boustane”.
- Abou El-Kheir Al-Ichbili (1108 - 1179), Seville: book “ûmdat at-tabib fî ma’arifat al-nabat”, plant classification trial.
- Al-Hadj Al-Gharnati (12th century): books “Traité d’agriculture” and “Dictionnaire de botanique”.
- Charif Al-Idrissi (Sebta, 1100 - 1165): geographer, naturalist; book “Traité de géographie (1154)”, rich in information on plants of Morocco, Algeria and the Iberian Peninsula.
- Al Ghafiqi (12th century), Andalus: book “Kitab al aduiya al moufrada”, description of several plants of Morocco and Spain.
- Ibn Al-Âwwam, Seville: book “Kitab Al Filaha”, treats more than 600 sp. of plants.
- Rachid-Eddin Ibn Essouri (Sour, 1177 - 1241): botanist.
- Abou El-Abbas An-Nabati (Seville, 1165 - 1239): book “Ar-rihla”, presents observations of travels through Spain, North Africa and the Middle East, a hundred new plant species are described.
- Ibn Al-Baytar (Malaga, 1197 - Damas, 1248): book “Jaamiâ al-moufradate” (traité des simples), it contains 1400 sp., most plants.
- Abdallah Ben Salah: botanist who lived in Seville and Sebta?

Sixteenth and Seventeenth centuries

- Al-Wazir Al-Ghassani (Fez, 1548 - 1610), physician of the King Ahmed Al-Mansour: book “Hadiqat al azhar fî charh mahiyat al-ûchoub wa lâaqa”, classification based on that of “ûmdat at-tabib”.
- Spotswood, surgeon in Tangier: published in 1696 “*Phytologia Tingitana*”, list of about 600 sp. from Tangiers.

Post-Linnaean period (1750 - today)

Pioneers of botanical research in Morocco

- Broussonet Ch. A. (1761 -1807)
- Desfontaines R. L. (c. 1751 -1833)
- Poirer J. L. M. (1755 -1834)
- Schousboe P. K. A. (1766 -1832)
- Webb P. B. (1793 -1854)
- Cosson E. S. C. (1819 -1889)
- Ball J. (1818 -1889)
- Balansa B. (1825 -1891)
- Battandier J.-A. (1848 -1922)
- Braun Blanquet J. (1884 -1980)
- Caballero A. (1877 -1949)

- Litardière (De) R. V. (1888 -1957)
- Emberger L. (1897 -1969)
- Font Quer P. (1888 -1964)
- Gattefossé J. (1899 -1960)
- Guinea E. (1907-1985)
- Hooker J. D. (1817 -1911)
- Humbert H. J. (1887 -1967)
- Jahandiez E. (1876 -1938)
- Maire R. (1878 -1949)
- Mauricio H. (1860 -1937)
- Murbeck S. S. (1859 -1946)
- Pau C. (1857 -1937)
- Pitard C. J. (1873 -1927)
- Salzmann P. (1781 -1852)
- Sennen F. (1861 -1937)
- Trabut L. (1853 -1929)
- Weiller M. (1880 -1945)
- Wilkzek E. (1867-1948)

Contemporary authors (deceased)

- Sauvage Ch. (1909 -1980)
- Vindt J. (1919 - 1993)
- Raynaud Ch. (1939 - 1993)
- Ozenda P. (1920-2019)
- Nègre R. (1922 -2014)
- Quézel P. (1926 -2015)
- Benabid A. (1952 - 2016)
- Mathez J. (1940 - 2018)

Main works of current use (old or recent) in Morocco

List in chronological order:

- Flora atlantica (923 p., 263 pl.). Desfontaines (1798-1799)
- Spicilegium florae maroccanae (1627 sp.). Ball (1878)
- Compendium Florae atlanticae (2 tomes). Cosson (1881, 1887)
- Flore de l'Algérie (2 volumes). Battandier & Trabut (1888, 1895)
- Catalogue des plantes du Maroc, vol. 1, 2 et 3. Jahandiez & Maire (1931 - 1934)
- Catalogue des plantes du Maroc, vol. 4. Emberger & Maire (1941)
- Catalogo de la flora del Rif oriental. Sennen & Mauricio (1933)
- Catalogo razonado de las plantas del Sahara espanol. Guinea (1948)
- Flore du Maroc : analytique, descriptive et illustrée (2 fasc., ouvrage inachevé). Sauvage & Vindt (1952, 1954)
- Flore de l'Afrique du Nord (16 vol., ouvrage inachevé). Maire (1951-1986)
- Flore des régions arides du Maroc occidental (2 vol.). Nègre (1961, 1962)
- Nouvelle Flore de l'Algérie et des Régions désertiques méridionales (2 vol.). Quézel & Santa (1962, 1963)

- Flore du Sahara. Ozenda (1977, 1991, 2004)
- Med-Checklist : Inventaire critique des plantes vasculaires des pays circumméditerranéens (ouvrage inachevé, 4 vol. parus sur 6 prévus). Greuter & *al.*, eds. (1984-2008)
- Catalogue des plantes vasculaires rares, menacées ou endémiques du Maroc. Fennane & Ibn Tattou (1998)
- Flore pratique du Maroc (3 vol.). Fennane, Ibn Tattou, Ouyahya, El Oualidi & Mathez, eds. (1999-2014)
- Catalogue des plantes vasculaires du Nord du Maroc (2 vol.). Valdés, Rejdali, Achhal, Jury & Montserrat, eds. (2002)
- Flore vasculaire du Maroc, inventaire et chorologie, vol. 1. Fennane & Ibn Tattou (2005)
- Flore vasculaire du Maroc, inventaire et chorologie, vol. 2. Ibn Tattou & Fennane (2008)
- Index synonymique de la flore d’Afrique du Nord (5 vol.). Dobignard & Chatelain (2010-2013).
- Livre Rouge de la flore vasculaire du Maroc. Fennane, avec la collaboration de Ibn Tattou & El Oualidi (2021).

The vascular flora of Morocco: quantitative and qualitative analysis

The statistics published in the literature on the number of plant species that exist in Morocco are sometimes remarkably different depending on the sources (Tab. 1). Nothing surprising, in so far as the appreciations and the scientific approaches are not necessarily the same, in particular on the taxonomic and chorological levels. Thus, for example, according to the authors, the same taxon: 1) can be accepted at different ranks (species, subspecies, variety); 2) can be counted present, doubtful or absent; 3) can be considered native, of questionable nativeness or exotic.

Table1. Number of species in Morocco according to recent bibliography.

Number of species	Reference
4500 native sp.	Benabid (2014) (in arabic)
4173 native + exotic sp. (p.p.)	Fennane, Ibn Tattou, Ouyahya, El Oualidi & Mathez, eds. (1999-2014)
4707 native sp. and subsp. 647 exotic sp. and subsp.	Dobignard & Chatelain (2010-2013)
3913 native sp. 261 sp. of doubtful presence 55 hybrid sp. 220 exotic sp.	Fennane & Ibn Tattou (2012)
4800 sp., whose: - 144 of dubious rank (species?) - 482 of doubtful presence - 90 hybrid - 298 exotic (naturalized or weeds)	Fennane & Rejdali (2018)
3842 native sp. c. 500 sp. of doubtful presence	Fennane, Taleb & Rejdali (2022)

As far as we are concerned here, the numbers put forward come from the exploitation of an unpublished database (Vascular flora of Morocco, Scientific Institute, Mohammed V University in Rabat), regularly updated. They complement each other (and compare each other) with others from more or less recent work, in particular: Fennane & Ibn Tattou (2012), Fennane & Rejdali (2018); Fennane & al. (2021, 2022). In this context, we are now able to draw up a fairly precise table of all the flora and its remarkable fractions such as the endemic and the rare or threatened ones.

Native flora

The vascular flora, native in Morocco, counts approximately 3800 species, to which one can add nearly 80 hybrids. The number of subspecies is around 1400, of which nearly 40 % are type subspecies (e.g., *Ephedra fragilis* Desf. subsp. *fragilis*), the others are additional (e.g., *Ephedra fragilis* subsp. *cossonii* (Stapf) Maire).

For the higher ranks, 140 families (according to APG III classification, updated in Angiosperm Phylogeny Website “www.mobot.org”) and 979 genera (including 2 hybrids: *Rapistrilla* and *Trachycnemum*) are listed, always with the same names at the top of the list. Thus, the first ten families, in decreasing order of species richness, are: *Asteraceae* (128 genera / 540 species), *Fabaceae* (57 / 403), *Poaceae* (122 / 330), *Brassicaceae* (86 / 212), *Caryophyllaceae* (32 / 202), *Lamiaceae* (30 / 195), *Apiaceae* (55 / 157), *Plantaginaceae* (18 / 122), *Amaranthaceae* (32 / 77), *Boraginaceae* (26 / 75). For genera, there are *Silene* (67 sp.), *Ononis* (55), *Teucrium* (53), *Astragalus* (51), *Centaurea* (50), *Trifolium* (42), *Euphorbia* (39), *Carex* (37), *Erodium* (36), *Orobanche* (33), *Linaria* (32), *Helianthemum* (31), *Ranunculus* (29), *Vicia* (25).

In terms of biological types (or forms), herbaceous plants (hemicryptophytes, geophytes, therophytes) constitute nearly three-quarters of the national spectrum; half (c. 1400 species) are annuals. Woody plants (phanerophytes, nanophanerophytes, chamaephytes) are around 900 species, among which almost a third are trees or shrubs.

The native vascular flora of Morocco shows great richness, within which two fractions are very important to us and deserve special attention: the endemic flora and the threatened one.

Endemic flora

The vascular flora of Morocco does not contain any endemic family. On the other hand, at the level of genera and species, the originalities are significant. Seventeen genera (including one hybrid, *Trachycnemum*) and 620 species are restricted to the national territory.

The endemic genera are mostly *Brassicaceae* (*Ceratocnemum*, *Crambella*, *Fezia*, *Hemicrambe*, *Roripella*, *Rytidocarpus*, *Trachycnemum*, *Trachystoma*). The others belong to six different families: *Apiaceae* (*Pseudoridolfia*, *Sclerosciadium*), *Asteraceae* (*Heliocauta*, *Nivellea*), *Amaranthaceae* (*Traganopsis*), *Campanulaceae* (*Feeria*), *Fabaceae* (*Hesperolaburnum*), *Orobanchaceae* (*Bartsiella*) and *Amaryllidaceae* (*Hannonia*). *Trachystoma* is represented by three species; the others are all monospecific.

For species, we count 620 strict endemics (plus 8 others, probably shared with neighboring countries), 16.3% of the national inventory. We can also add to this number 25 hybrid species, including probably 3 shared with neighboring countries.

On a larger geographical scale, endemism confirms the affinities and floristic originalities common to Morocco and its neighboring countries. 5 genera (4 *Brassicaceae* (*Cordylocarpus*, *Foleyola*, *Kremeriella*, *Rapistrella*, *Zahora*) and one *Lamiaceae* (*Saccocalyx*)) are shared with Algeria and one (*Celtica*) with the Iberian Peninsula. For the species level, ca. 200 are shared with Algeria and about the same with the Iberian Peninsula; ca. 135 species exist at the same time in Morocco, Algeria and the Iberian Peninsula.

In Morocco, endemic species can be found in all regions, but not with the same abundance. Unsurprisingly, the mountain ranges host the most of them: High-Atlas (330), Middle-Atlas (220), Anti-Atlas (170) and Rif (150).

Floristic endemism in Morocco is characterized not only by its richness (i.e., total number of species), but also by its taxonomic diversity: 52 families and 253 genera contain several endemic species. The families at the top of the list are: *Asteraceae*, *Fabaceae*, *Lamiaceae*, *Brassicaceae*, *Caryophyllaceae*, *Apiaceae*, *Poaceae* (Tab. 2). This order changes, sometimes significantly, if we look at the percentage of endemics per family. For example, the *Lamiaceae* take the 1st place (35 % of its species are endemic), while this family is in the 3rd place according to its total number of endemics and in the 6th place according to its total number of species (Tab. 2). In contrast, the *Poaceae* comes in the 15th place (9 % of endemic species), while the family is the 7th according to the total number of endemics and the 3rd according to the total number of species. For the level of the genera, the first ten names on the list are almost the same which recur in the literature following more or less different orders. According to our numbers (Tab. 2), the ten most notable genera, in terms of endemic richness and/or the rate of endemism, are: *Teucrium*, *Silene*, *Centaurea*, *Ononis*, *Astragalus*, *Linaria*, *Erodium*, *Euphorbia*, *Vicia* and *Lotus*.

Table 2. Families and genera that are notable by rate and/or number of endemics.

	Total of species	Endemic number	Rate (%) endemic	Rank according to endemic rates	Rank according to Endemic number	Rank according to Total of species
Families						
<i>Lamiaceae</i>	195	69	35.4	1	3	6
<i>Plumbaginaceae</i>	47	16	34	2	9	15
<i>Asteraceae</i>	540	125	23.2	3	1	1
<i>Apiaceae</i>	157	33	21	4	6	7
<i>Brassicaceae</i>	212	41	19.3	5	4	4
<i>Fabaceae</i>	403	73	18.1	6	2	2
<i>Caryophyllaceae</i>	202	36	17.8	7	5	5
<i>Papaveraceae</i>	48	8	16.7	8	12	14
<i>Geraniaceae</i>	50	8	16	9	13	13
<i>Plantaginaceae</i>	122	19	15.6	10	8	8

Table 2. continued.

<i>Euphorbiaceae</i>	45	7	15.5	11	14	16
<i>Rosaceae</i>	58	9	15.5	12	11	12
<i>Boraginaceae</i>	75	11	14.6	13	10	10
<i>Ranunculaceae</i>	60	6	10	14	15	11
<i>Poaceae</i>	330	29	8.8	15	7	3
<i>Amaranthaceae</i>	77	4	5.2	16	16	9
Genera						
<i>Teucrium</i>	53	27	51	1	1	3
<i>Silene</i>	67	20	30	2	2	1
<i>Centaurea</i>	50	13	26	3	3	5
<i>Ononis</i>	55	13	23.6	6	4	2
<i>Astragalus</i>	51	12	23.5	7	5	4
<i>Linaria</i>	32	8	25	4	6	11
<i>Erodium</i>	36	7	19.4	9	7	9
<i>Euphorbia</i>	39	7	18	10	8	7
<i>Vicia</i>	25	6	24	5	9	16
<i>Lotus</i>	29	6	20.7	8	10	13
<i>Ranunculus</i>	29	3	10.3	11	11	14
<i>Helianthemum</i>	31	3	9.7	12	12	12
<i>Orobancha</i>	33	3	9.1	13	13	10
<i>Carex</i>	37	2	5.4	14	14	8
<i>Trifolium</i>	42	2	4.8	15	15	6
<i>Juncus</i>	27	0	0	16	16	15

Threatened flora

We consider here the threatened flora as defined by the IUCN (IUCN 2012a and 2012b). Thus, all the species classified in the Categories “CR” (critically endangered), “EN” (danger of extinction) and “VU” (vulnerable) of the IUCN Red List.

According to data from the book “Livre rouge de la flore vasculaire du Maroc” (Fennane & al. 2021), the threatened flora in Morocco contains nearly a thousand species, distributed approximately equally between the three categories “CR” (37 %), “EN” (33 %) and “VU” (30 %). Unfortunately, nearly two thirds of national endemic species are concerned: 153 “CR”, 140 “EN” and 100 “VU”.

All regions of Morocco are home to threatened endemic species; the High-Atlas, the Middle-Atlas and the Anti-Atlas are in the lead with 150, 105 and 78 species respectively.

Flora of doubtful presence

Examination of the bibliography relating to the inventory of the flora of Morocco shows that there are approximately 560 vascular species of doubtful presence on a national scale. Among them, 15 are hybrids, 20 are of questionable taxonomic rank, 40 are national endemics, 100 are woody species (phanerophytes, nano-phanerophytes or chamaephytes).

Exotic flora

The exotic flora in Morocco is quite present, especially that voluntarily imported by human, since the dawn of time, for his needs of food, health, recreation. Thus, it is difficult to pronounce about the number of introduced species. In addition, for undesirable species (brought by humans involuntarily or by other means: rivers, winds, birds, etc.), there are nearly 200; most are herbaceous, generally qualified as weeds. It should be noted that over time, some of these exotics succeed to adapt to their new environments and end up settling there permanently and becoming part of the local flora.

Little-known flora

The book “Livre rouge de la flore vasculaire du Maroc” (Fennane & al. 2021) shows that there are about 1500 species for which there is a lack of information on the systematic levels (doubtful taxonomic rank, hybrid?) and/or chorological (uncertain presence, native or exotic state?, poorly known geographical distribution). Two thirds of these species are classified in Category “NA” (IUCN criteria: not applicable) of the IUCN Red List and one third are classified in Category “DD” (insufficient data).

Review and perspectives

The data presented in this article gives a mixed review about the current state of knowledge on the vascular flora of Morocco. On the one hand, we note with satisfaction the existence of important basic references: Catalogs, Flores (determination tools). However, on the other hand, we regret very much the persistence of many gray areas: about 1500 species are little-known (i.e., doubtful taxonomic rank, presence in Morocco to be confirmed, presence status unknown). In addition, we must add that even for a number of species whose presence is confirmed, the geographical distribution within the country is only vaguely known. Research in the field, and in herbaria, again and again reveals interesting surprises in terms of taxa that are new for science (recent examples: *Verbascum ifranensis* Khamar & al. 2017; *Centaurea ibn-tattoui* Chambouleyron & al. 2014; *C. peltieri* Homrani Bakali & Susanna 2021; *C. achilleifolia* Homrani Bakali & Susanna 2022), for Morocco or for different regions of the country.

The management (exploitation, development, protection, etc.) and the conservation (*in-situ* and *ex-situ*) of phytodiversity cannot be properly carried out without sufficiently precise knowledge of the species from all points of view: taxonomic, biological, ecological, chorological. This is to say and to recall the essential role of scientific research, which is stagnant today, if not in regression, with no concrete signs of recovery in the short or even the medium terms.

Conclusion

At present, the vascular flora of Morocco is relatively accessible through important synthesis works (catalogs, Floras, monographs, etc.) that give a general view of the overall

inventory, but they remain insufficient for managers to properly make efficient decisions for the conservation of biodiversity.

The role of researchers today is therefore to bring to light more information on our flora, but also to capitalize on it and present it in an accessible way to the public, as wide as possible, on different media, including digital tools. The constitution of databases and electronic Floras must retain all our attention. Their advantages are undeniable: continuous updating / corrections in real time; very wide dissemination of information; work in group for large number of collaborators; relatively low cost.

Certainly, Moroccan botany is not living its best days, but the flame of hope must remain alive with the digital era and all the possibilities they offer to maintain contacts and support the efforts of all those interested in knowing, exploiting, protecting and conserving the flora.

Acknowledgment

We are sincerely grateful to the anonymous reviewers for their valuable comments.

References

- APG III 2009: An update of The Angiosperm Phylogeny Group classification for the orders and families of flowering plants. – *Bot. J. Linn. Soc.* **161(2)**: 105-121. <https://doi.org/10.1111/j.1095-8339.2009.00996.x>
- Ball, J. 1878: *Spicilegium florae maroccanae*. – *J. Linn. Soc. (Bot.)* **16**: 281-772.
- Battandier, J. A. & Trabut, M. 1888, 1895: *Flore de l'Algérie*, **1-2**. – Alger, Paris.
- Bellakhdar, J. 1991: Les sciences de la nature et la botanique médicale chez les Arabes.–Al Biruniya, *Rev. Mar. Pharm.* **7(2)**: 87-112.
- Benabid, A. 2014 (in arabic): “البيئة الطبيعية والنبات بالمغرب” *Milieu naturel et plantes du Maroc*. – Casablanca.
- Chambouleyron, M., Bidat, M. & Léger, J.-F. 2014: *Centaurea ibn-tattoui (Asteraceae)*, a new narrow endemic species from northeastern Morocco. – *Phytotaxa* **174(3)**: 157-164. <https://doi.org/10.11646/phytotaxa.174.3.4>
- Cosson, E. 1881-1887: *Compendium Florae atlanticae*, **1-2**. – Paris.
- Desfontaines, R. 1798-1799: *Flora atlantica*, **1-2**. – Paris.
- Dobignard, A. & Chatelain, C. 2010-2013: *Index synonymique de la flore d'Afrique du Nord*, **1-5**. – Genève.
- Emberger, L. & Maire, R. 1941: *Catalogue des plantes du Maroc*, **4**. – Alger.
- Fennane, M. 2008: Les recherches floristiques au Maroc: passé riche, présent difficile et avenir incertain. – *Prospectives Universitaires Univ. Mohammed V (Rabat)* **1**: 109-116.
- (avec la collaboration de Ibn Tattou, M. & El Oualidi, J.) 2021: *Livre rouge de la flore vasculaire du Maroc*. – *Trav. Inst. Sci. (Rabat), Sér. Bot., Num. Spécial.* **1-12**: 1-750.
- & Ibn Tattou, M. 1998: *Catalogue des plantes vasculaires rares, menacées ou endémiques du Maroc*. – *Bocconea* **8** : 5-243.
- & — 2005, 2008: *Flore vasculaire du Maroc, inventaire et chorologie*, 1. – *Trav. Inst. Sci. (Rabat), Sér. Bot.* **37** (2005), 483 p. ; Vol. 2 (Ibn Tattou & Fennane). – *ibid.* **39** (2008), 398 p.
- & — 2012: *Statistiques et commentaires sur l'inventaire actuel de la flore vasculaire du Maroc*. – *Bull. Inst. Sci. Rabat, Sci. Vie* **34**: 1-9.
- & Rejdali, M. 2018: *Moroccan vascular plant Red Data Book: A basic tool for plant conservation*. – *Fl. Medit.* **28**: 339-350. <https://doi.org/10.7320/FlMedit28.339>

- , Taleb, M. S. & Rejdali, M. 2022 : Diversité végétale au Maroc: Ressources, gestion et défis de durabilité “التنوع النباتي بالمغرب : الموارد، التدبير وتحديات الاستدامة”. – Trav. Inst. Sci. (Rabat), Sér. Bot., **44**: 1-154 [in arabic].
- , Ibn Tattou, M., Ouyahya, A., El Oualidi, J. & Mathez, J. (eds): Flore pratique du Maroc, **1**. – Trav. Inst. Sci. (Rabat), Sér. Bot. **36** (1999); **2**. –ibid. **8** (2007); **3**. –ibid. **40** (2014).
- García, E. & Carabaza, J.M. 2009: Studies on the agronomy of Al-Andalus. – Rev. Mondes Musulmans Médit. **126**. <https://doi.org/10.4000/remmm.6465>
- Greuter, W., Burdet, M.M. & Long, G. (eds) 1984-2008: Med-Checklist: Inventaire critique des plantes vasculaires des pays circumméditerranéens. **1** (1984), **2** (2008), **3** (1986), **4** (1989). – Genève, Berlin, Palermo.
- Guinea, E. 1948: Catalogo razonado de las plantas del Sahara español. –Anales Inst. Bot. Cavanilles **8**: 357-442.
- Homrani Bakali, A. & Susanna, A. 2021: *Centaurea peltieri* (Asteraceae), a new endemic species from the Oriental High Atlas of Morocco. – Phytotaxa **523(2)**: 192-198. <https://doi.org/10.11646/phytotaxa.523.2.6>
- Homrani Bakali, A. & Susanna, A. 2022: *Centaurea achilleifolia* (Asteraceae), a new endemic species from the Oriental Middle Atlas of Morocco. – Phytotaxa **542(1)**: 83-89. <https://doi.org/10.11646/phytotaxa.542.1.7>
- Ibn Tattou, M. & Fennane, M. 1989: Aperçu historique et état actuel des connaissances sur la flore vasculaire du Maroc. – Bull. Inst. Sci. (Rabat) **13**: 85-94.
- Jahandiez, E. & Maire, R. 1931-1934: Catalogue des plantes du Maroc, **1-3**. – Alger.
- Khamar, H., Civeyrel, L., Pelissier, C., Badr, D., El Oualidi, J. & Touhami-Ouazzani, A. 2017: *Verbascum ifranensis* (Scrophulariaceae), a new endemic species from Morocco. – Phytotaxa **295(2)**: 132-140. <https://doi.org/10.11646/phytotaxa.295.2.2>
- Maire, R. 1951-1986: Flore de l’Afrique du Nord, **1-16**. – Paris.
- Nègre, R. 1961, 1962: Flore des régions arides du Maroc occidental, **1-2**. – Paris.
- Ozenda, P. 1977 (1991, 2004): Flore du Sahara. – Paris.
- Quézel, P. & Santa, S. 1962, 1963: Flore de l’Algérie et des Régions désertiques méridionales, **1-2**. – Paris.
- Renaud, H. P. J. 1935: La contribution des arabes à la connaissance des espèces végétales: les botanistes musulmans. – Bull. Soc. Sci. Nat. Maroc **15**: 58-71.
- Sauvage, Ch. 1954: L’orientation actuelle des recherches botaniques à l’Institut Scientifique Chérifien. – Bull. Enseign. Public Maroc **numéro spécial (août 1954)** : 39-47.
- 1975: L’état actuel de nos connaissances sur la flore du Maroc – Pp. 131-139 in: Coll. Intern. CNRS n° **235**. La flore du Bassin Méditerranéen, essai de systématique synthétique. – Montpellier.
- & Vindt, J. 1952, 1954: Flore du Maroc analytique, descriptive et illustrée, **1**. – Trav. Inst. Sci. Chérif. (Rabat), Sér. Bot. **1** (1952); **2** (1952); **3** (1954).
- Sennen, Fr. & Mauricio, Fr. 1933: Catalogo de la flora del Rif oriental. – Melilla.
- Valdés, B. 2021: Early botanical exploration of the Maghreb. – Fl. Medit. **31**: 5-18. <https://doi.org/10.7320/FIMedit31.005>
- , Rejdali, M., Achhal El Kadmiri, A., Jury, J. L. & Montserrat, J. M. (eds) 2002: Catalogue des plantes vasculaires du Nord du Maroc, **1-2**. – Madrid.
- UICN 2012a: Catégories et Critères de la Liste rouge de l’UICN. Version 3.1. Deuxième édition. – Gland, Cambridge.

— 2012b: Lignes directrices pour l'application des Critères de la Liste rouge de l'UICN aux niveaux régional et national. Version 4.0. – Gland, Cambridge.

Address of the authors:

Mohamed Fennane*, Mohamed Ibn Tattou, Jalal El Oualidi, Mohamed Sghir Taleb, Ouafae Benkhnigue, Hamid Khamar & Chouaib Moujahdi,
Mohammed V University in Rabat, Institut Scientifique, dépt. Botanique, Av. Ibn Battouta, Agdal, 10106, Rabat, Morocco.

*Corresponding author: mohamed.fennane@is.um5.ac.ma ; fennane@yahoo.com