



Angel Romo, Adam Boratyński

Chorology of *Juniperus thurifera* (Cupressaceae) in Morocco

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Abstract: The geographic distribution and occurrence conditions of *Juniperus thurifera* subsp. *africana* in Morocco were studied. The literature and herbaria data, together with field observations formed the basis of detailed maps of distribution of the species in the Middle and High Atlas and allow us to analyze its vertical distribution. The taxon occurs in the sub-arid and arid zones of the Middle and High Atlas with a separate population in the Anti-Atlas, mostly between altitudes 2000 and 2700 m, with an altitudinal maximum at 3400 m and a minimum at 1700 m. It forms forests in the area of about 30 000 ha. In many places of the High Atlas it is the only wood source for local populations. It is strongly endangered because of over exploitation of the wood, over pasturing and lack of seedlings and young specimens.

Additional key words: plant geography; plant ecology, High Atlas, Middle Atlas, Anti Atlas

Addresses: A. Romo, Consejo Superior de Investigaciones Científicas-AB, Institut Botànic de Barcelona, Passeig del Migdia s/n. Parc de Montjuïc, 08038 Barcelona, Spain; e-mail: a.romo@ibb.csic.es
A. Boratyński, Polish Academy of Sciences, Institute of Dendrology, Parkowa 5, 62-035 Kórnik, Poland, e-mail: borata@man.poznan.pl

Introduction

The tree-like *Juniperus thurifera* L. is a typical component of vegetal landscapes of the semi-arid mountain regions within the western part of the Mediterranean region. It is a variable species, in part as a result of long-term isolation of populations dispersed in separate mountain massifs. In Africa it is known as subspecies *africana* (Maire) Hugué de Villar (Gauquelin et al. 1988; Romo and Boratyński 2005), since from the nomenclatural viewpoint all the references of *J. thurifera* from Morocco should be referred to subsp. *africana*.

The general map of geographic distribution of *Juniperus thurifera* in Africa (including subsp. *africana*) has been published several times (see Tralau 1969), but without detailed data (Fig. 1). The area of distribution of the subspecies *africana* was recently shown

very schematically (Gauquelin et al. 1999). It occurs mostly in two centers in Morocco and also grows in the Aurès mountains in the Atlas of Algeria (Quézel and Santa 1962; Quézel 1980).

Much of the data concerning the distribution of *Juniperus thurifera* and conditions of its occurrence in Morocco is dispersed through several floristic and phytosociologic publications (Maire 1926; Humbert 1928; Jahandiez and Maire 1931; Emberger 1938, 1939; Emberger and Maire 1941; Quézel 1957; Lecompte 1969; Quézel and Barbero 1981; Gauquelin 1988; Fromard and Gauquelin 1993; Benabid and Fennane 1994; Auclair 1996; Alifriqui 1986; El Alaoui and Boumezzough 1993; El Alaloui et al. 1994, 1999; Blali 2001; Thinon and Alifriqui 2001; Gauquelin et al. 2002; Rahou 2002; Quézel and Médail 2003). The synthetic Moroccan floras traditionally give information about the occurrence of the

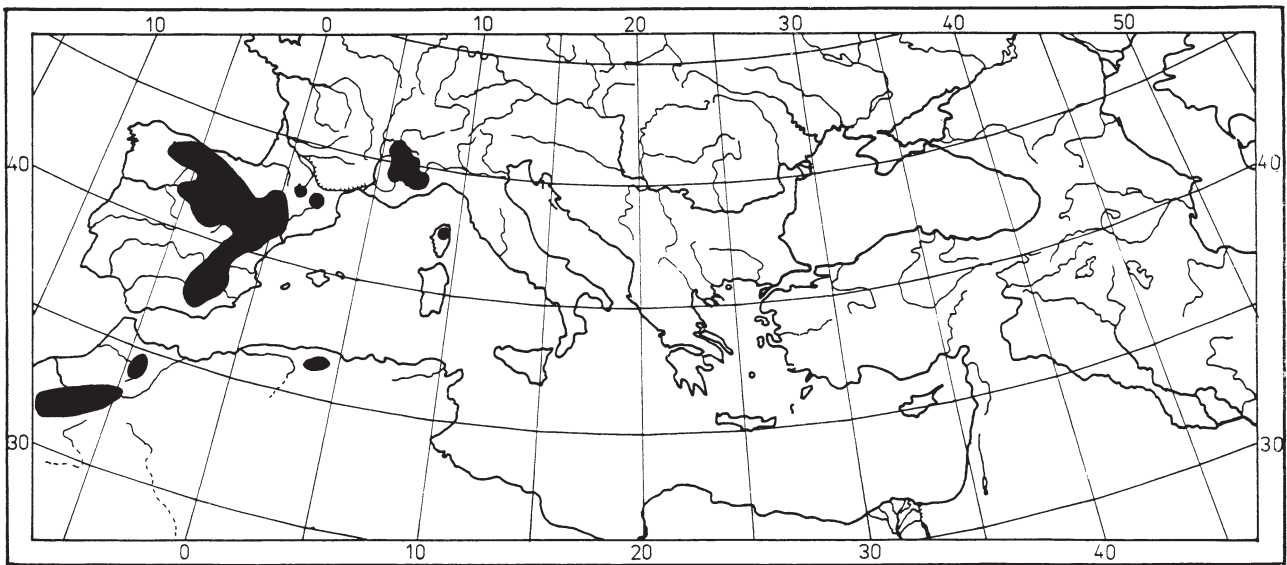


Fig. 1. General range of *Juniperus thurifera* in the Mediterranean region

species in the Middle and High Atlas (see for example El Oualidi and Mathez 1999).

Juniperus thurifera is a forest-forming tree, but in Morocco it regenerates only sparsely and as a rule only old trees are observed in most localities (Fennane and Ibn Tattou 1998; Gauquelin et al. 1999). The utilization of the wood, pasture activity and overgrazing are recognized reasons for this present state (Quézel 1980; Quézel and Pesson 1980; Auclair 1996; Montés et al. 2000, 2002).

The suggested protection of *Juniperus thurifera* subsp. *africana* (Fennane and Ibn Tattou 1998) needs to be based on a sufficiently accurate recognition of its distribution and conditions of occurrence. So, the main aim of the paper is a critical compilation of the data on the species' geographic repartition and its main ecologic conditions of occurrence in Morocco, dispersed through several dozen publications and in herbaria. With these data as a solid background, the authors' field investigations will also be used to illustrate the present state of *J. thurifera* in the African part of its range.

Methods

The geography was studied on the basis of data dispersed in botanical literature concerning Morocco, and in herbaria [B, BC, G, KOR, MA, MPU, P, RGN (Acronyms of herbaria follow Holmgren et al. 1990)] where the main collections of Moroccan plants are preserved. All the data were put into one database, which included possibly precise position (locality), and also: 1) altitude, 2) description of relief, 3) exposition, 4) plant community and 5) the status of the species, the number of individuals, dimensions, evidence of regeneration, and threats when available from the source data. The field observations con-

ducted in 1985–2004 by A. Romo provide an important supplement to the collected material and were included in the database.

The results of distribution are analysed cartographically for the Middle and High Atlas separately, and as general for Morocco. The vertical distribution is demonstrated on the profiles of the main watersheds of the Middle and High Atlas separately. The connections of the species localities with particular forms of relief, exposition and inclination were shown graphically (Boratyński 1985) for various altitudinal layers of the mountains.

Results

Distribution

The occurrence of *Juniperus thurifera* in Morocco is connected with the high mountain ridges. It grows in the Middle Atlas, the High Atlas and is known from dispersed localities in the Anti Atlas.

Juniperus thurifera grows most frequently in the Middle Atlas. It forms loose forests above the vegetation zone of forests of *Cedrus atlantica* and/or *Quercus ilex*, even covering extended areas, especially in the central part of the Middle Atlas (Fig. 2). Nevertheless, the distribution of *J. thurifera* is not on a continuous scale and is divided into several dozen more or less isolated populations, which cover the mountain massifs of sufficiently high elevations. The forest communities formed or dominated by *J. thurifera* are developed on the elevated parts of particular mountain massifs of the Middle Atlas, mostly at altitudes between 1900 and 2100 m (Fig. 3). Below 1900 m the species occurs as dispersed specimens, with an altitudinal minimum of about 1800 m at Aïn Nokra. The most elevated localities it attains are at 2600 m

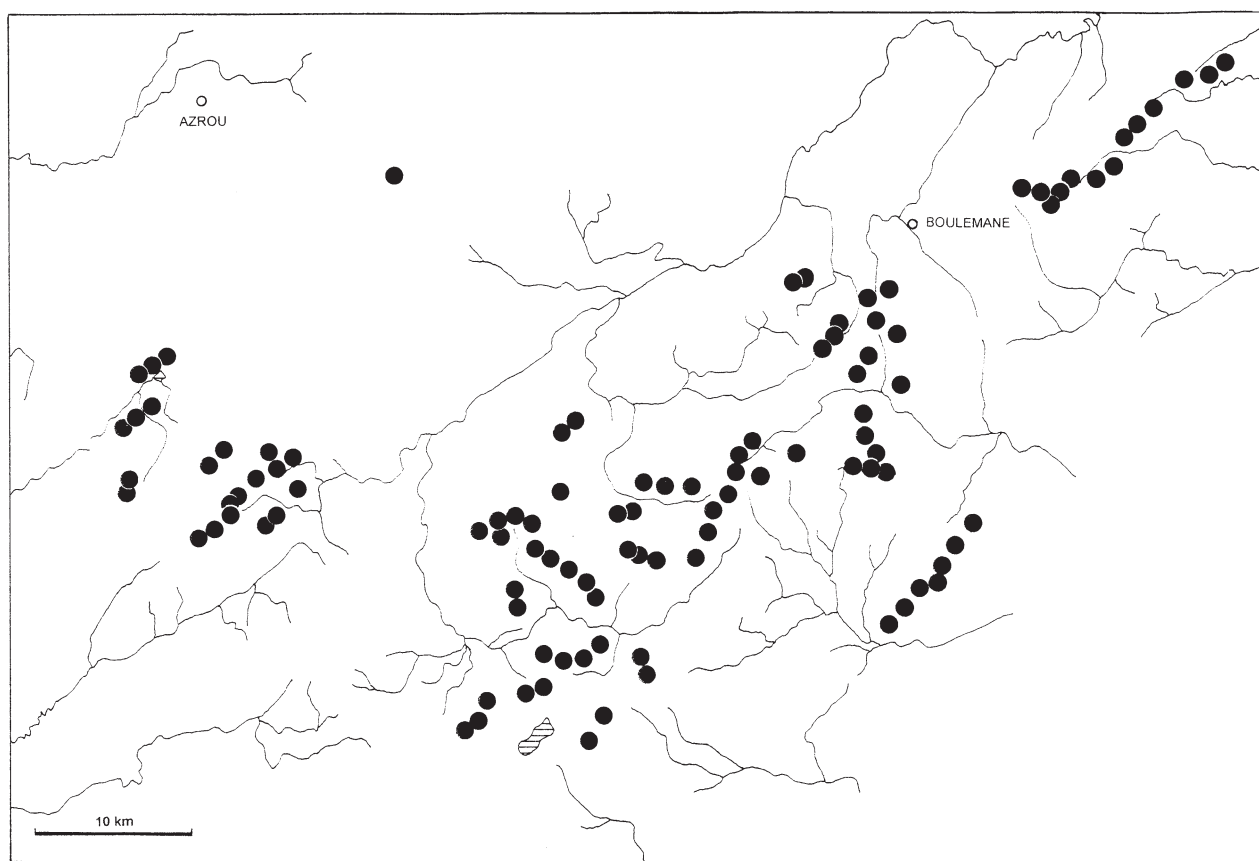


Fig. 2. Detailed cartography of *Juniperus thurifera* populations in the Middle Atlas (after Lecompte 1969, supplemented with herbaria and bibliographic records and authors' field observations)

on the southern slopes of Bou Iblane and 3000 m at Bou Naceur.

The distribution of *Juniperus thurifera* in the High Atlas is more dispersed than in the Middle Atlas (Fig. 4). As in the previous region, the species forms a forest belt in the mountains, mostly above the vegetation zone of *Quercus ilex* and *Juniperus phoenicea*, but communities of *J. thurifera* do not cover such extensive area. The occurrence of *J. thurifera* is connected mostly with altitudes between 1850 and 2500 m, with

a minimum of about 1500 m in the vicinity of Ilmil, and a maximum at 2700 on the slopes of Jbel Toubkal and Jbel Ayachi and even 3150 m on the Jbel Imidghas (Fig. 5). It is strongly restricted by the local population, as it is the only wood resource in some regions. The present localities of the species conserve predominantly tree-like individuals, completely without young individuals and seedlings.

In the Anti Atlas only a few localities of *Juniperus thurifera* are known (Fig. 4). The species occurs only

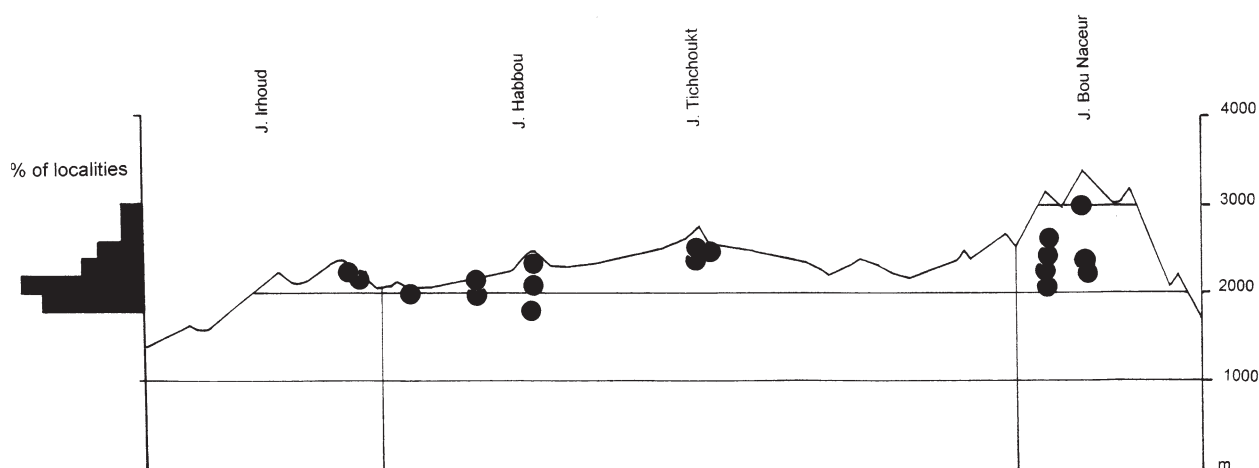


Fig. 3. Altitudinal distribution of *Juniperus thurifera* in the Middle Atlas

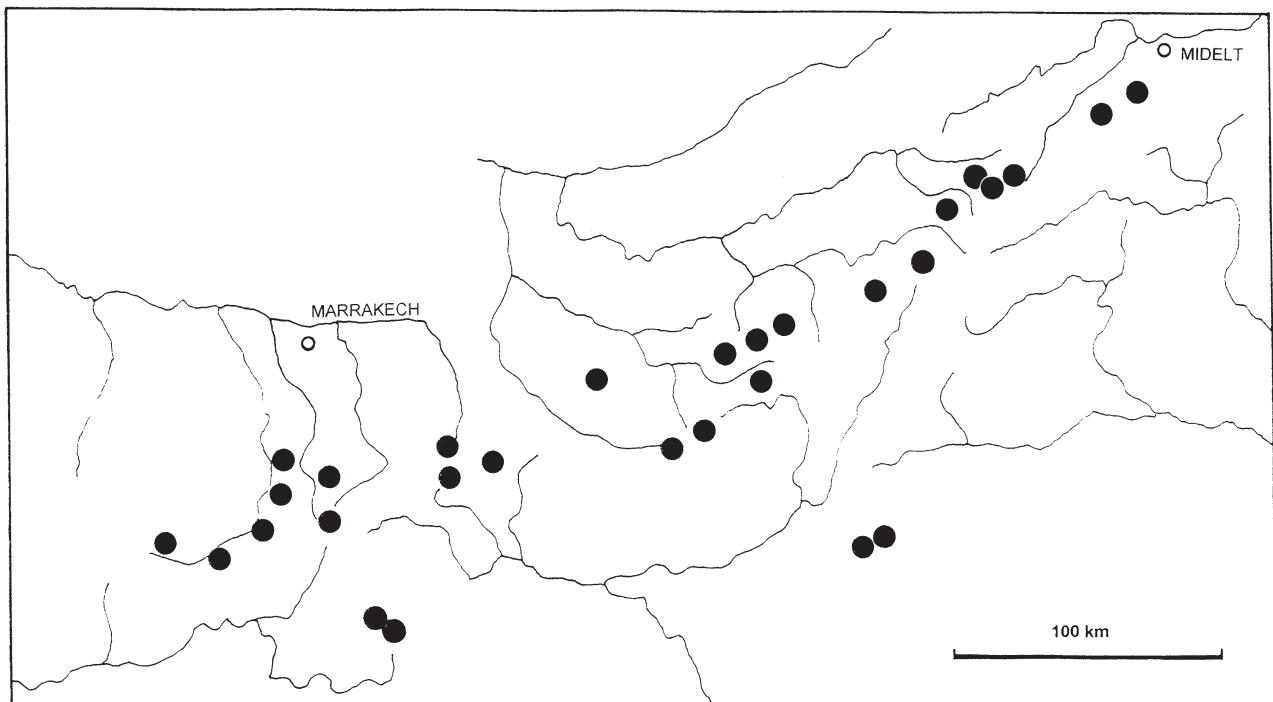


Fig. 4. Detailed cartography of the *Juniperus thurifera* populations in the High Atlas (on the basis of herbaria and bibliographic records and authors' field observations)

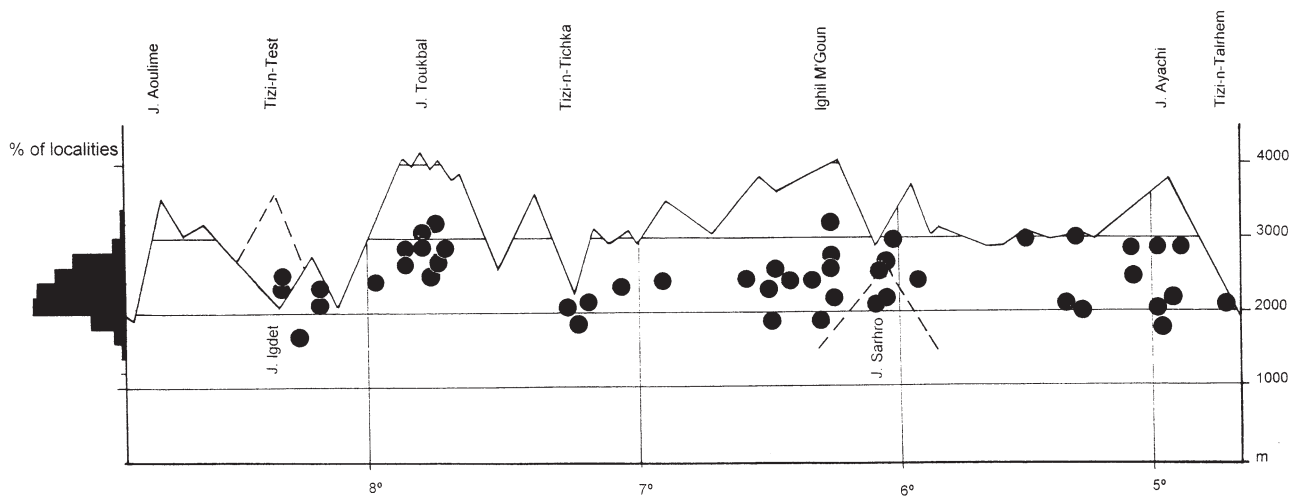


Fig. 5. Altitudinal distribution of *Juniperus thurifera* in the High Atlas.

as single individuals, dispersed at altitudes of about 2550–2700 m on Jbel Sarhro and between 2700 and 3200 m in the massif of Jbel Siroua (Fig. 5).

Occurrence conditions

The present occurrence of *Juniperus thurifera* is connected with slopes and concave relief forms, mostly exposed to the South, East and North. The species has not been reported from localities exposed toward the Atlantic. It seems to avoid the north-westerly and westerly exposed localities (Fig. 6).

Most of the *J. thurifera* stands were reported from calcareous rocks, but it grows also on other substrata,

such as sandstones and schist rocks, with a low content of Ca.

The soil where *J. thurifera* grows is predominantly only fragmentarily developed. The species grows very frequently on stony gravels or in the fissures of rocks filled with clay, but without a humus horizon. The more typically developed soils where the humus horizon can be easily recognized, have been observed in the areas of the Middle Atlas, especially in places with a richer herbal vegetation. In the High Atlas such site conditions are met with only scarcely, as for example in the Oukaïmeden.

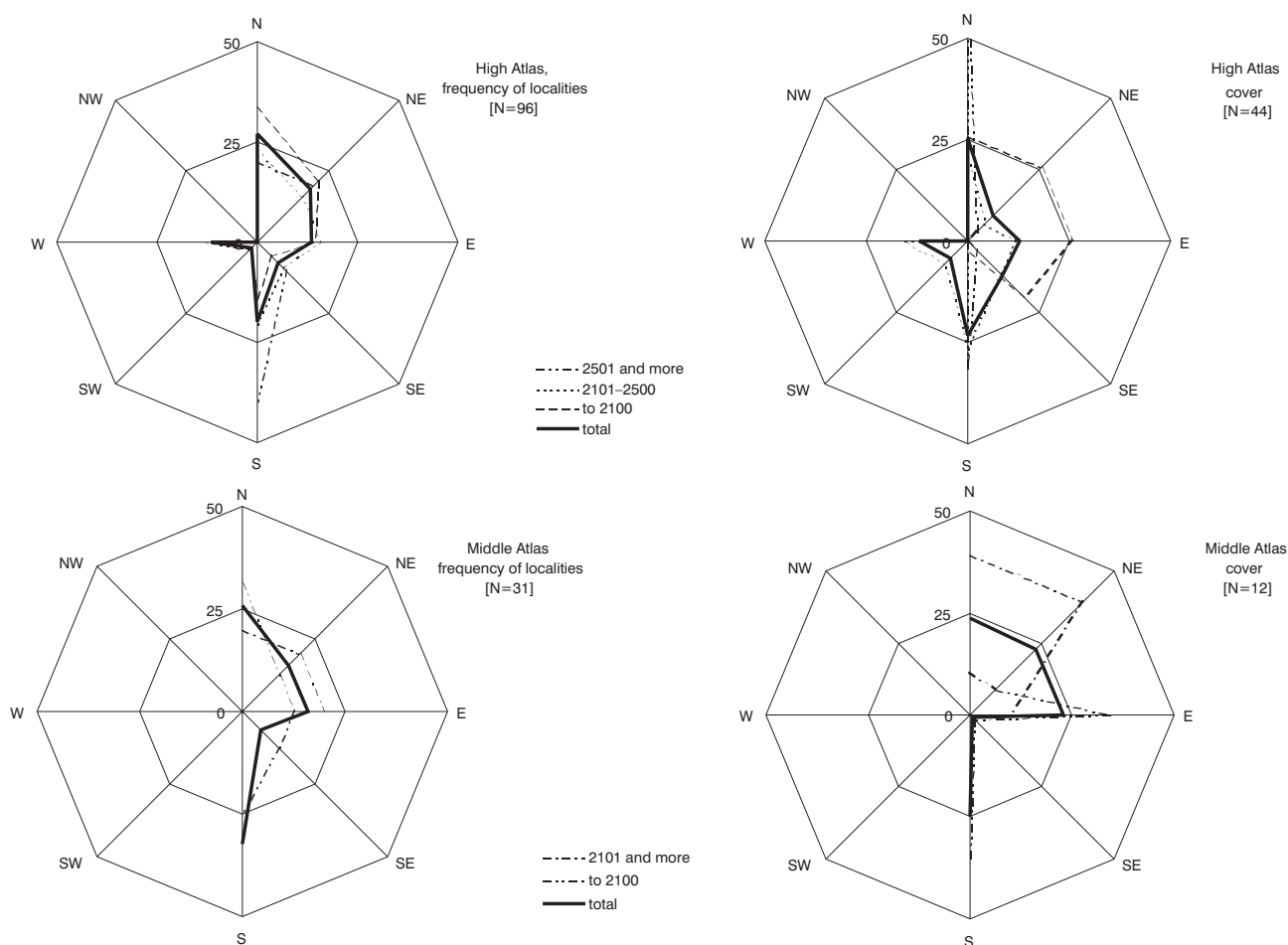


Fig. 6. Exposition of localities of *Juniperus thurifera* in Middle and High Atlas (after data from floristic and phytosociological literature and authors' field observations)

Discussion

Distribution

Quézel and Barbero (1981) mention *Juniperus thurifera* from the Middle Atlas and the eastern High Atlas at between 2100 and 2500 m. Despite what can be deduced from the earlier published maps, such as Barbero et al. (1994), the High and Middle Atlas populations are not continuous, and the oriental and occidental populations of the species in the High Atlas are also separated from each other (Fig. 7). In fact *J. thurifera* is found in the Atlas between 1800 and 3150 m, as already stated by Jahandiez and Maire (1931) and by Emberger (1938: 68), although in exceptional stations it can extend beyond these limits and descend to 1700 m, with isolated individuals even ascending 3400 m above sea level (Gauquelin et al. 1999).

The detailed study of distribution of localities of *Juniperus thurifera* showed a discontinuity of occurrence of the species. The area covered with their range in the Middle Atlas is divided into local populations, which occur in the sufficiently elevated mountain

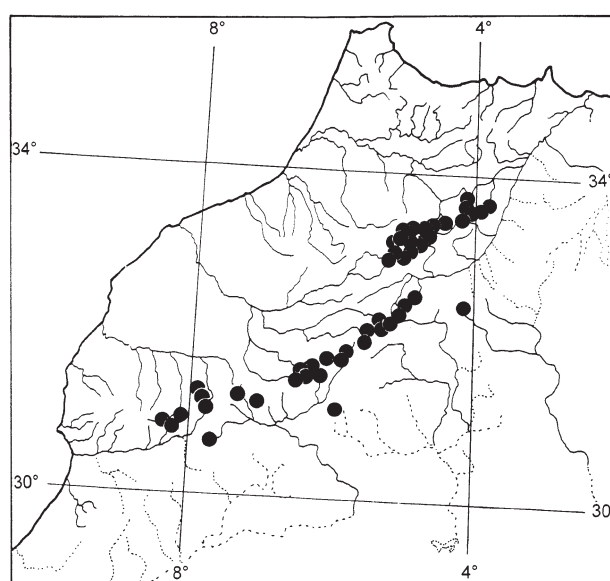


Fig. 7. Distribution of *Juniperus thurifera* in Morocco; the density of localities in the Middle Atlas and the dispersed nature of the High and Anti-Atlas populations stand out

massifs (Figs 2 and 3). Generally, the populations of the species become more numerous as we go towards the south-east (Fig. 2 and 3). The well conserved formations of *J. thurifera* have been reported from altitudes between 1900 and 2000 m in the Middle Atlas (El Alaoui and Boumzzough 1993). According to the phytosociologic data and our field observations, however, it should be pointed out that most of the localities with a determined altitude were reported from altitudes above 2000 m (Fig. 3).

In the Middle Atlas *Juniperus thurifera* occupies the aspects which are not exposed to direct oceanic influence proceeding from the west and northwest (Fig. 6). In contrast, in the massif of Bou Naceur, which is practically the easternmost in the Middle Atlas, we find a series of the species localities oriented from E to W, and *J. thurifera* is found in all types of exposition from altitudes between 2000 and 3000 m (Rahou 2002). For this area the continental influence becomes considerable also on the western slopes. In the case of Bou Iblane, located somewhat to the north-west of Bou Naceur, it can be seen that on the northern slopes, which are wetter, the white juniper is absent, and only when approaching the higher mountain elevations does it reappear on the southern slopes, which are sheltered from the winds loaded with humidity from the Atlantic. The absence of *J. thurifera* from the northern faces of this massif has already been indicated by Peyre (1973). She suggested, that these slopes of Bou Iblane receive humid oceanic winds and are also host to an elevated degree of innivation.

The High Atlas is a mountain range with a well marked continental character, the greater part of the populations of *Juniperus thurifera* being found between 2000 and 3000 m. The better conserved of them were reported from altitudes between 1850 and 2450 m (El Alaoui and Boumezzough 1993), but in our study most of the localities were found above 2100 m (Fig. 5).

The species is frequent throughout the mountain chain (Figs 4 and 5), although it is lacking in some outcrops, such as Seksaoua (Emberger 1934) and in the not sufficiently elevated parts of the mountains (Figs 4 and 5). The dispersion and isolation of the species in the various mountain ranges of the High Atlas is exaggerated by its utilization for fuel, as it is the only wood source in some parts of the mountains (Auclair 1996; Montés et al. 2000, 2002). More isolated are the populations to the south of the High Atlas, where *J. thurifera* mixes with *Juniperus phoenicea* (Emberger 1938) in the transition zone between the two species (Romo 2004). In fact, *J. thurifera* characterizes a vegetation layer of a very dry and continental character, which occurs above the temperate and humid band, where cedars and evergreen oaks dominate. This transition, where the atmospheric humid-

ity is very low, is marked by the substitution of *J. thurifera* with *J. phoenicea*.

Juniperus thurifera forms the upper limit of woodland in the High Atlas, constituting the transition from the forest communities (cedar, evergreen oak, etc.) and the xeroacanthic communities, which consist of chamaephytes (e.g. *Bupleurum spinosum*, *Erinacea anthyllis*, *Cytisus purgans*), typical of the high Mediterranean mountains.

In the zones of the High Atlas which constitute the transition towards the Saharan region, *J. thurifera* is absent, as was pointed out by Peltier (unpublished PhD thesis) or reappears in isolated localities, being found as a relict in higher and more northerly-exposed zones (Quézel et al. 1994).

The references from the eastern Anti-Atlas and the Sarhro can be traced back to Emberger (1938), though later Gauquelin (1993) did not mention these localities. In reality, it is present both in the Jbel Sarhro and in Jbel Sirwa (Dobignard, com. verbal and Fennane com. verbal). Recently, it has also been cited by Charco (2001) from the Jbel Sarhro.

In the Anti-Atlas the populations are entirely relict and are found only above 2000 m (Fig. 5).

Climate

Juniperus thurifera is a light-demanding tree suited to areas of dry and continental climate, far from areas of maritime influence. It colonizes places with an average yearly precipitation which oscillates from between 260 and 1120 mm per year (Walter and Lieth 1960; Lemoine-Sébastien 1965; Gauquelin et al. 1999). For this reason it is absent from the mountains in the north of Morocco (the Rif area), subjected to a maritime influence, and also from the more westerly massifs of the Middle and High Atlas (Fig. 7). On the other hand, it is frequent in the more continental zone of the middle Atlas, and in the greater part of the High Atlas, becoming rare, however, in the Anti-Atlas (Fig. 7). The southern limit of the range is also climatically conditioned, but in that case the restrictive factor is the lack of precipitation (Lemoine-Sébastien 1965). Generally, the species character is determined as occurring in the semi-arid to sub-humid regions, with a drought period of between 4 to 6 months or even longer (Lemoine-Sébastien 1965).

Juniperus thurifera has thermal demands comparable to other trees of the Middle and High Atlas, such as *J. phoenicea*, *Quercus ilex* and *Cedrus atlantica*. The thermal optimum of the white juniper covers a sufficiently broad range of temperatures, and it can also occur in the regions with minimum temperatures below -10°C and maximum above 40°C (Lemoine-Sébastien 1965). The localities of the species are placed in the areas with high yearly amplitudes of temperature.

Substrata

Juniperus thurifera did not show a particular preference for soil type either in the Middle or in the High Atlas (Lemoine-Sébastien 1965; Gauquelin 1985; Gauquelin and Boumezzough 1993; Gauquelin et al. 1999; El Alaoui et al. 1999). However the species communities have been reported much more frequently from the calcareous substrata in the Middle Atlas. The soil on occasions can be deep, when the trees are growing in the broad fissures of the rocks. In that case the soil is composed of clayey and floating parts with participation of calcareous skeleton stones. The average $\text{pH}_{\text{H}_2\text{O}}$ is at about 7.4 (Lemoine-Sébastien 1965), but can vary significantly (Gauquelin and Dagnac 1988). Similar conditions also occur in the High Atlas, where other than calcareous rocks can also be source material of the soils. Nevertheless, these soils have a basic pH and contain a considerable amount of clayey parts. Generally, in the more elevated localities, the soils become stony, with greater participation of skeleton material (Lemoine-Sébastien 1965). The soils, especially in the large fissures, are fairly rich in nutrient components. The soils in the southern part of the species range, and especially in the eastern part of the High Atlas and in the Anti Atlas can have a sialitic or xero-sialitic character (Lemoine-Sébastien 1965).

Phytosociology

Most of the phytosociological plant associations where *Juniperus thurifera* has been found belong to the alliance *Junipero thuriferae-Quercion rotundifoliae* Quézel et Barbero (1981) 1986 of the order *Ephedro majoris-Juniperetalia* Quézel et Barbero (1981) 1986. It was also reported, though not so frequently, from the communities included in the alliances *Ormenion scariosae* Quézel 1952 and *Genistion pilosae-Thymion communis*. The species forms woodlands, where it covers about 30–40% of the area of relevés or grows singly among the pasture lands (Barbero et al. 1981, 1982; Benabid 1987, 1988; Quézel et al. 1987, 1994; Benabid and Fennane 1994).

Conservation

In Morocco, with its 30 000 ha of *Juniperus thurifera* forests (Gauquelin et al. 1999), the species has its second greatest surface coverage after the Iberian Peninsula. The area of thuriferous juniper woodland has been strongly reduced by over-utilization and livestock pasturing for many centuries (Fromard and Gauquelin 1993; Auclair 1996; Gauquelin et al. 1999; Montés et al. 2000, 2002; Blali 2001; Thinon and Alifriqi 2001). The present area of thuriferous juniper woodland ought to be comprehended as a remnant. The potential area of the communities was much broader.

Human pressure and livestock pasturing has diminished over the last few decades in the High Atlas. Despite this, the regeneration of the species is minimal, if not to say inexistent. A considerable number of the Moroccan populations of the thuriferous juniper are in frank regression, which should alert us to take measures in order to conserve them. The climatic aridity, as Emberger (1938: 68) and Lemoine-Sébastien (1965) have stated, prevents the juniper from forming dense stands in the zones it colonizes. It is a fact that the species density, both in the Anti-Atlas and in the High Atlas, is very low, and on very few occasions is regeneration known to occur, or can young individuals living among adult ones be observed. It is a threatened taxon in Morocco, recorded as vulnerable (Fennane and Ibn Tattou 1998: 15).

Acknowledgments

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References

- Alifriqi M. 1986. Contribution à l'étude du milieu et de la végétation dans le Haut Atlas occidental d'Amizmiz. Thèse 3^{ème} cycle. Univ. Cadi Ayaad, Marrakech, 304 p.
- Alifriqi M. 2000. Le genévrier thurifère dans le Haut Atlas occidental Marocain: Répartition, écologie et relation avec les autres peuplements naturels. In: Le genévrier thurifère dans le bassin occidental de la Méditerranée: systématique, écologie, dynamique et gestion. Actes du Colloque international de Marignac (Haute-Garonne, France). Les dossiers forestiers 6: 74–81.
- Auclair L. 1996. L'appropriation communautaire des forêts dans le Haut Atlas marocain. Cahiers de Sciences Humaines 32(1): 177–194.
- Barbero M., Benabid A., Loisel R., Rivas-Martínez S. 1982. Contribution à la connaissance des matorrals du Maroc Oriental. Phytocoenologia 21(1-2): 117–174.
- Barbero M., Lebreton Ph., Quézel P. 1994. Sur les affinités biosystématiques et phytoécologiques de *Juniperus thurifera* L. et *Juniperus excelsa* Bieb. Ecologia Mediterranea 20(3/4): 21–37.
- Barbero M., Quézel P., Rivas-Martínez S. 1981. Contribution à l'étude des groupements forestiers et préforestiers du Maroc. Phytocoenologia 9(3): 311–412.

- Benabid A. 1987. Les grands écosystèmes terrestres et leur préservation. La grande encyclopédie du Maroc, Flore et Végétation (sous la direction de M. Fennane), pp. 186–190.
- Benabid A. 1988. Contribution to the study of the unforest communities in the central part of the Middle Atlas (Morocco). Bulletin de l'Institut Scientifique, Rabat 12: 79–98.
- Benabid, A. 2000. Flore et écosystèmes du Maroc. Ibis Press. Paris.
- Benabid A., Fennane M. 1994. Connaissances sur la végétation du Maroc: Phytogéographie, phytosociologie et séries de végétation. Lazaroa 14: 21–97.
- Blali A. 2001. L'aménagement des forêts de genévrier thurifère: Cas des thuriferaies de la région du Haut Atlas. Dégradation des thuriferaies marocaines. Premières données phytohistoriques et pédoanthracologiques. 2^{ème} Colloque International: Le genévrier thurifère et les forêts d'altitude dans les montagnes du pourtour méditerranéen. Marrakech, avril 2001.
- Boratyński A. 1985. Protected and deserving protection trees and shrubs of the Polish Sudety Mts. with their prealps.1. *Juniperus communis* L. s.l. Arboretum Kórnickie 30: 111–126.
- Charco J. 2001. Guía de los árboles y arbustos del N de África. Agencia española de cooperación internacional. Madrid.
- El Alaoui El Fels M. A., Roques A., Boumezzough A. 1999. Les arthropodes liés aux galbules et aux graines du genévrier thurifère, *Juniperus thurifera* L., dans l'Atlas marocains. Ecologia Mediterranea 25(1): 95–110.
- El Alaoui El Fels M. A., Boumezzough A. 1993. Contribution à l'étude des thuriferaies marocaines: I- Le genévrier thurifère et son environnement dans le Haut Atlas occidental (plateau de Tizrag et Matat). In: Bencherifa A. (ed.). Actes du deuxième Congrès des Géographes Africaines. Rabat et Agadir, 22–24 avril 1993: 49–57.
- El Alaoui El Fels M. A., Boumezzough A., El Alaoui, M. D. 1994. Contribution à l'étude des thuriferaies marocaines: II- Le genévrier thurifère et son environnement dans le Haut Atlas Central calcaire (bassin versant de l'Ahanssal). In: Alifriqui M., Ben Chabaane A. (eds.). Actes des deuxièmes journées de l'arbre. Laboratoire d'Ecologie végétale, Facultad des Sciences, Semlalia Marrakech, 20–21 Avril 1994: 92–95.
- El Oualidi J., Mathez J. 1999. *Cupressaceae*. In: Fennane M., Ibn Tattou M., Mathez J., Ouyahya A., El Oualidi J. (eds.). Flore pratique du Maroc. Travaux de l'Institut Scientifique de Rabat, Série Botanique 36: 59–64.
- Emberger L. 1934. La végétation du massif des Seksawas (Grand-Atlas occidental). Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, Paris 198: 968.
- Emberger L. 1938. Les arbres du Maroc. Larose Editeurs, Paris. 317 pp.
- Emberger L. 1939. Aperçu général sur la végétation du Maroc. Commentaire de la carte phytogéographique du Maroc, 1:1 500 000. Veröffentlichungen. Geobotanisches Institut Rubel, Zurich 14: 40–157.
- Emberger L., Maire R. 1941. Catalogue des Plantes de Maroc, 4: (920) 915–1181.
- Fennane M., Ibn Tattou M. 1998. Catalogue de plantes vasculaires rares, menacées ou endémiques du Maroc. Bocconeia 8: 5–243.
- Fromard F., Gauquelin T. 1993. Les formations à genévrier thurifère des montagnes marocaines: actions de recherche et de conservation sur un milieu et une espèce en régression. Unasylva 44 (172): 52–58.
- Gauquelin T. 1985. Végétation et formations superficielles dans les milieux supraforestiers du Haut Atlas de Marrakech: étude d'un transect (Massif de l'Oukaïmeden). Colloques phytosociologiques 13: 307–323.
- Gauquelin T. 1988. Dynamique de la végétation et des formations superficielles dans les montagnes du bassin occidental de la Méditerranée : Étude des formations à Genévrier thurifère et à xérophytes épineuses en coussinet des Atlas marocains. Thèse Doctorat es Sciences, Université P. Sabatier, Toulouse. tome I: 148 p., tome II: 80 fig. et 21 tableaux + annexes.
- Gauquelin T., Bertaudiere-Montes V., Badri W., Montes N. 2002. Sex Ratio and sexual dimorphism in mountain dioicous thuriferous juniper (*Juniperus thurifera* L., *Cupressaceae*). Botanical Journal of the Linnean Society 138: 237–244.
- Gauquelin T., Bertaudiere-Montes V., Montes N., Badri W., Asmode J. F. 1999. Endangered stands of thuriferous juniper in the western Mediterranean basin: ecological status, conservation and management. Biodiversity and Conservation 8: 1479–1498.
- Gauquelin T., Idrissi Hassani M., Lebreton P. 1988. Le genévrier thurifère, *Juniperus thurifera* L. (*Cupressaceae*): analyse biométrique et biochimique; propositions systématiques. Ecologia Mediterranea 14(3–4): 31–42.
- Gauquelin T., Dagnac J. 1988. Caractéristiques édaphiques des groupements à Genévrier thurifère des Atlas marocains: étude des niveaux superficiels des sols sous couvert et hors couvert. Ecologia Mediterranea 14(3/4): 43–56.
- Gómiz F. 2001. Flora selecta marroquí, Ed. Fco. Javier Navarro. Burgos. 351 pp.
- Holmgren P. K., Holmgren N. H., Barnett L. C. 1990. Index herbariorum. Part L. The herbaria of the

- world. Ed. 8. In *Regnum Vegetabile* 120. x + 693 pp. The New York Botanical Garden, Bronx, New York.
- Huguet del Villar, E. 1947. Types de sol de l'Afrique du Nord, 1: 138 pp. Rabat.
- Humbert H. 1924. Végétation du Grand Atlas marocain oriental. Exploration botanique de l'Ari Ayachi. Bulletin de la Société de Histoire Naturelle Afrique N 15(5): 147–234.
- Humbert H. 1928. Végétation de l'Atlas saharien occidental. Bulletin de la Société de Histoire Naturelle Afrique N 19: 219–221.
- Jahandiez E., Maire R. 1931. Catalogue des Plantes de Maroc, 1. Imprimerie Minerva, Alger. 159 pp.
- Lecompte M. 1969. La végétation du Moyen Atlas central (Esquisse phytogéographique et carte des séries de végétation au 1/200 000). Travaux de la Institut Scientifique Chérifien, Série Botanique et Biologie Végétale 31: 1–34.
- Lecompte M. 1986. Biogéographie de la montagne Marocaine: Le Moyen Atlas central. Mémoires et documents de Géographie. Éditions du CNRS, Paris. 202 pp.
- Lemoine-Sébastien C. 1965. Ecologie des genévriers au Maroc. Société des Sciences Naturelles et Physiques du Maroc 45: 49–116.
- Maire R. 1926. Contribution à l'étude de la flore de l'Afrique du Nord, Fascicule 10. Bulletin de la Société de Histoire Naturelle Afrique N 17: 125.
- Montès N., Bertaudière-Montes V., Badri W., Zaoui El. H., Gauquelin T. 2002. Biomass and nutrient content of a semi-arid mountain ecosystem: the *Juniperus thurifera* L. woodland of Azzaden Valley (Morocco). *Forest Ecology and Management* 166: 35–43.
- Montès N., Gauquelin T., Badri W., Bertaudière V., Zaoui El. H. 2000. A non-destructive method for estimating above-ground forest biomass in threatened woodlands. *Forest Ecology and Management* 130: 37–46.
- Ouhammou A., Muller S., M'hirit O. 2000. La diversité écologique et floristique des groupements à genévrier thurifère (*Juniperus thurifera* L.) dans le Parc National de Toubkal, Haut Atlas de Marrakech, Maroc. In: Le genévrier thurifère dans le bassin occidental de la Méditerranée: systématique, écologie, dynamique et gestion. Actes du Colloque international de Marignac (Haute-Garonne, France). Les dossiers forestiers 6: 67–73.
- Peltier J. P., Riser J. 1974. Introduction à l'étude géomorphologique et géobotanique du massif du Siroua. CNRS, Travaux de la Recherche Corporative Publique 249: 159–173.
- Peyre C. 1973. Quelques aspects de la végétation du massif du Bou Iblane. CNRS. Travaux de la Recherche Corporative Publique 249: 129–147.
- Peyre, C. 1978. Sur quelques climax à caducifoliées dans les montagnes du Maroc. Bulletin de l'Institut Scientifique, Rabat 2: 39–60.
- Quézel P. 1957. Le peuplement végétal des hautes montagnes de l'Afrique du Nord. Encyclopédie Biologique et Ecologique. Lechevalier, Paris. 463 pp.
- Quézel P. 1980. Biogéographie et Ecologie des conifères sur le pourtour méditerranéen. In: Actualités d'Ecologie forestière: Sol, Flore, Faune (Collection P. Pesson, INA). Gauthier-Villars, Paris: 205–255.
- Quézel P. 2000. Réflexions sur l'évolution de la flore et de la végétation au Maghreb méditerranéen. Ibis Press, Paris, 116 p.
- Quézel P., Barbero M. 1981. Contribution à l'étude des formations présteppeiques à genévriers au Maroc. Boletín Sociedade Broteriana, Serie 2, 53(2): 1137–1160.
- Quézel P., Médail F. 2003. Écologie et biogéographie des forêts du bassin méditerranéen. Elsevier, Paris.
- Quézel P., Barbero M., Benabid A. 1987. Contribution à l'étude des groupements forestiers et pré-forestiers du Haut Atlas Oriental (Maroc). *Ecologia Mediterranea* 13: 107–117.
- Quézel P., Barbero M., Rivas-Martínez S. 1994. Le passage de la végétation méditerranéenne à la végétation saharienne sur le revers méridional du Haut Atlas oriental (Maroc). *Phytocoenologia* 22(4): 537–582.
- Quézel P., Pesson P. 1980. Biogéographie des conifères sur le pourtour méditerranéen. Actualités d'écologie forestière (1980): 205–255.
- Quézel P., Santa S. 1962. Nouvelle Flore de l'Algérie 1. CNRS, Paris.
- Rahou A. 2002. Essai d'analyses quantitative, qualitative et biogéographique de la flore du Bou-Naceur (Moyen Atlas Oriental, Maroc). *Acta Botanica Malacitana* 27: 105–129.
- Romo A. 2004. Biogeografía de la vegetación en las montañas de Marruecos. In: Panadera J. M., Arozena M. E., Sanz C., López N. (eds.). Estudios en biogeografía 2004: 89–96. Editorial Aster, Barcelona
- Romo A., Boratyński A. 2005. Nomenclature notes on *Juniperus thurifera*. *Annales Botanici Fennici* (in press).
- Taleb M. S. 2000. Écologie et état actuel du genévrier thurifère au Maroc. In: Le genévrier thurifère dans le bassin occidental de la Méditerranée: systématique, écologie, dynamique et gestion. Actes du Colloque international de Marignac (Haute-Garonne, France). Les dossiers forestiers 6: 62–66.
- Thinon M., Alifriqui M. 2001. Dégradation des thuriferaies marocaines. Premières données phyto-

historiques pedoanthracologiques. 2^{ème} Colloque International: Le genévrier thurifère et les forêts d'altitude dans les montagnes du partout méditerranéen. Marrakech, avril 2001. Livre des résumés.

Tralau H. (ed.). 1969. Index Holmensis 1. The Scientific Publishers LTD., Zürich.

Walter H., Lieth H. 1960. Klimadiagram Weltatlas. G. Fischer Verlag, Jena.