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Flora of the biological and ecological interest site (BEIS) of Tichoukt mountain (middle atlas, Morocco)

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Abstract

The work deals with floristic diversity and chorology of taxa present in the Biological and Ecological Interest Site (BEIS) of Tichoukt mountain (Middle Atlas, Morocco).

Tichoukt mountain is covered by three main kinds of ecosystems :

- Forest and matorral ecosystems: dominant species are *Quercus rotundifolia* (holm oak), *Cedrus atlantica* (cedar of Atlas), *Juniperus phoenicea* (red juniper), *J. thurifera* (thuriferous juniper), *J. communis subsp. hemisphaerica* (common juniper), *Berberis hispanica*, *Crataegus laciniata*.
- Spiny xerophytic ecosystem with *Cytisus balansae*, *Bupleurum spinosum*, *Erinacea anthyllis*, *Alyssum spinosum*...
- Rocky (or rupicolous) ecosystem with *Ephedra major*, *Lonicera pyrenaica*, *Rhamnus atlantica*, *Globularia liouvillei*, *Saxifraga longifolia*, *Aethionema saxatile*...

The flora is valued at more than 184 species with a remarkable number of rare, threatened and / or endemic species. To give an overview on the flora distribution in the BEIS, localities of species sampled are provided with detailed geographical coordinates for the endemic and/or rare ones.

Keywords: Flora, Tichoukt mountain, Biological and Ecological Interest Site, Morocco.

1. Introduction

Following a national study on protected areas in Morocco [1], Tichoukt mountain were selected by the ministry of water and forest as a Biological and Ecological Interest Site (BEIS) that needs urgent protection measures. According to this study, Tichoukt mountain is one of 154 terrestrial BEIS identified in the whole country ; its main peculiarities are the presence of:

- Continental forest of *Cedrus atlantica*, unfortunately very degraded.
- Some stations of *Juniperus communis*, very rare species in Morocco, also currently degraded and fragmented populations.
- Many endemic and remarkable species (see below).

Exhaustive sampling has permitted to develop a fairly complete list of vascular plants for the first time. All

species observed are listed as well as those cited in this region by the "Flore vasculaire du Maroc: inventaire et chorologie" [2,3].

In this paper, we present, for the first time, the whole vascular flora of Tichoukt mountain with informations on the chorological aspect. Endemic and/or rare taxa are mentioned.

Beside scientific interest, the main aim of this work is to gather maximum of informations on floristic diversity and originalities in order to help decision makers for exploitation, conservation and protection issues.

2. Material and Method

Tichoukt mountain is located between the Central and Eastern parts of Middle Atlas (Fig. 1). It culminates at 2787 m with a ridge line that remains above the 2400 m over most of its length. The Guigou

river delimits the BEIS to the north with the depressions of the Tarhroute basin and Skoura. According to climate data of Boulmane, Tichoukt mountain receives an average of over 470 mm of rain. Average temperatures do not exceed 20°C, while minimum temperatures can reach -5°C in winter. Bioclimates are semi-arid and subhumid. The vegetation belts are montagnard mediterranean and oromediterranean [4].

The field sampling was oriented in order to cover all kind of vegetation represented in the map "Carte phytocologique du Moyen Atlas central" of Lecompte [6] ; for each ecosystem, the floristic surveys were spread over a maximum number of different stations depending on the altitude, exposure and soil.

Taxa listed below were noted and/or collected during three field trips: two in spring of year 2008 and one in the same season in 2009.

Informations on endemism and rarity of taxa come from the "Catalogue des plantes vasculaires rares, menacées ou endémiques du Maroc" [7].

: Abbreviations are as following

- E: Endemic to Morocco
- A: Endemic to Morocco and Algeria
- I: Endemic to Morocco and Iberian Peninsula
- V: Vulnerable in Morocco
- R: Rare in Morocco
- R?: Suspected rare in Morocco
- RR: Very rare in Morocco
- RR?: Suspected very rare in Morocco

Species abundance in the area of Tichoukt BEIS is expressed in three categories:

- (a): Abundant
- (b): Moderately abundant
- (c): Rare to very rare.

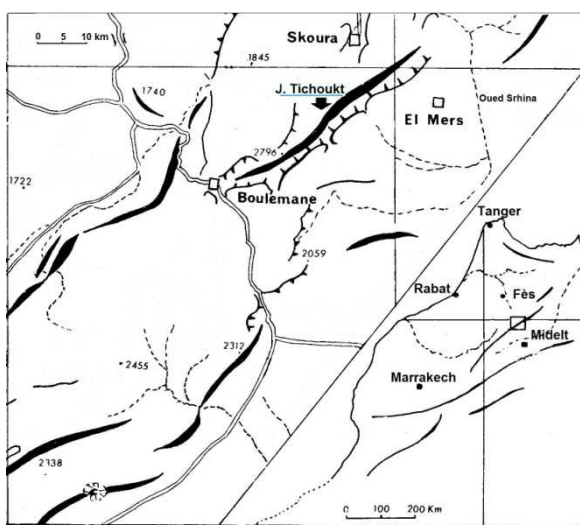


Fig. 1: Location of the study area

3. Results

3.1. vegetation survey

Due to its geographical position, Tichoukt mountain is submitted to both influences: wet from Western and Northern and dry from East and South [7]; consequently, it shows a rich flora (184 taxa) observed in three main kinds of ecosystems:

- Forest and matorral ecosystems (Fig. 2), organised by one or more of the following species: *Cedrus atlantica*, *Quercus rotundifolia*, *Juniperus phoenicea*, *J. thurifera*, *J. communis*, *Buxus balearica*, *Taxus baccata*, *Berberis hispanica*, *Crataegus laciniata*.



Fig. 2: Cedar forest

- Spiny xerophytic ecosystem (Fig. 3) with *Cytisus balansae*, *Bupleurum spinosum*, *Erinacea anthyllis*, *Alyssum spinosum*. The main association described here is *Avenastro filifolii-Erinaceetum anthyllidis* [4].



Fig. 3: Spiny xerophytic ecosystem

- Rocky ecosystems (Fig. 4) with *Juniperus communis*, *Ephedra major*, *Lonicera pyrenaica*, *Rhamnus atlantica* and others more alticoles like *Globularia liouvillei*, *Saxifraga longifolia*, *Aethionema saxatile*



Fig. 4: Rocky ecosystem

The flora and ecosystems of Tichoukt are submitted to high natural constraints (climate stress, parasites attack,...) and anthropozoic pressure (overgrazing, overexploitation of wood product, illegal clearing of woodlands, ...). Thus, many ecosystems are in advanced state of deterioration such as cedar, thuriferous and common juniper.

I- Flora

Asteraceae

Achillea santolinoides Lag. (c)

Red juniper ecosystem.

Artemisia herba alba Asso (c)

holm oak and red juniper ecosystems, isolated places, up to 2000 m.

Atractylis caespitosa Desf. (c)

Holm oak ecosystem, lower north side.

Bellis sylvestris Cirillo (c)

Holm oak ecosystem with *Buxus balearica*, 1650 m (33° 24' 10" x 4° 43' 14"); dead cedar, 2440 m (33° 23' 20" x 4° 40' 36"); thuriferous ecosystem, 2300 m (33° 22' 91" x 4° 40' 68").

Carthamus atractyloides (Pomel) R (b) ●A

Cedar, spiny xerophytic and common juniper ecosystems (33° 22' 94" x 4° 40' 67"), from 2 350 to 2 600 m.

Carthamus pomelianus (Batt.) Prain R? (c) ●A

Holm oak ecosystem, south side piedmont (33° 21' 54 x 4° 39' 58"), 2120 m.

Carthamus rhapsodicoides (Pomel) Greuter (c)

Cedar ecosystem, southern side (33° 23' 12" x 4° 40' 39"), 2370 m.

Catananche caerulea L. (b)

Holm oak with *Buxus balearica*, cedar, thuriferous and common juniper ecosystems, 2000-2400 m.

Cheirolophus benoistii (Humbert) Holub R? (c) ●E

Holm oak ecosystem, north side.

Centaurea involucreta Desf. (c)

South side.

Cyanus triumfetti (All.) A. Löve & D. Löve RR (c)

spiny xerophytic ecosystem, north side, above 2200 m.

Cirsium odontolepis DC. R (b)

Cedar ecosystem.

Geropogon hybridus (L.) Sch. Bip. (c)

Berberis hispanica and *Crataegus laciniata* ecosystem.

Pilosella pseudopilosella (Ten.) Soják R? (c) ●E

Spiny xerophytic and common juniper ecosystems; above 2 100 m.

Hypochoris laevigata (L.) Ces. & al. (c)

Rocky ecosystem from 2400 m.

Jurinea humilis (Desf.) DC. (b)

Spiny xerophytic and common juniper ecosystems; rare in the cedar ecosystem; from 2200 m.

Lactuca saligna L. (b)

Holm oak ecosystem.

Lactuca viminea (L.) J. Presl & C. Presl (c)

Spiny xerophytic ecosystem.

Rhodanthemum arundanum (Boiss.) B. H. Wilcox & al. (b)

Spiny xerophytic ecosystem.

Micropus supinus L. (b)

Red juniper ecosystem; holm oak ecosystem with *Buxus balearica*.

Onopordum acaulon L. (b)

Holm oak, cedar and spiny xerophytic ecosystems.

Pallenis spinosa (L.) Cass. (b)

Lower sides.

Phagnalon rupestre (L.) DC. (b)

Holm oak ecosystem with *Buxus balearica*.

Scolymus hispanicus L. (b)

Lower sides of clearings in the holm oak with *Buxus balearica* and red juniper.

Scorzonera caespitosa Pomel (a)

Spiny xerophytic, thuriferous and common juniper ecosystems.

Taraxacum obovatum (Willd.) DC. (c)

Spiny xerophytic ecosystem from 2 300 m.

Xeranthemum inapertum (L.) Miller (b)

Holm oak and red juniper ecosystems.

Fabaceae

Anthyllis vulneraria L. RR (c) ●E

- subsp. *atlantis* Emberger & Maire RR ●I

- subsp. *reuteri* Cullen RR ●E

Astragalus armatus Willd. (b)

- subsp. *numidicus* (Murb.) Tietz.

South lower sides in *Berberis hispanica* and *Crataegus laciniata* ecosystem and holm oak ecosystem with *Buxus balearica*.

Astragalus incanus L. (c)

Medium altitudes earth soils.

Coronilla minima L. (c)

- subsp. *lotoides* (Koch) Nyman

Cytisus balansae (Boiss.) Ball (a)

- subsp. *balansae*

Organizer with other species the spiny xerophytic ecosystem.

Cytisus fontanesii Ball (c) ●IA

Erinacea anthyllis Link. (a)

- subsp. *anthyllis*

Organizer with other species the spiny xerophytic ecosystem.

Hedysarum boveanum Bunge ex. Basiner (c)
Holm oak ecosystem northern side.
Medicago laciniata (L.) Miller (b)
Holm oak with *Buxus balearica* and red juniper ecosystems
Medicago suffruticosa DC. in Lam. & DC. (c)
Berberis hispanica and *Crataegus laciniata* formation ; mixed formation with holm oak and cedar; very earthy soil; 2050-2450 m.
Ononis cristata Miller (c)
Common juniper ecosystem from 2 500 m.
Ononis natrix L. (c)
Lower side.
Trifolium humile Ball (c) ●E
South side (33° 22' 61" x 04° 40' 49") ; low slope (5 à 10%) ; 2080 m.
Poaceae
Aegilops neglecta Req. ex Bertol. (b)
Holm oak with *Buxus balearica* and red juniper ecosystems, especially in formations of degradation.
Helictotrichon filifolium (Lag.) Henrard (c)
Spiny xerophytic ecosystem.
Helictotrichon sedenense (Clar. ex Lam. & DC.) Holub (c)
Rocky ecosystems from 2300 m.
Avena sterilis L. (c)
Holm oak ecosystem.
Anisantha rubens (L.) Nevski (b)
Holm oak and red juniper ecosystems.
Bromus squarrosus L. (b)
Holm oak with *Buxus balearica*, cedar with *Berberis hispanica*, thuriferous, xerophytes and common juniper ecosystems.
Anisantha sterilis (L.) Nevski (b)
Holm oak ecosystem with *Buxus balearica*; formation with *Berberis hispanica* and *Crataegus laciniata*.
Anisantha tectorum (L.) Nevski (b)
Holm oak with *Buxus balearica* and cedar with *Berberis hispanica* ecosystems.
Cynosurus effusus Link (b)
Holm oak and cedar ecosystems.
Dactylis glomerata L. (a)
Holm oak with *Buxus balearica*, cedar, spiny xerophytic and thuriferous ecosystems.
Dasypyrum breviaristatum (H. Lindb.) Fred. (c)
Holm oak ecosystem with *Buxus balearica*, *Berberis hispanica* and *Crataegus laciniata* ; cedar ecosystem ; spiny xerophytic ecosystem.
Hordeum murinum L. (a)
Red juniper and holm oak ecosystems.
Koeleria splendens Presl. R (b)
Spiny xerophytic and common juniper ecosystems from 2500 m.
Melica humilis Boiss. (b)
Berberis hispanica and *Crataegus laciniata*.
Piptatherum caeruleum (Desf.) P. Beauv. (c)
Cedar ecosystem.
Poa alpina L. (c)

Spiny xerophytic ecosystem.
Poa bulbosa L. (c)
Rocky ecosystems southern side between 2200 and 2300 m.
Stipa lagascae Roemer & Schultes (c)
Holm oak ecosystem with *Buxus balearica*.
Stipa nitens (Ball) Ball (b) ●E
Holm oak ecosystem south side (holm oak with *Berberis hispanica*, *Ribes uva-crispa* and *Juniperus thurifera*) 2150 m (33° 22' 84" x 04' 40' 53") 2300 m, rocky and thuriferous ecosystems 2280 m (33° 22' 91" x 04° 40' 68"), common juniper ecosystem 2490 m (33° 22' 97" x 04° 40' 83") and spiny xerophytic ecosystem.
Stipa apertifolia Martinovsky (b)
Cedar ecosystems with *Buxus balearica* and holm oak.
Macrochloa tenacissima (L.) Kunth (a)
Holm oak ecosystem, south lower side.
Trisetum flavescens (L.) P. Beauv. (b)
Cedar ecosystem with *Berberis hispanica*, southern side.
Vulpia geniculata (L.) Link (a)
Holm oak ecosystem with *Buxus balearica*.
Caryophyllaceae
Arenaria aggregata (L.) Loisel. RR (c)
- subsp. *mauritanica* (Batt.) Maire RR ●A
Common juniper ecosystem 2 600 m north side.
Arenaria armerina Bory (c)
Cedar ecosystem, north side to 2 300 m ; spiny xerophytic ecosystem to 2 600 m and common juniper ecosystem 2 500-2 600 m.
Arenaria serpyllifolia L. (b)
Cedar ecosystem.
Bufonia tenuifolia L. (b)
Cedar ecosystem 2 410 m, thuriferous ecosystem 2 280 m and common juniper ecosystem, 2 370 m southern side.
Cerastium gibraltarium Boiss. (a)
Cedar and spiny xerophytic ecosystems.
Dianthus lusitanus Brot. (b)
Holm oak with *Buxus balearica* and common juniper ecosystems.
Herniaria hirsuta L. (c)
Red juniper ecosystem.
Minuartia verna (L.) Hiern (c)
Holm oak ecosystem.
Paronychia argentea Lam. (a)
Red juniper ecosystem and holm oak ecosystem with *Buxus balearica*.
Polycarpon polycarpoides (Biv.) Jah. & Maire (b)
Holm oak with *Buxus balearica*, cedar and spiny xerophytic ecosystems.
Polycnemum fontanesii Durieu & Moq. (b)
Red juniper ecosystem with *Buxus balearica* and *Rosmarinus officinalis*; holm oak ecosystem with *Buxus balearica*.
Silene mesatlantica Maire (b) ●E

Common juniper ecosystem, 2 480 m, (33° 23' 06" x 04° 40' 88").

Silene vulgaris (Moench) Garcke (c)

Degradation formation of Red juniper ecosystem and holm oak ecosystem with *Buxus balearica*.

Telephium imperati L. (c)

- subsp. *imperati*

Berberis hispanica and *Crataegus laciniata* ecosystem.

Lamiaceae (Labiatae)

Ajuga iva (L.) Schreber (b)

Cedar ecosystem.

Lamium amplexicaule L. (b)

Mixed formation of holm oak and cedar ; holm oak ecosystem with *Buxus balearica*.

Marrubium ayardii Maire (b) ●E

Cedar ecosystem with *Berberis hispanica*, southern side, 2 360 m (33° 22' 51" x 04°40' 14").

Marrubium multibracteatum Humbert & Maire R (b)

●E

Cedar ecosystem, southern side, 2 220 m (33°22' 91" x 04° 40' 54"); *Berberis hispanica* and *Crataegus laciniata* ecosystem, 2 100 m ; xerophyte ecosystem (33° 22' 61" x 04° 40' 49") from 2 100 m ; thuriferous ecosystem.

Marrubium vulgare L. (b)

Holm oak with *Buxus balearica* and red juniper ecosystems.

Mentha pulegium L. (b)

Pistacia lentiscus formation, lower northern side.

Nepeta amethystina Poirlet in Lam. (c) ● IA

Holm oak ecosystem lower southern side.

Rosmarinus officinalis L. (b)

Red juniper ecosystem lower northern side.

Salvia phlomoides Asso (c)

North side.

Salvia verbenaca L. (b)

Holm oak ecosystem with *Buxus balearica*.

Satureja alpina (L.) Scheele (c)

Dead cedar ecosystem with *Berberis hispanica*, southern side 2470 m.

Sideritis incana L. (c)

- subsp. *matris-filiae* (Emberger & Maire) M. Fennane

Rocky ecosystems, southern side 2 500 m ; rocks northern side 2610 m; dead cedar ecosystem, 2580 m.

Sideritis montana L. (c)

- subsp. *ebracteata* (Asso) Murb.

Teucrium chamaedrys L. (c)

Berberis hispanica and *Crataegus laciniata* ecosystems ; cedar ecosystem with *Buxus balearica*.

Teucrium fruticans L. (c)

Holm oak ecosystem southern sides.

Teucrium musimonum Humbert (b) ●E

Rocky ecosystems southern sides 2300 m (33° 23' 12" x 04° 40' 00") ; thuriferous ecosystem.

Teucrium polium L. (b)

Holm oak ecosystem with *Buxus balearica* and red juniper ecosystem.

Thymus algeriensis Boiss. & Reuter (b)

Holm oak ecosystem with *Buxus balearica* ; red juniper and *Pistacia lentiscus* ecosystems lower north side.

Thymus willdenowii Boiss. (b)

Dead cedar ecosystem with *Berberis hispanica* south side; thuriferous ecosystem with *Bupleurum spinosum* and *Alyssum spinosum* 2 580 m ; spiny xerophytic ecosystem north side 2600 m ; common juniper ecosystem.

Thymus atlanticus (Ball) Roussine (a) ●E

Spiny xerophytic ecosystem south side.

Brassicaceae

Aethionema saxatile (L.) R. Br. (c)

Spiny xerophytic ecosystem south side; rock 2250 m, southern side 2 250 m ; common juniper ecosystem.

Alyssum alyssoides (L.) L., Gard. (c)

Holm oak ecosystem with *Buxus balearica*.

Alyssum serpyllifolium Desf. (c)

Spiny xerophytic ecosystem ; holm oak ecosystem with *Buxus balearica*.

Alyssum spinosum L. (a)

Cedar, xerophyte, thuriferous and common juniper ecosystems.

Arabis alpina L. (c)

Spiny xerophytic ecosystem.

Arabis auriculata Lam. (b)

Cedar and holm oak ecosystems.

Draba hispanica Boiss., Elench. (c)

- subsp. *hispanica*

Rocky ecosystems high southern side from 2300 m.

Eruca vesicaria (L.) Cav., Descr. (c)

Holm oak ecosystem.

Erucastrum leucanthum Cosson & Durieu (c)

Berberis hispanica and *Crataegus laciniata* ecosystem.

Erysimum incanum G. Kunze (c)

Thuriferous and spiny xerophytic ecosystems.

Isatis tinctoria L. (b)

Cedar-holm oak mixed formation.

Lobularia maritima (L.) Desv. (c)

Spiny xerophytic ecosystem.

Raffenaldia primuloides Godron (c)

Spiny xerophytic ecosystem.

Raphanus raphanistrum L. (c)

- subsp. *raphanistrum*

Berberis hispanica and *Crataegus laciniata* ecosystems.

Rosaceae

Amelanchier ovalis Medik, Gesch. Bot.: 79. 1793. R (c)

●I

Rocky ecosystems, southern side to 2250 m.

Cotoneaster nummularia Fisch. & C. A. Meyer (b)

Holm oak ecosystem with *Buxus balearica*.

Crataegus laciniata Ucria (a)

Holm oak ecosystem with *Buxus balearica*, *Berberis hispanica* and *Crataegus laciniata* south side.

Prunus prostrata Labill. (a)

Cedar, spiny xerophytic, thuriferous and common juniper ecosystems.

Rosa canina L. (b)

Berberis hispanica and *Crataegus laciniata* ecosystems.

Rosa sicula Tratt. (b)

Cedar ecosystem with *Buxus balearica*; dead cedar ecosystem with *Berberis hispanica*; spiny xerophytic and common juniper ecosystems.

Rubus ulmifolius Schott (c)

Near streams.

Sanguisorba minor Scop. (b)

Common juniper ecosystem.

Scrophulariaceae

Linaria simplex (Willd.) DC. in Lam. & DC. (c) ●I(A?)

Spiny xerophytic ecosystem.

Linaria tristis (L.) Miller (b)

Holm oak ecosystem with *Buxus balearica*; rocky ecosystems 2300 m; dead cedar ecosystem; thuriferous and spiny xerophytic ecosystems.

Nanorrhinum heterophyllum (Schousboe) Ghebr. (c)

Cedar-holm oak mixed ecosystem.

Scrophularia laevigata Vahl (b)

Rocky ecosystems, north side.

Cistaceae

Cistus clusii Dunal in DC. (b)

Red juniper ecosystem, lower southern side.

Fumana thymifolia (L.) Webb. (b)

Holm oak ecosystem with *Buxus balearica*.

Helianthemum cinereum (Cav.) Pers. (b)

Red juniper ecosystem; holm oak ecosystem with *Buxus balearica*; cedar ecosystem with *Buxus balearica*; degraded thuriferous ecosystem.

Helianthemum croceum (Desf.) Pers. (b)

Berberis hispanica and *Crataegus laciniata* ecosystem; cedar ecosystem with holm oak; cedar ecosystem with *Berberis hispanica*; xerophyte ecosystem; common juniper ecosystem.

Helianthemum pergamaceum Pomel (b)

Pistacia lentiscus ecosystem; red juniper ecosystem; holm oak ecosystem with *Buxus balearica*.

Cupressaceae

Juniperus communis L. RR (b)

- subsp. *hemisphaerica* (C. Presl) Nyman RR

High southern and northern sides.

Juniperus oxycedrus L. (b)

Red juniper, holm oak and cedar ecosystems.

Juniperus phoenicea L. (a)

Lower north side.

Juniperus thurifera L. V (b)

- subsp. *africana* (Maire) Gauquelin & al. V, ●A

High southern side.

Oleaceae

Fraxinus dimorpha Cosson & Durieu (b)

Red juniper ecosystem; holm oak ecosystem with *Buxus balearica*.

Jasminum fruticans L. (c)

Rocky ecosystems southern side.

Olea europaea L. (c)

Red juniper ecosystem.

Phillyrea angustifolia L. (b)

Red juniper and *Pistacia lentiscus* ecosystems.

Plantaginaceae

Plantago albicans L. (b)

Red juniper lower northern side.

Plantago coronopus L. (c)

Cedar-holm oak mixed formation.

Plantago afra L.

Holm oak ecosystem with *Buxus balearica*; *Berberis hispanica* and *Crataegus laciniata* ecosystem.

Apiaceae

Bupleurum fruticosum L. (a)

- subsp. *spinosum* (Gouan) O. Bolos & Vigo

= *Bupleurum spinosum* Gouan

Spiny xerophytic ecosystem northern and southern sides.

Eryngium bourgatii Gouan (c)

Spiny xerophytic, thuriferous and common juniper ecosystems.

Pimpinella tragium Vill. (c)

- subsp. *lithophila* (Schischk.) Tutin

= *P. lithophila* Schischk.

Spiny xerophytic ecosystem.

Globulariaceae

Globularia alypum L. (b)

Red juniper ecosystem with *Rosmarinus officinalis* and holm oak ecosystem with *Buxus balearica*.

Globularia liouvillei Jah. & Maire R(c) ●E

Rocky ecosystems, southern side 2 300 m (33° 23' 12" x 04° 40' 00"), 2 450 m (33° 22' 28" x 04° 40' 46"), 2 500 m (33° 23' 04" x 04° 40' 10"), 2 600 m (33° 23' 34" x 04° 39' 50").

Globularia nainii Batt (b) ●E

Holm oak ecosystem, north side 1 670 m (33° 23' 58", 04° 42' 23"); rocky ecosystem, north side 2210 m.

Saxifragaceae

Ribes uva-crispa L. (b)

Spiny xerophytic, cedar, thuriferous and common juniper ecosystems, southern and northern sides from 2360 m.

Saxifraga dichotoma Willd. RR(c), ●IA

High north side.

Saxifraga longifolia Lapeyr. RR (c)

Rocky ecosystems of the southern side in xerophyte area (33° 22' 91" x 04° 40' 54").

Rubiaceae

Asperula hirsuta Desf. (b)

Holm oak ecosystem with *Buxus balearica*.

Callipeltis cucullaria (L.) Steven (c)

Holm oak ecosystem with *Buxus balearica*; cedar ecosystem.

Geraniaceae

Geranium molle L. (a)

Holm oak ecosystem.

Liliaceae

Asphodelus ramosus L.

Holm oak ecosystem with *Buxus balearica*.

Lapiedra martinezii Lag. RR(c) ●I

Spiny xerophytic ecosystem, south side.

Linaceae

Linum austriacum L. (c)

Spiny xerophytic ecosystem, south side.

Linum suffruticosum L. (b)

Spiny xerophytic ecosystem, south side.

Rhamnaceae

Rhamnus lycioides L.

- subsp. *atlantica* (Murb.) Jah. & Maire (b)

Rocky ecosystem, southern side.

Rhamnus pumila Turra (c)

Rocky ecosystems, high south side 2 640 m.

Ranunculaceae

Delphinium balansae Boiss. & Reuter (c)

Buxus balearica and *Pistacia lentiscus* ecosystem lower north side.

Euphorbiaceae

Euphorbia megalatlantica Ball (c) ●E

Cedar ecosystem with *Berberis hispanica*, 2 360 m (33° 22' 51" x 04° 40' 14").

Euphorbia nicaeensis All. (b)

Holm oak ecosystem with *Buxus balearica*.

Valerianaceae

Centranthus nevadensis Boiss. R (c)

Rocky ecosystems, southern side.

Valerianella discoidea (L.) Loisel. (c)

Rocky ecosystems, southern side.

Campanulaceae

Campanula filicaulis Durieu in Bory & Durieu (b)

Holm oak ecosystem with *Buxus balearica*; spiny xerophytic and common juniper ecosystems.

Legousia falcata (Ten.) Janchen (c)

Dead cedar ecosystem with *Buxus balearica*, south side.

Dipsacaceae

Lomelosia stellata (L.) Rafin. (b)

Holm oak ecosystem with *Buxus balearica*.

Ephedraceae

Ephedra nebrodensis Guss. (b)

Rocky ecosystems, from 2200 m.

Fagaceae

Quercus ilex L. (a)

- subsp. *rotundifolia* (Lam.) T. Morais

South and north sides.

Buxaceae

Buxus balearica Lam. (a)

Holm oak and cedar ecosystems, north and south sides.

Berberidaceae

Berberis hispanica Boiss. & Reuter (a)

Spiny xerophytic and cedar ecosystems, north and south sides..

Caprifoliaceae

Lonicera pyrenaica L. (b)

- subsp. *pyrenaica*

Rocky ecosystem, from 2 200 m.

Aceraceae

Acer monspessulanum L. (c)

- subsp. *monspessulanum*

High north side, near cliffs.

Solanaceae

Verbascum simplex Hoffm. & Link (b)

Red juniper ecosystem, north side and holm oak southern and northern sides.

Violaceae

Viola maroccana Maire R? (c) ●E

Thuriferous ecosystem 2 280m (33° 22' 91" x 04° 40' 68"); spiny xerophytic ecosystem 2 240-2 500 m (33° 23' 31" x 04° 40' 39"); common juniper ecosystem 2 370 m (33° 23' 94" x 04° 40' 67") and 2 430 m (33° 23' 17" x 04° 40' 30").

Thymeleaceae

Daphne laureola L. (c)

Cedar and common juniper ecosystems, high north side.

Araliaceae

Hedera helix L. (c)

North side wet rocks.

Malvaceae

Malva sylvestris L. (c)

Red juniper ecosystem north side.

Pinaceae

Cedrus libani A. Richard

- subsp. *atlantica* (Endl.) Batt. & Trabut (a)

South and north sides.

Arecaceae

Chamaerops humilis L. (c)

Red juniper ecosystem with *Rosmarinus officinalis*; holm oak ecosystem with *Buxus balearica*, north side.

Taxaceae

Taxus baccata L. V (c)

High north side near cliffs.

Anacardiaceae

Pistacia lentiscus L. (b)

Low north side.

Convolvulaceae

Convolvulus mazicum Emberger & Maire (b) ●E

Spiny xerophytic ecosystem, from 2 300 m (33° 23' 05" N x 04° 40' 41" W); cedar ecosystem (33° 23' 12" N x 04° 40' 39" W); common juniper ecosystem, 2 430 m (33° 23' 17" N x 04° 40' 30" W).

Plumbaginaceae

Armeria ebracteata Pomel RR(c) ●A

Cedar ecosystem.

Primulaceae

Anagallis arvensis L. (b)

Holm oak ecosystem with *Buxus balearica*.

Boraginaceae

Onosma fastigiata (Br.-Bl.) Lacaita (c)

3.2. Discussion and conclusion

The list above contains 43 families, 143 genera and 184 species; about 20 others were collected but have not been identified (incomplete specimens). The richest families are *Asteraceae*, *Poaceae*, *Caryophyllaceae*, *Brassicaceae* and *Fabaceae* with more than 10 species each (Tab. 1). On the other hand,

50% of the families are represented by only one species and 16% by 2 species.

Table 1: Important families in Tichoukt mountain

Families	Number of species	
	Tichoukt mountain	Morocco
<i>Asteraceae</i>	27	550
<i>Poaceae</i>	23	355
<i>Caryophyllaceae</i>	20	204
<i>Brassicaceae</i>	14	212
<i>Fabaceae</i>	13	424
<i>Rosaceae</i>	8	62
<i>Cistaceae</i>	5	69
<i>Cupressaceae</i>	4	6
<i>Oleaceae</i>	4	7

Table 2: Tichoukt flora richness in Morocco

	Tichoukt mountain	Morocco	%
Area	12500 ha	71 500 000 ha	0,02
Families	43	155	28
Genera	143	981	15
Species	184	3913	5

This inventory is certainly incomplete. More visits to the region could add new taxa ; some interesting cliffs, very difficult to climb, have not been explored yet.

Almost all the taxa listed here were reported before by many authors in the Middle Atlas but with no certitude if they exist or not in Tichoukt mountain. So, we confirm here their presence with a more little information concerning ecology and repartition that is detailed for endemic taxa.

From biogeographical view, many special habitats (especially cliffs and rocks) in the highest altitudes of the site have favored the maintain of several remarkable taxa like the following ones that are endemic, very rare, rare or suspected rare in Morocco:

- *Anthyllis vulneraria* subsp. *reuteri*: very rare, endemic to Morocco
- *Armeria ebracteata*, *Arenaria aggregata* subsp. *mauritanica*: very rare, endemic to Morocco and Algeria
- *Cyanus triumfetti*, *Arenaria aggregata*, *Juniperus communis* subsp. *hemisphaerica*, *Saxifraga longifolia*: very rare
- *Lapiedra martinezii*, *Anthyllis vulneraria* subsp. *atlantis*: very rare, endemic to Morocco and Iberian Peninsula

- *Carthamus atractyloides*: rare, endemic to Morocco and Algeria
- *Carthamus pomelianus*: suspected rare, endemic to Morocco and Algeria
- *Cheirolophus benoistii*: suspected rare, endemic to Morocco
- *Cirsium odontolepis*, *Koeleria splendens*, *Centranthus nevadensis*: rare
- *Cytisus fontanesii*, *Nepeta amethystina*: endemic to Morocco, Iberian Peninsula and Algeria
- *Juniperus thurifera* subsp. *africana*: vulnerable, endemic to Morocco and Algeria
- *Marrubium multibracteatum*, *Globularia liouvillei*: rare, endemic to Morocco
- *Pilosella pseudopilosella*, *Viola maroccana*: suspected rare, endemic to Morocco
- *Saxifraga dichotoma*: very rare, endemic to Morocco, Iberian Peninsula and Algeria
- *Taxus baccata*: vulnerable
- *Trifolium humile*, *Stipa nitens*, *Silene mesatlantica*, *Marrubium ayardii*, *Teucrium musimonum*, *Thymus atlanticus*, *Euphorbia megalatlantica*: endemic to Morocco.

As mentioned before, the high summits of Tichoukt are very important at biogeographical level by offering natural refuge for rare and endemic taxa. Unfortunately, no quantitative data available about the abundance of this important part of flora; much further field investigations are still needed in order to help decision makers taking suitable conservation measures and settingsustainable management strategy of biodiversity of this BEIS.

Maybe, such management needs to change the status of BEIS to a National Park.

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