Distribution and Red List Assessment of the restricted-range endemic *Jacobaea mouterdei* (Asteraceae)

Mohamed bin Zayed Species Conservation Fund project number 180519099

by

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Cover photo: Flowers of *Jacobaea mouterdei*, June 2019

Acknowledgements

The Mohamed bin Zayed Species Conservation Fund is a significant philanthropic endowment established to provide targeted grants to individual species conservation initiatives, recognize leaders in the field of species conservation, and elevate the importance of species in the broader conservation debate.

The authors are grateful to the Mohammed bin Zayed Species Conservation Fund for granting our project and helping us collecting previously unseen information about the very restricted endemic species *Jacobaea mouterdei*. The Mohamed bin Zayed Species Conservation Fund delighted us by awarding a grant for the project which aims at the study on the endemic *Jacobaea mouterdei*. It is the first time that a fund for the conservation of nature was granted for this understudied area and also the first time ever that the MBZ species conservation fund awarded conservationists in Lebanon.

Figure 1 : View on the valley of Wadi el-Qattara in the district of Danniye, overlooked by the highest plateau of Mount Lebanon range, Jabal Makmel, June 2019

Abstract

This report describes the research carried out during 2019 to collect recent and accurate data about the very restricted endemic plant species Mouterde's ragwort (*Jacobaea mouterdei*) in the North of Lebanon. The main objective of this study was to contribute to the preservation of this rare and poorly known species through a better understanding of its geographic range and an estimation of its conservation status. The first activity was to carry out extensive fieldwork in the mountainous areas of the districts of Danniye and Akkar and to collect data about the distribution of *Jacobaea mouterdei*, its population size, biology, ecology and the threats affecting it. In total, 36 days were spent in the valleys of Hell during 11 different trips between the 24 April and the 22 October 2019.

Individuals of *Jacobaea mouterdei* were observed between 500 to 1750 meters of altitude in different types of habitats, mostly on soils derived from sandstone rather than limestone bedrocks. Although found within different kind of forests, mostly pine (*Pinus brutia*) or oak (*Quercus coccifera*) dominated woodlands, the species has a preference for shrublands, grasslands and rocky outcrops as these habitats sheltered the highest densities in terms of number of counted individuals with an average of 0.72 individuals per m².

More than 3200 individuals distributed in three subpopulations were counted and georeferenced in the area, and the total population size was estimated above 6000 individuals. The current trend of the population is decreasing due to the threats affecting some parts of the range of the species, for instance quarrying, unplanned urbanisation and agriculture. The population is not considered as fragmented regarding the estimated gene flow. The geographic range of the species was calculated by processing spatial analysis with an online Geographic Information Systems (GIS), the Geospatial Conservation Action Tool (GeoCAT, Bachman *et al*. 2011). The Extent of Occurrence (EOO) calculated was of 7.69 km² which categorises the species as Critically Endangered (CR). However the use of cells of 2 km of side width for the calculation of the Area of Occupancy (AOO) brings up the area of the EOO to 24 km². Considering the very restricted range of *Jacobaea mouterdei*, its number of locations (3), the threats affecting it and the current degradation causing the continuing decline in its (iii) area, extent and quality of habitat, the species is estimated as Endangered (B1ab(iii)+2ab(iii)) at the global level. Threatening events could easily lead the species to Critically Endangered.

By mapping the population, identifying the specific threats and estimating the conservation status, this report serves as species action plan. An area within the valley of Wadi el-Qattara is here proposed as the more appropriate potential site for *in-situ* conservation to ensure the survival of the species.

The area of distribution and the conservation status of *Jacobaea mouterdei* should be considered as temporary due to the fact that only 43% (29 km²) of the area initially expected (approximately 70 km²) could be explored. Indeed, the amount of time needed to visit this area of steep valleys and plateaus was more than estimated. The researchers are willing to finalize the study with the complete exploration of the remaining valleys to calculate a final area of distribution of *Jacobaea mouterdei* and to complete a proper assessment of the vulnerability of the species and the potential sites for *in-situ* conservation. There is a high probability that the northern unexplored valleys could shelter other subpopulations and environmental conditions which could modify the actual EOO, AOO and conservation status. Nevertheless, this current report and associated data constitute a significant

progress in addressing the gap of knowledge about this endemic species that was previously almost unknown.

Note

Both project managers are very attached to the preservation of the nature of the regions of Akkar and Danniye and attempting initiatives since several years already. Passionate botanist and dedicated to the conservation of nature, Hicham El Zein has been wandering inside the "Valleys of Hell" since 2014, exploring its biodiversity and contemplating the unique associations of plant species. He has been calling out for the urgent preservation of the valleys and met some of the inhabitants of Qemmamin, including Mohammed Taleb in charge of the local association Wadi ez-Zouhour in which he got involved. Carla Khater, Associate Researcher at the CNRS-Lebanon and coordinator of O-LiFE Environmental Observatory, supports initiatives to study and preserve the biodiversity of Lebanon, also joined the project. Projects of research on the flora of these regions were written and proposed but didn't receive support until the fund granted by the MBZ species conservation fund.

The fund was granted in November 2018; however due to the fact that it was winter during this period, the fieldwork was planned from April to November 2019 further an agreement between the MBZ Species Conservation Fund and the grantees.

The fact that the planned area of study could not be entirely explored was due to the under-estimation of different parameters. The estimated time in terms of number of days to survey the different valleys of the area was clearly under-estimated. This is was mainly due to the fact that the site of study is quite isolated and difficult to reach without a car. It motivated our decision to remain at least 3 consecutive days in the valleys. The other parameter slowing the exploration was the steepness of the slopes of the valleys. From the riverside to the crests of the valley, an average of two hours is needed. The authors had to camp on site for several days as long as provision and power bank would allow. Due to very windy conditions, it was most of time preferable to head back down to the bottom of the valley to camp. The amount of money asked to realize the fieldwork was also under-estimated compared to what was necessary.

Introduction

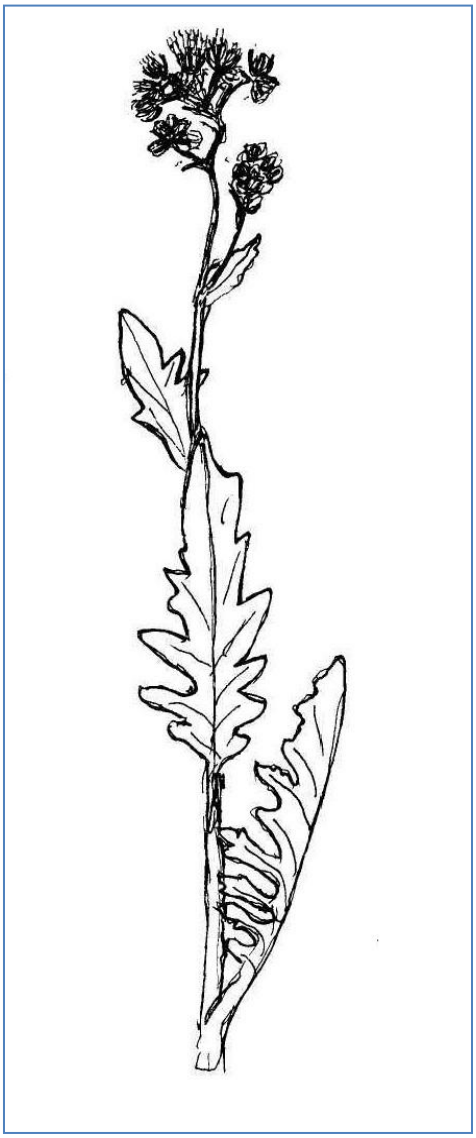

Figure 2 : Drawing of *Jacobaea mouterdei* from the Nouvelle flore du Liban et de Syria (Mouterde 1983)

Jacobaea mouterdei (Arènes) Greuter & B.Nord, previously *Senecio mouterdei* Arènes, is a steno-endemic (restricted range endemic) plant species of Mount Lebanon. It is known to occur exclusively in the "Valley of Hell" (*Wadi Jahannam*), in the districts of Danniye and Akkar, in North Lebanon. The species belongs to the Asteraceae family (Composites) and is a perennial plant that can reach heights of 150 cm. It can be identified using vegetative structures even outside flowering time. Therefore, field surveys can be undertaken from early spring to the beginning of the winter.

The species was first collected by Paul Mouterde in 1946 (P. Mouterde, 1983). The author mentioned only one occurrence in the valley below the village of Hrar, downstream of the village of Qemmamin. He described the observed subpopulation as constituted of only a few individuals and located in a place difficult to access. Only one sample was collected at the date of visit of the author. Since Mouterde, no collector ever reported the presence of this species anywhere in Lebanon, until 2009 when Georges and Henriette Tohmé found the species in the surroundings of Qemmamin (G. and H. Tohmé, 2009). The authors described the species as being abundant in one of the valleys, coming from above Qemmamin. One photo of the species is included in the Illustrated Flora of Lebanon (Tohmé and Tohmé 2014). The drawing realised by Paul Mouterde (1983) is here featured to show details of the structures of the plant.

The mountainous areas of the districts of Danniye and Akkar are among the less urbanised of Mount Lebanon mountain range. The border between the districts of Akkar and Danniye is drawn by the river. The distance from the capital has surely played a role in the preservation of many unique types of woodlands occurring in valleys, rocky slopes and plateaus. For instance, the main characteristic of these regions is hosting woodlands in which cedars (*Cedrus libani*), fir (*Abies cilicica*) and juniper (*Juniperus excelsa, J. drupacea, J. oxycedrus*) are associated.

The "Valley of Hell", habitat of the species under study, is actually formed of several valleys interconnected in dichotomous ramifications and therefore should be called "Valleys of Hell". The total area is around 70 km². Perennial rivers flow in each of these valleys and unite just below the village of Hrar. Each of these rivers is called indistinctly "Nahr el-Bared" (the cold river) meanwhile the different valleys are named differently. The topography with its impressively steep rocky slopes renders it quite complicated to cross the valley from the crests. The difficulty to access the slopes

and the complexity of rocky cliffs tangled with woodlands has relatively preserved the vegetation unlike most of the valleys of Mount Lebanon that have been more or less affected by human activities through the creation of roads, urbanization, pollution, overgrazing, agriculture or woodcutting for charcoal.

The “Valley of Hell” includes some vestiges of ancient agricultural activities with the presence of old abandoned terraces and old stone houses. Several areas of the valleys are still being cultivated, mostly in terraces for the production of fruits, apples, plums, peaches, cherries. Parts of the woodlands show signs of old exploitation of wood for the local production of charcoal. Until recently, the isolation of the “Valley of Hell” had spared it from important urbanisation, however the threat is important and conservation measures should be implemented soon before any construction project takes place.

Qemmamin is the only village present within the valleys. Located on the side of the district of Danniye, it is constituted of around fifty houses surrounded by orchards and small plantations. The village shows an atypical identity: isolated in a dead-end road half-way within the Valleys of Hell, it lies at the meeting point of two rivers and is surrounded by greenery and high rocky summits. The asphalt disappears from Qemmamin going upstream in the valleys. Dirt roads lead to the plateaus of Meshmesh or Mrebbin and two small farms are located further upstream and inhabited during cultivation season. Except the mentioned constructions and cultivated terraces, the valleys are free from the chaotic and unplanned urbanisation that had taken over the country and high slopes and cliffs are almost untouched.

The steep mountainous setting and the parameters have allowed the area to be a sanctuary for nature. The presence of one plant species exclusively endemic to these valleys illustrates their biological and ecosystemic importance and uniqueness.

Accurate geographic distribution and mapping of *Jacobaea mouterdei*, data about its ecology (habitat types, seed dispersal, flowering period), and identification of the specific threats affecting the species were missing information that prevent to accurately assess the vulnerability of the species using the IUCN criteria for Redlisting. A draft assessment was first realised to evaluate the status of the species prior to the fieldwork. The species was considered as Endangered at the global level with criterion B which uses the geographic range.

The study aimed at mapping as precisely as possible the subpopulations of *Jacobaea mouterdei* to understand its peculiar and limited distribution. Extensive fieldwork was planned in the different branches of the “Valley of Hell” and their surroundings to georeference the occurrence of the individuals. Knowing the exact locations of the main subpopulations is necessary for further conservation actions.

Methodology

Between the 24th April and the 22nd October 2019, extensive fieldwork was carried out in the Valleys of Hell in the districts of Danniye and Akkar to survey the flora. In total, 36 days were spent in the valleys during 11 different trips. Each of the trip lasted 3 days, except the last one during which we remained in the valleys for 6 consecutive days in order to properly end the fieldwork season.

Using a method of circular quadrats of 5 meters of radius, the vegetation was sampled in 191 plots carried out in different types of habitats at different altitudes. Every important group of *Jacobaea mouterdei* encountered were spotted and the number of individuals was counted. The maps were drawn using QGIS (QGIS 2019). The first activity was to carry out in the mountainous areas and to collect data about the distribution of *Jacobaea mouterdei*, its population size, biology, ecology and the threats affecting it. Basic information about the phenology of the species and its morphology, such as the shape of the leaves or number of stems and flowers, was collected from the observations of individuals from different groups throughout the valley.

Areas without *Jacobaea mouterdei* were also considered and sampled to understand the environmental requirements of the target species. The presence or absence of the target species, the type of bedrock, altitude and the associated plant species were noted down to draw an accurate map of the distribution of this rare endemic. The collection of these parameters allowed the understanding of the ecological preferences of the species.

The species vulnerability was assessed following the latest guidelines of the International Union for Conservation of Nature red list categories and criteria (IUCN 2019). Different observations concerning the activities and practices of locals living in the area and their impacts on natural habitats and on the target species were used to identify the specific threats. Collected specimens were given to the Post herbarium in Beirut and coded BEI HELB_349.

Results

Geographic range

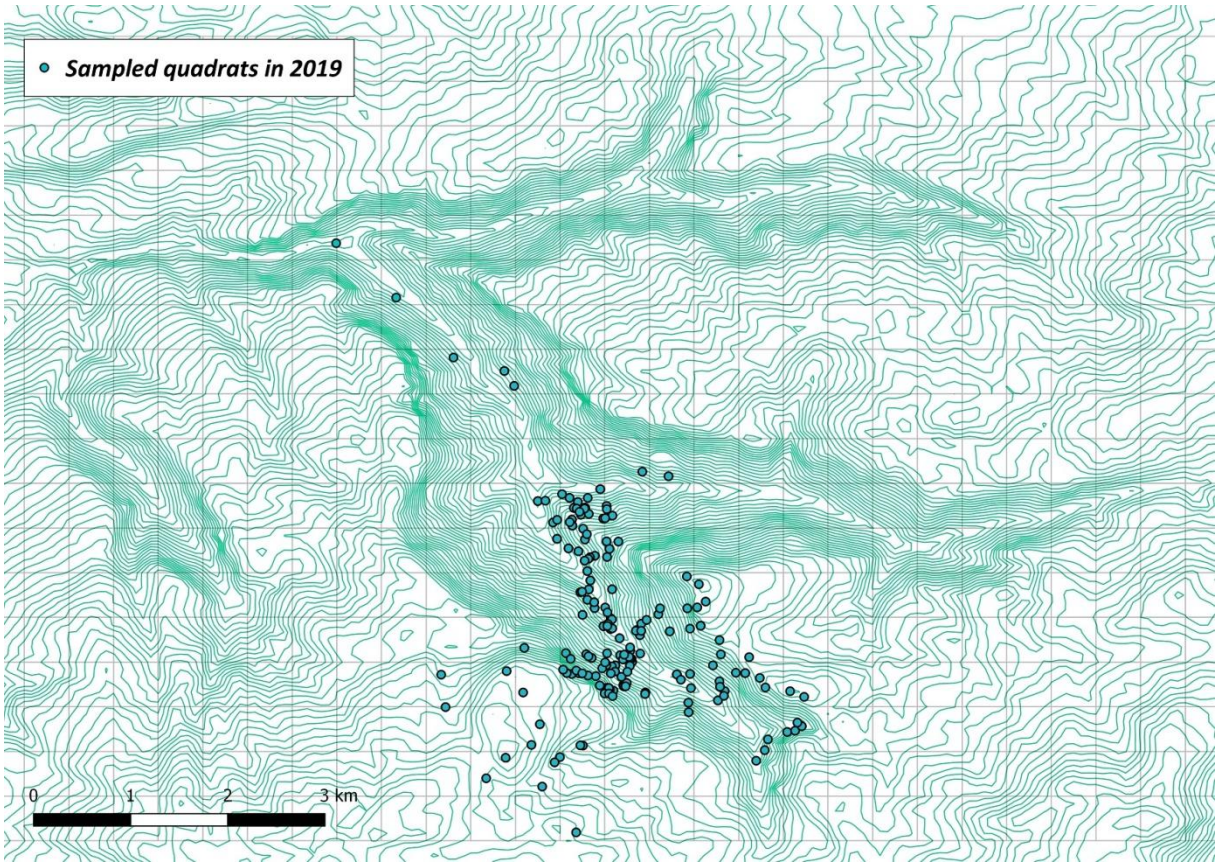

Figure 3 : Map of the sampled quadrats in the Valleys of Hell in 2019

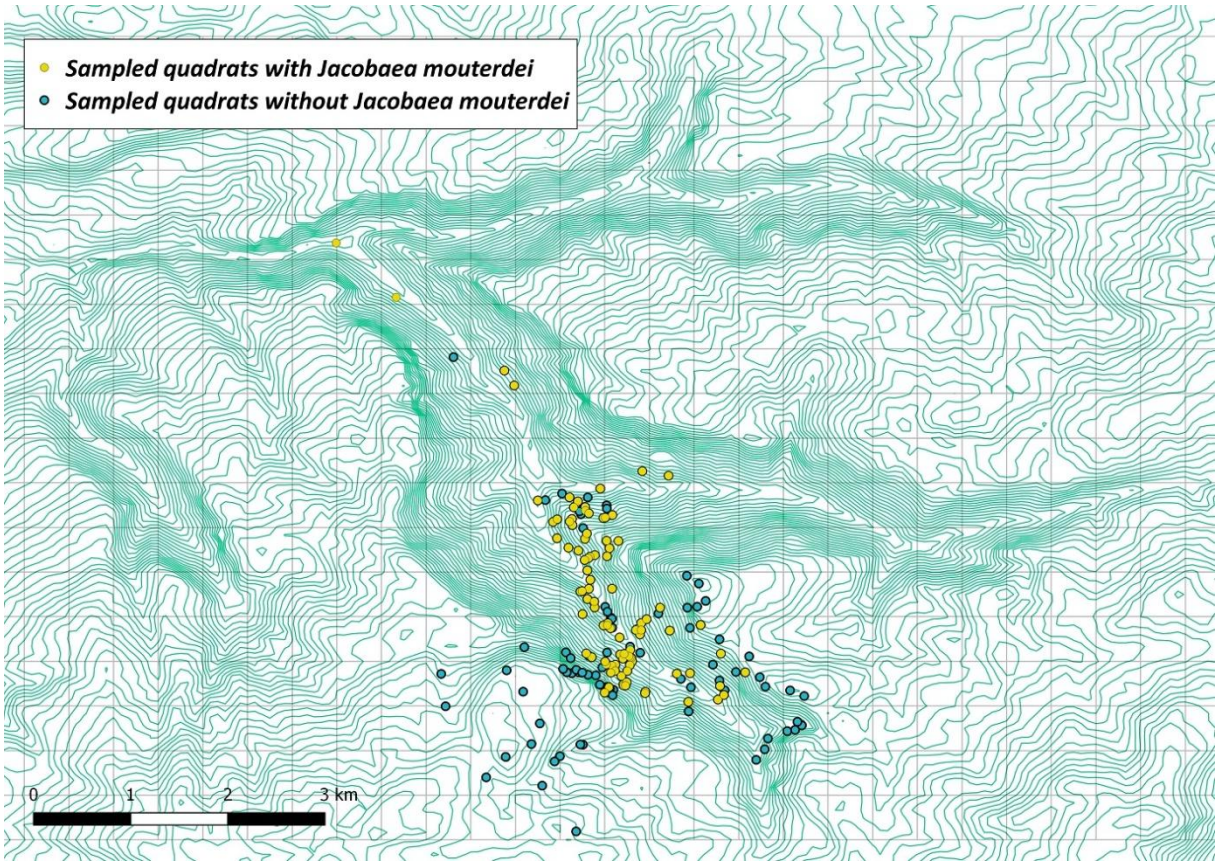

Figure 4 : Map of the sampled quadrats in which *Jacobaea mouterdei* was observed or not in the Valleys of Hell in 2019

Among the 191 sampled plots (Figure 3), *Jacobaea mouterdei* was present within 98 of them (Figure 4). It confirmed the restricted distribution of the species at least for the southern parts of the area and its absence from the surrounding plateaus of Mrebbin and Qemmamin. Most of the individuals were observed in one side of the area (Wadi el-Qattara) and almost none were observed in the other part (Wadi Haql el-Kherbe). Yet, the latter and other areas could not be visited thoroughly and the species could be potentially extant in the northern parts of the area. Further investigations have to be carried out to clarify the northern edge of distribution of *Jacobaea mouterdei*.

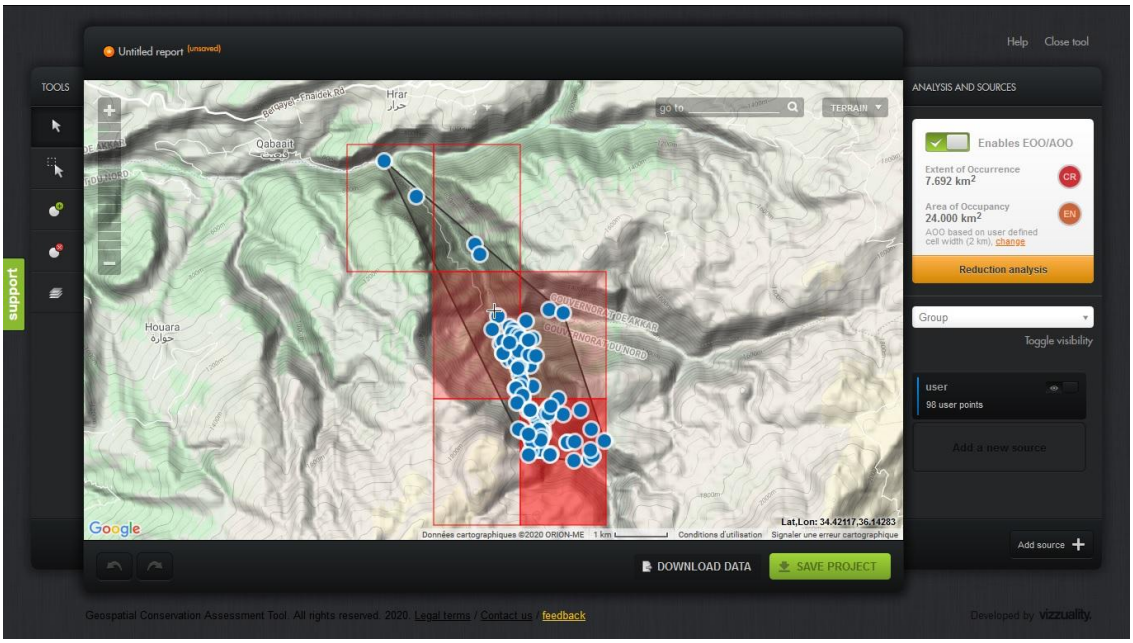

Figure 5 : Image of the calculation processed on the Geospatial Conservation Tool (GeoCAT) to calculate the AOO and EOO of *Jacobaea mouterdei*.

Both the extent of occurrence (EOO 24 km²) and the area of occupancy (AOO 24 km²) are very restricted (Figure 5), and the species is considered to occur in three locations. There is no evidence that the EOO and AOO were larger in the past as the historical botanic reference mentioned this species to be restricted to this valley. A decrease in AOO is suspected since, the habitat quality have severely been degraded in the lower parts of the valleys during the last decades; however no information is available concerning a decrease of the number of subpopulations.

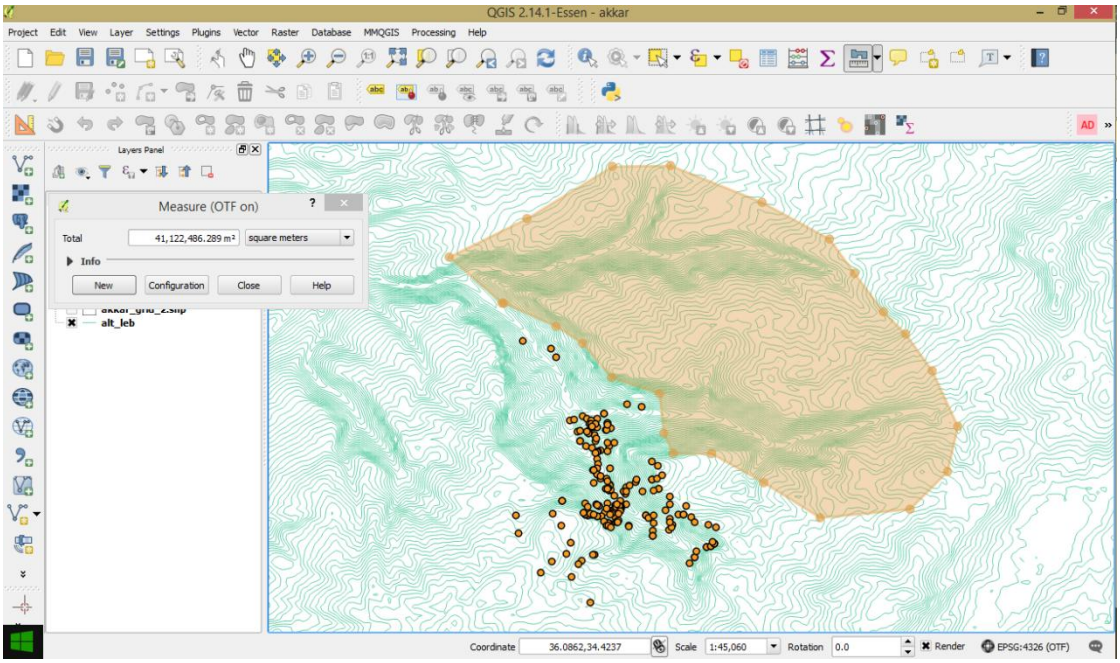

Figure 6 : Map showing the estimated unexplored area of the Valleys of Hell.

Around 43%, being 29 km², of the expected area of 70 km² were explored. The two other branches, namely the northern and eastern valleys need to be surveyed. The remaining unexplored area is estimated around 41 km² (Figure 6).

Population of Jacobaea mouterdei

The population size was estimated with accurate counting. Only the southern part of the "Valleys of Hell" was comprehensively visited and the vegetation was sampled to spot and count the number of individuals of *Jacobaeae mouterdei*.

The species was observed in 98 quadrats and 3,271 individuals were counted. According the environmental parameters and the local abundance of the species in some particular locations, the number of individuals occurring in the southern part of the area is estimated above 6,000. As explained in the distribution part, there is a probability for more individuals to be present in the northern valleys which could not be sufficiently explored during this fieldwork.

The observed number of subpopulations is three: the largest in Wadi el-Qattara (1), another in the valley below Qemmamin (2) and the smallest downstream in the section stretching from below Hrar to Qabaait (3). These subpopulations are disconnected by relatively short distances: a distance of around one kilometre was calculated between Wadi el-Qattara and Qemmamin and a distance of two kilometers was calculated between the subpopulation of the valley below Qemmamin to the one located downstream around Hrar and Qabaait. Even so, the population is not considered as severely fragmented as gene flow can be easily undertaken through these distances by pollinators which disseminate the pollen.

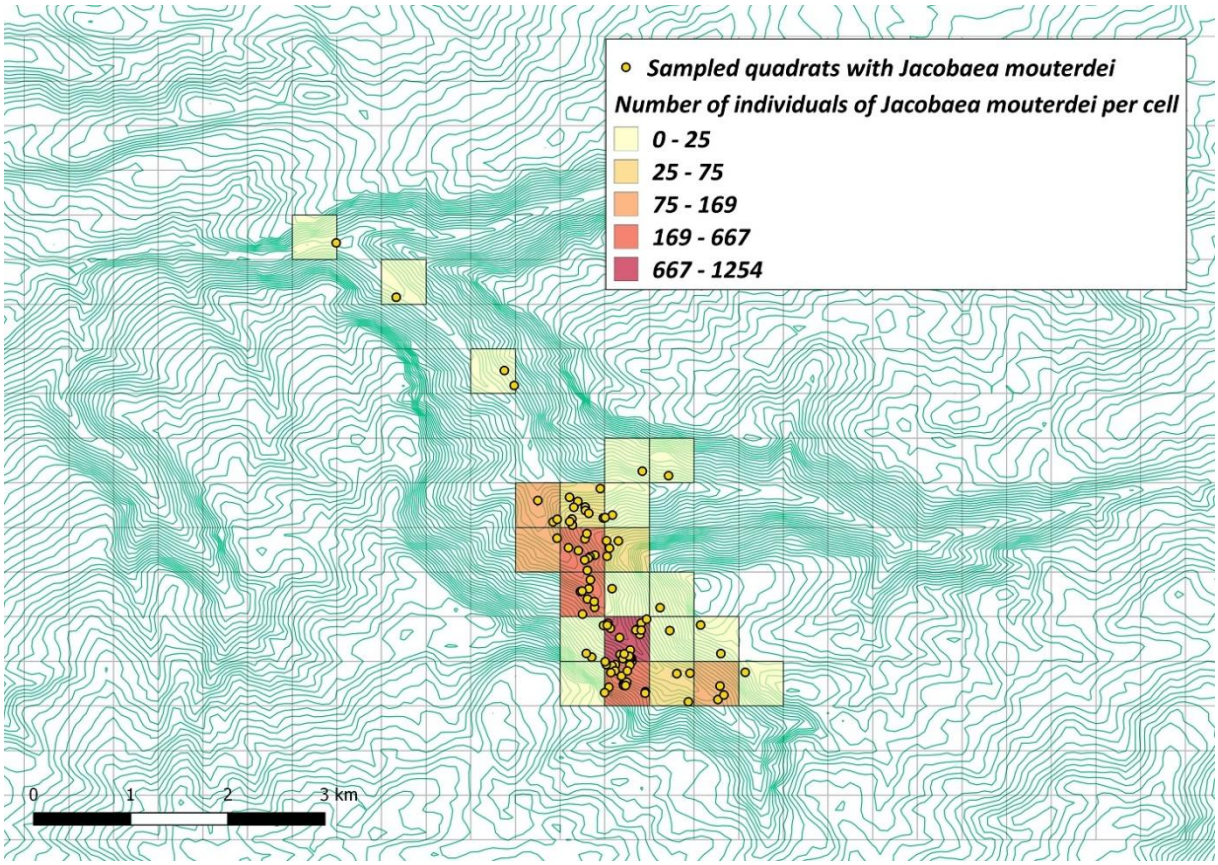

Figure 7 : Map of the sum of individuals of *Jacobaea mouterdei* counted per cell of 500 m x 500 m

The calculations allowed to estimate that the subpopulation of Wadi el-Qattara (1) is constituted of around 6,000 individuals as 3,154 individuals were counted there. Only 96 individuals were observed in the second subpopulation (2). In the lower subpopulation (3), 21 individuals were counted. In these two areas the altitude is lower, the slopes of the valley are very steep and locally quite disturbed by human activities, which could explain the inadequate conditions for the presence of the species.

In some areas within the valley Wadi el-Qattara, important densities of *Jacobaea mouterdei* were recorded, for instance the highest record counted 157 individuals within 80 m², being 1.96 individuals per square meter. The average calculated of number of individuals in preferred habitat types (check Habitats and Ecology Part) was of 58.71 individuals per 80 m².

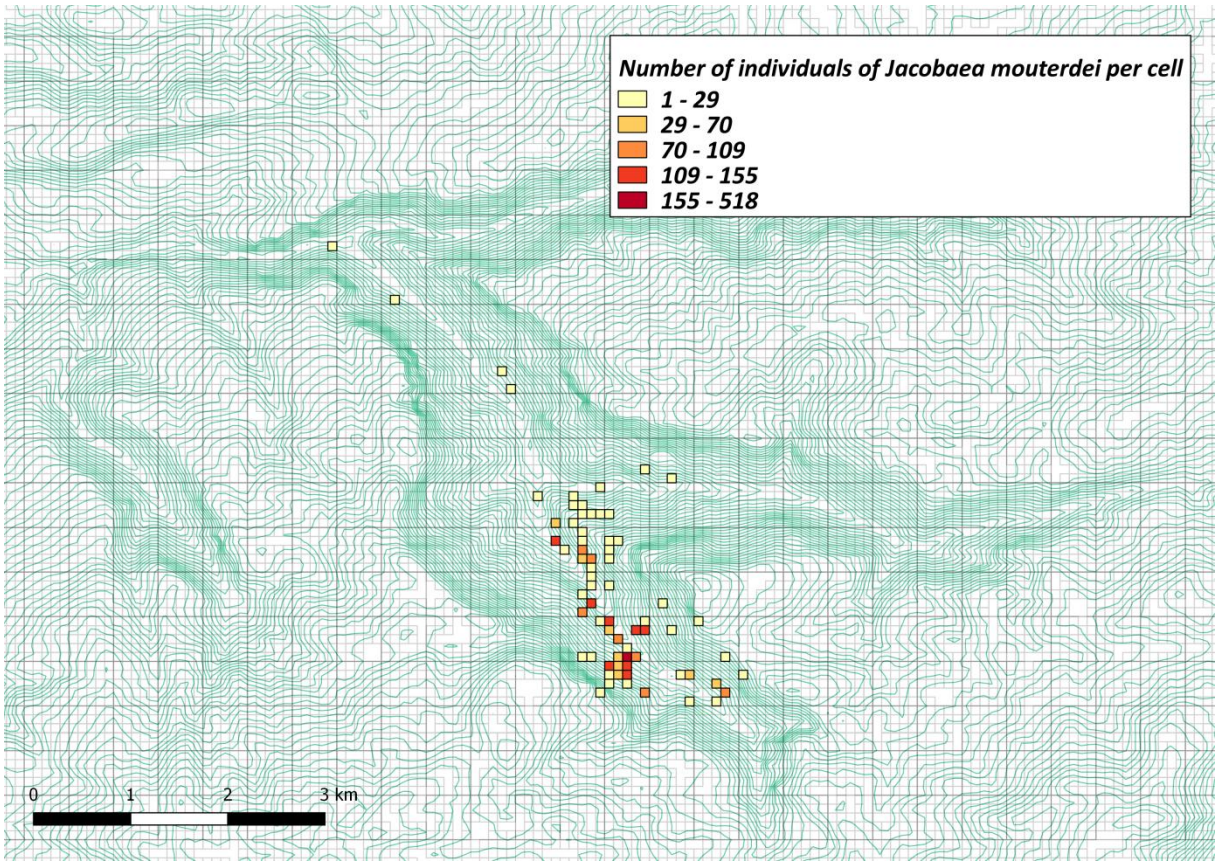

Figure 8 : Map of the sum of individuals of *Jacobaea mouterdei* counted per cell of 500 m x 500 m

Biology and Habitats of Jacobaea mouterdei

The plant sprouts between March to April depending on the altitude and aspect. It grows up to 60 cm in height during this first part of development. Each individual produces variable numbers of stems, from one to 50, depending on the age of the individual and the environmental parameters. There is an interesting polymorphism at the level of the shapes of the leaves: they can vary from almost entire to deeply pinnately lobed between different groups of individuals. The flowering time clearly extends from June to August, although some isolated individuals can still partly flower in September and early October. The flowering stems can reach up to 150 cm in height. One individual can produce up to 1,000 flowers. A flower head carries an average of 12 ray flowers and 40 disc flowers. Inflorescence type is a compound corymb. It was also observed that important amounts of seeds are produced by each individual and there is a low success rate because of the presence of maggots feeding on the fruits.

Jacobaea mouterdei, like many species of the genus *Jacobaea*, is anemochorous, which means that its seeds are dispersed by wind. It has the capacity to settle in recently disturbed mineral soils which make it quite resilient to the construction of non-asphalted roads or trails. Nevertheless, the species takes time to settle properly due to its slow growth and its fragility during the first years of development. Therefore the perturbation of the habitat should not be repetitive.

Jacobaea mouterdei was mostly observed on soil formed from sandstone bedrock. Only few individuals were observed on soils derived from limestone bedrock. The species occurs within woodlands, shrublands, grasslands and rocky outcrops. Different types of woodlands meet the requirements for *Jacobaea mouterdei.* In pine (*Pinus brutia*) woodlands, the species was present but in relatively small amount. In evergreen oak (*Quercus coccifera*) woodlands, deciduous (*Styrax officinalis*) woodlands, and mixed conifer broadleaved woodlands the species was relatively abundant. Nevertheless, shrublands, grasslands and rocky outcrops are the preferred habitat types of *Jacobaea mouterdei* and sheltered the highest densities in terms of number of counted individuals (See Population Part).

Figure 9 : *Jacobaea mouterdei* in flower, June 2019

Threats affecting Jacobaea mouterdei

The specific threats affecting *Jacobaea mouterdei* have been identified in the explored area. Other threats could occur in the northern parts of the range that could not be visited during this study.

The creation of quarries constitutes the major threat for the species in the area as it irreversibly destroys its natural habitats and the potential seed bank remaining in the soil. Although it has been recurrently denounced by some locals, this illegal activity is quite spread in Lebanon and chaotic quarries are currently multiplying in the area between Jayroun, Qabaait and Hrar.

Urbanisation and the construction of roads constitute important threats that affect the species marginally. Although these threats are not spread over the range of the species, they have irreversible impacts as they permanently destroy the natural habitat of *Jacobaea mouterdei*. Within the village of Qemmamin, the construction of houses remains marginal, nevertheless a few houses

built between 2015 and 2020 have destroyed some individuals of *Jacobaea mouterdei*. Urbanisation and road construction have a more significant impact in the area between Hrar and Qabaait where the density of inhabitants is larger and the villages keep on spreading.

The creation of agricultural lands including fields for crops such as bean, corn, potatoes but mostly for the plantation of orchards of apple trees, plums, cherries and other fruit trees constitute the most spread threat to the species in the surroundings of Qemmamin and particularly in the lower parts of the valley Wadi el-Qattara where the largest subpopulation is located. This activity had an important value in the area of Qemmamin which explains the large area reserved for it. Due to the disturbance occurring on the vegetation in these agricultural lands, such as ploughing and the use of herbicides, *Jacobaea mouterdei* cannot survive in the cultivated areas. Other ancient and abandoned terraces observed in the valley of Wadi el-Qattara however constituted surprising shelters for wild plants, including *Jacobaea mouterdei* when its specific environmental requirements were met.

The collection of wood of evergreen oak (*Quercus coccifera*) is the second most important rural activities in the valleys, after agriculture. Local woodcutters target a different slope of woodland each year and harvest from spring to autumn. The activity has serious impacts on the flora even though it is selective. The major part of the lower shrubby vegetation is removed to allow constant back and forth of the workers and their donkeys, destructive trampling permanently destroys the herbaceous stratum and erodes the fragile soil structure, several small terraces are built at different levels of the slope to set fire to the high conic piles of branches to make charcoal on the site, small branches are not collected and lie down creating an important risk of forest fires during the long Mediterranean dry season. Few annual species could be favoured by this activity but *Jacobaea mouterdei* is considered to be greatly affected as it was always found absent on the areas where oak charcoal production occurred, even on sites that were exploited 20 years ago.

The grazing activity is not popular in Wadi el-Qattara, probably due to the steepness of the valley. However, on the plateaus and the higher parts of the valleys, grazing has an important impact on the vegetation and can be qualified as over-grazing. Flocks of goats and sheep are driven through the high plateaus overhanging the valleys, in which cedars and junipers thrive, to reach the higher parts of Wadi el-Qattara. *Jacobaea mouterdei* is not the preferred species of the herbivorous during spring and early summer, yet in the end of summer and in autumn when most of the grass and forbs have turned dry and yellow, then it becomes seriously grazed to the base of the stems. Usually at this time of the year, the species has already completed part of their seed production. The palatability of *Jacobaea mouterdei* is also confirmed as donkeys appreciate it all year round to the last leaf. Taking into consideration the relatively lower impact of overgrazing on *Jacobaea mouterdei* in the explored areas, it is not considered here as a main threat. Further investigations would help understanding how grazing could constitute a major threat in the other valleys where the activity is more intense.

The presence of maggots feeding on the seeds inside the flowers heads was found on almost every inspected individual. The species of fly responsible for these damages could not be identified and it is unknown if it is a specific or generalist parasite. It is yet possible that the flies were present in the region and laying their eggs on the flowers of *Jacobaea mouterdei* way before the arrival of human activities in the valleys. This threat is considered as minor although it affects most of the

individuals (90%).

At least four illegal dumps have been spotted in the lower part of the main valley, between Qabaait to the way up that leads to Jayroun. Important amount of rubbish are directly thrown by the locals and the municipalities straight inside the valley down to the river. The solid pollution has clearly a negative impact on other components of the ecosystem, especially on water quality. Nevertheless, once in a while, the dump is set on fire to reduce its volume and then can cause serious threat to the surrounding natural habitats by starting uncontrolled forest fire. This is what happened in 2018 below the road that leads to Jayroun. The fire was controlled and burned a relatively limited part of the slope. Dumps constitute a risk of forest fire that could destroy the species and its habitat on a more or less large scale.

Figure 10 : Quarry on the way to Qemmamin, August 2019

Figure 11 : Illegal dump on the way to Qemmamin

Addressing the threats

Conservation actions should be implemented as soon as possible regarding the quick pace at which destructive and illegal human activities are spreading throughout Mount Lebanon since the three last decades and seriously affecting natural habitats, species, landscapes and rural lifestyle. Endemic species are part of the natural heritage of the country and more attention should be given to their survival.

The species does not occur in any protected areas. As most of the plant species endemic to Mount Lebanon, there is currently no action recovery plan, education and awareness programmes, legislation or *ex-situ* conservation actions concerning *Jacobaea mouterdei*.

The creation of quarries could be contained if there was better and transparent control over it in Lebanon. Although it is recurrently denounced, this illegal quarrying keeps on spreading due to locally influential and self-serving stakeholders. New regulations on quarrying and a reinforcement of the control at the national level would constitute a solution. Unplanned urbanisation is also lacking serious inspection to regulate illegal permits of construction delivered by municipalities for lands that cannot be built on or that should be considered as woodland areas by the official land law.

The other rural activities including woodcutting, grazing and creation of agricultural terraces could be better managed by developing education and awareness programme targeting local communities to highlight the importance of their unique and irreplaceable natural patrimony. The same awareness programme could even more efficient if it could lead directly to the creation of protected areas in which the largest subpopulation of *Jacobaea mouterdei* and associated habitats would be included.

One potential conservation site was identified in the valley of Wadi el-Qattara, above the village of Qemmamin as it shelters the largest subpopulation of *Jacobaea mouterdei* and the most well preserved associated natural habitats. The proposition for the protected site could include the cells in which the number of counted individuals varies between 169 and 1254 (Figure 7) and their surroundings.

Figure 12 : Village of Qemmamin

Conclusion

Jacobaea mouterdei had remained a mysterious and under-studied plant species until 2019 as part of the gap of knowledge was addressed through this project. Endemic plant with a very restricted distribution, the species only occurs in these particular valleys in the North of Mount Lebanon mountain range. The study allowed understanding its preferred environmental requirements and habitat types but also the different threats that are currently affecting it. Unplanned urbanisation, illegal quarrying, wood-cutting and extension of agricultural terraces are currently threatening the existence of this species. *Jacobaea mouterdei* was then assessed as globally Endangered using the IUCN guidelines and criteria, although half of its potential area of distribution could not be explored during the fieldwork carried out in 2019 due to limited amount of time. The sampling of the vegetation also revealed the existence of a highly diverse flora in this area. Conservation initiatives have to be implemented urgently to protect this plant but also to preserve its home, the entire area of the Valleys of Hell which constitute the less disturbed ecosystems of Lebanon and a rich mosaic of pristine Levantine natural habitats.

Figure 13 : Spring in the valley, April 2019

Figure 14 : Camping during fieldwork, June 2019

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