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(Article begins on next page)

***Boswellia sacra* Flueck. (Burseraceae) in the Hasik area (Eastern Dhofar, Oman) and a list of the surrounding flora**

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Boswellia sacra Flueck. (Burseraceae) nell'area di Hasik (Dhofar orientale, Oman) ed elenco della flora circostante – L'area montuosa intorno ad Hasik è nota fin dall'antichità per essere una delle zone dove *Boswellia sacra* (the frankincense tree) cresce abbondante. Tuttavia la conoscenza botanica di quest'area risultava piuttosto scarsa perché, fino al 2003, Hasik è rimasta isolata via terra per la mancanza di una strada di collegamento con Habdin. La costruzione della strada ha permesso di raggiungere l'area di Hasik, di studiare le popolazioni di *Boswellia sacra* sulle montagne prossime a questa piccola città e di effettuare raccolte floristiche sia nelle zone a *Boswellia sacra*, sia all'interno di alcuni piccoli wadi costieri. La lista floristica comprende 93 taxa; fra questi *Schweinfurthia pedicellata* risulta nuova per l'Oman, mentre *Convolvulus ulcinus*, *Limonium sarcophyllum* e *Tephrosia subtriflora* sono nuove per il Dhofar.

Key-words: *Boswellia sacra*, Burseraceae, flora, frankincense, Dhofar, Hasik, Oman.

Introduction

The analysis of the distribution and consistency of the populations of *Boswellia sacra* is a recurrent theme of our research activity in Dhofar (southern Oman). Some important *Boswellia* areas (Al-Mughsayl, Wadi Adownib and Wadi Dowkah) have been the subject of our research during the last years (Raffaelli et al., 2003 a; Raffaelli et al., 2003 b). However, remaining to be studied was the area of Hasik, the eastern most part of Dhofar, located in the remote mountainous zone that starts inland of Sath, and reaches Hasik itself, including the north-eastern part of Jabal Samhan.

Until 2003, Hasik was unreachable by land due to

the absence of a road beyond Habdin. Before this the connections between Habdin and Hasik were by sea, avoiding the steep cliffs of Rass Nuss, and navigating along the coast for approximately 30 km. Today reaching Hasik has become available thanks to a newly built road. Hasik is the starting point for the exploration of the vast *Boswellia sacra* area which stretches several kilometres towards the north-west from the Hasik mountains, up to the internal pre-desert region behind Jabal Samhan. Consequently the floristic knowledge of this area of Dhofar is limited; the available data come from Radcliffe-Smith (1980), Miller & Morris (1988) and Ghazanfar (1992; 2003).

The study area

Hasik is a small town, almost a village, located at the eastern extremity of Dhofar, along the Arabian Sea coast, located on a narrow sand bar with vertical mountains lying behind it. Lacking a road system, except along the coast, the area is rather inaccessible and hard to cross. The mountains may be reached through steep pathways up the slopes or proceeding along the principal wadis (Wadi Raykhut, Wadi Atawnt, Wadi Ataran, etc.), then ascending the overlying slopes. The topography of the territory is steep, with strongly inclined slopes dominated by vertical rock walls and large rocky blocks, or cut by deep-canyon like wadis. From Hasik, on a day trip, it is possible to climb the mountains only for a few kilometres, but anyway it is possible to reach the southern margins of the distribution area of *Boswellia sacra*.

Hasik is known from ancient times for the production and commerce of frankincense and is undoubtedly one of the areas where *Boswellia sacra* is most abundant today.

Floristic List

Specimens were collected in the Hasik mountains, in some *Boswellia sacra* areas (b1, b2, b3), along the coast inside two small wadis (w1, w2), and along a tract of the rocky coast (c) a few kilometres west of Hasik.

Among the species collected are: *Schweinfurthia pedicellata* new to Oman; *Convolvulus uliginosus*, *Limonium sarcophyllum* and *Tephrosia subtriflora* new to Dhofar.

Investigated localities (Fig. 1)

(b1): Frankincense area above Wadi Atawnt - 17°28.700' - 17°29.800'N, 55°11.380' - 55°13.140'E - March 22 and 23, 2004.

Travelling 3 km along the bed of the Wadi Atawnt, that flows into the sea 6 km east of Hasik, it is possible to climb the left

side mountain slope up to an altitude of 500 m; then with an ample north-east turn, to go back down to the coast. The topography of the territory is rough, the soil consists of boulders and large rock debris; the herbaceous vegetation is scarce and represented by occasional individuals of *Aerva artemisioides* subsp. *batharitica*, *Cleome austroarabica*, *Helicrysum somalense*, *Pulicaria omanensis*, *Hochstetteria schimperii*, *Teucrium* aff. *mascatense*, *Hermannia paniculata* and *Fagonia schweinfurthii*. Among perennial herbs, some succulents such as *Desmidorchis flavus*, *Caralluma* cf. *hexagona*, *Kleinia odora* and *Aloe dhufarensis* are present. The latter species, in the Hasik area, is rather abundant and forms thickets of united individuals with limited dimensions and thicker leaves compared to the other populations in Dhofar. Shrubs of *Cadaba heterotricha*, *Polygala obtusissima*, *Pycnocycla caespitosa* and *Gaillonia aucheri* are reported. Trees of *Boswellia sacra* are almost exclusive and, on certain slopes, reach a reasonable density of individuals. *Boswellia* trees are 3-4 m high and have a wide ramification with abundant third and fourth order branches (Fig. 2A). This is probably because of the absence of leaf stripping by the dromedaries that rarely reach this inaccessible and very slippery area with rock debris covering the ground.

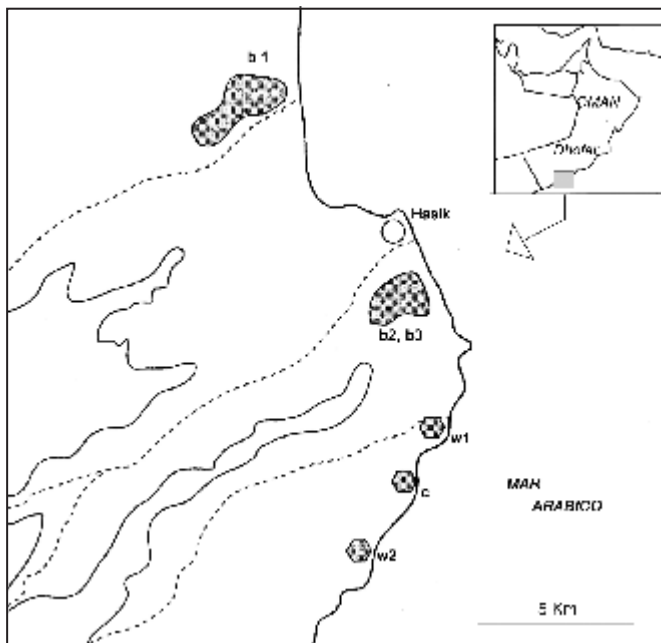


Fig. 1 – The investigated localities in the Hasik area.

(b2, b3): Frankincense area, mountain slopes west of Wadi Rakyut, 3 km from Hasik towards Habdin - 17°24.500' - 17°24.900'N, 55°15.900' - 55°16.800'E - 14 and 15 May, 2005 (b2); February 12, 2006 (b3).

Climbing up a small wadi perpendicular to the coast it is possible to reach the southern mountains slopes west of Hasik, up to an altitude of 550 m. After turning first to the east and then to the south, it is possible to descend back to the starting point. As in the previous area (b1), the topography of the territory is rough, boulders and big rock debris cover the ground. The sparse herbaceous vegetation comprises the same species reported in b1 as well as *Psilotricum virgatum*, *Heliotropium bacciferum*, *Cleome brachycarpa*, *Cometes abyssinica*, *Lavandula macra*, *Rhyncosia pulverulenta*, *Tephrosia subtriflora*, *Abutilon fruticosum*, *Senra incana*, *Melhanian muricata*, *Forsskaolea tenacissima*, *Pimpinella schweinfurthii*, *Iphionia senecionoides* and *Cenchrus pen-nisetiformis*. Shrubs of *Cadaba heterotricha*, *Pycnocycla caespitosa*, *Euphorbia uzmuk*, *Commiphora foliacea*, *C. habessinica*, *Limonium sarcophyllum*, *Convolvulus ulicinus* and *Tephrosia subtriflora* are reported. The last three species are new to Dhofar being only reported for N. Oman in Ghazanfar (1992). Among trees, *Boswellia sacra* is dominant in this area (Fig. 2B).

(w1): small coastal wadi 8.5 km west of Hasik - March 18, 2005; 12.02.2006 - 17°21.935'N - 55°17.490'E.

(w2): small coastal wadi 13 km west of Hasik - March 18, 2005; 12.02.2006 - 17°19.355'N - 55°16.170'E.

Specimens were collected along the bed and the walls of two small, embanked wadis that cut the mountain coast perpendicularly, to the left, along the Hasik-Habdin road. Both wadis have steep lateral walls with some ravines between the rocks where scarce vegetation grows. In the first wadi (w1) the gravely-sandy bed presents a rather similar flora to the b2 area together with *Corbiconia decumbens* (also in w2), *Anticharis glandulosa*, *Blepharis scindica*, *Kohautia caespitosa*, *Crotalaria aegyptiaca*, and *Tephrosia quartiniiana*. Trees are represented by sparse *Acacia senegal* individuals and sporadic *Tamarix arabica*. Of particular interest for this area is *Schweinfurthia pedicellata*, a new species to Oman, previously confined to Ethiopia, Somalia, and Yemen (Miller A. G. et al., 1982). In a small area where the wadi bed forms a terracing with some permanent water, a small *Phoenix dactylifera* thicket, of probable anthropogenic origin, grows.

The second wadi bed (w2) is covered by large rock debris carried downhill by the floodwaters (Fig. 2C). The vegetation is scarce and, together with some of the species found in w1, we collected *Pluchea arabica*, *Heliotropium brevilingue*, *Euphorbia arabica*, *Chrysopogon plumulosum* and two uncommon Scrophulariaceae: *Schweinfurthia papilionacea* and *Camptoloma villosa*, the latter growing inside a damp shady niche in the rock wall (Fig. 2D). Shrubs of *Commiphora foliacea* are common in the wadi bed.

(c): stretch of coast 10 km west of Hasik - February 12, 2006 - 17°21.140'N - 55°17.260'E.

Detrital littoral area along the coast, a few meters from the sea. Small *Echiochilon persicum*, *Dyerophytum indicum*, *Limonium axillare*, *Pulicaria glutinosa* shrubs and some herbaceous species like *Aerva artemisioides* subsp. *batharctica*, *Pergularia tomentosa*, *Enicostemma axillare*, *Phyla nodiflora*, *Aeluropus lagopoides* and succulents such as *Zygophyllum album* and *Z. simplex* are reported. In a rock niche *Exacum affine* was collected.

Frankincense collection in the Hasik area

On September 15, 2004 we have had a meeting with some elderly Hasik inhabitants, aiming to retrieve information on the collection and commerce of frankincense, and on the density of the *Boswellia sacra* populations distributed on the Hasik mountains.

The outcome of the conversation was clear: today the collection of frankincense is no longer practised, or just, sporadically, by a few women who climb the mountains to collect some resin for family use. Not long ago, however, the majority of the inhabitants of Hasik devoted themselves to the collection of this resin, and frankincense represented the major earnings for them. The suspension of the collection in the 1970's is connected with the modernization of the country and the oil industry that brought a life status improvement, offering more profitable and less laborious occupation.

According to the elderly of Hasik, frankincense collection is no longer an income source for some families as it was in the past; therefore, information provided by the elderly of Hasik about the way frankincense was once collected and traded is worthy to note.

The gatherers climbed up the mountain by foot, carrying along food supplies for 2-3 days. Then some of them descend back to the town with the collected resin and replenish the supplies for the others left to

carry on collecting. Although some of the production areas of frankincense were on the mountain slopes dominating Hasik, most of them were very far away in the mountains. From the nearby localities (approximately 7) frankincense was brought to Hasik and was stacked in deposits located in caves along the sea cliffs (the deposits were named Halhal; Fig. 2E). At the end of the gathering season the resin was transported by sea to Sath (no roads were available). More frankincense was collected in the inland mountain localities (15 in two areas named Isayb and Argath); from here numerous routes departed and then reunited in one track headed to Sath where the frankincense was deposited in appropriate storehouses which still exist today (Fig. 2F). With favourable monsoon winds (from south-west), frankincense was loaded on the ships and brought to the markets in India, a country with which Dhofar held active commercial trading.

List of the collected species

The list reports 93 taxa; the abbreviations indicate the investigated localities:

- b1** = frankincense area (year 2004)
- b2, b3** = frankincense area (years 2005, 2006):
- w1** = coastal wadi (2006)
- w2** = coastal wadi (2006)
- c** = stretch of coast (2006)
- R-S** = plants reported in Radcliffe-Smith (1980)
- G** = plants reported in Ghazanfar (2003)
- M** = plants reported in Miller (1985)
- +** new species for Oman
- *** new species for Dhofar

The collected specimens are kept in FT (Tropical Herbarium Studies Centre, Florence).

MAGNOLIOPSIDA

ACANTHACEAE

- Barleria aucheriana* Nees, **R-S**
- Blepharis scindica* T. Anderson, **b2, w1**

AIZOACEAE

- Corbichonia decumbens* (Forssk.) Excell, **w1, w2**

AMARANTHACEAE

- Aerva artemisioides* Vierh. et O. Schwartz subsp. *batharitica* A.G. Miller, **b1, b2, w1, c**
- Aerva javanica* (Burm. f.) Juss., **w1, w2**
- Amaranthus graecizans* L. subsp. *graecizans*, **w1**
- Psilotrichum sericeum* (Koen.) Dalr. & Gibson, **R-S**
- Psilotrichum virgatum* C.C. Towns., **b2**

APIACEAE

- Pimpinella schweinfurthii* Asch., **b2, w**
- Pycnocycla caespitosa* Boiss. & Hausskn. ex Boiss., **b1, b2, R-S**

ASCLEPIADACEAE

- Caralluma* sp. cf. *hexagona* Lavranos, **b1**
- Desmidorchis flavus* (N.E. Br.) Meve & Liede, **b1, b2**
- Pentatropis nivalis* (J.F. Gmel.) Field & Wood, **R-S**
- Pergularia tomentosa* L., **c**
- Periploca visciformis* (Vatke) K. Shum., **R-S**

ASTERACEAE

- Helicrysum somalense* Bak. f., **b1**

- Hochstetteria schimperi* DC., **b1, b2, R-S**
- Iphiona senecionoides* (Baker) A. Anderb., **b2**
- Kleinia odora* (Forssk.) Berger, **b1**
- Launaea castanosperma* F. G. Davies, **R-S**
- Launaea spinosa* (Forssk.) Sch. Bip., **R-S**
- Pluchea arabica* (Boiss.) Qaiser & Lack, **w2**
- Pulicaria glutinosa* (Boiss.) Jaub. & Spach subsp. *glutinosa*, **c**
- Pulicaria omanensis* Gamal-Eldin, **b1, b2, w1**

BORAGINACEAE

- Echiochilon persicum* (Burm. f.) I.M. Johnston, **b2**
- Echiochilon strigosum* (Deflers) I. M. Johnston, **R-S**
- Heliotropium longiflorum* (Hochst. & Steud. ex A. DC.) Jaub. & Spach., **b2, w1**
- Heliotropium bacciferum* Forssk., **b2, w1**
- Heliotropium brevilimbe* Boiss. (syn. *H. calcareum* Stocks), **w2, R-S**
- Trichodesma africanum* (L.) R. Br., **R-S**

BRASSICACEAE

- Farsetia longisiliqua* Decne., **G**

BURSERACEAE

- Commiphora foliacea* Sprague, **b2, w1, w2**
- Commiphora habessinica* (O. Berg.) Engl., **b2**
- Boswellia sacra* Flueck., **b1, b2, R-S**

CAPPARACEAE

- Cadaba farinosa* Forssk., **R-S**
- Cadaba heterotricha* Stocks ex Hook., **b1, b2**



Fig. 2A – Frankincense area above Wadi Atawnt (b1); Fig. 2B – Frankincense areas west of Wadi Rakyut (b2, b3); Fig. 2C – Wadi 14 km west of Hasik (w2); Fig. 2D – *Camptoloma villosa* inside a shady niche in the rocky wall of the w2 wadi; Fig. 2E – A cave along the sea cliff near Hasik used in the past as frankincense deposit; Fig. 2F – Ancient frankincense storehouse in Sadh.

Capparis cartilaginea Decne., w1

Cleome brachycarpa (Forssk.) Vahl. ex DC., b2, w1, w2, R-S, G

Cleome austroarabica Chamb. & Lam., b1, w1

CARYOPHYLLACEAE

Cometes abyssinica R. Br., b2

CHENOPODIACEAE

Salsola imbricata Forssk., G

Salsola rubescens Franch., R-S

Salsola spinescens Moq., G

CONVOLVULACEAE

Convolvulus glomeratus Choisy, b2, w1

* Convolvulus ulcinus Boiss., b1, b2

CUCURBITACEAE

Cucumis prophetarum L. subsp. prophetarum, R-S

EUPHORBIACEAE

Euphorbia arabica Hochst. & Steud. ex Boiss., w2

Euphorbia uzbek S. Carter & J.R.I. Wood, b2

FABACEAE

Acacia senegal (L.) Willd., w1

Acacia tortilis (Forssk.) Hayne, b1

Crotalaria aegyptiaca Benth., w1, w2

Indigofera colutea (Burm. f.) Merr., w2

Rhynchosia pulverulenta Stocks, b2, w1

Taverniera glauca Edgew., R-S

Taverniera multinoda Thulin, b2

Tephrosia quartiniana Cuf., w1, w2, R-S

Tephrosia purpurea (L.) Pers., b2

* Tephrosia subtriflora Baker, b2

GENTIANACEAE

Enicostemma axillare (Lam.) A. Raynal, c

Exacum affine Balf. f., c, R-S

LABIATAE

Lavandula hasikensis A.G. Miller, M

Lavandula macra Baker, b2

Teucrium sp. aff. mascatense Boiss., b1

MALVACEAE

Abutilon fruticosum Guill. & Perr., b2, w1

Abutilon pannosum (Forst. f.) Webb, w1, w2

Senra incana (Cav.) DC., b2, w1

Thespesia populnea (L.) Sol. ex Correa, c

NYCTAGINACEAE

Commicarpus boissieri (Heimerl.) Cufod., w1

PLUMBAGINACEAE

Dyerophytum indicum (Gibbs & Wight) Kuntze, w1, w2, c

Limonium axillare (Forssk.) Kuntze, c

* Limonium sarcophyllum Ghaz. & J.R. Edm., b2

POLYGALACEAE

Polygala obtusissima Hochst., b1

RESEDACEAE

Reseda sphenocleoides Deflers., b2, w1

RUBIACEAE

Gaillonia aucheri (Guill.) Jaub & Spach, b1

Kohautia caespitosa Schnitzl., w1

SCROPHULARIACEAE

Anticharis glandulosa Asch., w1

Camptoloma villosa Balf. f., w2

Schweinfurthia papilionacea (L.) Boiss., w2

+ Schweinfurthia pedicellata (T. Aderson) Balf.f., w1

STERCULIACEAE

Hermannia paniculata Franch., b1

Melhania muricata Balf. f., b2

TAMARICACEAE

Tamarix arabica Bunge, w1

URTICACEAE

Forsskaolea tenacissima L., b2, w1

VERBENACEAE

Phyla nodiflora (L.) Greene, c

ZYGOPHYLLACEAE

Fagonia schweinfurthii (Hadidi) Hadidi, b1, b2, w1

Zygophyllum album L.f., b1, c

Zygophyllum simplex L., b2, w1, w2, c

LILIOPSIDA

ALOACEAE

Aloe dhufarensis Lavranos, b1, b2

ARECACEAE

Phoenix dactylifera L., w1

POACEAE

Aeluropus lagopoides (L.) Trin. ex Thwaites, c

Cenchrus pennisetiformis Hochst. & Steud., b2, w1, w2

Chrysopogon plumulosus Hochst., w2

Saccharum ravennae (L.) Murray, R-S

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Abstract: The mountainous area surrounding Hasik is renown from antiquity as one of the areas where the frankincense tree, *Boswellia sacra*, grows in abundance. However, the botanical knowledge of this area is limited since up to 2003, Hasik had remained isolated due to the absence of a connecting road with Habdin. The construction of a road has allowed reaching the Hasik area, studying the *Boswellia sacra* populations on the mountains surrounding this small town, and carrying out floristic collections both in the *Boswellia sacra* area, and inside some small coastal wadis. The floristic list includes 93 taxa; among these *Schweinfurthia pedicellata* is new to Oman, while *Convolvulus ulcinus*, *Limonium sarcophyllum*, and *Tephrosia subtriflora* are new to Dhofar.

