

The Frankincense Tree (*Boswellia sacra* Flueck., Burseraceae) in Dhofar, southern Oman: field-investigations on the natural populations*

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L'incenso (Boswellia sacra Flueck., Burseraceae) nel Dhofar, Oman meridionale: indagini sulle popolazioni naturali. — Il Dhofar, la regione più meridionale dell'Oman, è uno dei Paesi, insieme a Yemen e N Somalia, dove cresce *Boswellia sacra*, l'albero dell'incenso. È stata indagata la distribuzione e la consistenza delle popolazioni di *Boswellia* del Dhofar anche in vista di successive proposte per la loro salvaguardia e protezione. Per le aree di maggiore interesse vengono fornite informazioni vegetazionali e una lista floristica delle specie ivi raccolte, comprendente 180 taxa. Vengono anche segnalate alcune specie nuove per l'Oman o per la regione del Dhofar.

Key-words: *Boswellia sacra*, *Burseraceae*, Dhofar, Frankincense Tree, Oman.

The southern region of Oman, extending from the Gulf of Hasik to the Yemen border for about 250 km, is currently named Dhofar. The region is characterised by a mountain range running parallel to the coast and reaching an altitude of 1,400 m at Jabal Sayk near the Yemen border. Eastwards, the mountains are lower, with a mean height of 800-900 m (i.e., Jabal Qara near Taqah, to the east of Salalah); then the range continues to rise to over 2000 m at Jabal Samhan, the highest mountain in Dhofar. The southern slopes of the coastal mountains are very steep; they block the clouds and the damp wind brought by the SW monsoon, allowing a dense and luxuriant vegetation of trees and shrubs to develop southwards under whose canopy many herbs and grasses grow during the appropriate season, i.e. July, August and September. On the other hand, the northward rocky slopes are scarcely affected by the monsoon and therefore are rather arid and occupied by a sparse semi-desert vegetation. Moreover, the northern slopes dip gently, first forming a dry plateau, and then a succession of cliffs and gullies incised by deep wadis cut through the vast northern desert area as far as the Saudi Arabian border (see RADCLIFFE-SMITH, 1980; MILLER & MORRIS, 1988).

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PRESENT DISTRIBUTION OF *BOSWELLIA SACRA* IN DHOFAR

Dhofar has traditionally been one of the countries producing frankincense. Since ancient times the resin has been an object of commerce, with trade routes by sea and land through the Arabian peninsula towards the Mediterranean countries or eastwards to Iran and India. The ruins of the ancient harbour of Sumharam (Ist century BC - IIIrd century AD), from where frankincense was exported, remain near Khor Rori, east of Salalah (GROOM, 2000; AVANZINI, 2000).

In Dhofar, the species yielding frankincense is *Boswellia sacra*, that also grows in Yemen (Hadramawt) and in N Somalia (THULIN and WARFA, 1987). The resin is of good quality (EL QASSANI, 1984).

Four field-trips to verify the present distribution of *Boswellia sacra* were carried out during the years 2000, 2001 and 2002 in co-operation with the Archaeological Italian Mission to Oman (IMTO) of Pisa University and the Oman Government. The aim of the research was to investigate the location and floristic peculiarities of the most remarkable populations of *Boswellia* in order to propose future measures for their safeguard and improvement. Today, in fact, *Boswellia sacra* is in decline because of overgrazing, chiefly by dromedaries and goats, and cutting the trees for firewood by rural populations and local shepherds.

The Dhofar sites of *Boswellia sacra* which we investigated are mapped in fig. 1 and are briefly described as follows.

THE INVESTIGATED AREAS

A) Wadi Afal and Wadi Mughsayl (Al Mughsayl — Ajdarawt Road), a few km past Al Mughsayl; on the right at the bottom of the wadi (at the end of the down going road). Stand 1: alt. 50-112 m; coord. 16 52 02 N, 53 42 96 E. - Stand 2: alt. 100-200 m; coord.: 16 52 21 N; 53 42 77 E. - Date: 21.04.01, 27.04.01, 23.09.01, 10.09.02. - Fig. 2a, b.

These are deep-set wadis running among arid mountain gorges. *Boswellia sacra* grows on the lateral left wadis tributaries to the principal bed. In this area *Boswellia* trees are numerous and luxuriant of growth. This is probably due to the geographical location of the lateral wadis, being protected from the SW monsoon-rain by the coastal mountains, providing a suitable environment where the frankincense trees can assume notable organographic development.

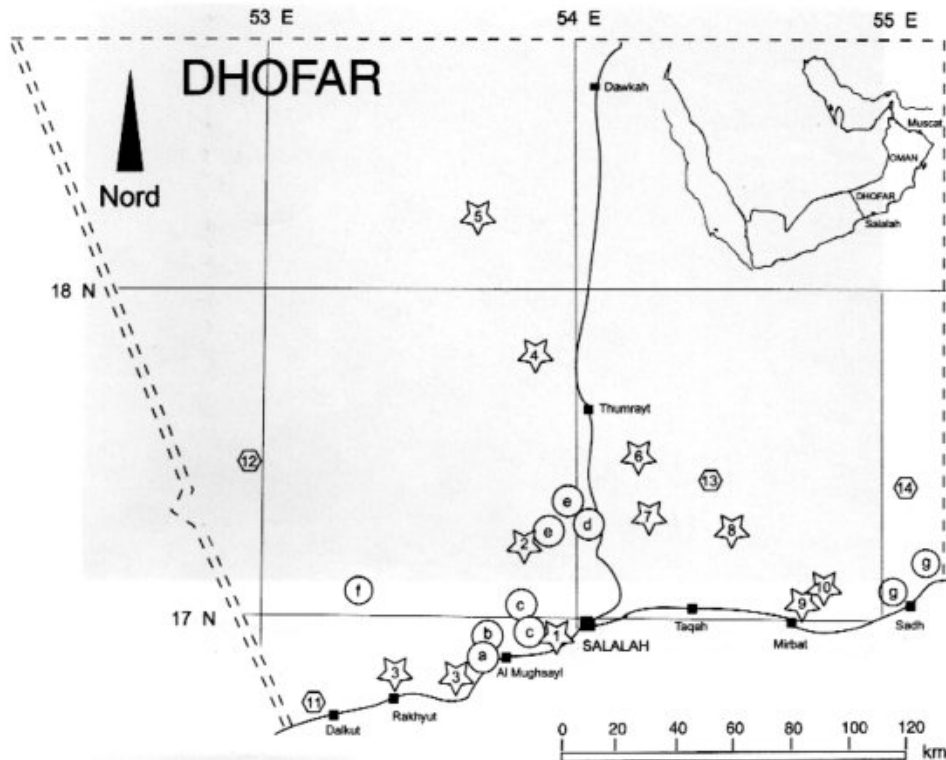


Fig. 1 — Location of the frankincense areas in Dhofar. — Open circles: main investigated areas; stars: other observed areas; hexagons: data from literature.

On the hill slopes surmounting these wadis, the *Boswellia* plants are rather scattered and spaced a few metres from one another, and most of them are in shrubby form, 2–4 m high (fig. 2a). On the other hand, in wadi beds, the plants grow in closer groups (7–9 m high); many of them assume the shape of a tree with unbranched trunks up to 1–2 m from the ground. The vegetation here is scrubland where *Boswellia sacra* is predominant (fig. 2b), with rare trees of *Commophora foliacea*, *Moringa peregrina*, *Acacia etbaica*, *Ficus cordata* subsp. *salicifolia*, *Grewia erythraea* and *Boscia arabica*. Among the trees in the gravelly and stony beds of the wadis, shrubs of *Acridocarpus orientalis*, *Fagonia schweinfurthii*, *Periploca visciformis* and the thorny *Ziziphus leucodermis* are seen. The most common herbs include: *Aerva javanica*, *Hochstettera schimperi*, *Chrozophora oblongifolia*, *Heliotropium* sp. pl., *Cleome* sp. pl., *Lavandula macra*, *Gypsophila montana* subsp. *somalensis*, *Fagonia mahrana*, a rare plant recently described by BEIER (2001), *Reseda sphenocleoides*, *Withania qaraitica*, *Teucrium* aff. *polium* (very similar to “*Teucrium* sp. A” reported in KING (1988), and the succulent *Aloe dhufarensis*.

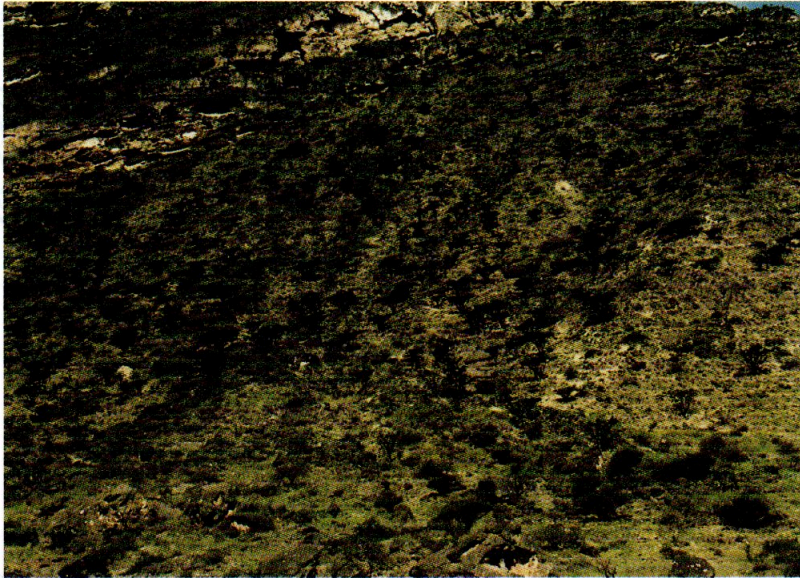


Fig. 2a — Al-Mughsayl frankincense area; *Boswellia* scrubland on the hill slopes of Wadi Afal, a few km past Al-Mughsayl.



Fig. 2b — Plants of *Boswellia sacra* in the bed of Wadi Afal (Al-Mughsayl area).

B) Wadi Ashawq (Al Mughsayl-Ajdarawt Road): cross-roads on the right immediately after the Al Mughsayl lagoon, along the wadi and its lateral tributaries, 3-8 km inland from the coast. Stand 1: alt 36 m; coord. 16 53 84 N, 53 46 35 E. - Stand 2: alt. 51 m; coord.: 16 55 24 N, 53 44 35 E - Stand 3: alt. 50 m; coord.: 16 53 88 N, 53 44 32 E - Date: 24.04.01, 02.09.02.

This is an arid valley in the final part of the course of Wadi Ashawq. The vegetation is sparse, the soil is rocky and pebbly. The frankincense trees grow especially on the banks of the wadis and on the steep hilly slopes. Locally, the wadi beds run through vertical rocky cliffs accommodating numerous *Boswellia sacra* plants and few *Acacia nilotica*, *A. laeta* and *Ficus ingens*, scattered shrubs of *Cadaba heterotricha*, *Acridocarpus orientalis*, *Jatropha pelargoniifolia*, *Fagonia luntii*, *Periploca visciformis*, as well as many herbs, among which are *Pupalia lappacea* var. *velutina*, *Heliotropium longiflorum*, *Lavandula macra*, *Commicarpus stenocarpus*, *Pulicaria jaubertii*, *Kelleronia revolii* and the small *Euphorbia hadramautica*. *Dracaena serrulata* is locally abundant on tops of the hills overlooking the wadis.

C) Wadi Adawnib, 30 km west of Salalah, 7-10 km inland from the road. Stand 1: alt. 220 m; coord. 16 56 37 N, 53 50 59 E - Stand 2: alt. 200 m; coord.: 16 57 28 N, 53 51 12 E - Date: 22.10.00, 05.09.02. - Fig. 3a, b.

These are arid rocky depressions among the hills with locally gentle or steep slopes. *Boswellia sacra* scrubland with plants 1- 4 m high, spaced 3-4 m from one another on the hill slopes (fig. 3a), more grouped in the bottom of the depressions and in the beds of the numerous wadi tributaries of the great Wadi Adawnib (fig. 3b). Besides the *Boswellia* plants, *Moringa peregrina* and *Salvadora persica* trees are scattered and sparse. A few shrubs of *Commiphora foliacea*, *Cadaba heterotricha* and several herbs such as *Arnebia hispidissima*, *Blepharis scindica*, *Heliotropium fartakense*, *Gossypium stocksii*, *Lavandula macra*, *Commicarpus boissieri*, *Dyerophytum indicum* and *Caralluma flava* also occur.

D) Wadi Doka —Salalah-Thumrayt Road, 42 km north of Salalah: rocky and pebbly semi-desert area to the left of the road. Alt: 680-550 m; coord.: 17 19 60 - 17 21 50 N; 54 03 00 - 54 05 00 E - Date: 23.10.00, 23.04.01, 28.09.01, 03.09.02, 08.09.02, 13.09.02, 14.09.02. - Fig. 4a, b.

Wadi Doka is a typical rocky and pebbly semi-desert area characterised by small rounded hills intermixed with low depressions excavated by past wadi flow. The vegetation is scarce, forming local open scrubland where the *Boswellia sacra* trees are predominant (fig. 4a). Besides the *Boswellia*, there are rare individuals of *Acacia pachyceras*, low *Euphorbia larica* bushes, a few



Fig. 3a — Frankincense trees on the hills of Wadi Adawnib area.



Fig. 3b — Plants of *Boswellia* in the bed of a wadi tributary to Wadi Adawnib.



Fig. 4a — Frankincense trees at Wadi Doka, one of the most remarkable sites in Dhofar.



Fig. 4b — Old plant of *Boswellia sacra* at Wadi Doka, showing an impressive branching architecture; the tree is about 4 m high.

xerophilous herbs such as *Blepharis scindica*, *Arnebia hispidissima*, *Centaurea pseudosinaica*, *Iphiona scabra*, *Farsetia latifolia*, *F. longisiliqua*, *Euphorbia granulata*, *Indigofera semitrijuga*, *Polygala erioptera*, *Cleome* sp. plur *Pulicaria* sp. pl., *Zygophyllum* sp. pl., *Asphodelus tenuifolius* and numerous grass species.

Currently there are about 1,200 *Boswellia sacra* plants growing in this site, scattered over a surface of 6-7 km² and extending to the sides and the wadi bed. The oldest plants, 4.0-4.5 (-5.5) m high, show an impressive branching architecture, branching as low as from the base, at or near the ground level (unlike the oldest plants in Al Mughsayl), some are undoubtedly centenarian (fig. 4b).

Wadi Doka is one of the four world heritage sites of Oman listed by UNESCO (2000). Currently the Oman Government is showing great interest in creating a National Natural Park in the Wadi Doka frankincense area on account of the wealth of the *Boswellia* population and its vicinity to Salalah town, only 42 km away along an excellent road. The Frankincense Park Project aims to provide adequate protection from animal grazing, cutting and other damaging human activities in order to assure future conservation of this natural site (RAFFAELLI et al., 2003).

E) Rocky plateau between Haluf and Uyun — Semi-desert area between Salalah and Thumrayt. Crossroad on the left about km 47 along the Salalah-Thumrayt road. Stand 1: alt. 600 m; coord.: 17 21 40 N, 53 58 88 E - Stand 2: alt. 750 m; coord.: 17 14 80 N, 53 53 33 E - Date: 23.04.01, 01.10.01.

Rocky semi-desert plateau with ridges and deep wadis. Vegetation almost absent except for scattered *Boswellia sacra* shrubs (0.5-2.5 m high) on the banks of the wadi sides; many with evident signs of browsing and cutting. On the rocky slopes of the wadis grow sparse shrubs of *Acacia tortilis*, *Moringa peregrina*, *Cadaba farinosa*, *C. heterotricha*, *Ziziphus leucodermis* and some herbaceous plants, e.g. *Ruellia longiflora*, *Andrachne telephioides*, *Crotalaria aegyptiaca*, *Limonium axillare* and the long trailing *Merremia somalensis*.

F) Hayrun — Aydam road: Alt. 600-800 m; coord.: 17 04 N; 53 21 E - Date: 13.09.02.

This is a semi-desert rocky plateau etched with deep wadis and steep-sloped gorges; the soil is gravelly and the vegetation is scarce, where scattered and stunted shrubs of *Boswellia sacra* on the sides and in the wadi beds occur. Among the *Boswellia* plants a few herbaceous species are recorded, such as *Limonium axillare*, *Cleome noeana*, *Lavandula dhofarensis* ssp. *ayunensis*, *Hochstettera schimperii*, *Fagonia luntii* and *F. schweinfurthii*.

G) Mirbat-Sadh coastal plain: car-track between Mirbat and Sadh, lowland and rocky ridges. Stand 1: alt 18 m; coord.: 17 02 86 N, 55 04 37 E - Stand 2: alt. 60 m; coord.: 17 09 10 N; 55 08 72 E - Date: 26.04.01, 16.09.02.

This is a dissected coastal plain, a few km inland from the ocean; the soil is rocky and sandy, the vegetation is scarce. Stunted scattered shrubs of *Boswellia sacra* (1-2 m high) or in small groups on the ridges and depressions grow along the road. Among the *Boswellia* plants there are rare shrubs of *Commiphora foliacea* and *Acacia tortilis*, low bushes of *Euphorbia schimperi* and *Cassia holericea*, and a few individuals of *Blepharis scindica*, *Aerva javanica*, *Cucumis prophetarum*, *Tephrosia apollinea*, *Aleuropus lagopoides*, *Cenchrus pennisetiformis* and *Aloe dhufarensis*.

OTHER LOCALITIES IN DHOFAR

In other localities of Dhofar, here and there, we encountered *Boswellia sacra* growing either isolated or in small groups (see fig. 1). These plants, generally small sized and shrubby, often exhibit cut branches or suffer of grazing, and in our opinion their state being very critical; some were dying out. These specimens are the survivors of a probably more extensive growth of frankincense trees in the past, today reduced by human activities and overgrazing.

1) - Coastal road past Raysut - Three plants are growing together and some isolated individuals in a small wadi on southern hills facing the Arabian Sea. Alt. 30-100 m; coord.: 16 55 N, 53 58 E - Date: 04.09.02.

2) - Road Teetaan-Uyun -. Some isolated plants grow in the wadi beds along the road sides. Alt. 600-700 m; coord.: 17 11 N, 53 56 E - Date: 30.04.01, 01.10.01

3) - Arid plateau between Al Mughsayl and Rakhyut - Isolated plants grow in a depression near the crossroads to Hilal and on the rocky plateau between Hilal and Defar. Alt. 700-800 m; coord.: 16 44 - 16 48 N; 53 20 - 53 22 E - Date: 30.09.01.

4) - Road Thumrayt - Ginan Bin Nawatish - A few shrubs grow on the rocky desert plateau. Alt. 425 m; coord.: 17 48 N, 53 56 E - Date: 28.09.01.

5) - On the outskirts of Shisr (the ancient Ubar) - Isolated shrubs grow on the rocky desert plateau. Alt. 350 m; coord.: 18 15 N, 53 39 E - Date: 28.09.01.

6) - Rubkoot area - Three plants grow together and some isolated individuals on a rocky wadi bank. Alt. 550 m; coord.: 17 29 N, 54 12 E - Date: 23.10.00.

7) - To north of Zayk and Ashanhab - Isolated plants grow in the the wadi beds and on the hilly slopes. Alt. 800-850 m; coord.: 17 17 N- 54 10 E - Date: 27.09.01.

8) - Semi-desert plateau near Jibjat - A few plants grow along the road side and on the rocky and sandy ground - Alt. 950 m; coord.: 17 14 N - 54 26 E - Date: 27.09.01.

9) - Mirbat inland - Small isolated shrubs grow on the hills behind Mirbat - Alt. 50-125 m; coord. 17 03 N - 54 42 E - Date: 09.09.02

10) - Wadi Ayn-Hilf (hight part), between Mirbat and Sadh - Some luxuriant plants grow on the south cliffs of Jabal Samhan. Alt. 650 m; coord.: 17 07 N, 54 48 E - Date: 17.09.02.

OTHER LOCALITIES, NOT SEEN, BUT MENTIONED IN THE LITERATURE (RADCLIFFE-SMITH, 1977; MILLER & MORRIS, 1982)

11) - Wadi Sayq along the coast, near the Yemen border.

12) - Wadi Aydim, upper section, near the Yemen border.

13) - Wadi Barbazum and Wadi Dhahabun, east of Thumrayt.

14) - Wadis behind Sadh and Hasik, to the east of the Dhofar Region.

PLANTS COLLECTED IN THE FRANKINCENSE AREAS OF DHOFAR

Floristic list

Legend (see fig. 1):

A: Wadi Afal and Wadi Mughsayl, Al Mughsayl

B: Wadi Ashawq, Al Mughsayl

C: Wadi Adawnib

D: Wadi Doka

E: Haluf-Uyun

F: Hayrun

G: Mirbat-Sadh coastal plain

collected plants and localities	A	B	C	D	E	F	G
Magnoliopsida							
Acanthaceae							
<i>Barleria acanthoides</i> Vahl		+					
<i>Blepharis scindica</i> T. Anderson		+	+	+			
<i>Dyschoriste dalyi</i> A.G. Miller				+			
<i>Ecbolium viride</i> (Forssk.) Alston	+						
<i>Justicia diffusa</i> Willd.		+	+				
<i>Ruellia longiflora</i> Vahl	+	+	+		+		

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collected plants and localities	A	B	C	D	E	F	G
Aizoaceae							
<i>Aizoon canariense</i> L.				+			
Amaranthaceae							
<i>Achyranthes aspera</i> L. var. <i>pubescens</i> (Moq.) C.C.Towns.				+			
<i>Aerva javanica</i> (Burm. f.) Juss. ex Schult.	+	+	+	+			+
<i>Alternanthera pungens</i> Kunth	+						
<i>Amaranthus graecizans</i> L. subsp. <i>graecizans</i>				+			
<i>Amaranthus hybridus</i> L. subsp. <i>hybridus</i>				+			
<i>Digera muricata</i> (L.) Mart. subsp. <i>muricata</i>		+		+			
<i>Pupalia lappacea</i> (L.) Juss. var. <i>velutina</i> (Moq.) Hook. f.	+	+					
Asclepiadaceae							
<i>Caralluma flava</i> N.E. Br.			+				
<i>Pergularia tomentosa</i> L.	+						
<i>Periploca visciformis</i> (Vatke) K. Schum.	+	+		+			
Boraginaceae							
<i>Arnebia hispidissima</i> (Lehm.) DC.		+		+		+	
<i>Echichilon kotschy</i> (Boiss. et Hohen.) I.M. Johnston				+		+	
<i>Echiochilon longiflorum</i> Benth.	+		+				
<i>Echiochilon persicum</i> (Burm. f.) I.M. Johnston			+			+	
<i>Heliotropium fartakense</i> O. Schwartz	+	+	+	+		+	
<i>Heliotropium longiflorum</i> (A. DC.) Jaub. & Spach				+			
<i>Trichodesma africanum</i> (L.) R. Br.						+	
<i>Trichodesma hildebrandtii</i> Guerke	+						
Burseraceae							
<i>Boswellia sacra</i> Flueck.	+	+	+	+	+	+	+
<i>Commiphora foliacea</i> Sprague	+		+				+
<i>Commiphora wightii</i> (Arn.) Bhandari	+						
Capparaceae							
<i>Boscia arabica</i> Pestalozzi	+						
<i>Cadaba farinosa</i> Forssk.					+		
<i>Cadaba heterotricha</i> Stocks ex Hook.		+	+				
<i>Cleome albescens</i> Franchet subsp. <i>omanensis</i> Chamb. & Lam.	+	+	+				
<i>Cleome austroarabica</i> Chamberlain & Lamond	+		+	+			
<i>Cleome brachycarpa</i> (Forssk.) Vahl ex DC.			+	+			
<i>Cleome brevipetiolata</i> D.F. Chamberlain & Lamond				+			
<i>Cleome noeana</i> Boiss. subsp. <i>noeana</i>	+	+	+			+	
<i>Maerua crassifolia</i> Forssk.					+		
Caryophyllaceae							
<i>Gymnocarpus dhofarensis</i> Petruss. & Thulin				+	+		
<i>Gypsophila montana</i> Balf.f. subsp. <i>somalensis</i> (Fr.) M. Gilbert	+						
<i>Polycarpaea spicata</i> Wight ex Arn.	+			+			
Chenopodiaceae							
<i>Halothamnus bottae</i> Jaub. & Spach							+
<i>Suaeda vermiculata</i> Forssk. ex Gmelin (syn.: <i>S. fruticosa</i>)				+			

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collected plants and localities	A	B	C	D	E	F	G
Compositae							
<i>Bidens biternata</i> (Lour.) Merr. & Sherff.	+						
<i>Centaurea pseudosinaica</i> Czerep. subsp. <i>niebuhrii</i> Wagenitz				+			
<i>Hochstetteria schimperi</i> DC.	+	+	+			+	
<i>Iphiaea scabra</i> DC.				+			
<i>Launaea almahrahensis</i> N. Kilian				+			
<i>Launaea castanosperma</i> F.G. Davies	+						
<i>Launaea massauensis</i> (Fresen.) Kuntze	+			+			
<i>Osteospermum vaillantii</i> (Decne.) Norl.				+			
<i>Pluchea arabica</i> (Boiss.) Qaiser & Lack					+		
<i>Pluchea dioscorides</i> DC.						+	+
<i>Pulicaria argyrophylla</i> Franchet var. <i>oligophylla</i> Gamal-Eldin				+			
<i>Pulicaria jaubertii</i> Gamal-Eldin	+	+		+			
<i>Pulicaria omanensis</i> Gamal-Eldin		+	+	+			
<i>Pulicaria undulata</i> (L.) C.A. Mey.						+	
<i>Vernonia arabica</i> F. G. Davies	+		+	+			
Convolvulaceae							
<i>Convolvulus glomeratus</i> Choisy	+		+				
<i>Convolvulus hystrix</i> Vahl				+	+		
<i>Merremia somalensis</i> (Watke) Hall. f.	+		+		+		
Cruciferae							
<i>Diplotaxis harra</i> (Forssk.) Boiss.	+	+					
<i>Farsetia latifolia</i> Jonsell & A.G. Miller				+			
<i>Farsetia longisiliqua</i> Decne.				+			
<i>Moricandia sinaica</i> (Boiss.) Boiss.				+			
Cucurbitaceae							
<i>Cucumis prophetarum</i> L. subsp. <i>prophetarum</i>				+			+
<i>Citrullus colocynthis</i> (L.) Schrad.							+
Euphorbiaceae							
<i>Acalypha indica</i> L.		+					
<i>Andrachne aspera</i> Spreng. var. <i>aspera</i>	+	+					
<i>Andrachne aspera</i> Spreng. var. <i>glandulosa</i> A. Rich.			+	+			
<i>Andrachne telephioides</i> L.		+	+	+	+		
<i>Chrozophora oblongifolia</i> (Del.) A. Juss. ex Spreng.	+	+	+	+			
<i>Dalechampia scandens</i> L.	+						
<i>Euphorbia arabica</i> Boiss.	+		+				
<i>Euphorbia granulata</i> Forssk.	+		+	+			
<i>Euphorbia hadramautica</i> Baker		+	+				
<i>Euphorbia hirta</i> L.	+						
<i>Euphorbia larica</i> Boiss.				+			
<i>Euphorbia schimperi</i> Presl							+
<i>Jatropha pelargonifolia</i> Courb.		+	+				
<i>Phyllanthus maderaspatensis</i> L.	+						
<i>Ricinus communis</i> L.			+				
Gentianaceae							
<i>Canscora concanensis</i> C.B. Cl.	+		+	+			+

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collected plants and localities	A	B	C	D	E	F	G
Geraniaceae							
<i>Monsonia heliotropoides</i> (Cav.) Boiss.			+	+			
Labiatae							
<i>Lavandula dhofarensis</i> A.G. Miller subsp. <i>ayunensis</i> A.G. Miller	+	+	+			+	
<i>Lavandula dhofarensis</i> A.G. Miller subsp. <i>dopharensis</i>							+
<i>Lavandula macra</i> Baker	+	+	+				
<i>Salvia</i> aff. <i>aegyptiaca</i> L.			+				
<i>Teucrium nummularifolium</i> Baker				+			
<i>Teucrium</i> aff. <i>polium</i> L.	+						
<i>Teucrium stoksianum</i> Boiss. subsp. <i>stenophyllum</i> R.A. King			+	+			
<i>Teucrium yemense</i> Deflers	+						
Leguminosae							
<i>Acacia etbaica</i> Schweinf. subsp. <i>uncinata</i> Brenan	+						
<i>Acacia laeta</i> R. Br ex Benth.		+					
<i>Acacia nilotica</i> (L.) Willd.		+					
<i>Acacia pachyceras</i> O. Schwartz				+			
<i>Acacia tortilis</i> (Forssk.) Hayne					+		+
<i>Cassia holosericea</i> Fresen.	+	+	+	+			+
<i>Crotalaria aegyptiaca</i> Benth.				+	+		
<i>Indigofera oblongifolia</i> Forssk.					+		+
<i>Indigofera semitrijuga</i> Forssk.				+			
<i>Tephrosia apollinea</i> (Delile) DC.						+	+
<i>Tephrosia quartiniana</i> Cuf.				+			
Loranthaceae							
<i>Oncocalyx schimperi</i> (Hochst. ex A. Rich.) M.G. Gilbert					+	+	
Lythraceae							
<i>Woodfordia uniflora</i> (A. Rich.) Koehne	+				+		
Malpighiaceae							
<i>Acridocarpus orientalis</i> A. Juss.	+	+					
Malvaceae							
<i>Abutilon hirtum</i> (Lam.) Sweet.			+				
<i>Gossypium stoksii</i> Masters	+	+	+				
<i>Pavonia arabica</i> Hochst. & Steud ex Boiss.	+						
<i>Pavonia triloba</i> Guill. & Perr.	+						
<i>Senra incana</i> (Cav.) DC.							+
Menispermaceae							
<i>Cocculus balfourii</i> Schweinf. ex Balfour	+						
Moraceae							
<i>Ficus cordata</i> Thunb. subsp. <i>salicifolia</i> (Vahl) C.C. Berg	+						
<i>Ficus ingens</i> (Miq.) Miq. (syn.: <i>F. lutea</i> Vahl)		+					
Moringaceae							
<i>Moringa peregrina</i> (Forssk.) Fiori	+		+		+		
Nyctaginaceae							
<i>Boerhavia elegans</i> Choisy			+				+
<i>Commicarpus boissieri</i> (Heimerl) Cuf.	+		+	+			+
<i>Commicarpus stenocarpus</i> (Chiov.) Cuf.		+					

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(continued)

collected plants and localities	A	B	C	D	E	F	G
Oleaceae							
Jasminum grandiflorum L. subsp. floribundum (Fresen) P. Green							+
Orobanchaceae							
Cistanche rosea Baker	+						
Cistanche tubulosa (Schenk.) Hook f.	+						
Orobanche cernua Loefl.	+						
Papaveraceae							
Argemone mexicana L.	+						
Plantaginaceae							
Plantago ovata Forssk.	+	+		+			
Plumbaginaceae							
Dyerophytum indicum (Gibs. ex Wight) Kuntze	+		+		+		
Limonium axillare (Forssk.) Kuntze	+			+	+	+	+
Polygalaceae							
Polygala erioptera DC.				+			
Polygala obtusissima Hochst.	+	+					
Polygala tinctoria Vahl	+						
Polygonaceae							
Rumex vesicarius L.	+			+			
Portulacaceae							
Portulaca quadrifida L.	+	+	+				
Resedaceae							
Reseda sphenocleoides Deflers	+	+	+	+	+		
Rhamnaceae							
Ziziphus leucodermis (Baker) O. Schwartz	+	+			+		
Salvadoraceae							
Salvadora persica L.			+		+		
Scrophulariaceae							
Anthicharis glandulosa Aschers.							+
Campylanthus mirandae/pungens					+		
Kickxia qaraica D.A. Sutton	+		+	+			
Lindenbergia muraria (Roxb.) Bruhl.	+			+			
Schweinfurthia spinosa Miller, Sutton & Short				+			
Solanaceae							
Physalis angulata L.	+		+				
Withania qaraitica A. Miller & J. Biagi	+						
Withania somnifera (L.) Dun	+						
Sterculiaceae							
Hermannia paniculata Franch.	+		+	+			
Melhania muricata Balf. f.	+	+	+				
Tamaricaceae							
Tamarix aphylla (L.) Karst.		+			+		
Tiliaceae							
Corchorus depressus (L.) Stocks		+	+				
Corchorus trilocularis L.	+						
Grewia erythraea Schweinf.	+		+				

(next page)

(continued)

collected plants and localities	A	B	C	D	E	F	G
<i>Grewia gillettii</i> Sebsebe (syn.: <i>G. bicolor</i> Juss.)	+						
<i>Grewia villosa</i> Willd.	+						
Umbelliferae							
<i>Ammi majus</i> L.				+			
Urticaceae							
<i>Forsskaolea tenacissima</i> L.	+				+		
<i>Forsskaolea viridis</i> Ehrenb.	+						
Violaceae							
<i>Viola cinerea</i> Boiss.	+	+	+	+			
Zygophyllaceae							
<i>Fagonia luntii</i> Baker		+	+			+	
<i>Fagonia schweinfurthii</i> (Hadidi) Hadidi	+		+	+		+	
<i>Fagonia mahrana</i> Beier	+						
<i>Kelleronia revolii</i> (Franch.) Chiov.	+	+					
<i>Zygophyllum album</i> L. f.				+			
<i>Zygophyllum coccineum</i> L.		+					
<i>Zygophyllum decumbens</i> Del.					+		
<i>Tribulus terrestris</i> L.					+		
Liliopsida							
Agavaceae							
<i>Dracaena serrulata</i> Baker	+	+					
Aloaceae							
<i>Aloe dhufarensis</i> Lavranos	+	+	+	+			+
Asphodelaceae							
<i>Asphodelus tenuifolius</i> Cav.	+			+			
Asparagaceae							
<i>Asparagus africanus</i> Lam.	+						
Cyperaceae							
<i>Cyperus conglomeratus</i> Rottb.	+		+				
Gramineae							
<i>Aeluropus lagopoides</i> (L.) Trin. Ex Thwaites	+		+				
<i>Aristida adscensionis</i> L.		+		+			
<i>Cenchrus pennisetiformis</i> Hochst. & Steud.	+	+	+				+
<i>Chloris virgata</i> Sw.	+						
<i>Chrysopogon plumulosus</i> Hotchst.		+		+			+
<i>Cymbopogon schoenanthus</i> (L.) Spreng.				+			
<i>Dactyloctenium aegyptium</i> (L.) Willd.				+			
<i>Dactyloctenium scindicum</i> Boiss.	+			+			
<i>Dichanthium foveolatum</i> (Delile) Roberty	+			+			
<i>Digitaria ciliaris</i> (Retz.) Koel.	+						
<i>Eragrostis barrelieri</i> Daveau				+			
<i>Panicum atrosanguineum</i> Hochst. ex A. Rich.			+				+
<i>Stipagrostis sokotrana</i> (Vierh.) de Winter				+			
Palmae							
<i>Nannorrhops ritchiana</i> (Griff.) Aitch.	+						

FLORISTIC COMMENTS

Despite the arid and rocky environment of most frankincense areas in Dhofar, about 180 species were collected; some of them are of particular interest because they are new to Oman or to the Dhofar region.

New to Oman:

Andrachne aspera Spreng. var. *glandulosa* A. Rich. (*Euphorbiaceae*)- New findings: Wadi Adawnib and Wadi Doka. - These plants show a dense glandular hairy indumentum typical of var. *glandulosa* recorded, up to now, from W C Saudi Arabia (COLLENETTE, 1985) and Yemen (WOOD, 1997).

Ecbolium viride (Forssk.) Alston (*Acanthaceae*) - New finding: Al-Mughsayl - Previously recorded from Saudi Arabia (COLLENETTE, 1985; MILLER & COPE, 1996) and Yemen (WOOD, 1997).

Euphorbia hirta L. (*Euphorbiaceae*)- New finding: Al Mughsayl - Recorded from Saudi Arabia (COLLENETTE, 1985) and Yemen (WOOD, 1997).

Physalis angulata L. (*Solanaceae*) - New finding: Al-Mughsayl. Previously recorded from Yemen (WOOD, 1997). The large calix of this plant fully agrees with *P. angulata* rather than with *P. minima* Link recorded from Dhofar in MILLER & MORRIS (1988).

Zygophyllum coccineum L. (*Zygophyllaceae*) - New finding: Wadi Adawnib - Previously recorded from Saudi Arabia (COLLENETTE, 1985), Yemen (WOOD, 1997) and Ethiopia (HADIDI in HEDBERG & EDWARDS, 2000).

New to the Dhofar region

Amaranthus hybridus L. subsp. *hybridus* (*Amaranthaceae*) - New finding: Wadi Dokha - Previously recorded from N Yemen and N Oman (MILLER & COPE, 1996).

Teucrium stoksianum Boiss. subsp. *stenophyllum* R.A. King (*Labiatae*)- New finding: Wadi Doka - Recorded, up to now, from NE Oman (KING 1988).

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Summary

Dhofar, the southern region of Oman is, together with Yemen and N Somalia, where the Frankincense tree *Boswellia sacra* grows. The aim of this research was to investigate the location and floristic peculiarities of the most relevant populations of *Boswellia* in order to propose future measures for their safeguard and improvement. The most important Frankincense sites in Dhofar are described and mapped. A floristic list of 180 taxa is also given: some are new to Oman or to the Dhofar region.