MEDITERRANEAN ELEMENTS IN ROCKS OF THE NEGEV AND SINAI DESERTS

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ABSTRACT. Numerous species common in the Mediterranean region, where the annual rainfall is above 300 mm, are found in a special habitat in the Negev and N Sinai with 80–150 mm of rainfall. This paper describes and attempts to interpret the phytogeographical significance of this phenomenon.

OBSERVATIONS

Most of the species listed in Table 1 grow in the Mediterranean zone of Israel in "batha" (= phrygana) and macchie and are confined there to areas with an annual rainfall of 300–1000 mm (cf. fig. 1). In the anticlines of the Negev and Northern Sinai (Isthmic Desert), they are restricted to crevices and soil pockets of smooth-faced horizontal, sloping and terraced rock-outcrops and on low cliffs (cf. Davis, 1951, Danin, 1967); here the rainfall is 80–150 mm.

The smooth-faced rock-outcrops, uncovered by soil or stones, are found in anticlinal ridges mostly in two geomorphic positions: 1, dip-slope of hard rocks steeply inclined where the transportation of weathered materials is faster than their accumulation; 2, strike slopes of homogeneous hard rocks in northern exposures where crustose lichens cover the rock, preventing fissuring or fracturing of rock surface by weathering agents. In these conditions, high run-off from the exposed rock concentrated in crevices and soil pockets leads to a relatively submesic water regime. It was observed that even weak showers of 1 mm led to small floods concentrated in the crevices; stronger showers saturated the soil at the foot of rock outcrops. In the area with 70–150 mm of rainfall, the presence of smooth-faced rock habitats is dependent mainly on geomorphological factors. In many cases the rock type influences the floristic composition much more than altitude does. One can find more Mediterranean species in low altitudes than in higher ones if there are well developed smooth-faced rock-outcrops in the lower ones; i.e. there are far more Mediterranean species in Gebel Libni (460 m) than in Shushet el Maghara (770 m) since there are smooth-faced rock-outcrops in the first one and fissured rocks covered with soil in the second.

The same phenomenon can be demonstrated in tree distribution. (cf. Danin & Orshan, 1970); in Gebel Halal at the 400–500 m belt there are far more *Juniperus phoenicea* trees than on the peaks of Gebel Yi'allaq (1090 m) due to differences in rock types.

As the occurrence of such relatively mesophytic and rare desert species is virtually constant on smooth-faced rocks, one can in fact predict the occurrence of such plants. This was the case when on an excursion to Gebel Halal we chose a smooth-faced rock-outcrop of 300 × 500 m after observing

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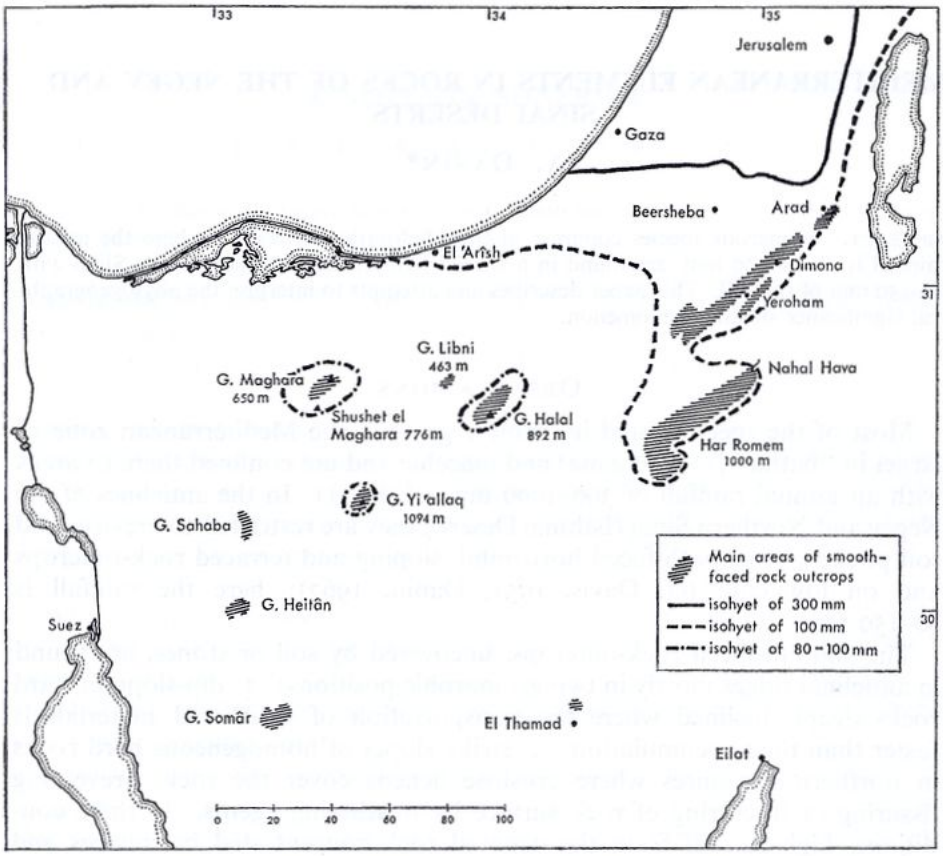

FIG. 1. Distribution of smooth-faced rock-outcrops in the Negev and N Sinai. The rainfall isohyets are taken from "The Atlas of Israel".

it from a distance of 10 km. We found there dozens of Junipers distributed on the slope (and not in runnels as they grow in other anticlines). Among the other interesting species there were *Ephedra campylopoda*, *Astoma seselifolium* (Umbelliferae) and *Origanum isthmicum* (Danin, 1969) which is endemic to a 5 km belt in Gebel Halal.

The Mediterranean species growing in the desert resemble very much their counterparts found beyond the desert gap. Apart from *Rosularia lineata* which seems to be a different variety, most of the species listed in Table 1 are not worth taxonomic separation even at infraspecific rank.

CONCLUSIONS

The most probable explanation of the distribution pattern described above is that these are markers of recent shrinkage of the Mediterranean flora. This flora covered in the past a wider range of habitats when the climate was more humid and after "desertification" of the area they became extinct in most habitats, surviving in the rock crevices which provide a submesic water regime. This assumption fits with palynological findings of a submesic Mediterranean flora in the mountains of the Central Sahara dating 2800–10,000 B.C. (Quézel & Martinez, 1961). These authors deduced that

TABLE 1

Habitats and distribution of several Mediterranean species

Abbreviation. Life forms—(T) = tree; (Ch) = chamaephyte; (H) = hemicryptophyte; (G) = geophyte; (L) = climber. Habitats—B = batha (phrygana), mostly on rocky mountains; M = macchie; C = crevices and small soil pockets in smooth-faced outcrops of hard rocks; P = large soil pockets (> 50–100 cm) in smooth-faced rock-outcrops or at the foot of such outcrops; RF = runnels with smooth-faced rock-outcrops in their catchment area; R = runnels with various types of rocks and soils in their catchment area; ( ) = not common.

	In Mediterranean zone		In the desert		
Species & life form	Annual rainfall (mm)	Habitat	Location	Annual rainfall	Habitat
Andropogon distachyus (*H*)	400–1000	B	Yeroham	100	C
Arum palaestinum (G)	450–800	B, M	Arad	100	C
Astoma seselifolium (G)	300–400	B	Arad, Dimona, Yeroham	80–100	C, P.
Astoma seselifolium	400–700	weed in cereals	Har Romem, G. Halal	80–100	C, P.
Ballota undulata (Ch)	300–700	B	all the anticlines	80–150	C, RF (R)
Ceterach officinarum (H)	350–1000	rocks in B, M.	Yeroham, H. Romem, G. Halal	80–100	C
Cheilanthes fragrans (H)	350–1000	rocks in B, M.	Arad, Yeroham, H. Romem G. Maghara	80–100	C
Cynoglossum creticum (H)	450–1000	B	Yeroham	100	C
Ephedra campylopoda (L)	400–1000	M	G. Halal, G. Yi'allaq	80–100	C
Fumana arabica (Ch)	450–1000	B, M.	G. Maghara	80–100	C
Fumana thymifolia (Ch)	350–1000	B	all the anticlines	80–100	C
Juniperus phoenicea (T)	above 500	M	G. Halal, G. Maghara, G. Yi'allaq	80–100	C, RF.
Narcissus tazetta (G)	500–1000	B, heavy swampy soil	Dimona-Yeroham	100	C
Orzyopsis miliacea (H)	400–1000	B	all the anticlines	80–100	C, RF
Phagnalon rupestris (Ch)	300–1000	B	all the anticlines	80–150	C, RF (R).
Phlomis brachyodon (H)	250–350	B	Yeroham	100	C, RF
Prasium majus (L)	400–1000	M	H. Romem	100	C
Rosularia lineata (H)	500–700	cliffs	N. Hava, G. Halal, G. Maghara	80–100	C
Rubia tenuifolia (L)	400–1000	M	G. Halal	80–100	C
Sarcopoterium spinosum (Ch)	300–1000	B	Dimona, Yeroham	100	C, P, RF
Sternbergia clusiana (G)	450–1000	B, M	Yeroham, H. Romem	100	C (RF)

'desertification' of the Central Sahara took place in two phases beginning circa 2800 and 500 B.C. Of the 13 submesic species listed in their pollen analysis, 10 do not grow there any more; the only relics are endemic vicariads of the Mediterranean *Olea*, *Cupressus* and *Myrtus* (Quézel, 1964). We have not collected palynological data yet, but the taxonomic resemblance of the desert-Mediterranean populations can serve for dating this disjunction to Sub-Recent, post-pluvial "desertification". According to dendrochronological data from Junipers of N Sinai (Waisel et al., 1968), it seems that desiccation in N. Sinai was not so rapid as in the Sahara. They deduced that in the last 600 years there were gradual changes in annual rainfall from 300 mm to 30 mm (today—100 mm). From our data we can conclude that in the "rain deserts" (Zohary, 1962) of the Near East, relics of past invading floras will be found in crevices and soil pockets of smooth-faced rock-outcrops, disjunct from their main area where they grow as components of relatively mesic plant communities. In southern Sinai this phenomenon was found on sandstone, magmatic and metamorphic rocks as well.

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