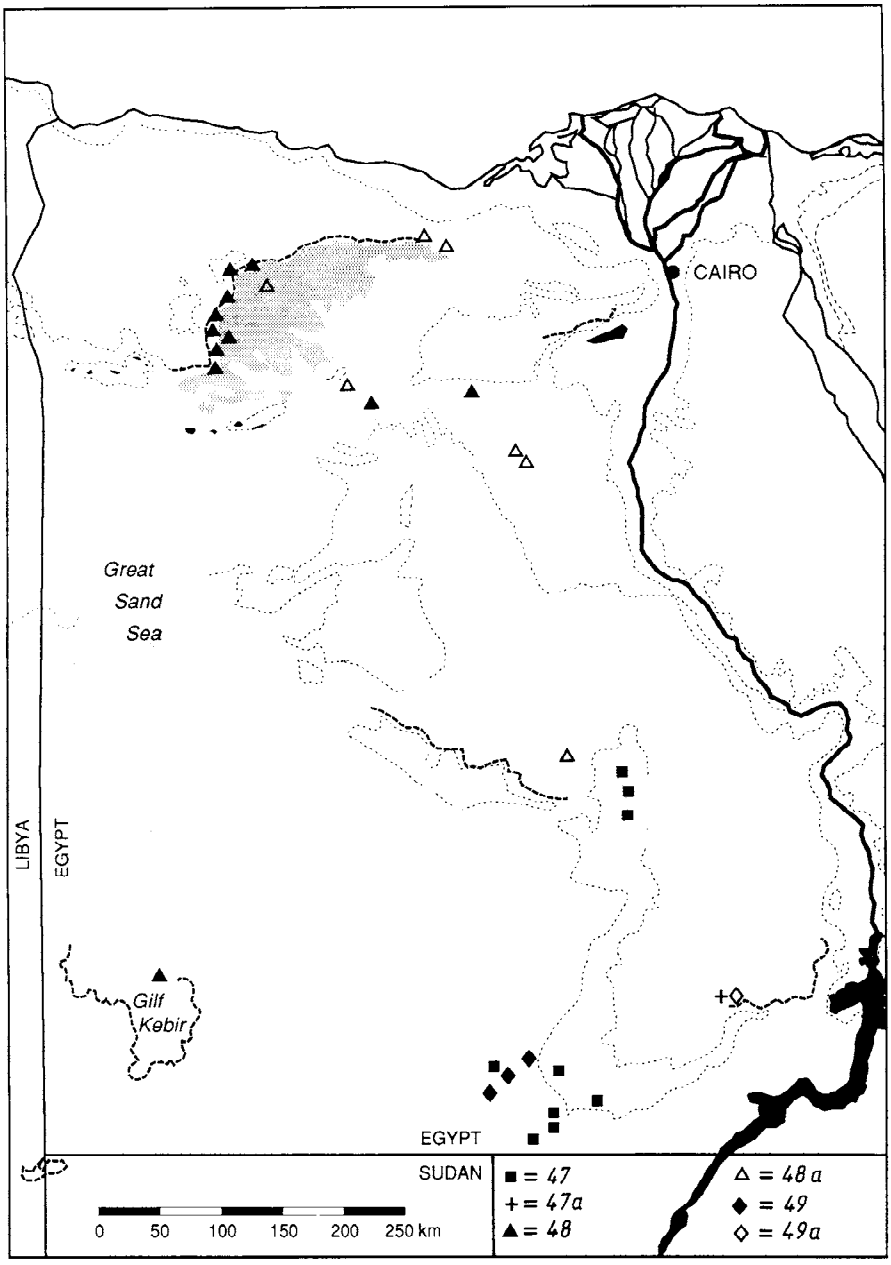


Fig. 13. Sampling places of vegetation units 47–49.
47 *Hyphaene thebaica* stands, 47a record from literature (ZAHRAN 1968); 48 Zygophyllum coccineum-Acacia raddiana ass.; 48a records from literature (SHAW & HUTCHINSON 1931, 1933; KASSAS 1971; LÉONARD 1969; PÖHLMANN et al. 1982a, b, c, d, 1984); 49 *Acacia ehrenbergiana* stands; 49a records from literature (SHAW & HUTCHINSON 1931, 1933; ZAHRAN 1968; PÖHLMANN et al. 1982e; ALBERTZ et al. 1987).
For further information see Fig. 2.

coccineum or other components of the Zygophyllum-Schouwia ass. and grows most vigorously in the same area (the northern part of the Qattara depression, see Fig. 13). We can, therefore, speak of a Zygophyllum coccineum-Acacia raddiana ass. (Table 10: 48). *Aca-*

Table 10. 46 Phoenix dactylifera ass. (P); 47 *Hyphaene thebaica* stands (H); 48 Zygophyllum coccineum-Acacia raddiana ass. (ZA); 49 stands of *Acacia ehrenbergiana* (A); 50 stands of *Cocculus pendulus* (Cp); 51 stands of *Capparis decidua* (Cd).
For further explanation see Table 1.

	-46- P			-47- H			-48- ZA			-49- A			-50- Cp			-51- Cd		
average species number	2.1			1.6			3.8			1.0			1.7			1.0		
average height (dm)	67			105			69			34			4			14		
number of relevés	31			8			23			5			3			2		
vitality	92/3/5			85/0/15			83/3/14			100/0/0			100/0/0					
	T	C	P	T	C	P	T	C	P	T	C	P	T	C	P	T	C	P
Phoenix dactylifera	4	63.7	100		7.8	13								0.2	33			
Hyphaene thebaica				5	58.2	100												
Acacia raddiana							5	73.0	100									
Zygophyllum coccineum		0.1	3				2	3.7	52									
Acacia ehrenbergiana										5	87.5	100						
Cocculus pendulus													2!	10.8	100			
Capparis decidua																2!	20.0	100
Tamarix nilotica	1	5.7	19		1.3	13												
Juncus rigidus	1	5.2	32		0.1	25												
Imperata cylindrica		0.1	6		0.1	13								0.2	33			
Salsola baryosma ssp. gaetula		1.6	13					0.3	17									

In only one of the units occurred: P: Stipagrostis vulnerans -/0.0/3; Sporobolus spicatus -/0.1/10; Phragmites australis -/0.1/10; Nitraria retusa -/0.4/6; Periploca angustifolia -/1.9/6. ZA: Cotula cinerea (+) 0.1/22; Schouwia thebaica -/0.5/22; Atriplex leucoclada -/0.5/17; Reseda kahirina -/0.1/13; Anastatica hierochuntica (+)/0.1/13; Pulicaria undulata -/0.2/13; Trigonella stellata -/0.0/9; Calligonum comosum +/0.0/9; Fagonia bruguieri -/0+0/9; Astragalus vogelii Francoeuria crispa -/0.5/9; Randonia africana -/0.5/9; Stipagrostis plumosa -/0.1/9; Fagonia arabica -/0.0/9; Torularia toruosa -/0.0/9; Lotus glinoides -/0.0/4; Zygophyllum simplex -/0.0/4; Cleoma aegyptia -/0.0/4; Oligomeris linifolia -/0.0/4; Monsonia nivea -/0.0/4; Launaea nudicaulis -/0.0/4; Pituranthos tortuosus -/0.1 -/0.1/4; Euphorbia chamaesyce -/0.0/4.

cia raddiana becomes very rare south of the Qattara depression and is lacking in the driest part of the East Sahara showing a large gap in our area under investigation. Around this gap the tree is distributed in most parts of North Africa (FRANKENBERG & KLAUS 1980), and *Acacia raddiana* stands with different floristic composition are described from e.g. South Algeria (WOJTERSKI 1985), Libya (even the extreme southeast: SHAW & HUTCHINSON 1931, LÉONARD 1971), the Eastern Desert (KASSAS & GIRGIS 1969/70, 1970; see also HASSAN 1987), Saudi Arabia (e.g. BATANOUNY & BAESHIN 1983, BAIERLE et al. 1985, BAIERLE & FREY 1986, BATANOUNY 1987), Sinai (DANIN 1986) and from the Arava valley (ZOHARY & ORSHAN 1956; ZOHARY 1973 1982; DANIN 1983). Evidently a whole series of *Acacia raddiana*-communities has to be discerned.

In our area the Zygophyllum-Acacia ass. (Photo 8) forms small stands of contracted vegetation, usually comprising not more than a few (up to several dozens) trees with very open structure (see the contributions of the different life forms, Table 18). ZOHARY (1973) speaks of 'pseudosavanna'. Saharo-Arabian and Sudanian elements are equally important. The structure of one of the largest stands we encountered is presented in Fig. 14. Nearly all stands show signs of browsing, cutting and drying up (Table 11). Permanent plots would be helpful in order to predict the future development of these endangered kind of vegetation.

Stands of *Acacia ehrenbergiana* (Table 10: 49) reach their northern limit in our investigated area (Fig. 13). They form monotypic stands – no companion ever has been detected by us – in form of large hillocks in the region between Bir Safsaf and Bir Kiseiba (see BORNKAMM 1986) and Wadi Dungul (ZAHRAN 1968). The notion 'dry acacias' in PÖHLMANN et al. (1982e) resp. ALBERTZ et al. (1987) may refer to *Acacia ehrenbergiana*. This species grows as a shrub, like it

Photo 8. Zygophyllum coccineum-Acacia raddiana ass. (48) in Wadi Ghuweidir S of Qara.

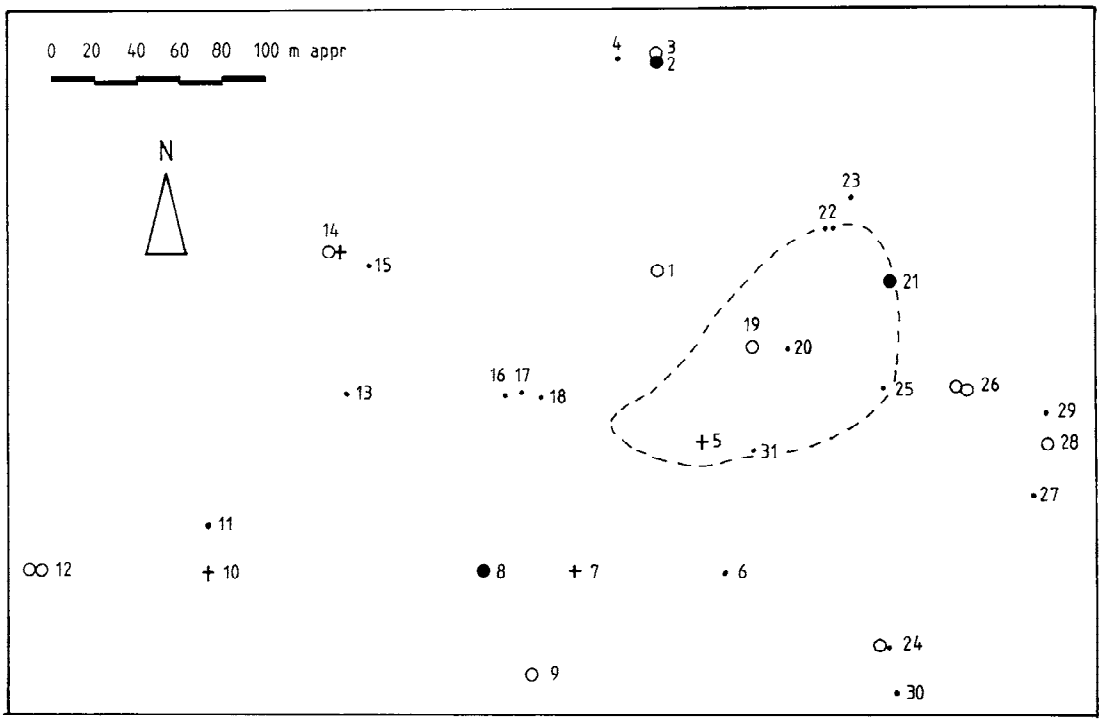


Fig. 14. Population structure of an *Acacia raddiana* stand near the Bahariya-Giza road, 20°53'N, 29°28'E. – Open circles: living, diameter > 20 cm; closed circles: dead, diameter > 20 cm; dots: living, diameter < 20 cm; crosses: dead, diameter < 20 cm; (see also Table 11). – – – Limit of the scattered understory vegetation (*Salsola baryosma* ssp. *gaetula* and *Stipagrostis plumosa*).

Table 11. Size and vitality of *Acacia raddiana* in a stand near the Bahariya-Giza road, 20°53'N, 29°28'E (distribution see Fig. 14).

Number	vitality	diameter (cm) in 50 cm height	height (m)
1	green, fruiting	26	4
2	dead	28	5
3	60 % green	32	5
4	green, shrub	-	1,2
5	dead	19	broken
6	green, fruiting	7	2,0
7	dead	12	broken
8	dead	23	broken
9	green	18	4,5
10	dead	19	broken
11	50 % green, shrub	3	1,2
12	I 50 % green, fruiting, wilting	30	5
	II 30 % green, fruiting, wilting	22	5
13	green, shrub	2,5	1,2
14	I dead	26	4
	II	14	4
15	80 % green, shrub	3	1,4
16	shrub, green	4	1,8
17	shrub from old trunk, fruiting	3	1,2
	(old trunk	13	broken)
18	shrub from old trunk, fruiting	5	1,6
	(old trunk	15	cut)
19	10 % green, fruiting some branches cut	35	5,5
20	70 % green,fruiting	18	3,5
21	dead	trunk cut	
22	I green, fruiting	16	broken
	II green, fruiting	16	4
23	green, fruiting	16	3,5
24	I dead, one branch cut	23	4
	II green	18	3,5
25	green, shrub	1	0,7
26	I 50 % green, fruiting	22	cut
	II 20 % green, fruiting	22	5
27	green, fruiting	17	3,8
28	green, fruiting	21	3,8
29	green	-	0,4
30	green, shrub	2	1,1
31	80 % fruiting	16	3,5

usually does in the Eastern Desert (SPRINGUEL, pers. comm.; see also KASSAS & GIRGIS 1969/70, EL-HADIDI & SPRINGUEL 1978, SPRINGUEL 1985, SPRINGUEL et al. 1986). In the Arabian peninsula it can grow as gree, and here it is associated with a number of other species (BATANOUNY & BAESHIN 1983; BAIERLE et al. 1985; BAIERLE & FREY 1986; DEIL 1986; KÖNIG 1987, 1988; BATANOUNY 1987).

Specimens of *Capparis decidua* (Table 10: 51), forming stands with phytogenic mounds (Photo 9), occur rarely in the south of our area (see also BORNKAMM 1986). Stands of *Cocculus pendulus* (Photo 10) were seen by us only in the northern part of the Farafra oasis (Table 10: 50, Fig. 12). This species occurs more frequently in the Eastern Desert (KASSAS & GIRGIS 1969/70, HASSAN 1987) and seems to reach in Farafra the western limit of its Egyptian distribution (FRANKENBERG & KLAUS 1980).

Finally it should be mentioned that some *Tamarix* species, which are main components of the vegetation of the oases, try to grow in rain-fed areas (one example is presented in Fig. 10G). This is especially true for *Tamarix nilotica* which nearly without companions becomes a component of the accidental vegetation (Tamaricetum nudum typical subass., see chapter 3.5.3.2.).

Photo 9. *Capparis decidua* 20 km E of Bir Kurayim.

Photo 10. *Cocculus pendulus* ca. 35 km NNE of Qasr El-Frarafra.

3.4. Precipitation-dependent contracted accidental vegetation

3.4.1. Zygophyllum coccineum-Salsola baryosma ass. (Table 9: 40–43)

This association is the most important vegetation type outside the oases in the south of our investigation area. Special run-off conditions are needed to allow plant growth under climatic conditions with less than 5 mm precipitation per

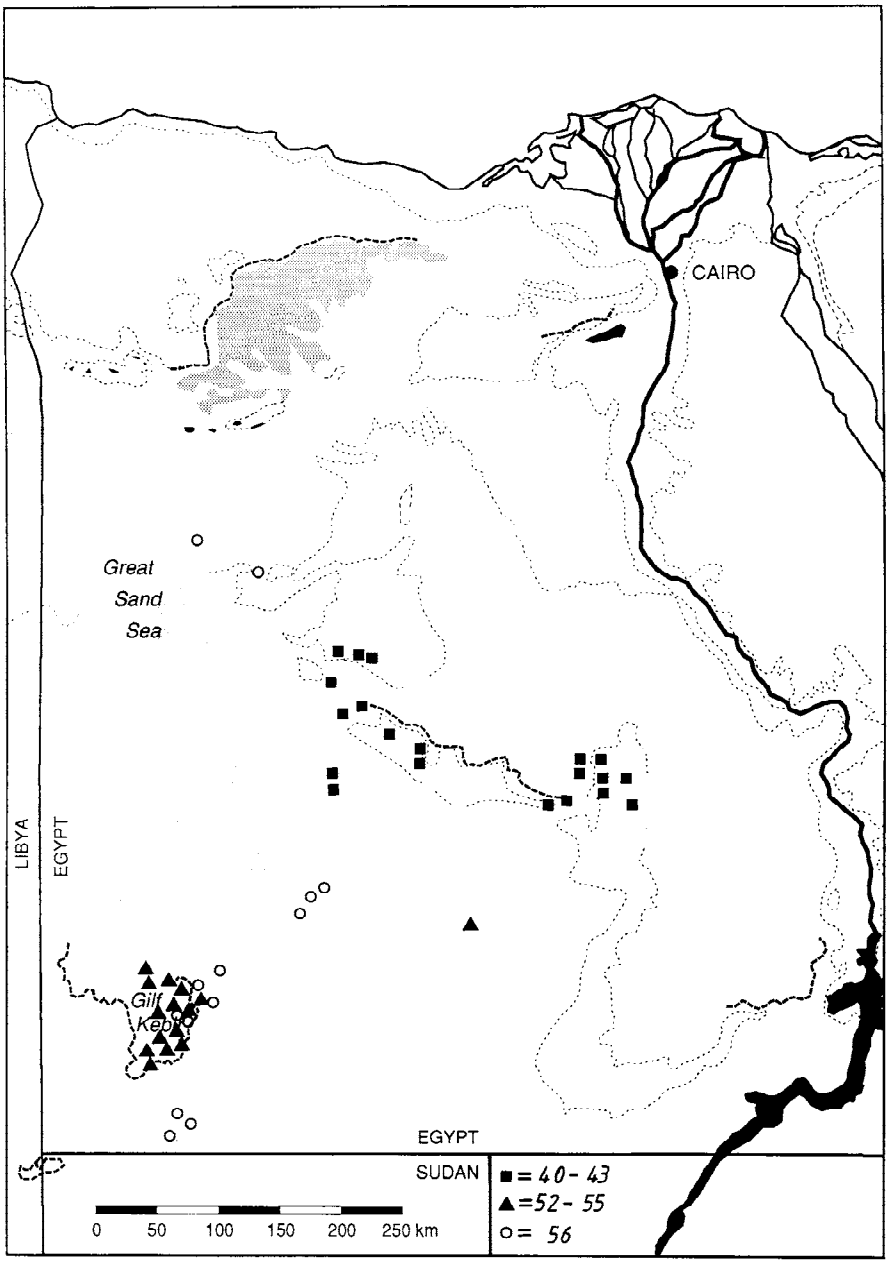


Fig. 15. Sampling places of vegetation units 40–43 and 52–56.
40–43 Zygophyllum coccineum-Salsola baryosma ass.; 52–55 *Salsola baryosma* stands, *Fagonia arabica* stands and Stipagrostis acutiflora-Zilla spinosa ass.; 56 pure stands of *Stipagrostis acutiflora*.

year (on the average). Such conditions are provided in the pediment area of the steep slopes of the Abu Tartur and other hills between and around the Kharga and Dakhla oases (Fig. 15). The variability of the association can be described as follows: The typical subass. (40) usually grows in small runnels, the Zilla spinosa subass. (41) in small depressions, the Astragalus vogelii subass. (43) in larger runnels, the Trichodesma subass. (42) in larger depressions, or otherwise good run-off conditions. The latter contains the rare species *Psoralea plicata* as an interesting component and *Fagonia bruguieri* here shows its maximum performance. The number of species increases in the direction mentioned. In the Astragalus subass. *Morettia phileana* occurs, which was already regarded by KASSAS (1971) to be an important species of the accidental vegetation (see also the *Morettia* community in the Eastern Desert, KASSAS & GIRGIS 1969/70). The vitality figures are very low indicating that the vegetation is predominantly accidental. The vegetation spots are very small and not differentiated into subunits. This kind of vegetation may have grown since long time in this area: age determinations of *Salsola baryosma* material ranged between one and five centuries (HAYNES & HAAS 1980).

Similar plant communities occur in the Nubian Desert EL-HADIDI 1980, EL-SHARKAWI et al. 1982a, b). Phytogeographically the situation starts to change: Although the Saharo-Arabian element still is the dominating element (59 % on the average), the Sudanian element is a strong codominant (34 %, i.e. more than in the Zygophyllum-Schouwia ass.) and it is the main element in one of the subunits (Astragalus subass.). The life form spectrum is rather diverse, comprising considerable amounts of all life forms except trees, but changes very much according to the subunits (Table 19). This is not astonishing: The more specimens by the growing conditions are forced to perform short life cycles the less meaningful is the traditional life form system.

3.4.2. Vegetation of the Gilf Kebir area (Table 12)

In the southwesternmost part of our investigation area, the Gilf Kebir plateau attains altitudes of more than 1000 cm above sea level. In and around this plateau accidental vegetation occurs. In shallow depressions on the plateau grow stands of *Salsola baryosma* ssp. *baryosma* (52), in depressions or edges of the wadis stands of *Fagonia arabica* (53). On sandy deposits and terraces the Stipagrostis acutiflora-Zilla spinosa ass. (Table 12: 54–56) is developed. *Zilla spinosa* and *Citrullus colocynthis* occur only on the deepest soils in larger wadis, and are surrounded by *Fagonia* and *Stipagrostis*. In narrower wadis *Fagonia* frequently forms a vegetation strip along the wadi edge (*Fagonia arabica* stands, Table 12: 53; Photo 11). If *Stipagrostis* grows in the same habitat, it usually builts up an outer margin (see Fig. 16 on low dunes on the left, but not at the steep slope on the right). A special habitat is provided by fritted sandstones around volcanites. Remains (litter) of a larger number of plant species can be found here. Since we did not see these plants in situ we are not able to describe the structure of this type of plant community or commu-

Table 12. 52 *Salsola baryosma* stands (S); 53 *Fagonia arabica* stands (F).
Stipagrostis acutiflora-Zilla spinosa ass. (SZ): 54 SZ-t typical subass.; 55 SZ-F *Stipagrostis acutiflora-Zilla spinosa-Farsetia ramosissima* assembly; 56 SZ-n pure *Stipagrostis* stands (Stipagrostietum nudum).
For further explanation see Table 1.

	-52- S		-53- F		-54- SZ-t		-55- SZ-F		-56- SZ-n	
average species number	1.5		1.3		3.2		3.9		1.0	
number of relevés	28		26		5		16		23	
vitality	0/2/98		0/9/91		0/0/100		0/0/100		0/26/74	
	T	P	T	P	T	P	T	P	T	P
Salsola baryosma ssp. baryosma	x	100						6		
Fagonia arabica			x	100	x	60		19		
Stipagrostis acutiflora		46		27	x	80	x	94	x	100
Zilla spinosa		4			x	80		19		
Citrullus colocynthis					x	100				
Farsetia ramosissima								63		
Astragalus vogelii								50		

In only one of the units occurred:
SZ-F Trichodesma africanum x/38; Fagonia indica -/31; Tribulus of pterocephalus -//31; Schouwia thebaica x/13; Monsonia nivea -/13; Prasium majus -/13; Acacia raddiana -/6.

Photo 11. Stands of *Fagonia arabica* (53) in Wadi Maftuh, Gilf Kebir. Series of phytogenic mounds along the wadi edge formed by the *Fagonia arabica* as only species present. All specimens are dead and the mounds are in the process of erosion.

nities (see *Stipagrostis-Zilla-Farsetia* assembly, Table 12: 55), see also the findings of OSBORN & KROMBEIN (1969) and BOULOS (1980). The vegetation of the Gilf Kebir area and its living conditions have been discussed more in detail by ALAILY et al. (1987a).

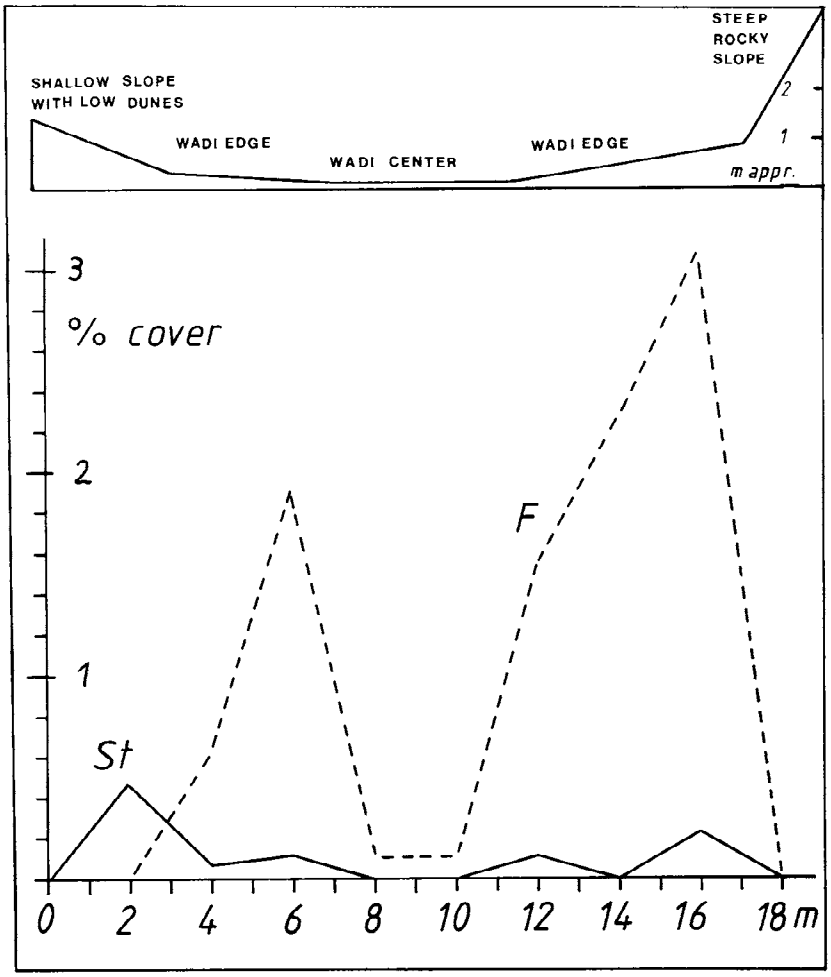


Fig. 16. Distribution of *Fagonia arabica* (F) and *Stipagrostis acutiflora* (St) in a shallow wadi at the eastern edge of the Gilf Kebir plateau 23°14'E (63 squares a 4 sqm., 1.12.82).

Pure *Stipagrostis* stands (S t i p a g r o s t i e t u m n u d u m in Table 12: 56), usually consisting in only very few tussocks (BORNKAMM 1987a, occur in the Great Sand Sea and from the southwesternmost corner of Egypt to the Abu Ballas region, where it forms the border to the large vegetation-free region in the south of our investigated area (see chapter 4.2.).

3.5. Groundwater-dependent vegetation

3.5.1. Introduction

The area under investigation is completely void of rivers or streams. Even temporary water flow over a distance of several km usually takes place only in the coastal area between the first or second escarpment and the Mediterranean. Nearly all groundwater-dependent habitats, therefore, are saline. Since the main aim of the present investigation was to study the vegetation outside the oases, the types of groundwater-dependent vegetation will be discussed here

Table 13. 57 *Cyperus laevigatus* stands (C).
Juncus rigidus ass. (J): 58 J-t typical subass.; 59 J-A subass. of Arthrocnemum; 60 *Arthrocnemum macrostachyum* stands (A).
Arthrocnemum macrostachyum-Limnoniastrum monopetalum ass. (L): 61 L-t typical subass.; 62 L-Z subass. of Zygophyllum album; 63 *Ruppia rostrata* stand (R).
For further explanation see Table 1.

	-57-			-58-			-59-			-60-			-61-			-62-			-63-	
	C			J-t			J-A			A			L-t			L-Z			R	
average species number	3.8			1.7			2.6			1.5			3.3			9.0			1.0	
average height (dm)	nn			14.0			16.0			6.0			nn			nn			-	
number of relevés	4.0			32.0			5.0			4.0			6.0			5.0			1.0	
vitality	100	0.0	0	96	2.0	2	92	8.0	0	100	0.0	0	100/0/0			98/0/2			-	
	T	C	P	T	C	P	T	C	P	T	C	P	T	C	P	T	C	P	T	C
Cyperus laevigatus	3	33.1	100																	
Juncus rigidus	+	0.4	75	3	16.7	97	4	57.5	100	4	0.6	50								
Arthrocnemum macrostachyum	+	0.3	50				2	3.1	80	2	51.9	100	+	0.9	50		0.1	20		
Phragmites australis	+	0.4	75	2!	9.7	38		7.6	40											
Limoniastrum monopetalum													2!	11.8	100	1	3.6	100		
Salsola tetrandra													1	2.3	100	+	0.9	100		
Frankenia revoluta														0.1	50		0.2	40		
Atriplex portulacoides														0.3	50		0.1	20		
Zygophyllum album		0.2	25		0.0	3								0.1	17	1	1.3	100		
Ifloga spicata																+	0.3	60		
Ruppia rostrata																			5	88
Tamarix nilotica				(+)	0.3	9		0.5	20		5.0	25								
Cressa cretica					0.0	3		2.0	20											
Salsola schweinfurthii														0.1	17	+	0.3	60		

In only one of the units occurred:

C: Setaria adhaerens -/0.1/25; Imperata cylindrica -/0.1/25. J-t: Sporobolus spicatus -/0.1/6; Typha domingensis -/0.0/3; Zygophyllum coccineum -/0.1/13.
L-t: Halocnemum strobilaceum -/0.4/17; Nitraria retusa -/304/17; Suaeda palaestina -/0.1/17. L-Z Erodium hirtum -/0.2/40; Malva parviflora -/0.2/40; Iris sisyrhinchium --/0.2/40; Lygeum sparteum -/0.2/40; Filago desertorum -/0.1/20; Adonis dentatus -/0.1/20; Plantago spec. -/0.1/20; Echinops spinosissimus -/0.1/20; Gagea reticulata -/0.1/20; Astragalus spec. -/0.1/20; Mesembryanthemum nodiflorum -/0.1/20; Launaea tenuiloba -/0.1/20; Scorzonera alexandrina -/0.1/20; Allium spec. -/0.1/20; Pituranthos tortuosus -/0.1/20

only briefly. Two general types of landscapes are involved: 1.) coastal salt marshes, 2.) oases.

3.5.2. Coastal salt marsh

Like the littoral dunes the coastal salt marshes have attracted much attention in earlier investigations (e.g. EL-GHONEMY & AYYAD 1977, KAMAL 1983, SHALTOUT 1985). Salt marsh communites are an important part of the Egyptian rangelands. For comparative purpose a few relevés of the Arthrocnemum macrostachyum-Limoniastrum monopetalum ass. (TADROS & ATTA 1958a) are presented in Table 13. Here the typical subass. (61) covers the wetter habitats, whereas the Zygophyllum album subass. (62) forms a transitional belt to the Thymelaea-Plantago ass. A very high number of Mediterranean elements can be recognized (Table 19).

3.5.3. Oases

3.5.3.1. General character of oasis vegetation

Basing on surveys like MIGAHID et al. (1960) a number of careful studies of the oasis vegetation have been carried out, e.g. ABU ZIADA (1980), EL HABIBI & ABU-ZIADA (1981), EL HABIBI et al. (1981a, b) for Kharga and Dakhla, ZAHRAN (1972) for Dungul, ABD-EL-GHANI (1985) for Farafra and Bahariya, ZAHRAN & GIRGIS (1970) for Wadi El-Natrun, ZAHRAN (1972) for Siwa, GIRGIS et al. (1971) for Moghra. Not many vegetation types in the oasis are really azonal, but most of them contain a great number of plurizonal species (Table 18). Therefore they are not as clearly differentiated under phytogeographical aspects as the units of desert vegetation. Nevertheless, a considerable floristic difference between the northern and the southern part of the area under investigation is visible. According to land use three types of oases can be discerned: 1.) uninhabited, mostly small, wild oases, 2.) inhabited oases with traditional land use system, 3.) inhabited oases with new land use system.

3.5.3.2. Wild oases

The whole northern edge of the Qattara depression is a long, narrow wild oasis at the base of the escarpment. Fig. 17A shows a transect through the vegetation belts near Ras El Qattara. In the depression itself and on the bordering dunes Nitraria stands (Table 14: 70, cf. Nitrarietum, KASSAS & IMAM 1954), are developed. In the dune valleys not only in the depression itself but also on the slope the Juncus rigidus ass. typical subass. (Table 13: 58) grows. The drier parts of the slope are void of vegetation or bear the Zygophylletum nudum typical var. and Zygophyllum album var. The foot of the following steep slopes shows a gallery forest of Phoenix dactylifera ass. (Table 10: 46), which attain a height of 10–12 m. In the wadi itself some pattern of the depression is repeated, but in addition a zone where *Cressa cretica* stands occurs (Table 15: 77).

A large number of oases which are not inhabited any more, but used to be populated in the Roman age (FAKHRI 1983), can be found in the Sitra depression, comprising several salt lakes. According to the geomorphological

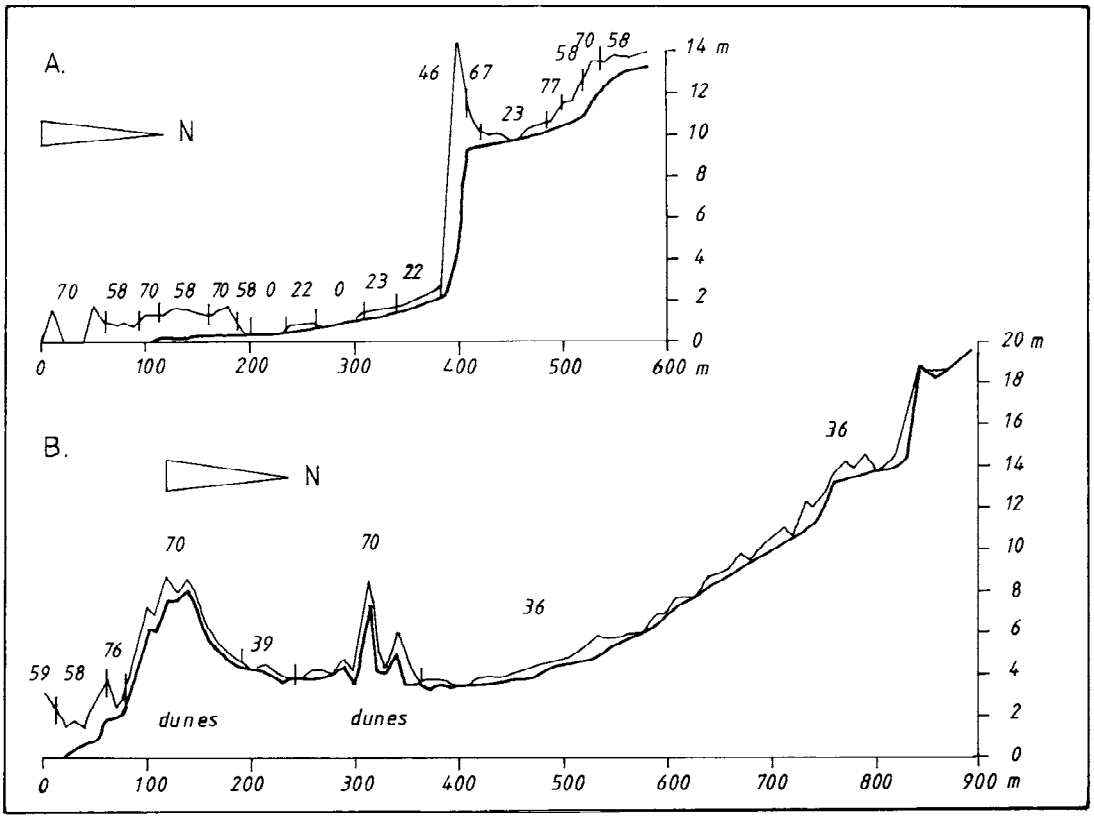


Fig. 17. Transects through vegetation zones at large depressions. – A) Qattara depression, close to Ras El Qattara, 30°13'N, 27°16'E (58 relevés, 14.10.86); B) Sitra depression at Nuweimisa East, 28°38'N, 26°46'E (88 relevés, 4.10.86).
Plant communities:
Zygophyllum coccineum-Schouwia thebaica ass.: 22 Zygophylletum nudum typical var., 23 Zygophylletum nudum Zygophyllum album var.; 36 Cornulaca monacantha-Fagonia arabica ass. typical subass. Zygophyllum coccineum var.; 39 *Zygophyllum album* stand; 46 Phoenix dactylifera ass.
Juncus rigidus ass.: 50 typical subass., 59 subass. of Arthrocnemum macrostachyum; 67 Tamarix passerinoides ass.; 70 *Nitraria retusa* stands; 76 Alhagi mannifera ass. Cressa cretica subass.; 77 *Cressica cretica* stand.

features, the south bank is steep because it is covered with sand dunes (Photo 12). Here a small belt of *Phragmites* stands (see Table 16: 80) leads to the Tamarix nilotica ass. (Table 14: 64–65) and Phoenix dactylifera ass. (Table 10: 46; Photo 13). To the west and east directions a gentle slope allows the occurrence of a variety of vegetational zones. The same is true for the northern banks up to the first rocky escarpment. As an example, Fig. 17B shows a transect through the northern part of Nuweimisa East. At seapage level the Juncus rigidus ass. subass. of Arthrocnemum macrostachyum (Table 13: 59) and locally pure *Arthrocnemum* stands (Table 13: 60) grow. These two vegetation units have not been observed further south. It shows a considerable height by high culms of *Phragmites australis*. From here the vegetation becomes lower: through the Juncus

Table 14. Tamarix nilotica ass. (Tn): 64 Tn-t typical subass., 65 Tn-P subass. of Phragmites australis; 66 Tamarix tetragyna ass. (Tt); 67 Tamarix passerinoides ass. (Tp); 68 stands of *Tamarix amplexicaulis* (Ta); 69 stands of *Tamarix aphylla* (Ty); 70 stands of *Nitraria retusa* (N). For further explanation see Table 1.

	-64- Tn-t			-65- Tn-P			-66- Tt			-67- Tp			-68- Ta			-69- Ty			-70- N		
average species number	1.3			3.1			3.0			2.7			1.0			1.8			1.6		
average height (dm)	26			28			27			32			20			41			17		
number of relevés	23			28			15			9			11			5			33		
vitality	67/20/13			94/1/5			60/20/20			72/20/8			50/30/20			67/22/11			75/21/4		
	T	C	P	T	C	P	T	C	P	T	C	P	T	C	P	T	C	P	T	C	P
Tamarix nilotica	4	59.5	100	3	42.5	100															
Phragmites australis				2!	6.6	57	2	0.6	40	2	1.1	11								0.3	9
Juncus rigidus				2!	5.6	21		1.3	27		1.2	22								0.5	15
Imperata cylindrica				2	0.5	25					1.2	11		0.3	18					0.0	3
Zygophyllum album					1.1	21		0.1	13					0.2	9					0.0	6
Tamarix tetragyna					3.4	11	3	40.3	100												
Suaeda monoica								14.2	27												
Tamarix passerinoides					2.2	4		1.5	33	4	49.2	100									
Tamarix amplexicaulis													3	25.9	100						
Tamarix aphylla																4	67.5	100			
Nitraria retusa																			4	41.6	100
Zygophyllum coccineum		0.0	4																	0.4	9
Salsola baryosma ssp. gaetula		0.0	8		0.0	4								0.6	33						
Hyphaene thebaica		0.0	4		0.0	4															
Thypha domingensis					0.2	11		0.3	13												
Alhagi mannilera					0.1	14	+	0.0	7								0.0	40		0.1	3
Stipagrostis vulnerans					1.2	14								0.1	18		0.0	20			
Fagonia arabica								0.7	13		0.0	11									
Hyoscyamus muticus								0.7	7		0.0	11									
Cornulaca monacantha								0.7	7		0.0	11		0.1	27		0.0	20			
Convolvulus pilosellifolius								0.0	7		0.0	11									
Calligonum comosum								0.0	7		0.0	11									
Cotula cinerea											0.0	11								0.0	3

In only one of the units occurred: Tn-n: Zygophyllum coccineum -/0.1/4; Fagonia indica -/0.1/4; Astragalus vogelii -/0.1/4; Francoeuria crispa -/0.0/4.
Tn-P: Cyperus laevigatus -/2.8/18; Phoenix dactylifera -/0.5/11; Tt: Aeluropus lagopoides -/0.2/7; Suaeda aegyptiaca -/0.1/13; Anabasis articulata -/0.0/7; Stipagrostis zittelii -/0.0/7; Tp: Salsola baryosma ssp. baryosma -/0.0/11; Fagonia bruguieri -/0.0/11; Suaeda vermiculata -/0.0/11; N: Cressa cretica -/0.0/3; Salsola tetrandra -/0.0/13; Salsola schweinfurthii -/0.0/3;

Table 15. Imperata cylindrica ass. (I): 71 I-n pure stands (Imperatetum nudum); 72 I-P subass. of Phragmites australis; 73 I-A subass. of Alhagi mannifera; 74 *Prosopois farcta* stands (P).
Alhagi mannifera ass.: 75 A-n pure stands (*Alhagietum nudum*); 76 A-C subass. of Cressa cretica; 77 *Cressa cretica* stands (C).
For further explanation see Table 1.

		-71-			-72-			-73-			-74-			-75-			-76-			-77-	
		I-n			I-P			I-A			P			A-n			A-C			C	
average species number		1.8			3.8			2.4			1.3			1.4			3.7			1.5	
average height (dm)		6			16			7			nn			6			7			4	
number of relevés		12			21			12			9			26			6			8	
vitality		60/40/0			90/10/0			66/31/3			86/14/0			67/30/3			88/8/4			75/25/0	
	T	C	P	T	C	P	T	C	P	T	C	P	T	C	P	T	C	P	T	C	P
Imperata cylindrica	1	20.8	100	4	32.4	100	2	22.1	100		0.3	33		0.1	8		1.7	17			
Phragmites australis		0.0	8	2!	4.8	71								0.4	8		0.4	33		0.1	25
Alhagi mannifera					0.7	38	1	4.7	100				3	26.0	100	2	23.4	83		0.1	13
Prosopis farcta					0.1	5				2	16.7	78									
Capparis leucophylla										+	1.4	44									
Cressa cretica														0.1	4	+	0.8	83	2	7.3	100
Cotula cinerea		0.0	17		0.0	5															
Juncus rigidus		0.0	8	+	5.1	48											0.0	17			
Cynodon dactylon		0.0	8													1	6.7	33			
Tamarix nilotica					0.2	38								0.1	8		0.1	17			
Phoenix dactylifera, juv.					0.1	19										(+)	0.0	33			
Centaurium spicatum					0.3	14		0.0	8							2	2.1	33			
Francoeuria crispa					0.2	10		0.0	8												
Sporopolus spicatus								0.0	8					0.5	8					0.3	13
Aeluropus lagopoides					0.1	5								0.0	4						
Schouwia thebaica					0.0	5											0.1	17			
Zea mays														0.0	4	+	0.1	17			

In only one of the units occurred: I-n: Zygophyllum coccineum -/0.0/8; Astragalus vogelii -/0.0/8; Zygophyllum album -/0.1/17; Traganum nudatum -/0.1//17. I-P: Cyperus laevigatus +/0.3/19; Typha domingensis -/0.5/5; Dichanthium annulatum -/0.0/5; Conyza linifolia -/0.0/5. I-A: Stipagrostis vulnerans -/0.3/17. P: Sorghum virgatum -/0.3/17. A-C: Frankenia pulverulenta -/1.8/33.

rigidus ass. typical subass. (Table 13: 58) we come to the Alhagi mannifera ass. subass. of Cressa cretica (Table 15: 76) (Table 12) on the foot of the dunes, which are covered with *Nitraria* stands (70). Here again *Zygophyllum album* (in the form of pure stands, see Table 8: 39) indicates

Photo 12. South bank of the Sitra Lake with the Tamarix nilotica ass. (64) in front of *Phragmites* stands (80).

Photo 13. *Phoenix dactylifera* stand (46) and *Alhagi mannifera* stand (75) in El Bahrein East (Sitra region).

Table 16. 78 *Sporobolus spicatus* stands (Sp); 79 *Stipagrostis vulnerans* stands (St). Phragmites australis ass. (P): 80 P-n pure *Phragmites* stands (Phragmitetum nudum); 81 P-T subass. of Typha domingensis.
For further explanation see Table 1.

	-78- Sp			-79- St			-80- P-n			-81- P-T		
average species number	2.5			1.5			1.6			3.5		
average height (dm)	8			10			24			17		
number of relevés	10			13			18			10		
vitality	92/10/8			76/5/19			89/11/0			100/0/0		
	T	C	P	T	C	P	T	C	P	T	C	P
Soprobolus spicatus	5	66.3	100		0.8	15						
Alhagi mannifera	2	7.7	70									
Stipagrostis vulnerans				4	28.1	100		2.3	17			
Phragmites australis		6.5	20				3	40.6	100	3	15.6	90
Typha domingensis		0.3	10							2!	29.0	100
Juncus rigidus								0.0	6	2!	27.3	60
Imperata cylindrica		0.3	10		0.0	8						
Hyoscyamus muticus		1.0	10		0.1	15						
Tamarix nilotica		0.1	20					0.0	6		0.4	40
Hyphaene thebaica,juv.					0.0	8					0.0	10

In only one of the units occurred:

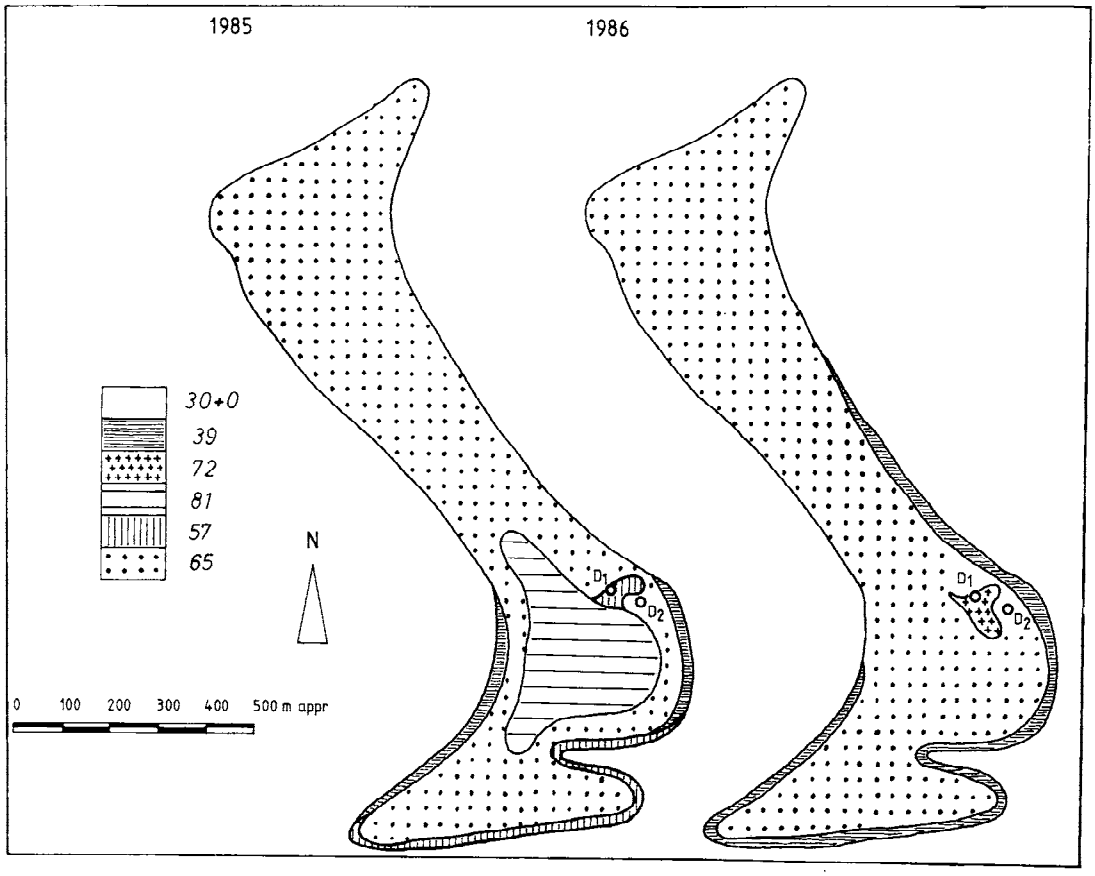
Sp: Aeluropus lagopoides -/0.3/10; St: Citrullus colocynthis -/0.1/15; P-n: Cynanchum acutum -/0.7/11; Tamarix tetragyna -/0.0/6; Tamarix amplexicaulis -/0.1/6. P-T Cyperus laevigatus -/2.3/20; Conyza linifolia -/1.1/20 ; Scirpus tuberosus -/0.3/10. .

the borderline of accessible groundwater. The slope is covered by small stands of the Cornulaca-Fagonia ass. Zygophyllum coccineum subass. (Table 8: 36) with barren spots in between, which become more frequent on the upper slope.

A very special situation was created near El-Bahrein by the fact that the General Petroleum Company drilled two water holes in 1971 and did not plug them afterwards (see FAKHRI 1983). One of the pipes is still active and produces water of 43 °C (1985) and with a flow of ca. 20 l/min (1986), which rinses on a nearly level limestone plateau (Photo 14). As a consequence an appr. 1500 m long vegetation island did develop. We had the opportunity to visit this area twice in an interval of 18 months. Sketches of the vegetation are given in Fig. 18. In April 1985 near the well swamp vegetation was developed, namely

Fig. 18. Vegetation map of the artificial oasis near El-Bahrein, 28°48'N, 26°33'E. Left: 13.4.85 (21 relevés); right: 5.10.86 (after burning, 23 relevés). D1 active drilling hole; D2 inactive drilling hole.
Plant communities:
30 Stipagrostis plumosa ass. Fagonia arabica subass.; 39 *Zygophyllum album* stands; 57 Juncus rigidus ass.; 65 Tamarix nilotica ass. Phragmites australis subass.; 72 Imperata cylindrica ass. Phragmites australis subass.; 81 Phragmites australis ass. Typha domingensis subass.; 0 vegetation-free.

Photo 14. Artificial oasis N of El Bahrein, ca. 90 km of Qara. Imperata cylindrica ass. subass. of Phragmites australis (72) and Tamarix nilotica ass. subass. of Phragmites australis (65).



Cyperus laevigatus stands (which followed the stream, Table 13: 57) and a broader area of Imperata cylindrica ass. subass. of Phragmites australis (Table 15: 72). The central part was covered by a very high reed stand (Phragmites australis ass. subass. of Typha domingensis, see Table 16: 81), while the main area contained scattered Tamarix nilotica ass. subass. of Phragmites australis (Table 14: 65) and some *Tamarix passerinoides* stands (Table 14: 67). Uphill (to the east) a margin of pure *Zygophyllum album* stands was developed, here again indicating the border of groundwater-fed habitats. The surrounding limestone plateau bears islands of Stipagrostis plumosa ass. Fagonia arabica subass. (Table 7). The shrub started in the very first year as can be seen by the fact that a trunk of *Tamarix nilotica* showed 15 annual rings of equal size (A. VON LÜHRTE, pers. comm.).

Eighteen months later the picture was changed. First of all the whole area was burnt recently. The *Phragmites* stand was destroyed, most of the *Tamarix* were also burnt but were recovering and starting regrowth in all parts of the vegetation island. The Imperata ass. Phragmites subass. was still in its place, but the *Cyperus laevigatus* stands had vanished, whereas the *Zygophyllum album* stands were extended considerably. The difference between these two vegetation maps is not only to be explained by burning, but presumably also by drying out. It would be noteworthy to follow the further development of this interesting experiment in the desert!

Photo 15. Outblown stand of *Tamarix aphylla* (69) in the northern part of the Farafra depression.

Another area of wild oases is situated in the northernmost part of the Farafra oasis, especially around Wadi Hennis. Here grow stands of *Phoenix dactylifera* (46), *Alhagi mannifera* (75) and *Imperata cylindrica* (71), *Tamarix nilotica* (64), *T. aphylla* (69; Photo 15) and *T. amplexicaulis* (68), which seems to reach here its southern border (Fig. 16; see also BAUM 1978, map 46, p. 155). A small water hole (Ain El Wadi) contains *Ruppia rostrata* (see Table 13: 63). On the borderline of groundwater influence, *Tamarix aphylla* stands are developed on smooth limestone under sand cover (Table 15). Here also grows *Imperata cylindrica* in pure stands (Table 15: 71; Photo 16). With its large rhizome systems (AYENI 1985a, b) it creeps below the sand sheet, and even climbs chalk rocks (Photo 16) using the water capacity of the stones and thus performing one of the spectacular views of the 'white desert'. In a similar way *Imperata* grows on siltstone in the Abu Tartur area close to a stand of *Tamarix tetragyna*

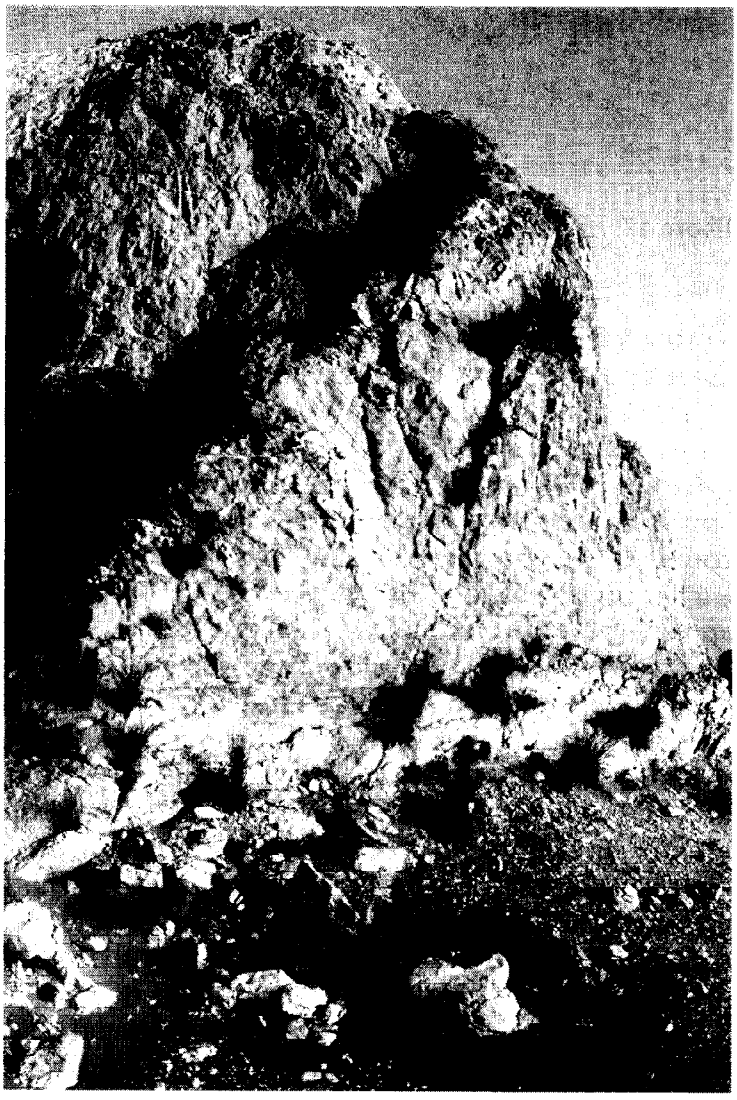


Photo 16. Pure stands of *Imperata cylindrica* (71) in the 'White Desert' N of Farafra.

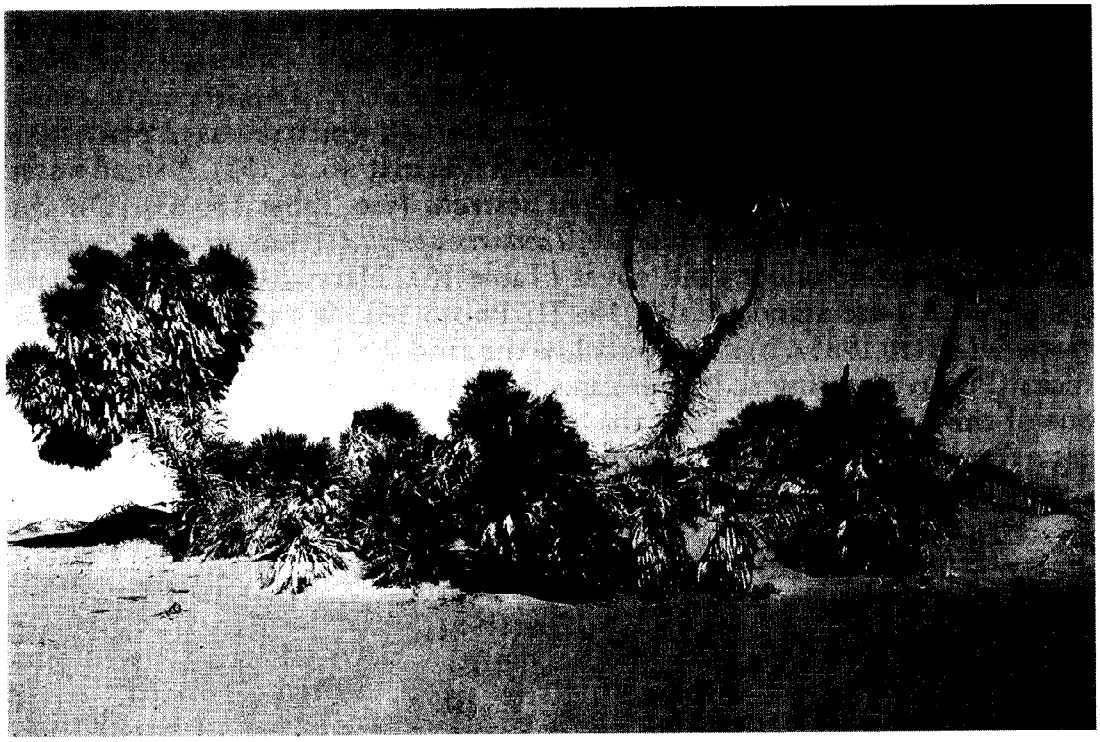


Photo 17. *Hyphaene thebaica* stand (47) in Bir El-Shab.

(Table 14: 66). Wadi Hennis has lost its former importance as a resting place since the opening of the Bahariya-Farafra road.

The example discussed shows the typical combination of vegetation in wild oases in the northern part of the Western Desert, which show up also in inhabited oases in the large areas between the agriculturally used lands. In the southern part of the area under investigation only small wild oases are to be found. They extend from Bir Tarfawi to the southeast and east. As reported earlier (BORNKAMM 1986, see also DARIUS 1989, SCHNEIDER 1990) only 15 plant species were found here in an area of appr. 20000 km^2 (in the meantime in addition *Zizyphus spina-christi* was observed at Bir Takhlis). The most important stands are dominated by *Acacia ehrenbergiana* (Table 10: 49), *Hyphaene thebaica* (Table 10: 47; Photo 17). *Phoenix dactylifera* (46), *Tamarix nilotica* (64), *Cornulaca monacantha* (34), *Stipagrostis vulnerans* (Table 15: 79; Photo 18), *Sporobolus spicatus* (Table 16: 78). From these as already mentioned, *Acacia ehrenbergiana* is restricted to the very south of the investigated area, *Hyphaene thebaica* (the doum-palm) reaches the Kharga oasis, *Stipagrostis vulnerans* and *Sporobolus spicatus* were found up to the Farafra oasis. Similar stands have been described from the Dungul oasis, where in addition *Medemia argun* grows (ZAHRAN 1968).

It is interesting to observe habitats where date palm and doum palm grow in common. Both trees exhibit a maximum height of about 10–12 m. But since *Phoenix* always shows a mixture of old and young stands, the average height of *Phoenix* is lower than that of *Hyphaene* where young plants have been observed