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INTER-RELATIONSHIPS OF VEGETATION, SOILS AND TERMITES IN PAKISTAN. I. ARID MARINE TROPICAL COASTILANDS

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Abstract

Six plant communities, i.e., *Acacia arabica, A. senegal, Euphorbia caducifolia, Prosopis glandulosa, Salvadora oleoides* and *Tamarix gallica* have been recognized in the southern coastal areas of Pakistan. Thirteen termite species belonging to eight genera, i.e., *Amitermes, Anacanthotermes, Coptotermes, Eremotermes Microcerotermes, Microtermes, Odontotermes* and *Psammotermes* have been found in these communities. Soil samples obtained from these communities have been analysed for their physical and chemical characteristics. Relationships of dominant plant species to soil have been described with regard to texture, porosity, water table depth, pH, salinity and sodicity. Distribution of 13 termite species in relation to various plant communities and soil characteristics (texture, porosity, water table depth, pH, salinity and sodicity) have been described.

Introduction

Vegetation of an area is governed by a complex of environmental factors including climate, soil, geology, topography and biota (Major, 1951). Climate of an area paints the general picture of vegetation while details are related to other habitat factors and among these soil plays an important role in this regard. Vegetation is a good indicator of the quality of the soil which effects it in every conceivable direction. Thus in the natural vegetation of a particular climatic area the relationship of plants to soil is very close. The concept of 'plant indicator' is based on this relationship. Detailed studies have been carried out on soil-plant relationships in other countries but very little has been done on this aspect in Pakistan (Rutter & Sheikh, 1962; Shah, et al., 1964; Snead & Tasnif, 1966).

Termites play an important role at herbivore and decomposer levels in the mineral cycling and flow of energy in ecosystems in arid to sub-humid regions. Climate, vegetation and soil are the important ecological factors involved in termite distribution. Only a

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few studies have been carried out on termite distribution in relation to vegetation conditions (Sands, 1965, 1967; Coaton & Sheasby, 1972). Termite distribution in relation to soil conditions has hardly been investigated. However, Kayani et al (1979) have studied the altitudinal distribution of termites in relation to vegetation and soil conditions.

In Pakistan, eight major climatic regions have been recognized (Ahmad, 1951). Quantitative description of vegetation and its relationships with existing soil conditions and termite fauna have been investigated in each of the eight major climatic regions. The present paper describes the results obtained in this regard in the arid marine tropical coastlands region of Pakistan. Subsequent papers in this series shall describe the results of investigation on this subject in the other major climatic regions of Pakistan.

Arid marine tropical coastlands climatic region includes southern coastal areas of Pakistan and lies between 62°E and 71°E longitude and 24°N and 26°N latitude (Fig. 1).

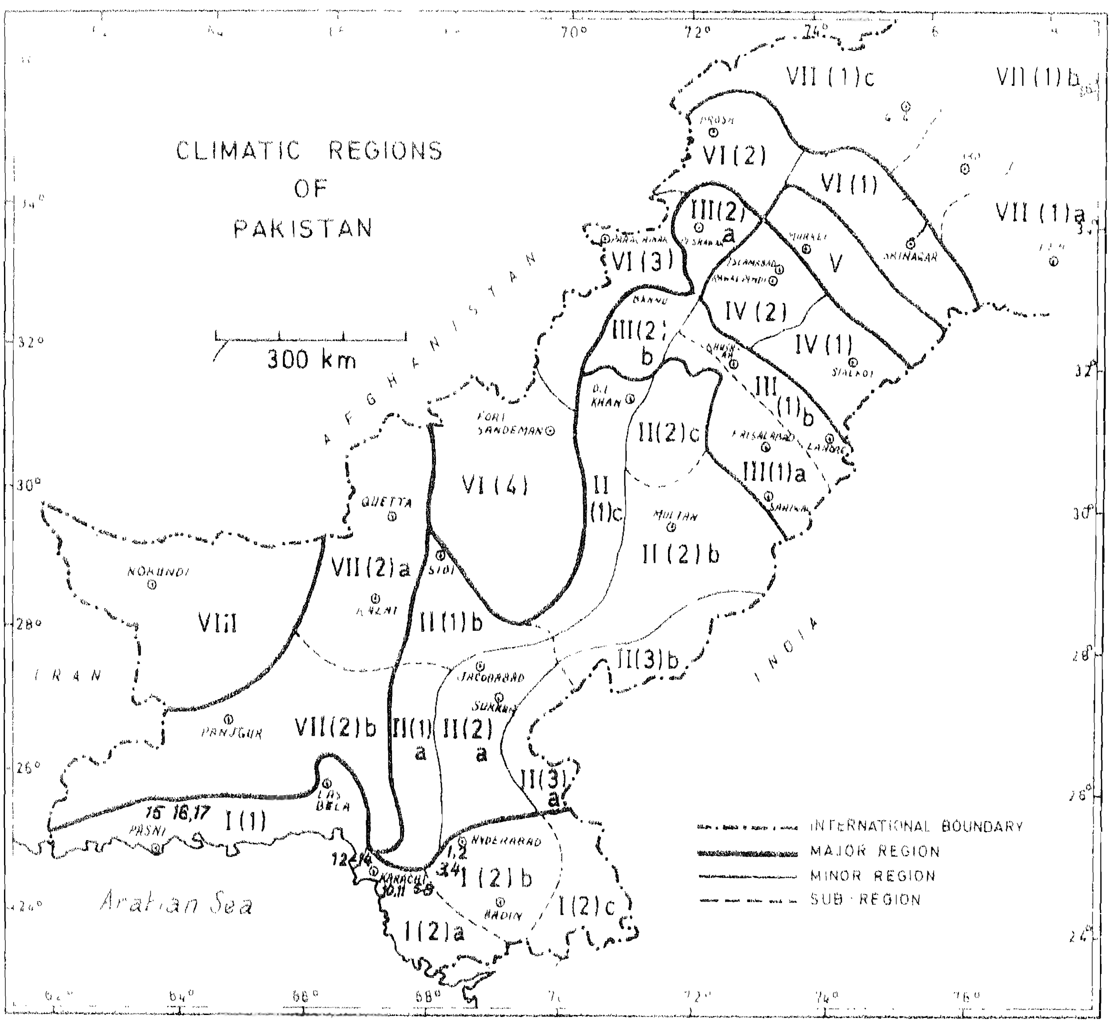

Fig. 1. Map of Pakistan showing Climatic Regions and location of sampled plots.

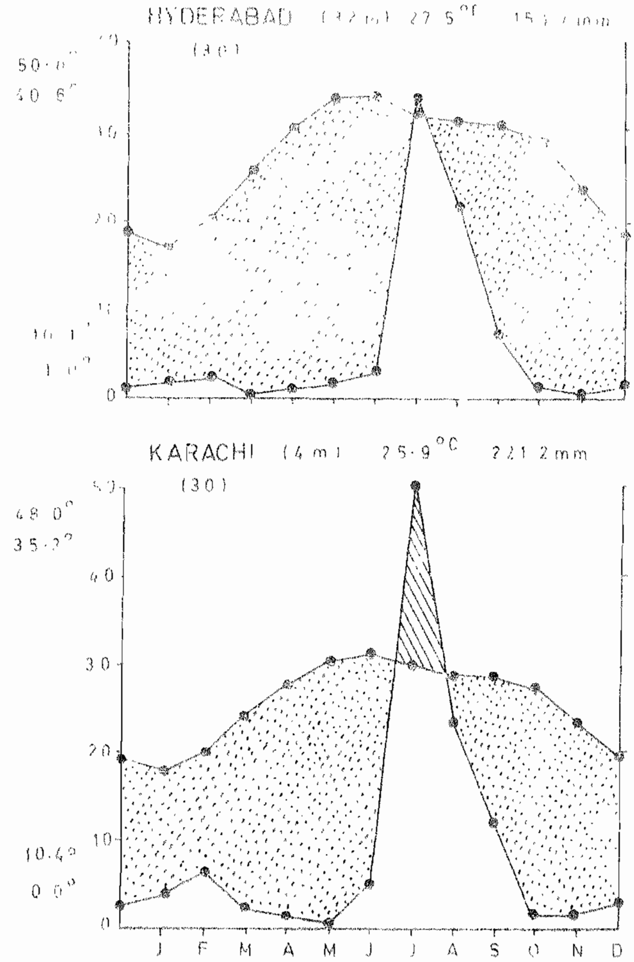

Fig. 2. Climatic diagrams of Hyderabad and Karachi.

Aridity is the main characteristic feature of this region. The annual rainfall varies between 150 and 250 mm. The mean maximum temperature of hottest month ranges from 32 to 40°C with high humidity and steady sea breeze in the summer. This major climatic region is divided into two minor regions: (a) Makran and Lasbela coast, and (b) Lower Sind. The latter is further subdivided into three sub-regions: (a) Western, (b) Central, and (c) Eastern.

Figure 2 shows climatic diagrams of Hyderabad and Karachi as representative for Central and Western Sub-regions, respectively.

Vegetation of some parts of the arid marine tropical coastlands region has been described (Chaudhry, 1960, 1962; Champion et al, 1965; Shaukat & Qadir, 1971; Beg, 1975). However, no detailed quantitative studies have been made of the vegetation of this region. Soils of the area have also not been analysed in order to recognize soil-vegetation relationships in nature.

In the present work different localities in the study area were visited for vegetation study, soil sampling and collection of termites. On the basis of these studies, different communities have been recognized. The soils have been analysed for their physical and chemical characteristics. Data obtained have been used to discern relationships between: (a) soil and vegetation, (b) soil and termites, and (c) vegetation and termites.

Materials and Methods

Different termite-affected localities were visited for the studies of their vegetation, termite fauna and soils. These studies were made at different times from 1974-1978. The plots established for studies are shown in Fig. 1.

Vegetation Study

Single plot (1000 sq.m size) method was used to study vegetation. In each plot 15 quadrats of 10 x 10 m for tree layer and 4 x 4 m for shrub layer were laid at random. In each quadrat total number of individuals of a species were counted. Total cover of individuals of all the species was measured by the 'Crown diameter' method (Mueller – Dombois & Ellenberg, 1974). From the foregoing observations relative density (D_3), relative frequency (F_3) and relative cover (C_3) were determined as follows:

Relative density (D_3) =

$$\frac{\text{Total No. of individuals of a species}}{\text{Total No. of individuals of all the species}} \times 100$$

Relative frequency (F_3) =

$$\frac{F_1 \text{ of a species}}{F_1 \text{ of all the species}} \times 100$$

where F_1 =

$$\frac{\text{Points of occurrence of a species in all the quadrats}}{\text{Total number of quadrats}} \times 100$$

Relative cover (C_3) =

$$\frac{\text{Total cover of individuals of a species}}{\text{Total cover of individuals of all the species}} \times 100$$

Following Curtis and McIntosh (1950), Importance Value (I.V.) was determined as under:

$$\text{Importance Value} = D_3 + F_3 + C_3.$$

For herbs and grasses their cover was determined by line transect method.

Community was named after a tree or shrub (where tree layer was absent) having highest Importance Value.

Termite Collection

Soldiers, workers and imagoes (when present) of the termite species present in a plot were collected, preserved in 80% Ethyl alcohol and brought to the laboratory for identification.

Soil Analysis

Three composite soil samples were obtained from 0 – 15 cm depth from each plot. These were analysed for their physical and chemical characteristics. These included the determination of texture by hydrometer method (Bouyoucos, 1951); water-stable aggregates by wet sieving method (U.S.D.A., 1954); soil porosity by mositure tension method described by Jamison (1958) and modified by Rutter & Sheikh (1962); pH with glass electrode pH meter; electrical conductivity by 'Solu Bridge' conductivity meter, and organic matter content by chromic acid with sulphuric acid heat of dilution method of Walkley & Black, described by Jackson (1958). Soil cation exchange capacity was determined by leaching soil with sodium acetate as per details given by U.S.D.A. (1954). Ca and Mg were determined by titration with Ethylene-diamine tetra acetate (versenate). Na and K were determined by flame photometry.

Depth of water table was measured from the level of open wells obtaining in the sampling area or in its neighbourhood. The values obtained for soil parameters have been used to classify them into various descriptive categories (Table 1).

Climatic Diagram

Following Walter (1971), the climatic data for 30 years (1931 – 1960), supplied by the Meteorological Department, Government of Pakistan, was used for the preparation of climatic diagrams.

Results

On the basis of highest Importance Value, three tree dominated and three shrub dominated communities were recognized in the study area (Table 2). The data pertaining

Table 1. Classification of various soil parameters into descriptive categories.

Soil parameters	Values	Categories
Water-stable aggregates, % soil a.d. wt.	<5	Poor
	5–15	Moderate
	>15	Good
Water holding capacity, % soil o.d. wt.	<25	Low
	25–50	Medium
	>50	High
Porosity, % soil vol. (at 60 cm tension)	<7.5	Low
	7.5–15	Medium
	>15	High
Water table depth, meter	<8	Shallow
	8–25	Intermediate
	>25	Deep
pH	<6.5	Acidic
	6.5–7.5	Circum-neutral
	>7.5	Basic
Salinity (EC, mmohs/cm)	<4.0	Salt-free
	4–8	Slight
	8–15	Moderate
	>15	Strong
Cation exchange capacity, meq/100 gm o.d. wt.	<15	Low
	15–30	Medium
	>30	High
Organic matter content, % soil o.d. wt.	<1	Low
	1–3	Medium
	>3	High
Soluble cations (Ca , Mg , K , & Na), meq/l	<15	Low
	15–40	Medium
	>40	High
Sodicity (ESP)	<10	Sodium-free
	10–20	Slight
	20–30	Moderate
	>30	Strong

to composition of vegetation, soil conditions and termite fauna of each community is presented in Tables 2, 3 and 4. Results of detailed studies of composition of vegetation in three strata, i.e., tree, shrub, and herb and grass layers, soil physical and chemical characteristics and composition of termite fauna in each of the six plant communities are described below:

Acacia arabica community

Vegetation

Prosopis spicigera has relatively higher I.V. in tree layer, while *Prosopis glandulosa* and *Tamarix dioica* have higher I.V. in shrub layer of *A. arabica* community. Among herbs and grasses *Desmostachya bipinnata* has greater cover (Table 2).

Soils

Soils of *A. arabica* community are clay loam and sandy loam, having poor to good aggregation. They have high water holding capacity, medium porosity and shallow to intermediate water table depth. They are salt-free to slightly saline and are basic in reaction. They have high cation exchange capacity, organic matter content and medium amount of soluble cations (Table 3).

Termites

Four termite species have been recorded in *A. arabica* community. However, only *Microcerotermes championi* shows positive association with it (Table 4).

Acacia senegal community

Vegetation

Prosopis spicigera and *Acacia arabica* have relatively higher I.V. in tree layer of *A. senegal* community. *Euphorbia caducifolia, Grewia tenax* and *Zizyphus nummularia* are important shrubs of this community. *Eleusine flagellifera* and *Cymbopogon schoenanthus* have relatively greater cover in herb and grass layer of *A. senegal* community (Table 2).

Soils

Soils of *A. senegal* community are poorly aggregated sandy loams with medium water holding capacity and porosity, and intermediate to deep water table depth. They are salt-free to slightly saline and are basic in reaction. They have medium organic matter

Table 2. Community types found in the Arid Marine Tropical Coastlands.

Vegetation	Community types Acacia arabica † 5–7	Acacia senegal 1–3	Salvadora oleoides 4, 8, 9	Euphorbia caducifolia 10–13	Prosopis glandulosa 14, 15	Tamarix gallica 16,17
Trees						
Acacia arabica	146.3	45.2	45.5	–	–	–
Prosopis spicigera	95.8	70.7	40.4	–	–	–
Populus euphratica	19.4	–	–	–	–	–
Tamarix articulata	38.5	–	15.6	–	–	–
Acacia senegal	–	138.7	–	–	–	–
Cordia rothii	–	29.3	–	–	–	–
Salvadora oleoides	–	16.1	198.5	–	–	–
Shrubs						
Tamarix dioica	150.0	–	–	–	–	–
Prosopis glandulosa	150.0	–	94.4	36.5	192.5	–
Euphorbia caducifolia	–	91.1	–	152.1	27.3	–
Grewia tenax	–	100.2	–	–	–	–
Commiphora mukul	–	38.1	–	–	–	–
Calligonum polygonoides	–	16.1	–	–	–	–
Zizyphus nummularia	–	54.5	–	2.2	–	56.9
Capparis decidua	–	–	156.2	47.6	45.5	–
Calotropis procera	–	–	49.4	48.3	23.2	–
Ehretia obtusifolia	–	–	–	13.3	–	–

Tamarix gallica	–	–	–	–	11.5	205.4
Lycium europaeum	–	–	–	–	–	15.1
	–	–	–	–	–	12.8
Nerium oleander	–	–	–	–	–	9.8
Herbs & grasses*						
Desmostachya bipinnata	(24.1)	(2.6)	(12.0)	–	–	(4.1)
Eleusine flagellifera	–	(4.0)	(0.4)	(3.4)	(2.2)	(1.1)
Cymbopogon schoenanthus	–	(4.7)	–	(1.8)	–	–
Dactyloctenium aegyptiacum	–	–	–	(4.1)	–	–
Sporobolus pallidus	–	–	(7.9)	–	–	–
Suaeda fruticosa	–	–	(6.8)	–	–	–
Alhagi maurorum	–	–	(3.7)	–	(5.3)	–
Cynodon dactylon	(1.4)	–	–	(1.1)	(6.2)	–
Saccharum munja	(1.8)	–	(2.3)	–	–	(10.7)

Figures without parenthesis refer to mean Importance Value of Trees and Shrubs.
Figures in parenthesis refer to mean percentage cover of Herbs and Grasses.
†Plot number.
*Species having cover greater than 4% (in any community type) were included in the Table.

content, medium to high ca exchange capacity and medium to high amount of soluble cations (Table 3).

Termites

Seven termite species belonging to five genera, i.e., *Amitermes, Coptotermes, Microcerotermes, Microtermes* and *Odontotermes* occur in *A. senegal* community. Only *Microtermes unicolor* has positive association with it (Table 4).

Salvadora oleoides community

Vegetation

Acacia arabica and *Prosopis spicigera* are the common associates of *S. oleoides* in the tree layer while *Capparis decidua* and *Prosopis glandulosa* have higher I.V. in the shrub layer of this community. Among herbs and grasses *Desmostachya bipinnata, Sporobolus pallidus* and *Suaeda fruticosa* have greater cover (Table 2).

Soils

Soils of *S. oleoides* community are poorly aggregated sandy loam to loamy sand with medium water holding capacity, low porosity and intermediate water table depth. They are moderately to strongly saline and are basic in reaction. They have medium to high cation exchange capacity and low to medium organic matter content and high amount of soluble cations (Table 3).

Termites

Amitermes belli, Microtermes mycophagus and *Odontotermes lokanandi* are present in *S. oleoides* community (Table 4).

Euphorbia caducifolia community

Vegetation

Capparis decidua and *Calotropis procera* have relatively higher I.V. in the shrub layer of *Euphorbia caducifolia* community while *Dactyloctenium aegyptiacum* and *Eleusine flagellifera* have greater cover in its herb and grass layer (Table 2).

Soils

Soils of *E. caducifolia* community vary from silt loam to sand in texture and have poor aggregation. They have low to medium water holding capacity and porosity, and shallow to intermediate water table depth. They are salt-and sodium-free and are basic in reaction with low cation exchange capacity and low to medium amount of organic matter and soluble cations (Table 3).

Termites

Four species have been collected from *E. caducifolia* community, of which only *Microtermes mycophagus* shows positive association with this community (Table 4).

Prosopis glandulosa community

Vegetation

Capparis decidua has relatively higher I.V. in shrub layer of *P. glandulosa* community while in its herb and grass layer *Cynodon dactylon* and *Alhagi maurorum* have greater cover (Table 2).

Soils

Soils of *P. glandulosa* community are poorly aggregated sand. They have low to medium water holding capacity, medium porosity and shallow water table depth. They are salt and sodium free and are basic in reaction with low cation exchange capacity, organic matter content and amount of soluble cation, (Table 3).

Termites

Only *Anacanthotermes macrocephalus* and *Psammotermes rajasthanicus* occur in this community (Table 4).

Tamarix gallica community

Vegetation

Prosopis spicigera has relatively higher I.V. in *T. gallica* community while *Saccharum munja* and *Desmostachya bipinnata* have greater cover in its herb and grass layer (Table 2).

Soils

Soils of *T. gallica* community are poorly aggregated loam to loamy sand with shallow water table. They have medium water holding capacity and medium to high

Table 3. Soil conditions in the sampled plots of the various community types of Arid Marine Tropical Coastlands.

Soil conditions	Community types					
	Acacia arabica † 5 – 7	Acacia senegal 1 – 3	Salvadora oleoides 4, 8, 9,	Euphorbia caducifolia 10 – 13	Prosopis glandulosa 14, 15	Tamarix gallica 16, 17
Physical						
% Sand	*45.5±11.3	69.4± 3.8	81.8± 1.7	72.1± 6.9	92.3± 5.7	67.2±16.9
	**32.5–68.0	61.8–74.1	74.5–85.6	54.0–86.6	86.6–98.0	50.4–84.0
% Silt	26.5± 6.9	22.9± 3.2	12.4± 3.2	20.8± 7.1	4.2± 2.9	23.5±13.9
	13.0–35.5	19.7–29.4	7.4– 8.5	7.4–40.0	1.4– 7.1	9.6–37.4
% Clay	28.0± 4.5	7.7± 0.8	5.8± 1.4	7.1± 1.1	3.5± 2.8	9.3± 2.9
	19.0–33.0	6.2– 8.8	3.0– 7.2	5.6–10.3	0.6– 6.3	6.4–12.2
Textural class	Clay loam Clay loam, Sandy loam	Sandy loam Sandy loam	Loamy sand Sandy loam, Loamy sand	Loamy sand Silt loam, Sandy loam, Sand	Sand Sand	Sandy loam Loam, Loamy sand
Water-stable aggregates,	11.8± 4.8	3.0± 1.2	0.4± 0.4	1.4± 0.9	0.5± 0.5	1.1± 0.6
% soil a.d. wt.	3.5–18.2	0.5– 4.6	0.0– 1.1	0.0– 3.5	0.0– 1.0	0.5– 1.7
Water holding capacity,	74.1± 2.4	33.2± 3.7	37.0± 1.8	26.1± 4.1	26.4± 1.7	39.0± 5.1
% soil o.d. wt.	69.3–77.2	26.0–38.0	33.6–39.6	20.0–38.2	25.7–28.1	34.0–44.1
Porosity, % soil vol.	8.9± 0.4	11.7± 0.2	1.2± 0.6	4.8± 0.4	7.1± 0.1	14.8± 6.0
(at 60 cm tension)	8.2– 9.3	11.4–12.2	0.0– 2.0	3.7– 5.3	7.0– 7.2	8.8–20.7
Water table depth,	10.3± 1.7	28.0± 5.0	16.0± 3.0	14.0± 5.1	7.0± 1.0	5.0± 2.1
meter	7.0–12.0	18.0–33.0	13.0–22.0	4.0–23.0	6.0– 8.0	3.0– 7.0

Chemical							
pH		7.9± 0.3	8.1± 0.3	8.4± 0.1	8.0± 0.1	7.7± 0.1	8.0± 0.2
		7.5– 8.5	7.8– 8.6	8.2– 8.6	7.7– 8.2	7.6– 7.8	7.7– 8.2
EC, mmhos/cm		3.1± 0.6	3.4± 0.6	17.4± 6.2	1.6± 0.5	0.4± 0.0	0.8± 0.3
		1.9– 4.1	2.7– 4.6	9.5–19.6	0.4– 3.1	0.4– 0.4	0.5– 1.1
Cation exchange capacity,		34.0± 0.6	28.9± 5.2	25.5± 4.9	8.8± 2.3	1.6± 0.5	3.9± 0.9
meq/100 gm o.d. wt.		33.1–35.1	18.4–35.0	16.0–32.0	2.5–12.5	1.1– 2.1	3.0– 4.7
Organic matter, % soil		3.9± 0.3	2.3± 0.6	1.3± 0.3	0.9± 0.3	0.3± 0.2	0.3± 0.1
o.d. wt.		3.3– 4.2	1.1– 3.4	0.9– 1.9	0.8– 1.8	0.1– 0.4	0.2– 0.4
Soluble cations,		13.8± 3.3	21.8± 5.6	37.8± 9.8	14.6± 7.9	2.5± 0.5	3.1± 1.6
meq/l	Ca	8.3–19.7	12.6–32.0	22.6–56.0	1.4–33.0	1.9– 3.0	1.5– 4.6
	Mg	11.7± 3.4	8.9± 3.3	18.5± 7.6	4.4± 0.4	6.3± 1.3	10.0± 2.9
		5.7–17.6	4.8–15.5	5.6–32.1	3.5– 5.6	5.0– 7.7	7.1–12.9
	K	0.4± 0.1	2.0± 0.4	5.0± 2.3	0.6± 0.2	1.0± 0.7	1.0± 0.7
		0.2– 0.6	1.7– 2.8	1.9– 9.6	0.3– 1.0	0.3– 1.8	0.3– 1.7
	Na	6.2± 3.8	7.3± 3.4	108.6±54.7	4.2± 1.7	1.7± 0.7	3.1± 0.7
		2.2–13.8	3.8–14.1	40.5–216.9	1.0– 9.0	0.9– 2.4	2.5– 3.9
ESP		1.1± 1.1	1.2± 0.8	22.9±11.7	0.7± 0.4	0.1± 0.1	0.6± 0.1
		0.0– 3.3	0.3– 2.8	9.4–46.1	0.0– 1.7	0.0– 0.3	0.5– 0.7

†Plot number.
*Mean with Standard Error
**Range

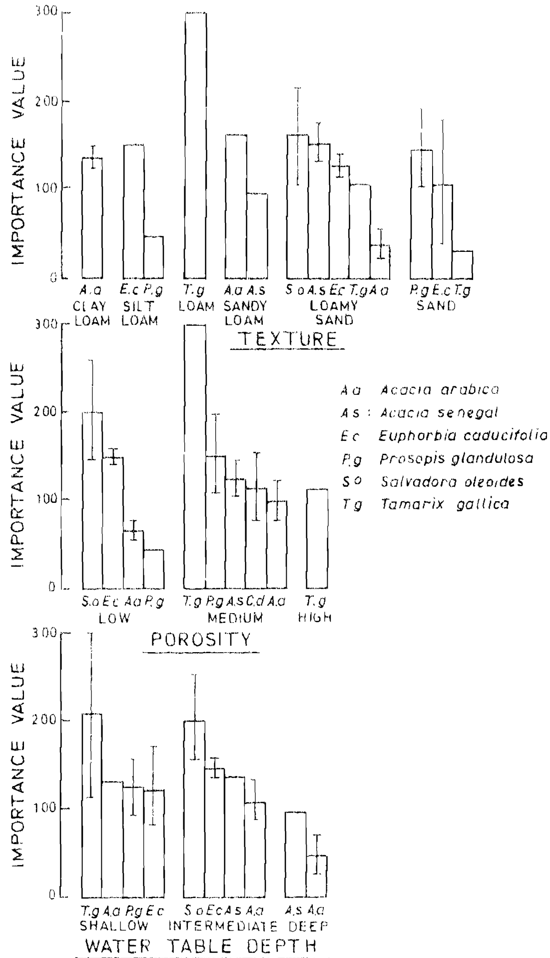

Fig. 3. Importance Value of different plant species in relation to soil texture, porosity and water table depth.

porosity. They are salt-and sodium-free and are basic in reaction. They have low cation exchange capacity, organic matter content and amount of soluble cations (Table 3).

Termites

Amitermes belli, Eremotermes neoparadoxalis, Microcerotermes heimi and *Psammotermes rajasthanicus* have been collected from *T. gallica* community (Table 4).

Inter-relationships

There exist a fair degree of correlations between: (a) soil and vegetation, (b) soil and termites, and (c) vegetation types and termite species.

Soil and vegetation

Distribution of some important plant species of this Major climatic Region in relation to various soil characteristics is given below:-

Table 4. Distribution of termites in relation to different community types of Arid Marine Tropical Coastlands.

Species	Community types						
	Acacia arabica	Acacia senegal	Salvadora oleoides	Euphorbia caducifolia	Prosopis glandulosa	Tamarix gallica	Total
Amitermes belli	–	+	+	–	–	+	3
Anacanthotermes macrocephalus	–	–	–	+	+	–	2
Coptotermes heimi	+	+	–	–	–	–	2
Eremotermes neoparadoxalis	–	–	–	–	–	+	1
Microcerotermes baluchistanicus	–	+	–	–	–	–	1
Microcerotermes championi	++	+	–	–	–	–	2
Microcerotermes heimi	+	–	–	–	–	+	2
Microtermes mycophagus	–	–	+	++	–	–	2
Microtermes obesi	–	+	–	+	–	–	2
Microtermes unicolor	+	++	–	–	–	–	2
Odontotermes lokanandi	–	–	+	–	–	–	1
Odontotermes obesus	–	+	–	–	–	–	1
Psammotermes rajasthanicus	–	–	–	+	+	+	3
Total	4	7	3	4	2	4	

– absent; + present; ++ positive association*

*Calculated by comparing observed value (number of plots having particular termite species) and expected value.

Positive association: Observed value > Expected value
Negative association: Observed value < Expected value
Independent: Observed value = Expected value

Soil texture (Fig. 3)

Acacia arabica is present in clay loam, sandy loam and loamy sand but it has very low I.V. in loamy sand which indicates its preference for heavy soils. *Euphorbia caducifolia* is present in silt loam, loamy sand and sand with more or less equal I. V. *Prosopis glandulosa* is present in silt loam and sand with higher I.V. in the latter. *Tamarix gallica* is found in loam, loamy sand and sand. It has highest I.V. in loam and lowest in sand. *Acacia senegal* occurs in sandy loam and loamy sand with higher I.V. in the latter. *Salvadora oleoides* is confined to loamy sand.

Porosity (Fig. 3)

Euphorbia caducifolia and *Salvadora oleoides* are present in soils of low porosity. *Acacia arabica* and *Prosopis glandulosa* are represented in soils having low and medium porosity with higher I.V. in the latter. *Acacia senegal* is present in soils of medium porosity. *Tamarix gallica* is present in soils of medium and high porosity with higher I.V. in the former.

Water table depth (Fig. 3)

Prosopis glandulosa and *Tamarix gallica* are found in soils with shallow water table depth. *Salvadora oleoides* is represented in soils with shallow to deep water table. But it has low I.V. in soils with deep water table. *Acacia senegal* occurs in soils with intermediate and deep water table with higher I.V. where the water table is deep.

Soil salinity (Fig. 4)

Tamarix gallica is found in salt-free soils only. *Euphorbia caducifolia* is present in salt-free to slightly saline soils with more or less equal I.V. *Acacia arabica* and *Prosopis glandulosa* are represented in salt-free to moderately saline soils. They have fairly high I.V. in slightly and moderately saline soils thus showing that they have some ability to withstand saline conditions.

Acacia senegal is present in salt-free to moderately saline soils having decreasing I.V. with increasing salinity.

Salvadora oleoides is present in slightly to strongly saline soils. There is an increase in its I.V. with an increase in soil salinity indicating thereby its high salt tolerance.

pH (Fig. 4)

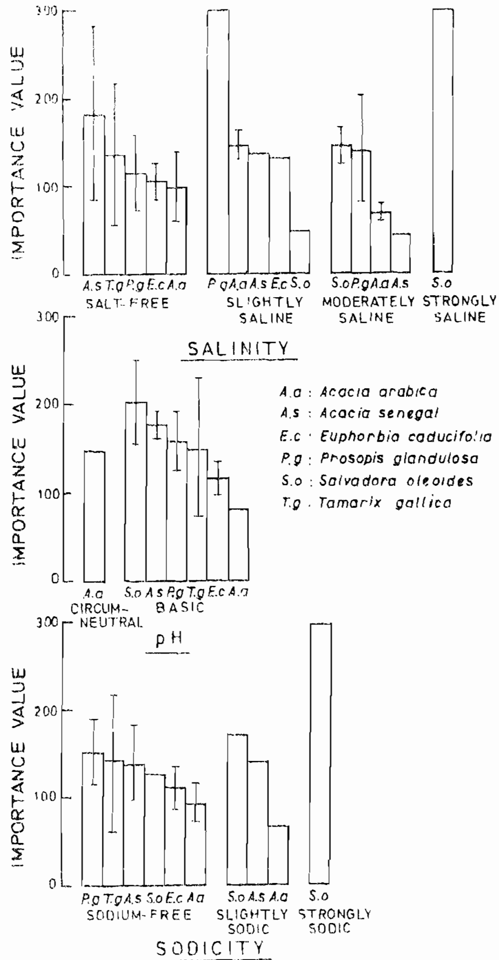

Fig. 4. Importance Value of different plant species in relation to soil salinity, pH and sodicity.

Acacia arabica is present in circum-neutral and basic soils with higher I.V. in the former. *Acacia senegal, Euphorbia caducifolia, Prosopis glandulosa, Salvadora oleoides* and *Tamarix gallica* are present in basic soils only.

Soil sodicity (Fig. 4)

Euphorbia caducifolia, Prosopis glandulosa and *Tamarix gallica* are found in sodium-free soils only. *Acacia arabica* and *Acacia senegal* are present in sodium-free and slightly sodic soils. *Salvadora oleoides* is found in sodium-free to strongly sodic soils. There is some indication of an increase in its I.V. with an increase in soil sodicity.

Soil and termites

Soil texture (Fig. 5)

Different soil textural classes hold different number of termite genera and species. Sandy loam soils have greater number of termite genera and species than soils of other textural classes.

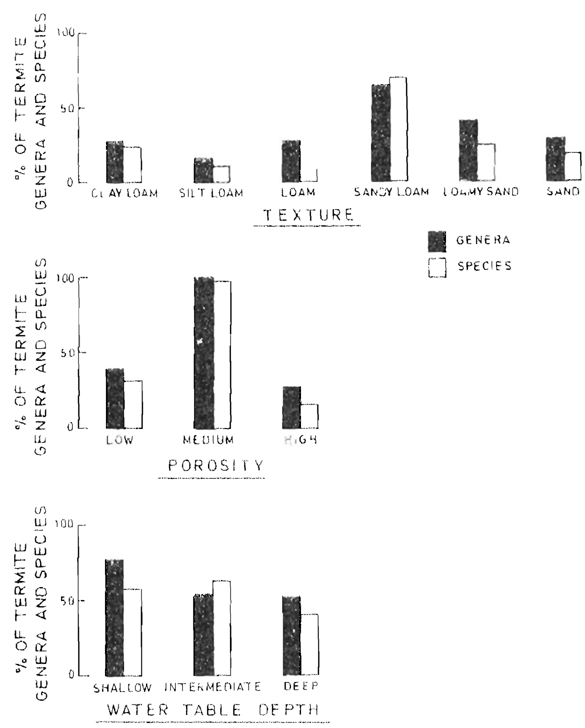

Fig. 5. Percentage of termite genera and species in relation to soil texture, porosity and water table depth.

Porosity (Fig. 5)

Soils of medium porosity have greater number of termite genera and species than those with low and high porosity.

Water table depth (Fig. 5)

Soils with shallow and deep water table contain more or less equal number of termite genera and species.

pH (Fig. 6)

Basic soils have higher number of termite genera and species than the circum-neutral ones.

Soil salinity (Fig. 6)

The number of termite genera and species decreases with an increase in soil salinity. Salt-free soils have maximum number of termite genera and species, slightly and moderately saline soils hold a fewer termite genera and species, while strongly saline soil is devoid of termites.

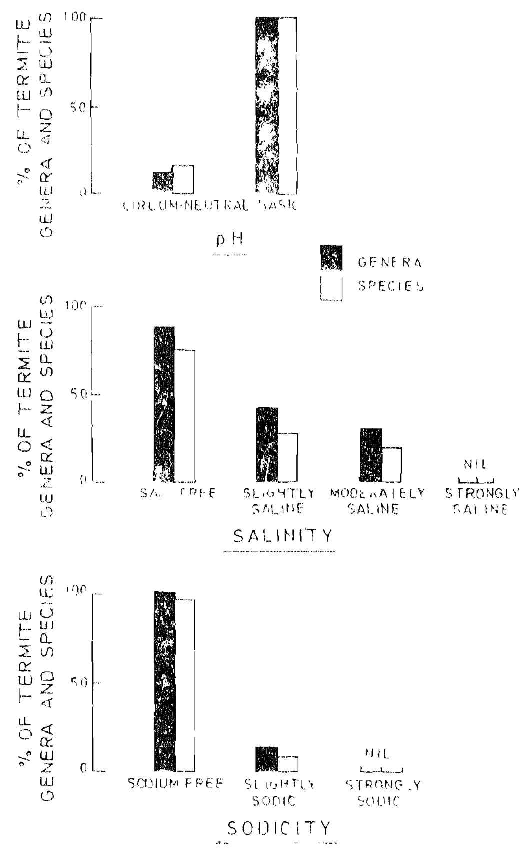

Fig. 6. Percentage of termite genera and species in relation to soil pH, salinity and sodicity.

Soil sodicity (Fig. 6)

Sodium-free soils have a greater number of termite genera and species, slightly sodic soils contain lesser termite fauna while strongly sodic soils are free from termites. Thus there is a decrease in termite fauna with an increase in soil sodicity.

Vegetation and termites

Nature and composition of termite fauna vary from community to community (Table 4). *Acacia senegal* community has greater number of termite species. *Acacia arabica, Euphorbia caducifolia* and *Tamarix gallica* communities have lesser number of termites, while *Salvadora oleoides* and *Prosopis glandulosa* communities have the lowest number of termites.

As regards the ecological amplitude of individual species vis-a-vis their distribution in different community types, *Amitermes belli* and *Psammotermes rajasthanicus* have greater ecological amplitude (found in 50% of total community types). Species like *Anacanthotermes macrocephalus, Coptotermes heimi, Microcerotermes championi,* *Microcerotermes heimi, Microtermes mycophagus, Microtermes obesi* and *Microtermes unicolor* have lesser ecological amplitude (found in 33% of total community types) while *Eremotermes neoparadoxalis, Microcerotermes baluchistanicus, Odontotermes lokanandi* and *Odontotermes obesus* have lowest ecological amplitude (occur in about 17% of total community types).

Discussion

Vegetation was studied layer by layer. Only three strata, i.e., tree, shrub, and herb and grass layer were recognized. Importance Value,introduced by Curtis and McIntosh (1950),was calculated for each species of tree and shrub layer. The Importance Value gives equal importance to three important parameters,i.e., density, frequency and cover. Moreover, it emphasises relative importance of various components of a community to each other and relative to other communities. Importance Value of herb and grass layer was not determined due to difficulties in determining their density (grasses are intermixed with each other). Their cover was determined by line transect method. For herbs and grasses plant cover is commonly used in vegetation study (Mueller-Dombois & Ellenberg, 1974).

Vegetation and Climate

High temperature and low precipitation are characteristic features of this major Climatic region and consequently dry period prevails for major part of a year in this region (Fig. 2). Thus here plants experience lack of water and consequently have xerophytic adaptations. Xerophilly is a peculiar phenomenon of arid and semi-arid areas of world (Emberger & Lemee, 1962). Due to predominance of thorny species, Champion et al (1965) described the vegetation of this major climatic region under tropical thorn forest. This forest group once extended over vast area but with the extension of canal irrigation and biotic interference it has been destroyed over large tracts of land. However, at present in some places original natural vegetation of this Region is represented by its various climatic, edaphic, seral and degraded types.

Soil and Vegetation

Acacia arabica is a common species of the study area. It predominates in 3 plots and occurs as an associate species in *Acacia senegal* and *Salvadora oleoides* communities (Table 2). *A. arabica* is a principal species of Sind Riverian forest and together with *Prosopis spicigera* constitutes about 75% of total plant cover (Qadri, 1955). It has appreciably high I.V. in slightly and moderately saline and slightly sodic soils (Fig. 4). Sheikh (1974) reported that *A. arabica* can grow in salt-affected and water-logged soils. Its relatively high I.V. in soils with fine and medium texture and those having shallow and intermediate water table depths (Fig. 3) suggests its preference for the soils of these charateristics.

Acacia senegal and *Euphorbia caducifolia* predominate separately in the study area. Chaudhry (1960) reported that forests of both the species are seral stage of tropical thorn forest on detached hills. Bharucha (1955) reported that both the species are found on sandy rocks where alluvium has not yet been deposited. On rocks *E. caducifolia* makes its appearance before *A. senegal* (Chaudhry, 1960) and this may be responsible for the greater amount of organic matter in the former than in the latter (Table 3). This greater amount of organic matter in the soil is further responsible for greater water holding and cation exchange capacities in *A. senegal* community soils (Table 3).

Salvadora oleoides predominates in salt-affected soils only (Table 3). It is a characteristic species of saline and/or sodic soils (Champion et al., 1965) and is a component of climax vegetation of Indus plains (Chaudhry, 1960). An increase in its I.V. with an increase in soil salinity/sodicity (Fig. 3) indicates that this species is a preferential halophyte (see Tsopa, 1939). Its high I.V. in soils having poor aggregation (Tables 2 and 3) and low porosity (Fig. 3) is due to presence of high amounts of sodium in the soils of this community (Table 3).

Prosopis glandulosa predominates in 2 plots but occurs as an associate species with appreciable I.V. in *Acacia arabica, Salvadora oleoides* and *Euphorbia caducifolia* communities (Table 2). *P. glandulosa* is an exotic species (Khattak, 1976). Its dominance and occurrence as common associate of *A. arabica, S. oleoides* and *E. caducifolia* indicates that this species has adapted itself in the study area.

Tamarix gallica predominates only in two plots and occurs as an associate species in *Prosopis glandulosa* community (Table 2). Its confinement to soils with shallow water table, basic reaction and those which are salt-and sodium-free (Figs. 3 and 4) suggests its relatively narrow ecological amplitude.

Soil and Termites

Sandy loam and loamy sand hold greater number of termite species than sand, loam, silt loam and clay loam (Fig. 5). In the soil classified as 'sand', clay is either absent or present in very small quantities. Clay is preferred by termites in their nest building (Harris, 1955). Absence of *Coptotermes acinaciformis* from deep sand has been explained by Claby & Gay (1956) as probably due to non-availability of clay for nest building.

Poor representation of termite fauna in soils with high porosity (Fig. 5) may be related to coarse texture of these soils.

Physical properties of fine-textured soils, such as cracking in dry period and waterlogging in wet period, are inimical to termite survival (Ratcliffe et al. 1952). These soils have, therefore, poor termite fauna (Fig. 5).

Soils with deep water table have relatively poor termite fauna (Fig. 5). This may be because in the study area low rainfall coupled with high temperature (Fig. 2) results in shortage of water. In soils with water table up to 25 m deep this shortage may be overcome by supply of extra moisture from water table by capillary action (see Bouillon, 1970).

There is a decrease in the number of termite species with an increase in soil salinity/sodicity (Fig. 6). This is due to unsuitability of salt-rich soils for nest building because of the difficulty in binding salt-rich particles together particularly where the soil is deflocculated due to its high Na content.

Vegetation and Termites

Nature and composition of termite fauna vary from community to community. *Acacia senegal* community has greater number of termite species. *Acacia arabica, Euphorbia caducifolia* and *Tamarix gallica* have lesser number while *Salvadora oleoides* and *Prosopis glandulosa* communities have the lowest number of termites (Table 4). These variations are most probably due to nature and availability of vegetative material. The plant material is a basic diet of termites. Termites have choice of different plant species and their parts (Bouillon, 1970). Snyder (1948) reported that soft, large celled, fast growing tissues are preferred to denser, small celled and slow growing tissues. Nature of the soil (its suitability for nest building) of a particular community is also associated with these variations. Poor representation of termite fauna in *Prosopis glandulosa* and *Salvadora oleoides* communities is, in all probability, due to coarse-texture (sand) and salinity/sodicity of the soils of these communities, respectively.

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