Chapter II.

MATERIAL & METHOD

M A T E R I A L A N D M E T H O D

Aerobiology is a scientific discipline focused on transport of organisms and biologically significant materials through the atmosphere. The attention is given to source of organisms or materials released to the atmosphere, their dispersion, deposition and impact on animals, plants or human system.

SAMPLING SITE -

The dissertation is based on the aerobiological studies of Sangli city. Originally it was proposed to study the general aeromicroflora of Sangli city. The sampling was made from indoor as well as outdoor places. Taking into consideration the application of intramural studies in relation to biodeterioration of materials particularly in the library, studies were restricted to aerospora inside the libraries in Sangli. The library of Willingdon

College, Sangli was found to be most convenient place as the college is situated away from city and hence there are no possibility of contamination from other sources (Fig. 1).

Rotorod sampler was kept inside the library of Willingdon College at the height of 1 meter from the ground level.

The air monitoring by use of samplers aims at removal of spores and microbial population for further microscopic observations or culturing those for observations after growth. The volumetric sampler provide qualitative and quantitative data. A variety of samplers are available. Some widely used are gravity slide sampler-Durham-Rotating arm sampler, Rotorod sampler, Filtration sampler, Molecular filter membrane, Volumetric sampler-Tilak, Hirsts Burkara, Insect samplers, Bacterial samplers, aircraft samplers etc..

The Rotorod sampler was used for collecting the data for present piece of work (Plate No.I). It is well fitted to use in the field and relatively independent of external wind speed. This sampler was originally described by Dr. W.A. Perkins in 1957. The device relies upon the high efficiency with which small airborne particles are deposited on narrow cylinders

oriented at right angles to high velocity winds. A small constant speed, battery operated motor is used to whirl the thin sticky coated brass rods about its axis at a constant high speed. It has been developed by Tilak (1982) into a cheap, portable and high efficiency sampler with high sensitivity.

Collecting arms of the model are made up of 0.159 cm (1/16 inch)square section brass rods slightly bent inwards. The vertical arms are 6 cm long and 4 cm from axis.

According to Gregory (1952) the width should give more than 60-70% efficiency of deposition for 20 µm diameter spores at wind speed above 4 m.p.h. (2 mm/sec). The model employs D.C. controlled speed motors of the type used for record players with the rods in position the motor gives 2300 r.p.m..

SAMPLING RATE -

The sampling rate is the volume swept by the collecting surface per unit time. The dimensions selected make this,

$$2(\text{arms}) \times 0.159 \text{ cm} \times 6 \text{ cm} \times 8 \times 2300 \times 10^{-3}$$

$$= 48.0 \times 10^{-3} \times 2300 \text{ liters/min.}$$

$$\approx 110 \text{ liters/min (Approx.)}$$

SAMPLING METHOD -

Sampling was carried out operating Rotorod air sampler. The collection efficiency of this model is 85%. The petroleum jelly is used as a adhesive on cellotape.

The Rotorod sampler has been used for a wide variety of airborne particles. After the application of Jelly or Vaseline the edges of cellotape are trimmed back to the width of the rods with sharp razor blade (the alternative would be to apply the transparent cellotape, trim and then coat with adhesive.). The cellotape is cut into four equal parts, 1.5 cm length before adhesive is applied. After exposure these are mounted beneath a cover glass with suitable mountant like Glycerin jelly which has the best optical properties for visual examination. It was prepared as follows,

Gelatin	- 40 gm
Glycerin	- 120 ml
Distilled water	- 140 ml
Phenol crystals	- 0.5 gm

SCANNING -

The total spore counts obtained on the known areas during morning hour and evening hour were scanned under 10 x 45 X eyepiece-objective combination of the microscope regularly. The number of spores per unit volume of the air was computed with the help of conversion factor 5 for obtaining the total number of spores/cum of air and efficiency.

Considering the encounted efficiency to be 85% with the help of conversion factor the number of spore counted on the tape of known area was readily converted into an estimated number of spore per cubic meter of air. All timings are given in Indian standard time (I.S.T.). The identification of the spore caught was based on morphological characters studied microscopically.

In all possible cases generic counts were made which are based on colour, shape and other diagnostic features of the spores.

AERIAL SURVEY BY CULTURE PLATE TECHNIQUE :

Aerial survey is also made by exposing culture plates containing different culture media. Various media used are Potato Dextrose Agar,

Sabouraud's Agar, Czapek-Dox Agar etc. employed by different workers.

In the present investigation Potato Dextrose Agar medium was used. The ingredients for this medium are as follows,

Potato slices	- 200 gm
Dextrose	- 20 gm
Agar-Agar	- 20 gm
Distilled water	- 1000 ml
pH	- 6.0 to 6.5

The culture plates were prepared. These plates were exposed for 5 to 10 minutes in the library twice a day i.e. in the morning in between 10 to 11 A.M. and in the evening in between 4 to 5 P.M. The exposed plates were incubated in an inverted position at $30^{o}C$ depending upon the growth of colonies. The fungal colonies developed were identified, counted and isolated by subculturing on sterile slant tubes containing nutrient medium. These subcultures are maintained for record purposes (and are also used as source for the mass culture of various fungi responsible for deterioration of book).

PERIOD DURING INVESTIGATION -

Airspora of the library of Willingdon College, Sangli was investigated for a period of one year from 1st October 1992 to 30th September 1993 twice in a week i.e. on monday and friday. On these days sampling was done at 10 A.M. and 4 P.M.

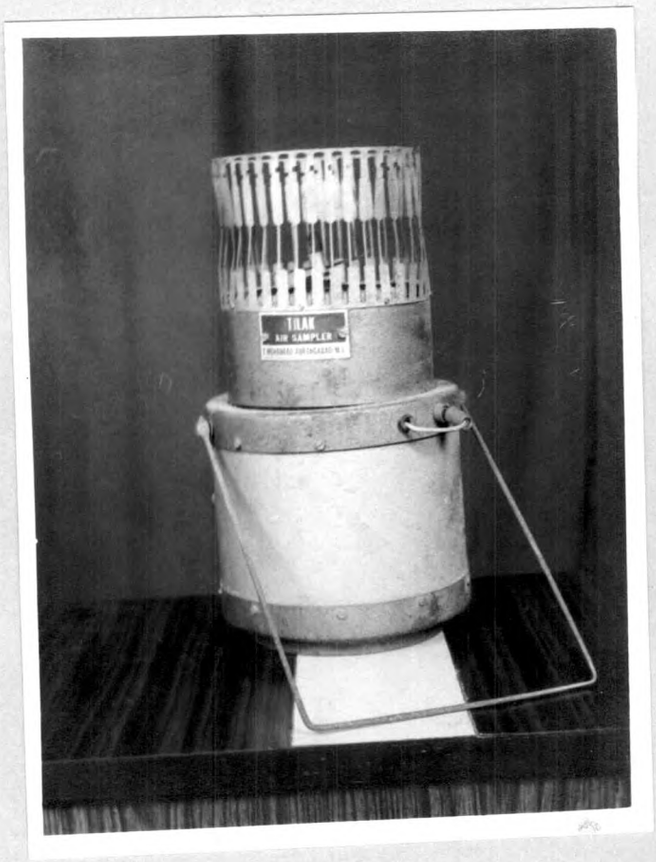
METEOROLOGICAL DATA -

During the period of investigation daily record of temperature, rainfall and moisture were obtained from Agriculture Research Station, Digraj, (Sangli) (Table No.1).

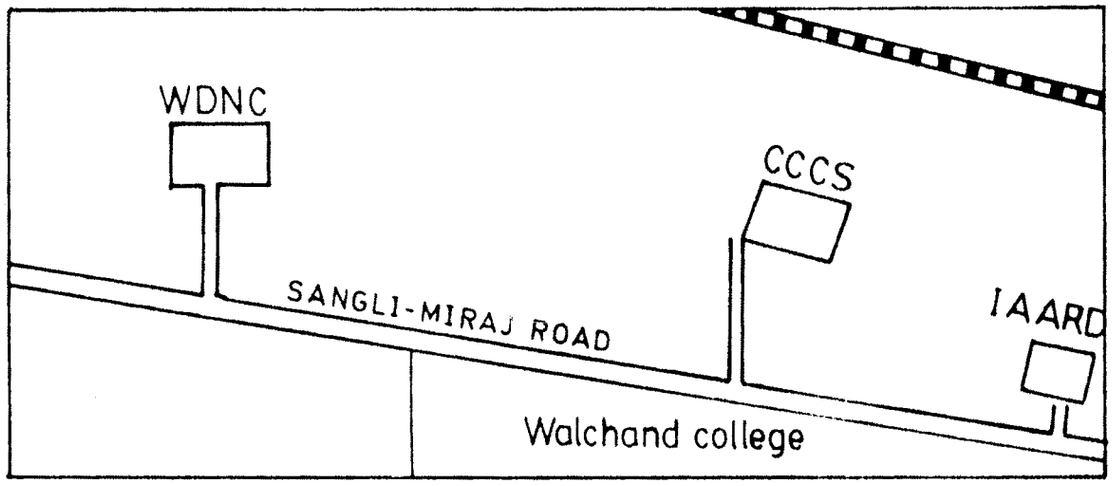
EXPLANATION OF PLATE I

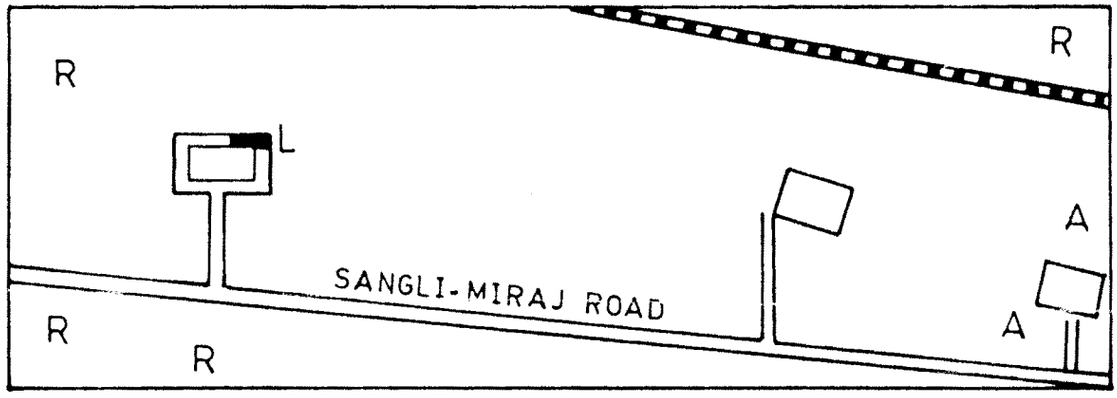
ROTOROD AIR SAMPLER

PLATE-I



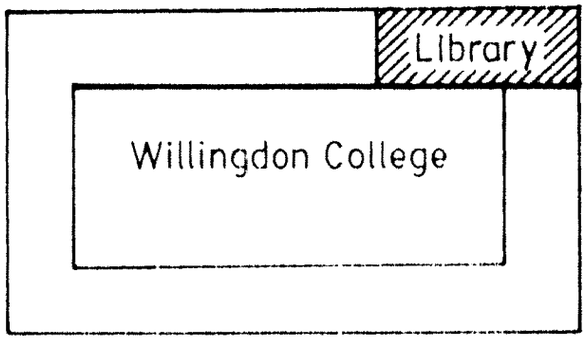
Location of Willingdon College, Sangli.





R=Residential area A=Agricultural lands ▬ L=Library

Location of Willingdon College library.



KG

Fig.1

Chapter III.

OBSERVATIONS

O B S E R V A T I O NS

In the present study of aerospora of library of Willingdon College, Sangli the sampling was carried out for one year from Oct. 92 to Sept. 93. As it is an intramural aerobiological studies from library building, the aerospora mainly consisted of fungal spores, few insect parts, other components and rare occurrence of pollen grains.

During the period of investigation the total number of biopollutants trapped was 12122/m^3. Most of them are fungal spores belonging to different groups. In general peak period of fungal spore contribution is October to January and then afterwards there is decrease in their concentration. In the next four months from March to June and from July again they slightly increase in concentration upto September (Table II, Hist 1). This is correlated with temperature variations (Table I, Fig. No.2) during the course of investigation. As the atmospheric temperature increased the concentration of fungal spore decreases.

The total 12122 aerospora collected during the period of investigation was assigned to respective

groups of fungi and their concentration is as follows,

1. Phycomycetes spores - Nil
2. Ascomycetes spores - 465/cum - 3.836%
3. Basidiomycetes spores - 960/cum - 7.919%
4. Deuteromycetes spores - 8940/cum - 73.750%
5. Other types - 1852/cum - 15.27%

The monthwise quantitative representation of these different groups of biopollutants is shown in Table III and Fig. No.3. As far as different seasons are considered, the quantitative representation of different groups of biopollutants is shown in Table IV and His.No.2.

The percentage concentration of each group of fungi indicates that Deuteromycetes and other types contributing 73.750 and 15.27 percent to the total aerospora and are the chief biopollutant. The Ascomycetes and Basidiomycetes contribute very less and Phycomycetes nil to the aerospora of the library of Willingdon College, Sangli.

The Basidiomycetes which contributes 7.919 percent to the total aerospora during period of investigation are represented by 3 genera only. The total number of spores belonging to each genus and

their percentage contribution in each month of the period of investigation is given in Table V, Hist. No.3 and Plate II.

Deuteromycetes is the most abundant group and contributes 73.750 percent to the total aerospora and show that it is the most diversified group represented by 21 genera (Table V, Hist. No. 4,5,6 and Plates III, IV, V, VI, VII, VIII).

Ascomycetes are represented by 5 genera and contribute 3.836 percent to the total aerospora while there is no contribution of Phycomycetes to the total aerospora (Table V, Hist. No.7).

The other type i.e. Algal fragments, epidermal hair, hyphal fragments, insect scale, insect parts, insect mite, plant fiber contributes 15.27% to the total aerospora (Table V, and Hist. No.8).

The Phycomycetes group is not represented in any month of the period of investigation (Table V, Fig.No.2).

Ascomycetes accounting 3.836% of the total aerospora during one years investigation are represented by five genera. Among them Chaetomium is recorded throughout the year from October to September. with average contribution of 0.404% to the total

aerospora. It's percentage in the aerospora is found to be increased in the month of Oct. to March and then decreased from April to Sept. The other four genera are Didymosphaeria, Hysterium, Sordaria, Teichospora are very rare and found to have inconsistance distribution during investigation period. They are recorded rarely in different seasons (Plate II).

Basidiomycetes account for 7.919% of the total aerospora. It is represented by Ustilago i.e. spores of smut, uredospores and Tilletia. Tilletia form most dominant spore type (Plate II). In contrast to smut spores and uredospores they are abundant between January to June. The smut spores contribute 0.494% of total aerospora. They are abundant in January. In the next three months they decreases considerably and again in the month of May show increase in abundance. From June to Sept. they show more or less constant distribution and again in the next three months i.e. till December decreases considerably. Rust spores i.e. uredospores were contribute 0.255 percent to total aerospora. Their number remain some what constant throughout the period of investigation.

Deuteromycetes form most dominant group in the total aerospora investigated during the period Oct. 1992 to Sept. 1993 and contribute 73.750% to the total aerospora. It is most diversified among the four groups of fungi and the percentage contribution of individual genus is as shown in Table V, Hist. No. 4,5,6.

Among the 21 genera recorded here Aspergillus, Alternaria, Curvularia, Epicoccum, Fusarium, Helminthosporium, Memnoliella spores are most dominant. (Hist.No.4, Plates III, IV, V, VI, VII).

During investigation Aspergillus, Curvularia and Fusarium are most dominant contributing 6.640, 1.295 and 1.245 percent to the total aerospora respectively. Aspergillus is highest in the October and decreases till March and then again show increase from April to September. Curvularia Fusarium are almost constant throughout the year except in the month of August and September. The other contributors are as follows, Alternaria (0.676%), Epicoccum (1.171%), Helminthosporium (0.956%), Memnoliella (0.998%), Nigrospora (0.579%) and Trichothecium (0.742%) (Hist.No.4)

Rest of genera of Deuteromycetes contribute 0.090 to 1.707 percent to the total aerospora and were

found to be inconsistent members of the aerospora (Hist. No. 5,6).

In other types i.e. Algal fragments, Epidermal hair, Hyphal fragments, Insect scale (Insect) mite and Plant fiber togather contribute 15.27% total aerospora. (Plate VIII, IX) Among them insect parts and hyphal fragments are more common and accounts for about 2.632%, 0.112% respectively. They are more common through out of year and other types such as algal fragments, epidermal hairs, plant fibers are inconsistently occurring and contribute least to the aerospora inside the library.(Hist. No.8).

The aerial survey of culture plate technique shows Alternaria, Fusarium, Cladosporium, Mucor, Penicillium, Aspergillus, Fusarium, and Mucor colonies were inabandance while Alternaria, Cladosporium, Torulla colonies were less abundant (Table VI and Plates X, XI, XII, XIII, XIV).

Thus in general the biopollutants inside library of Willingdon College, Sangli shows dominance of Chaetomium, Tilletia, Alternaria, Aspergillus, Curvularia, Epicoccum, Fusarium, Helminthosporium and Memnoliella. The genera Didymnosporium, rust and smut spores, Nigrospora, Trichothesium, Ceratopherium,

Melanospora, *Sporodesmium*, *Torula*, *Apirhynocostous*, *Bitrimonospora*, *Oidium*, *Pyriculuria*, *Scapuloropsis* form the subdominant group. All others are rare and inconsistantly occurring.

TABLE I

AVERAGE MONTHLY TEMPERATURE, RELATIVE HUMIDITY AND RAINFALL DURING THE PERIOD OCT. 1992 TO SEPT. 1993.

MONTH	TEMP ^{O}C	RELATIVE HUMIDITY % (MOISTURE)	RAINFALL (mm)
Oct	26.3	71.8	64.8
Nov	25.4	64.2	--
Dec	22.4	55.9	--
Jan	23.6	50.3	--
Feb	23.4	43.1	--
Mar	27.2	54.9	--
Apr	29.8	48.4	11.0
May	30.5	58.4	38.2
Jun	27.3	75.7	203.8
Jul	25.2	82.4	132.8
Aug	23.6	84.6	112.1
Sept	26.4	71.4	50.0

TABLE II

RELATIVE ABUNDANCE OF BIOPOLLUTANTS IN DIFFERENT MONTHS DURING THE PERIOD OCT 1992 TO SEPT 1993

MONTH	NO. OF BIOPOLLUTANTS/m^3
Oct	1650
Nov	1270
Dec	1215
Jan	1020
Feb	1130
Mar	660
Apr	586
May	750
Jun	716
Jul	810
Aug	1000
Sept	1315
TOTAL	12122

TABLE III

AVERAGE NO. AND PERCENTAGE CONTRIBUTION OF DIFFERENT GROUPS OF FUNGI TO THE TOTAL AEROSPORA DURING OCT 1992 TO SEPT 1993.

	OCT		NOV		DEC		JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEPT	
GROUP	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
Phycomycetes	--	--	--	--	--	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ascomycetes	40	0.329	55	0.453	80	0.659	50	0.412	40	0.329	40	0.329	20	0.164	25	0.206	40	0.329	25	0.206	30	0.247	35	0.288
Basidiomycetes	25	0.206	40	0.329	65	0.536	135	1.113	90	0.742	85	0.701	80	0.659	110	0.907	65	0.536	80	0.659	75	0.618	110	0.907
Deuteromycetes	1450	11.961	1105	9.115	865	7.135	635	5.238	790	6.517	420	3.464	435	3.588	395	3.258	460	3.794	535	4.413	775	6.393	1075	8.868
Other type	135	1.113	70	0.577	205	1.691	200	1.649	210	1.732	115	0.948	151	1.245	220	1.814	151	1.245	170	1.402	120	0.989	95	0.788

TABLE IV

AVERAGE NO. AND PERCENTAGE CONTRIBUTION OF DIFFERENT GROUPS OF FUNGI TO THE TOTAL AEROSPORA SEASONWISE DURING OCT 1992 TO SEPT 1993.

	WINTER (OCT-JAN)		SUMMER (FEB-MAY)		MANSOON (JUNE-SEPT)	
GROUP	TOTAL NO.	%	TOTAL NO.	%	TOTAL NO.	%
Phycomycetes	--	--	--	--	--	--
Ascomycetes	220	1.814	125	1.031	120	0.989
Basidiomycetes	265	2.186	365	3.011	330	2.722
Deuteromycetes	4055	33.451	2049	16.828	2845	23.469
Other type	610	5.032	696	5.741	546	4.504

TABLE V

AVERAGE CONTRIBUTION OF DIFF. BIOPOLLUTANTS TO THE AEROSPORA DURING THE PERIOD OF OCT 1992 TO SEPT 1993

SPORE TYPE	WINTER				SUMMER				MANSOON			
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
Phycomycetes	--	--	--	--	--	--	--	--	--	--	--	
Ascomycetes												
Chaetonium	0.049	0.082	0.074	0.065	0.032	0.024	0.008	0.016	0.016	0.008	0.008	0.016
Didymosphaeria	0.008	0.008	0.024	--	0.016	0.028	--	0.008	0.024	0.016	0.016	0.032
Hysterium	--	--	0.008	0.008	--	0.016	0.016	--	0.024	--	0.008	0.008
Sordaria	0.008	--	0.008	--	0.008	0.016	0.008	0.008	--	0.008	0.008	--
Teichospora	--	--	0.016	0.008	0.008	--	--	0.008	--	0.008	0.008	--
Basidiomycetes												
Tilletia	0.024	0.032	0.041	0.123	0.082	0.098	0.082	0.065	0.065	0.049	0.032	0.082
Smut (U. spora)	--	0.024	0.041	0.082	0.032	0.024	0.024	0.082	0.041	0.057	0.057	0.074
Uredospore of rust	0.016	0.008	0.024	0.016	0.032	0.016	0.029	0.032	--	0.024	0.032	0.024

SPORE TYPE	WINTER				SUMMER				MANSOON			
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
Deuteromycetes												
Alternaria	0.082	0.074	0.057	0.065	0.032	0.041	0.065	0.041	0.032	0.049	0.065	0.065
Apiorhocottoma	--	0.032	--	0.024	0.016	0.008	0.008	--	0.008	0.008	0.016	0.008
Aspergillus	1.649	0.907	0.659	0.329	0.659	0.247	0.206	0.206	0.247	0.288	0.412	0.824
Bitrinurospora	--	0.016	0.016	--	0.008	--	0.008	0.008	--	0.008	0.008	0.016
Cercospora	0.008	--	0.008	0.024	0.008	0.016	0.024	0.016	0.016	0.008	0.016	0.016
Ceratophorium	0.016	0.008	0.008	0.016	--	--	0.008	0.008	0.016	0.008	0.016	0.008
Clastoporium	0.016	0.008	--	--	--	--	0.008	0.008	0.008	0.008	--	--
Curvularia	0.148	0.164	0.140	0.082	0.065	0.057	0.049	0.057	0.041	0.065	0.170	0.230
Diploidia	--	0.016	0.016	--	0.008	--	0.008	0.008	0.016	0.016	0.016	--
Epicocum	0.123	0.164	0.140	0.082	0.164	0.123	0.082	0.065	0.057	0.016	0.082	0.065
Fusarium	0.082	0.164	0.098	0.090	0.082	0.065	0.057	0.049	0.032	0.082	0.206	0.164
Helminthosporium	0.090	0.041	0.032	0.098	0.065	0.057	0.049	0.057	0.032	0.082	0.164	0.181
Melanospora	0.024	0.016	0.008	--	0.016	0.008	--	0.016	0.016	0.016	0.008	0.016
Memnoliella	0.065	0.164	0.098	0.115	0.090	0.082	0.041	0.032	0.065	0.057	0.082	0.098
Nigrospora	0.074	0.057	0.041	0.032	0.016	--	0.032	0.041	0.016	0.049	0.082	0.098

SPORE TYPE	WINTER				SUMMER				MANSOON			
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
Oidium	0.008	0.008	0.016	0.024	0.016	--	--	0.008	0.008	0.016	--	0.016
Pyricularia	0.008	0.008	0.016	0.024	0.016	--	0.016	--	0.008	0.008	--	0.024
Scapuloropsis	0.008	0.008	0.016	0.016	0.008	--	--	0.016	--	0.008	0.008	0.016
Sporedesmium	0.041	0.057	0.049	--	0.032	0.041	0.016	0.024	0.016	0.032	--	0.032
Torula	0.032	0.024	0.016	0.016	--	--	0.016	0.008	0.024	0.032	0.016	0.024
Trichothecium	0.057	0.049	0.123	0.082	0.057	--	0.065	0.032	0.041	0.065	0.074	0.090
Other types												
Algal fragments	--	0.016	0.041	0.016	--	0.008	0.016	0.008	--	--	--	0.008
Epidermal hair	--	--	0.008	0.008	--	--	0.008	--	--	--	0.008	--
Hyphal fragment	--	0.016	0.016	0.008	0.016	0.008	0.008	--	0.008	0.008	0.016	0.008
Insect scale	0.016	--	0.016	--	0.008	--	--	0.008	--	0.008	0.008	0.016
Insect part	0.206	0.082	0.247	0.288	0.313	0.164	0.206	0.329	0.247	0.263	0.184	0.123
Insect mite	--	--	--	0.008	0.008	--	0.008	0.008	--	--	--	--
Plant fiber	--	--	0.008	--	--	0.008	0.008	0.008	--	--	--	--

TABLE VI

NO. OF COLONIES RECORDED ON CULTURE PLATES IN DIFF. SEASONS DURING THE PERIOD OCT.92 TO SEPT.93

COLONIES IDENTIFIED	WINTER (OCT - JAN)		SUMMER (FEB - MAY)		MONSOON (JUN - SEPT)	
	M	E	M	E	M	E
White- Bacteria	13	16	36	25	15	16
Green-*Aspergillus*	21	33	14	13	14	13
White(Mycellium) *Penicillium*	2	6	3	3	5	3
Black- *Mucor*	3	1	1	2	2	2
Pink white *Fusarium*	-	1	1	-	1	-
Dark red *Torula*	1	1	1	4	3	-
Yellow-*Alternaria*	-	-	-	1	1	-
Olive green *Cladosporium*	-	1	1	-	1	-

fig. No.2 Average monthly tempt., relative humidity and rain fall.

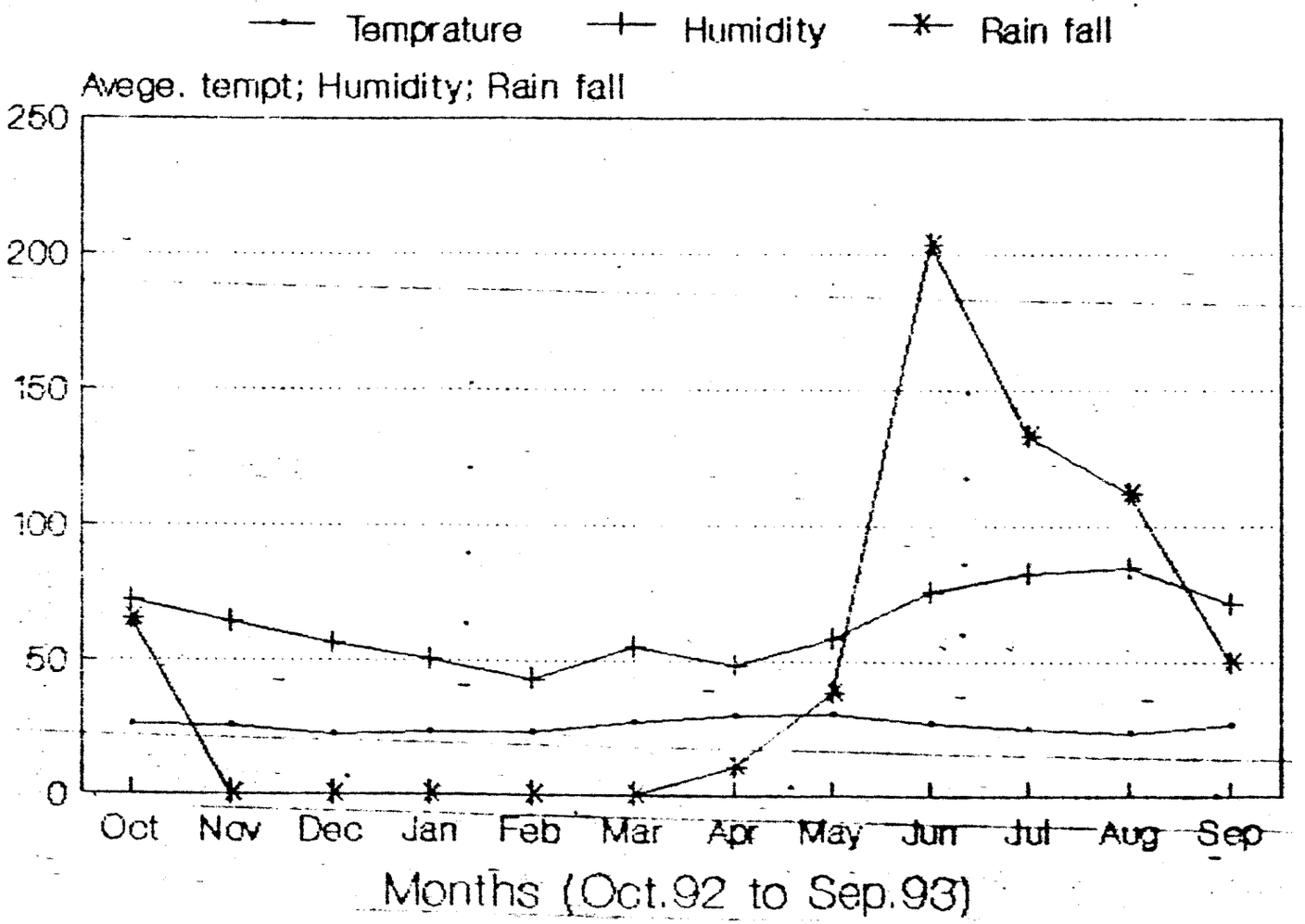
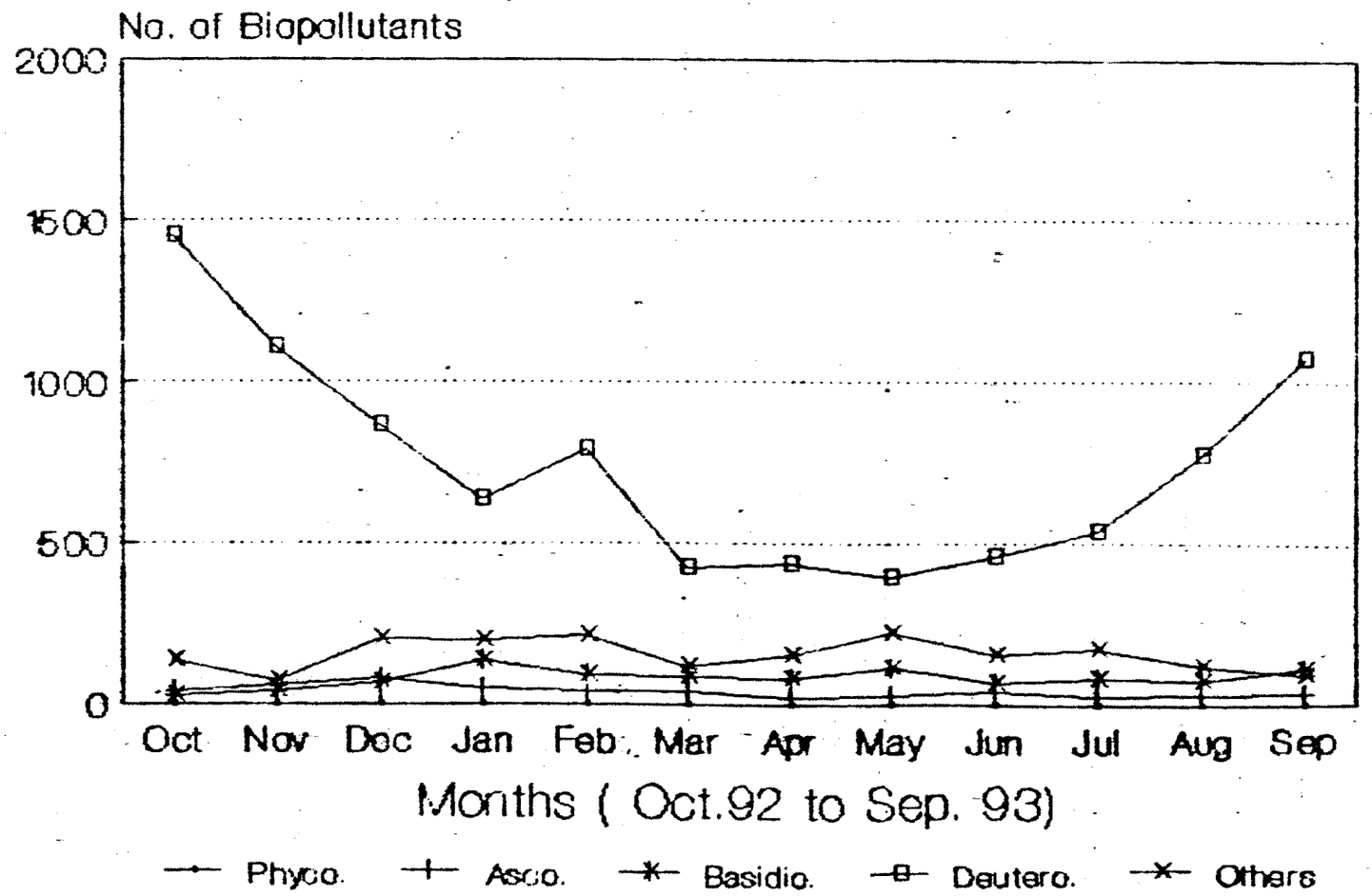
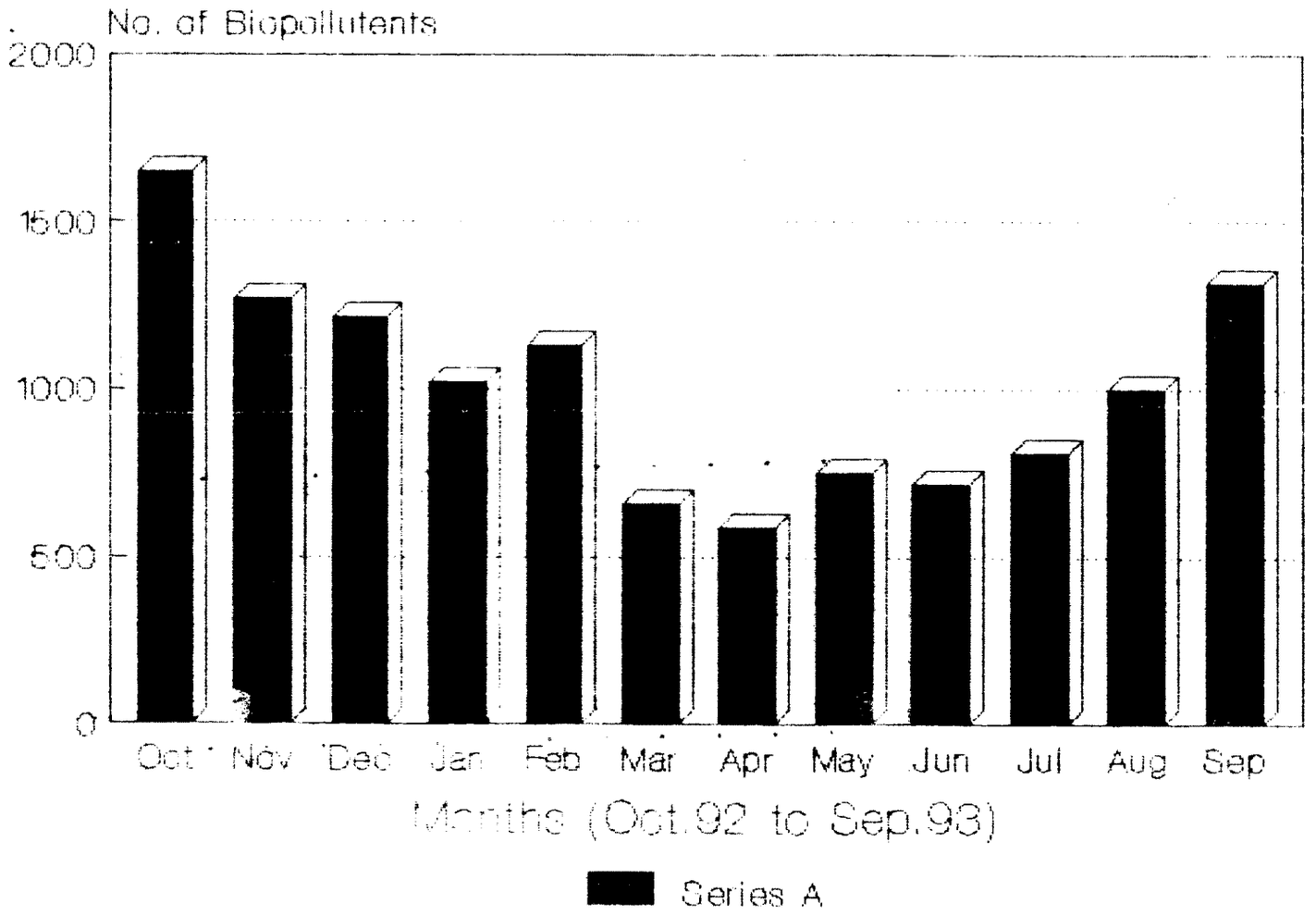


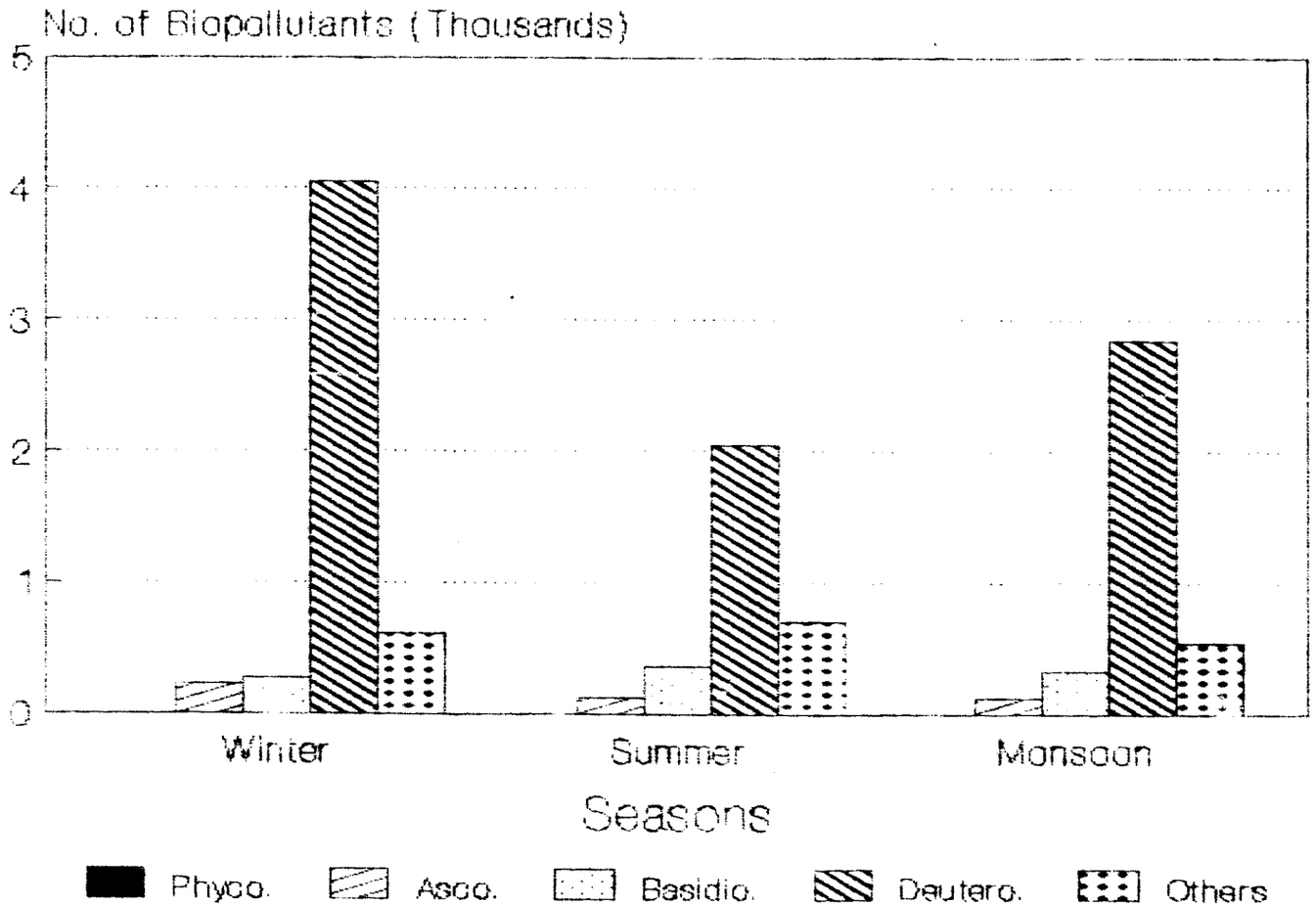
Fig. No.3 Monthwise quantitative repr. of diff. groups of Biopollutants.



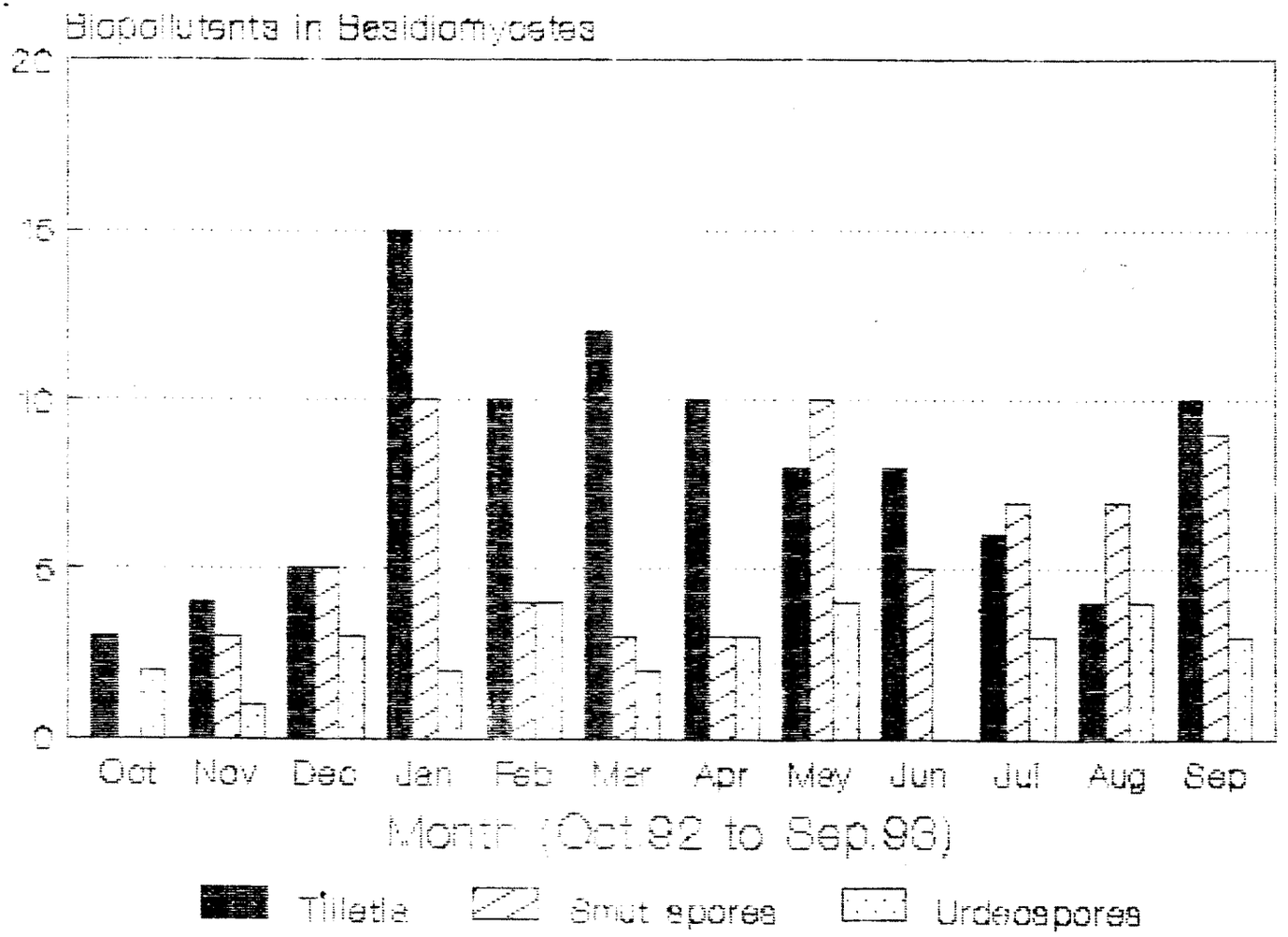
Histogram No.1 Monthwise quantitative representation of Biopollutants



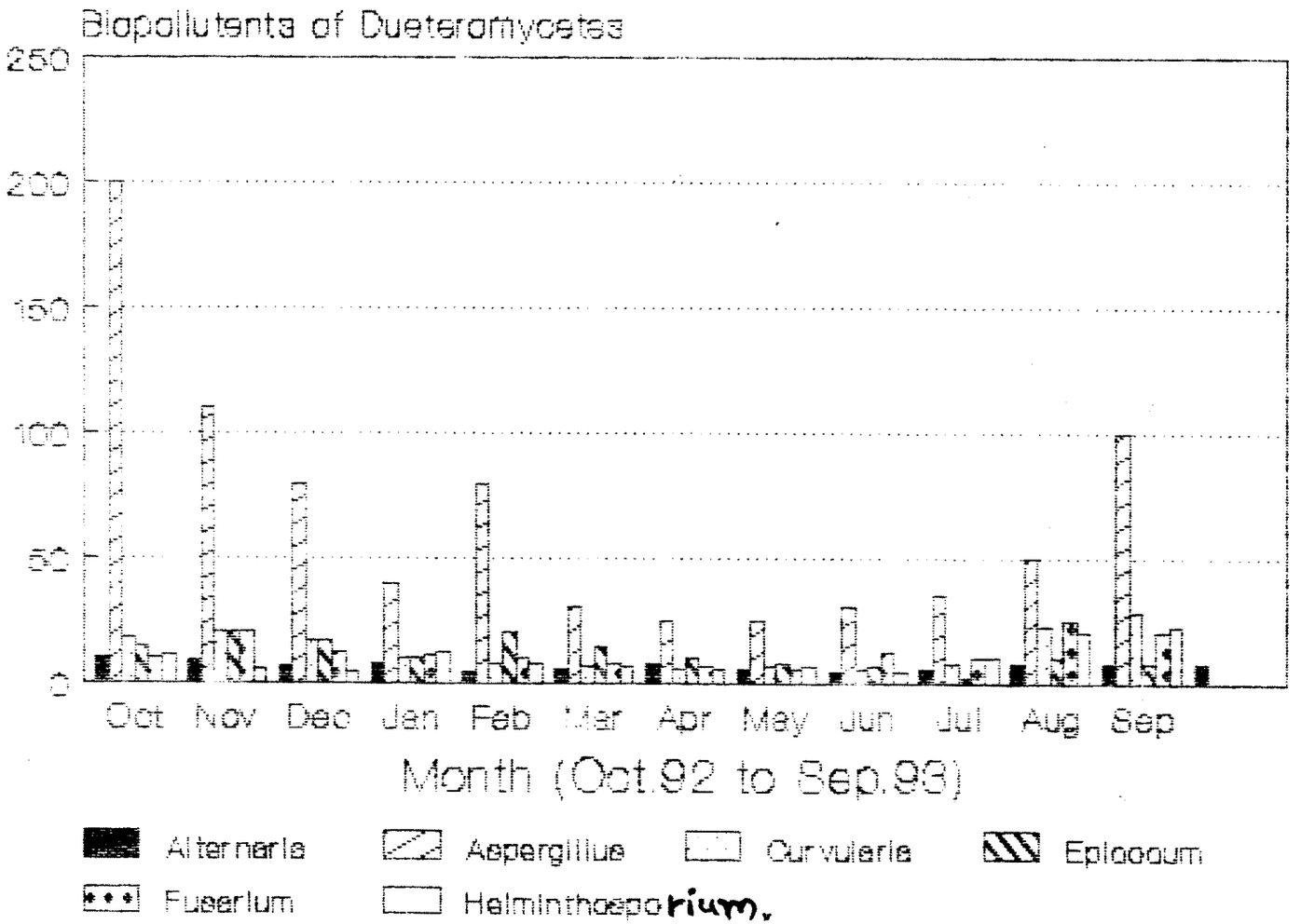
Histogram No.2 Seasonal quantitative repr. of diff. groups of biopollutants



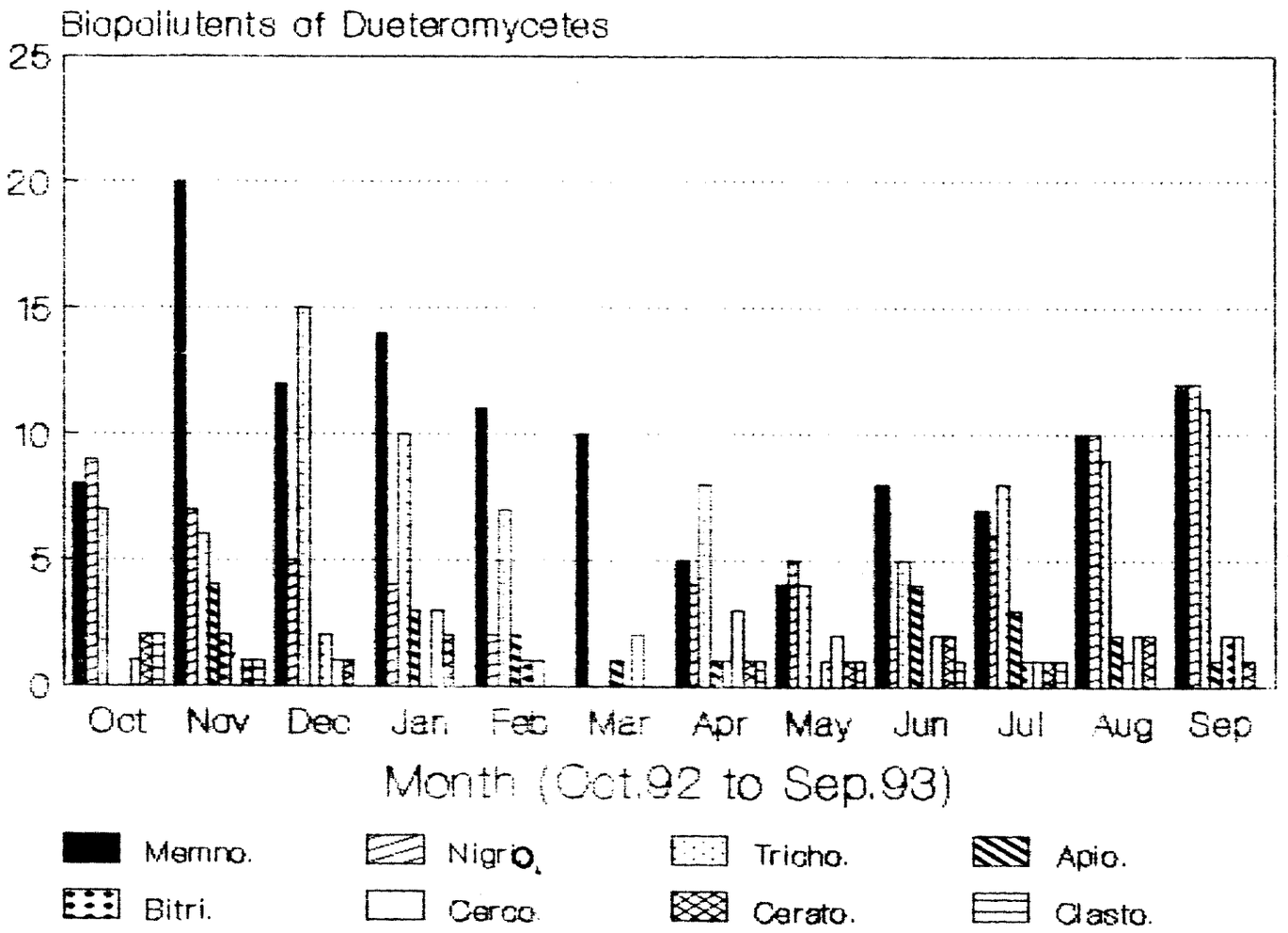
Histogram No.3 Monthly quantitative representation of Basidiomycetes



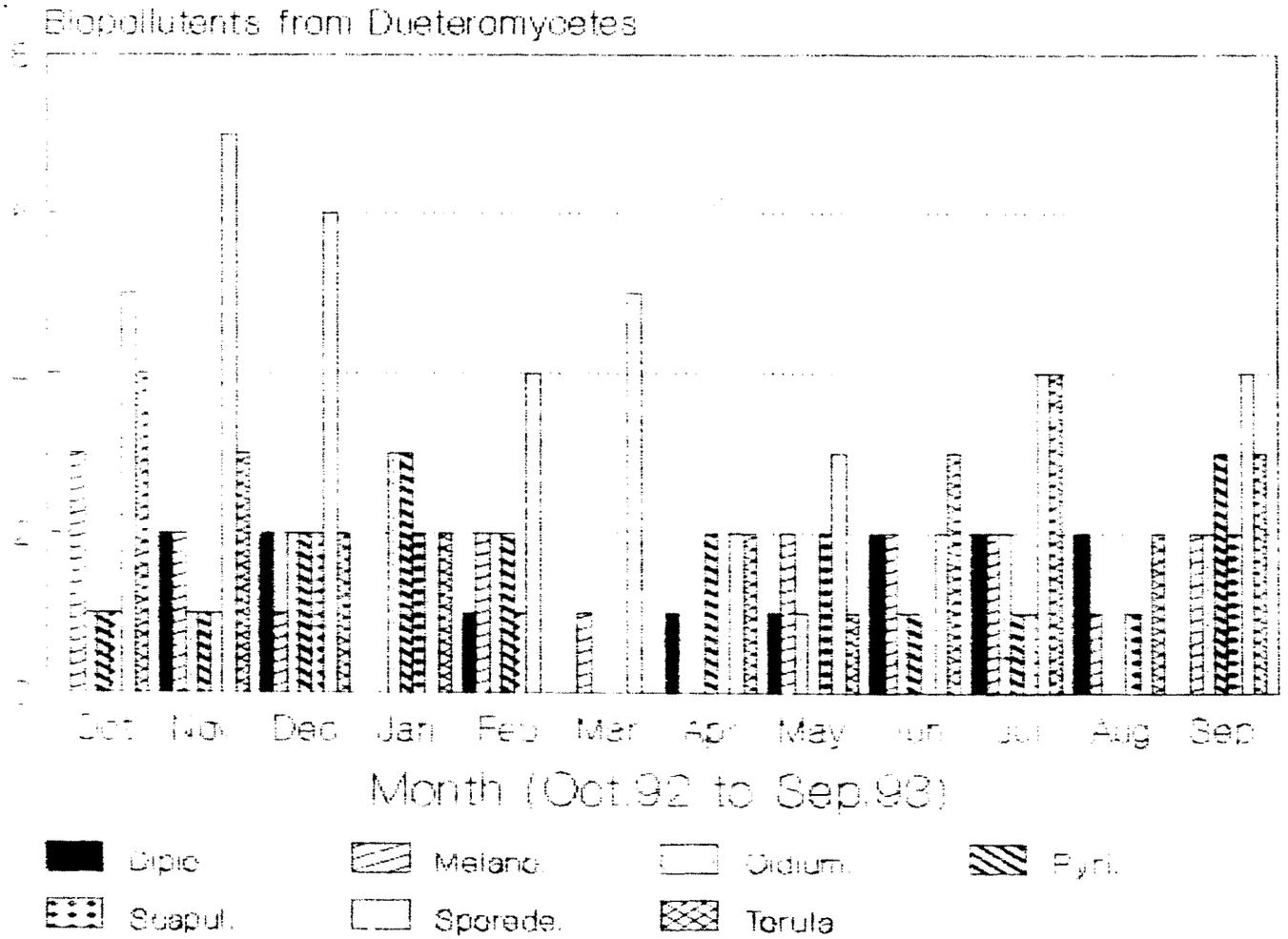
Histogram No.4 Monthly quantitative rep. of Dueteromycetes dominent genera.



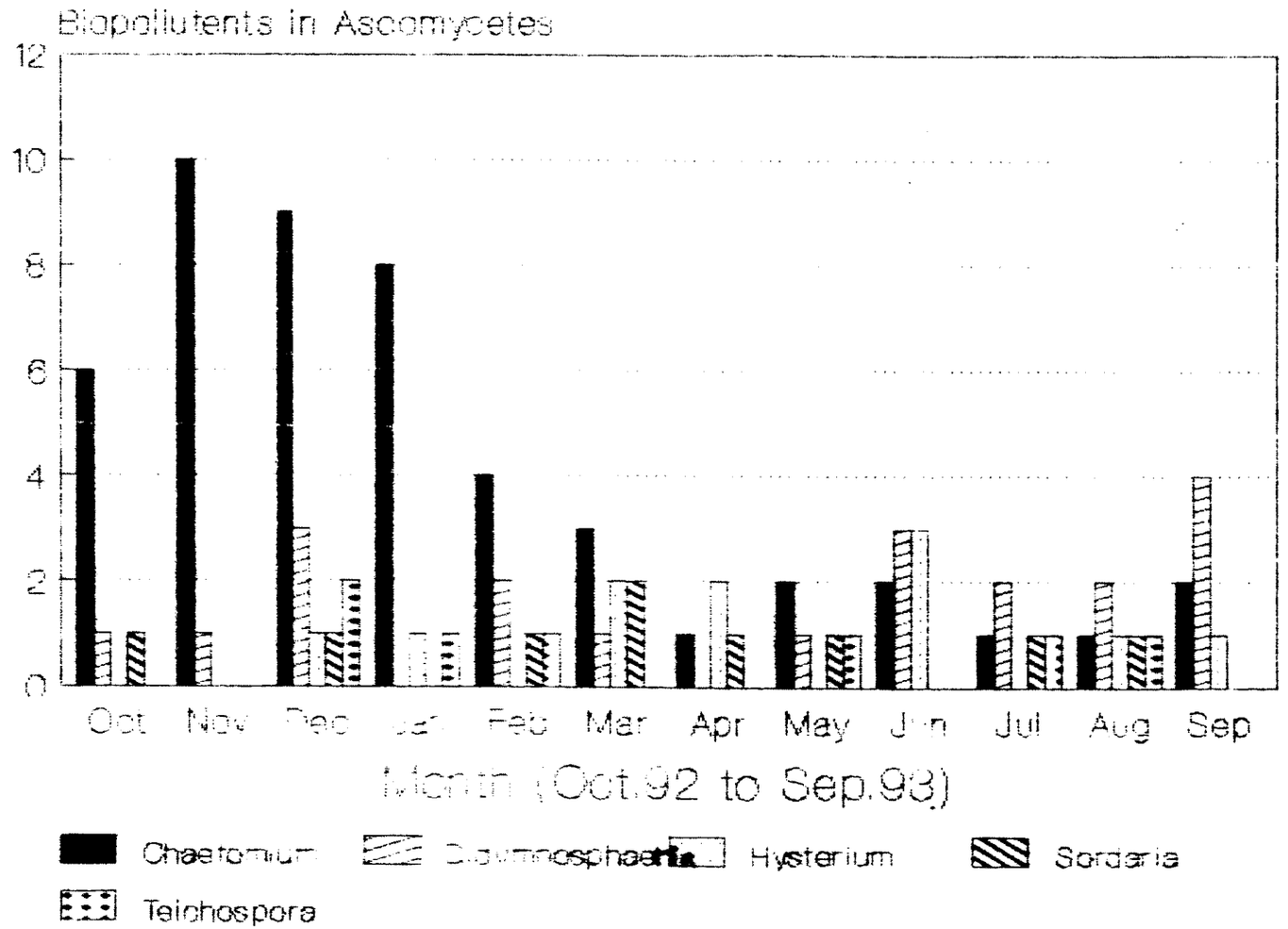
Histogram No.5 Monthly quantitative rep. of Dueteromycetes subdominant genera



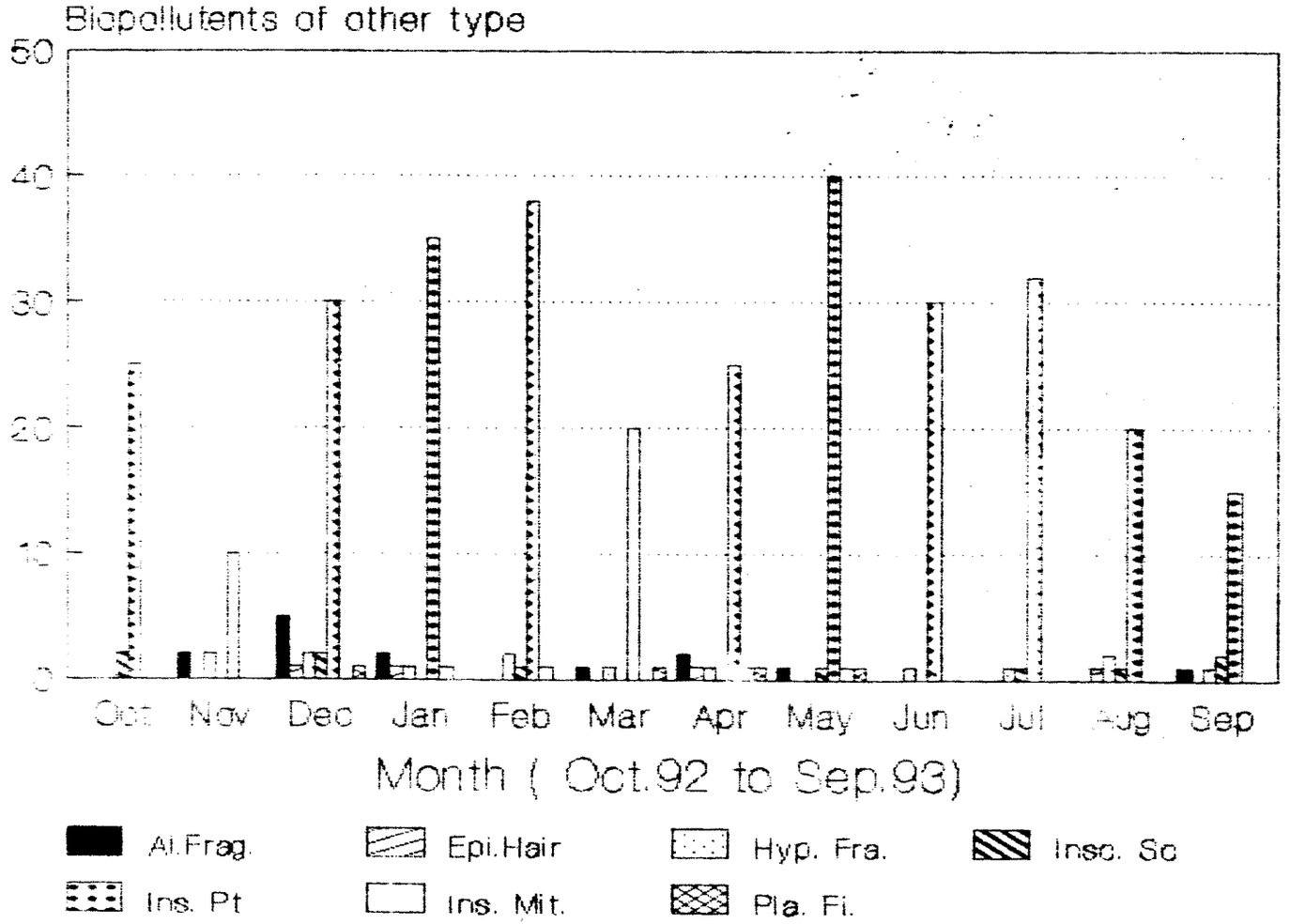
Histogram No.6 Monthly quantitative representation of Dueteromycetes rare



Histogram No.7 Monthly quantitative representation of Ascomycetes



Histogram No.8 Monthly quantitative repr. of Biopollutants of other types.



EXPLANATION OF PLATE II

Biopollutants inside library of Willingdon College, Sangli.

1. Didymnosphaeria
   (250x)

2. Teichospora
   (400x)

3. Hysterium
   (400x)

4. Rust i.e. Uredospores
   (400x)

EXPLANATION OF PLATE III

Biopollutants inside library of Willingdon College, Sangli.

1. Altenaria
   (400x)

2. Aspergillus
   (1000x)

3. Bitrimonospora
   (400x)

4. Cercospora
   (400x)

EXPLANATION OF PLATE IV

Biopollutants inside library of Willingdon College, Sangli.

1. *Cercospora* (long tail type) (400x)

2. *Ceratophorium* (400x)

3. *Clastophorium* (400x)

4. *Curvularia* (400x)

EXPLANATION OF PLATE V

Biopollutants inside library of Willingdon College, Sangli.

1. Helminthosporium a
   (400x)

2. Helminthosporium b
   (400x)

3. Helminthosporium c
   (400x)

4. Helminthosporium d
   (400x)

EXPLANATION OF PLATE VI

Biopollutants inside library of
Willingdon College, Sangli.

1. Helminthosporium e
   (400x)

2. Helminthosporium f
   (400x)

3. Helminthosporium g
   (400x)

4. Melanospora
   (100x)

EXPLANATION OF PLATE VII

Biopollutants inside library of
Willingdon College, Sangli.

1. Memnoliella
   (400x)

2. Oidium a
   (400x)

3. Oidium b
   (400x)

4. Pyricularia
   (400x)

EXPLANATION OF PLATE VIII

Biopollutants inside library of Willingdon College, Sangli.

1. Spëridesmium (400x)

2. Epidermal hair (400x)

3. Insect scale (400x)

4. Insect part a (400x)

EXPLANATION OF PLATE IX

Biopollutants inside library of
Willingdon College, Sangli.

1. Insect part b
   (400x)

2. Insect mite
   (400x)

3. Plant fibre
   (400x)

4. Insect scale with
   Helminthosporium
   (400x)

EXPLANATION OF PLATE X

Fungal colonies recorded on
Culture plates exposed inside library

Season - Winter (Oct-Jan)

M1 - Morning (10 am)

E1 - Evening (4 pm)

Colonies Recorded

I - White - Bacteria

II - Green - *Aspergillus*

III - White mycellium - *Penicillium*

IV - Black - *Mucor*

V - Dark Red - *Torula*

VI - Olive green - *Cladosporium*

EXPLANATION OF PLATE XI

Fungal colonies recorded on
Culture plates exposed inside library

Season - Summer (Feb-Mar)

M2 - Morning (10 am)

E2 - Evening (4 pm)

Colonies Recorded

I - White - Bacteria

II - Green - Aspergillus

III - White mycellium - Penicillium

IV - Black - Mucur

V - Pink white - Fusarium

VI - Dark Red - Torula

VII - Yellow - Alternaria

VIII - Olive green - Cladosporium

EXPLANATION OF PLATE XII

Fungal colonies recorded on
Culture plates exposed inside library

Season - Monsoon (June-Sept)

M3 - Morning (10 am)

E3 - Evening (4 pm)

Colonies Recorded

I - White - Bacteria

II - Green - *Aspergillus*

III - White mycellium - *Penicillium*

IV - Black - *Mucur*

V - Dark Red - *Torula*

VI - Yellow - *Alternaria*

VII - Olive green - *Cladosporium*

EXPLANATION OF PLATE XIII

Biopollutants identified from culture plates

1. Alternaria
   (400x)

2. Aspergillus
   (400x)

3. Cladosporium
   (400x)

4. Fusarium
   (400x)

EXPLANATION OF PLATE XIV

Biopollutants identified from culture plates

Aspergillus

1. Mucor
   (1000x)

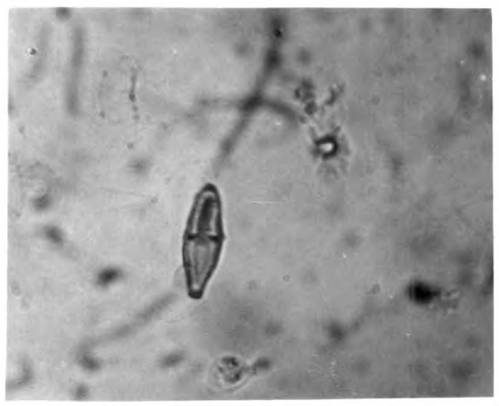
2. Penicillium
   (1000x)

3. Torula
   (400x)

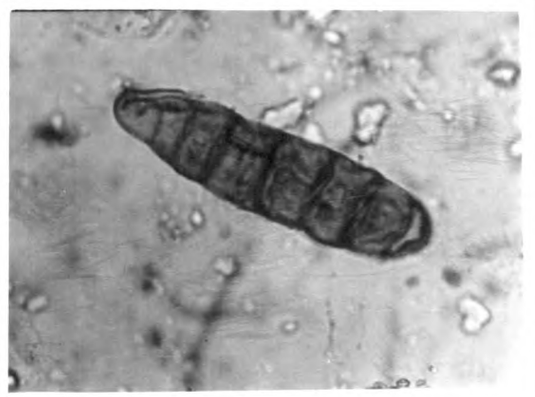
4. Spores of Torula
   (400x)

PLATE-II

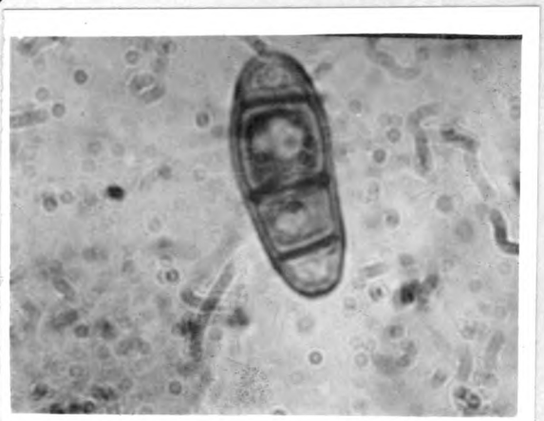
1



2



3



4

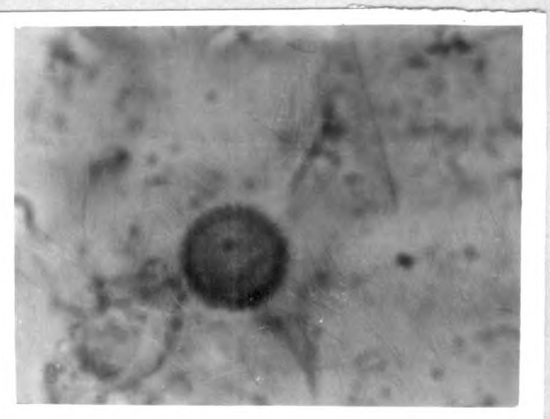
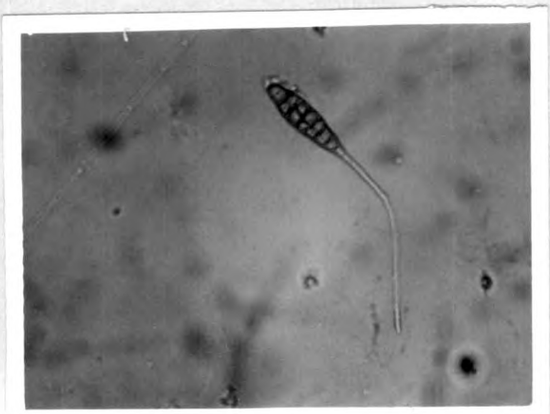
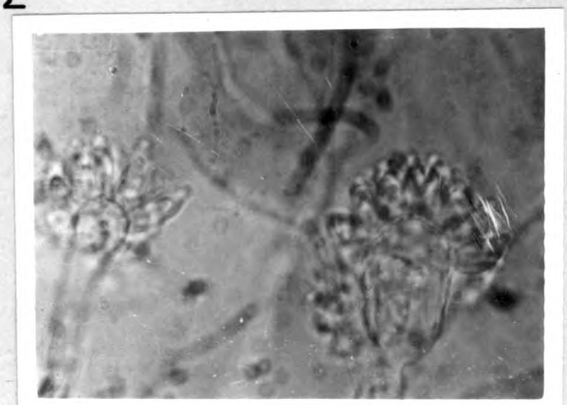


PLATE-III

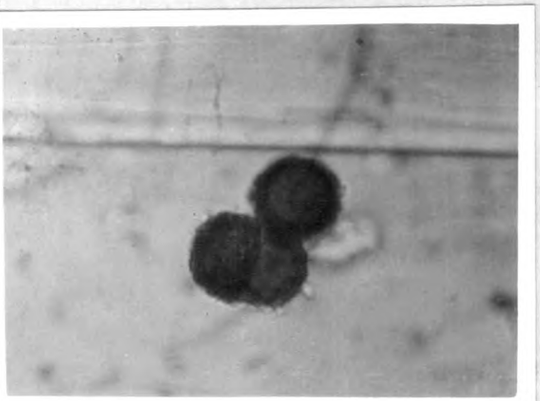
1



2



3



4

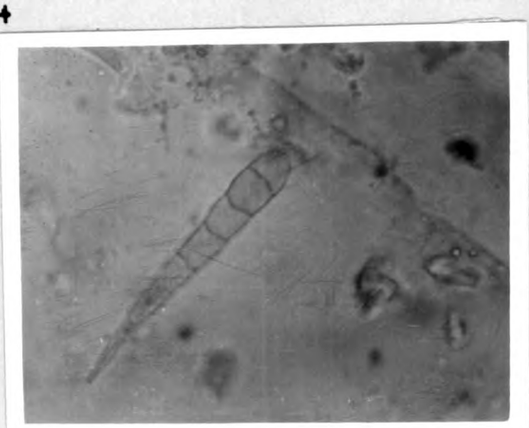
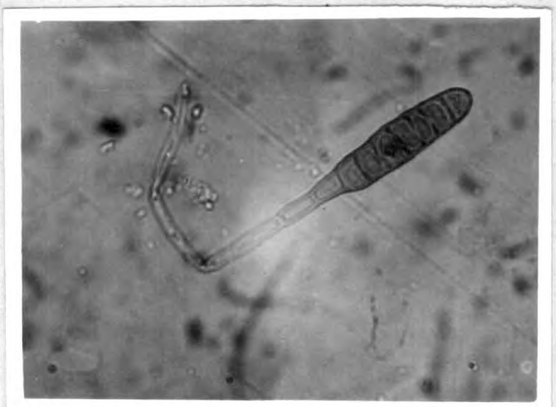
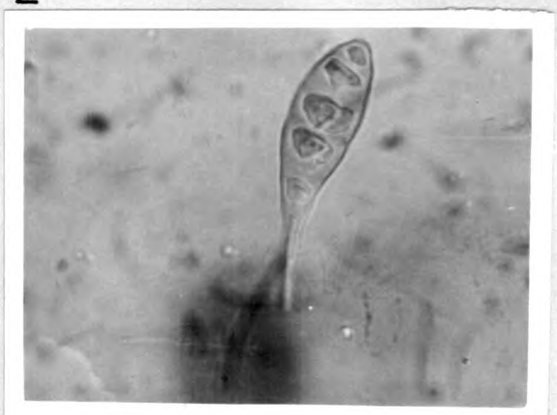


PLATE-IV

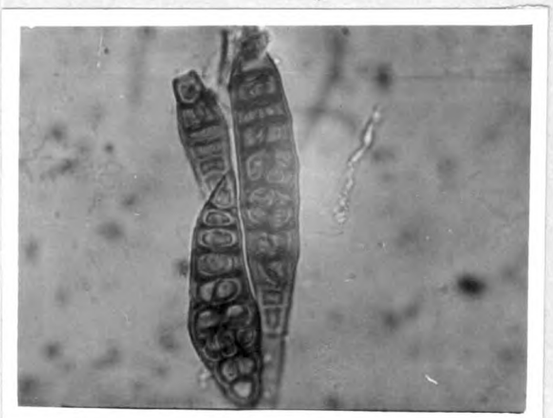
1



2



3



4

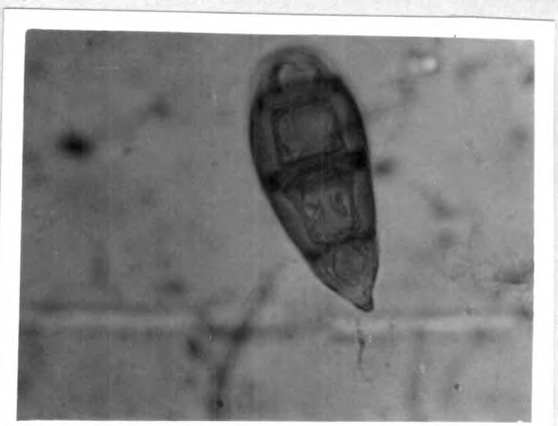
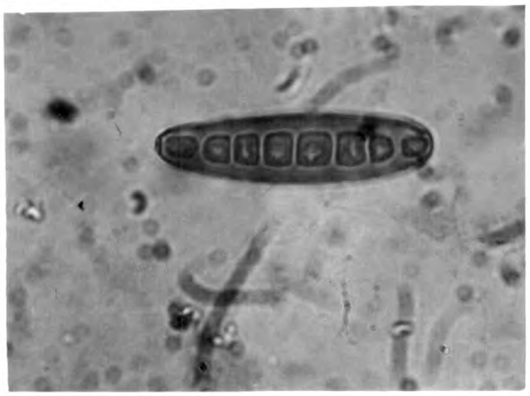
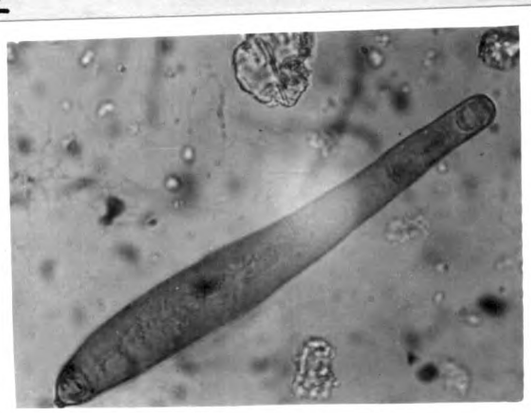


PLATE-V

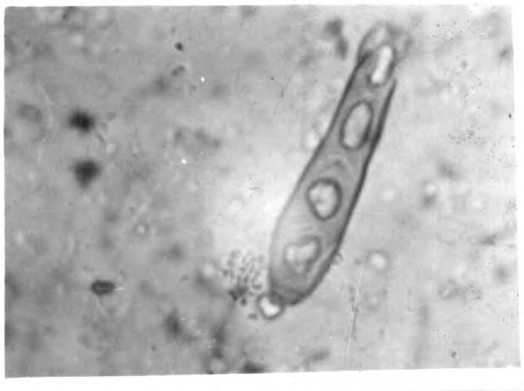
1



2



3

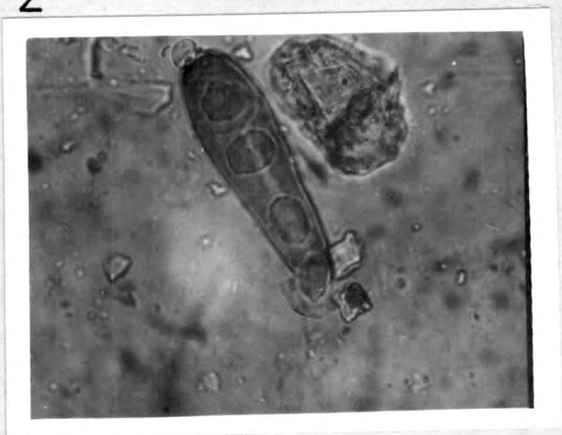


4

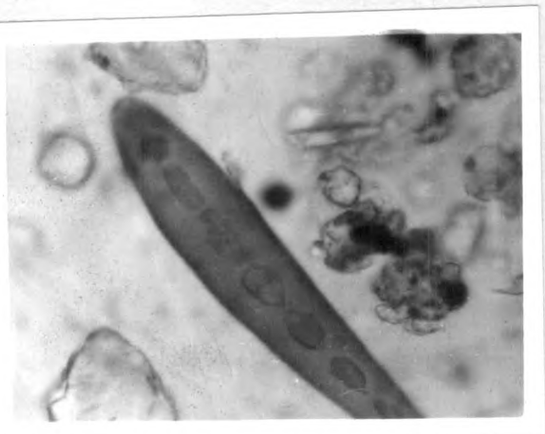
PLATE-VI

1

2



3



4

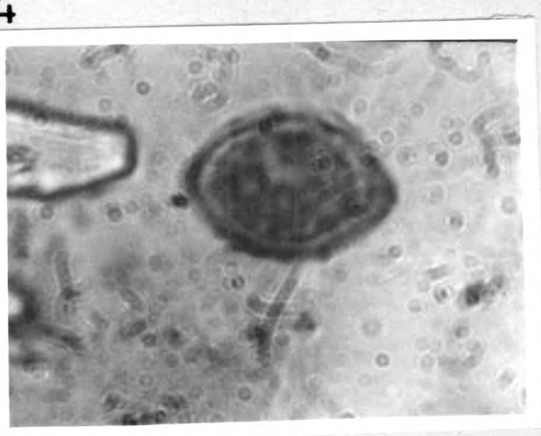
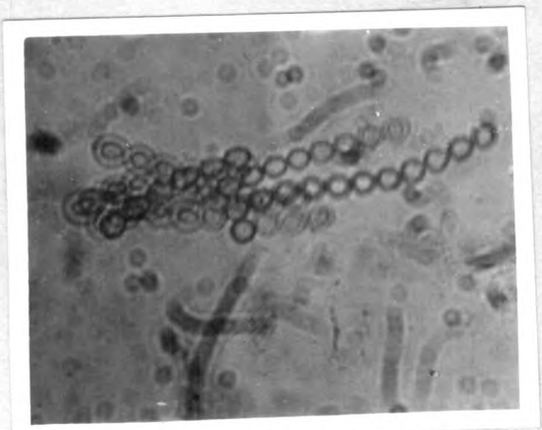
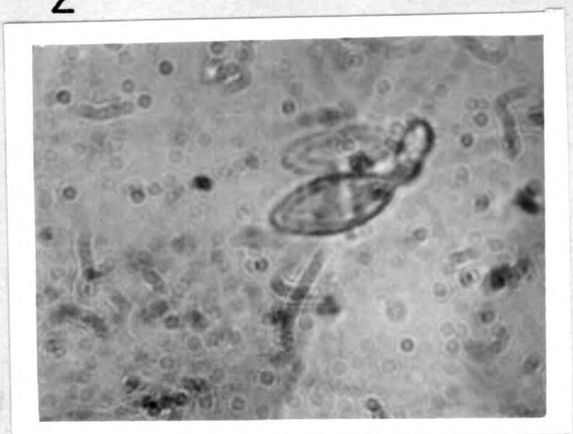


PLATE-VII

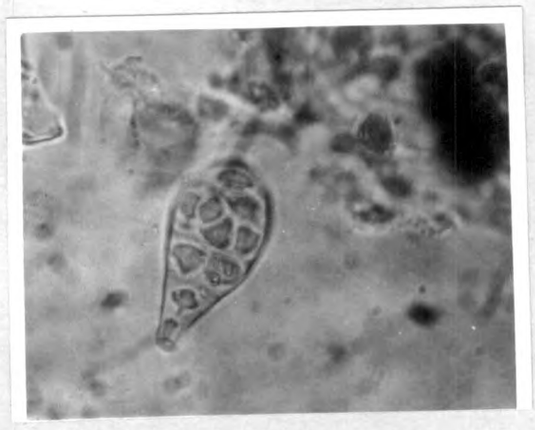
1



2



3



4

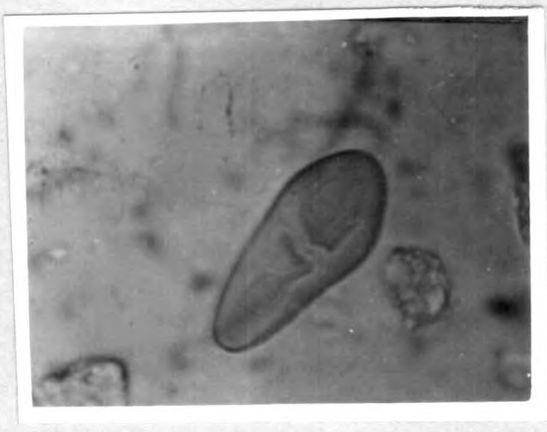
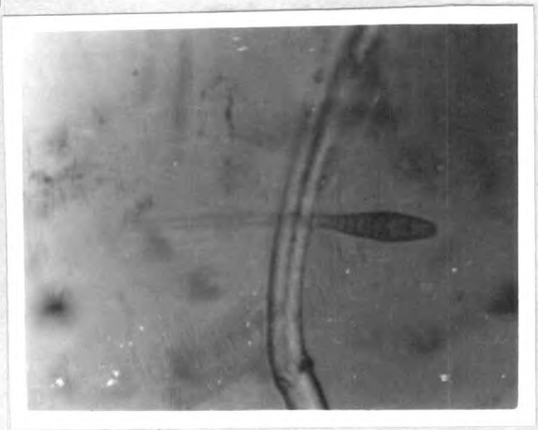
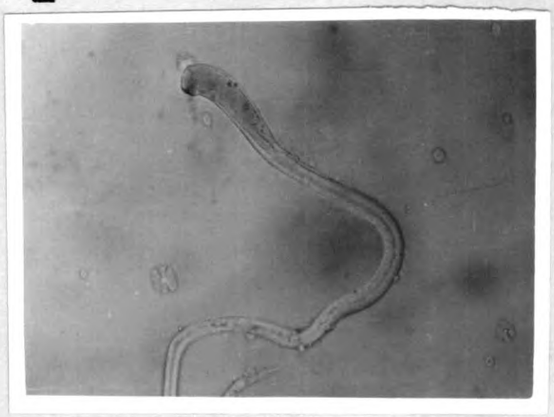


PLATE-VIII

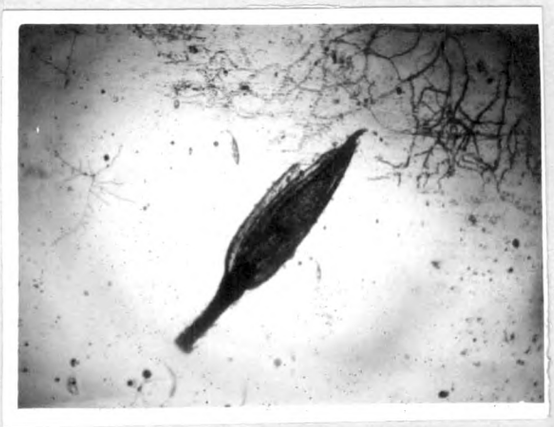
1



2



3



4

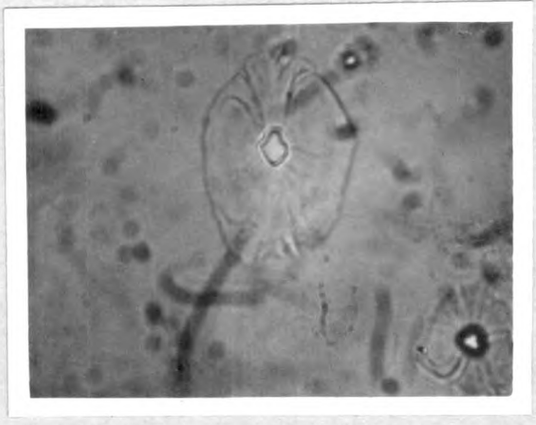
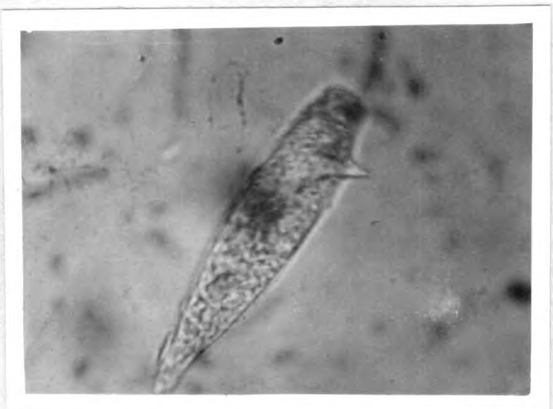
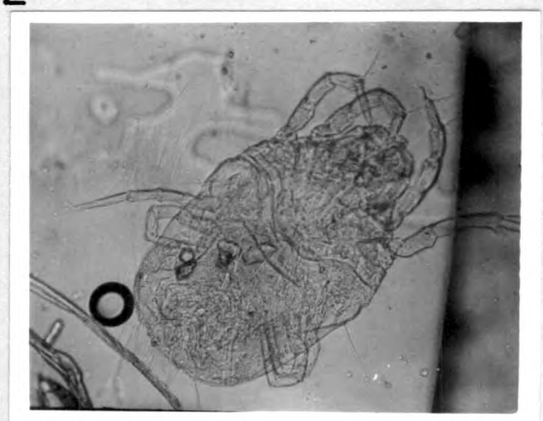


PLATE-IX

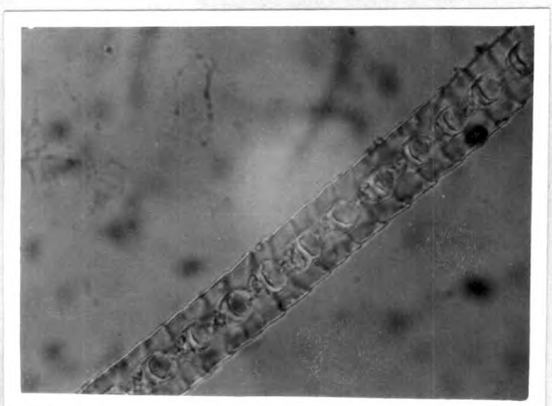
1



2



3



4

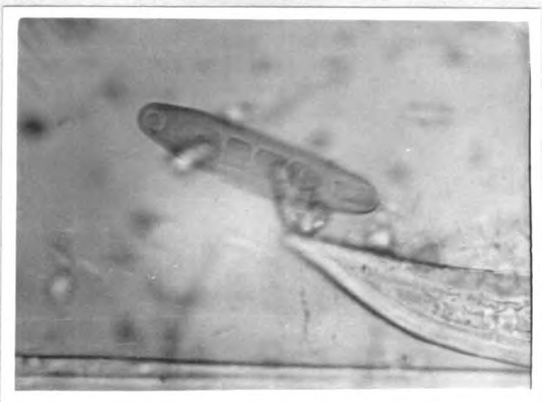
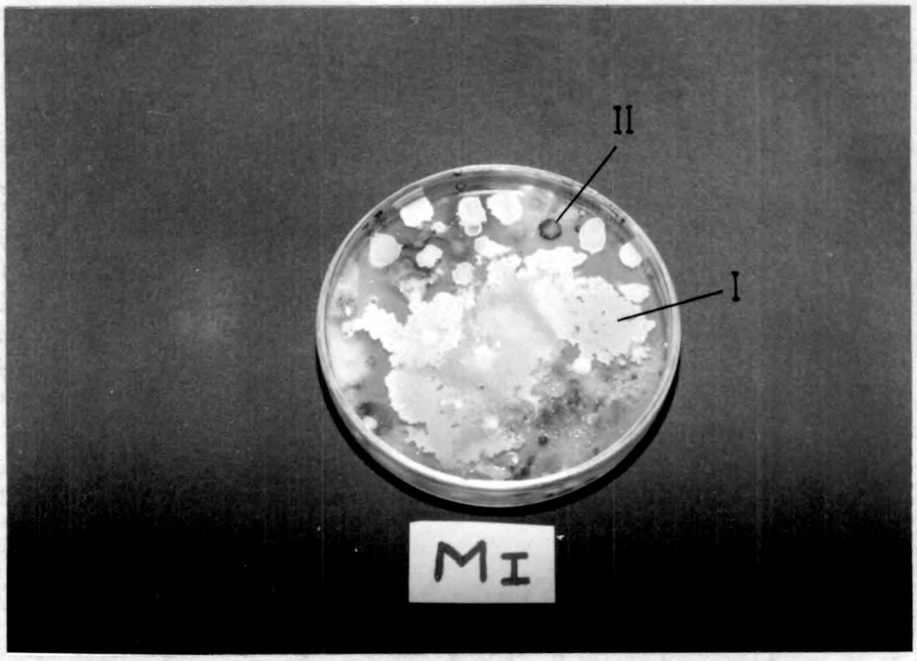


PLATE-X



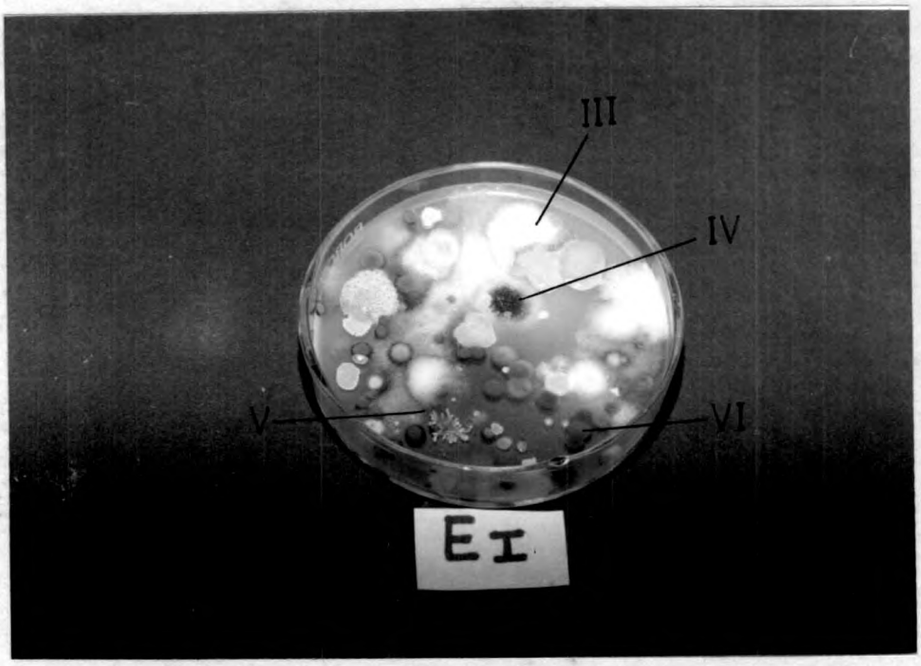
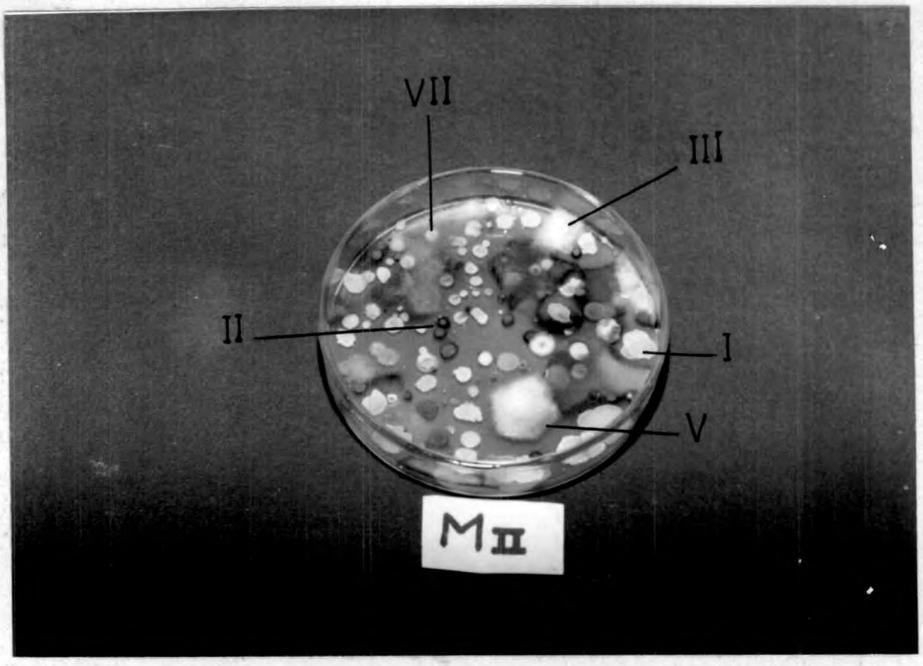


PLATE-XI



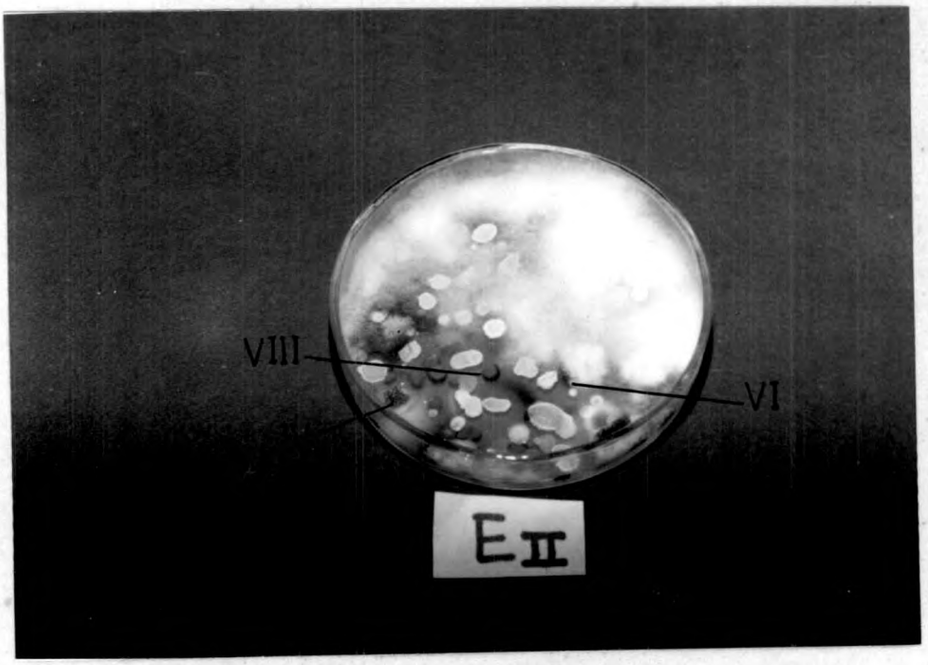
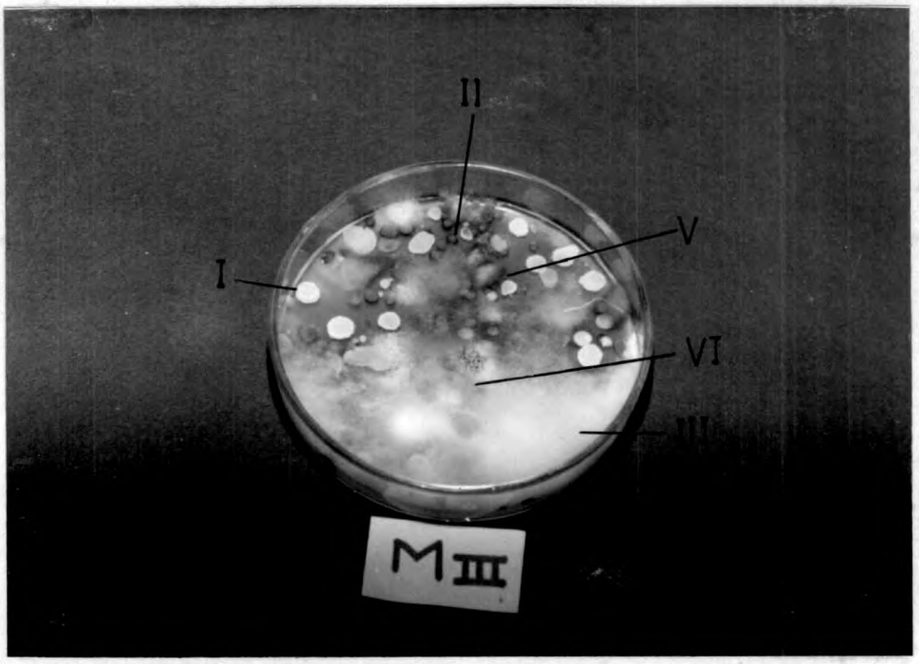


PLATE-XII



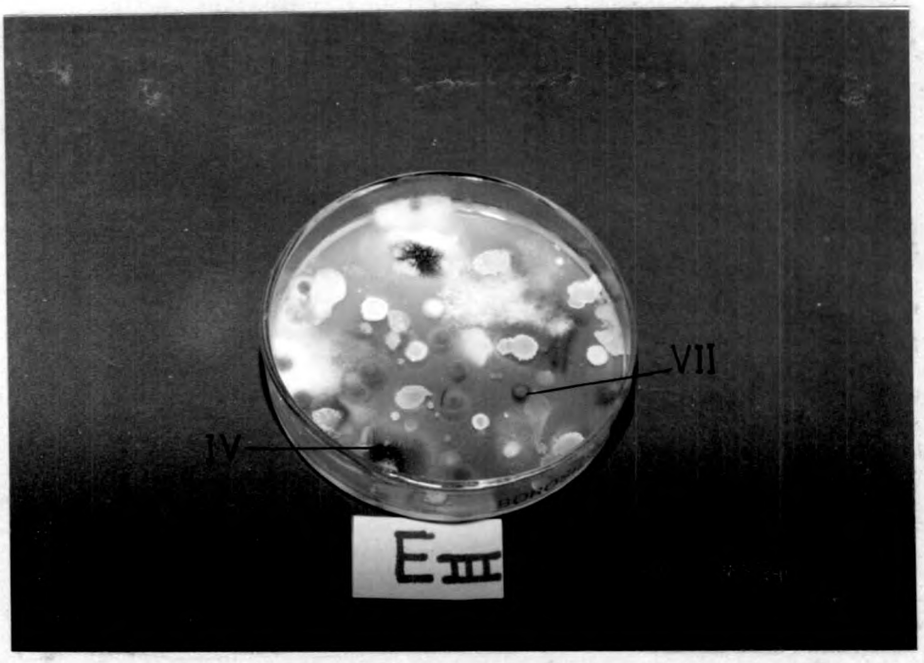
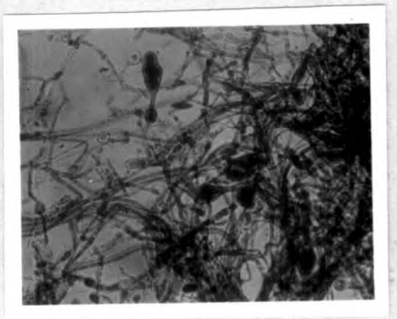
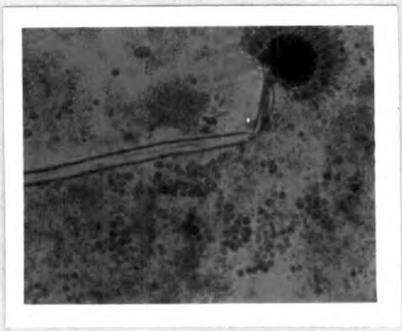


PLATE-XIII

1



2



3

4

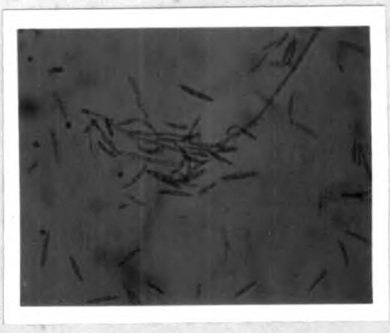
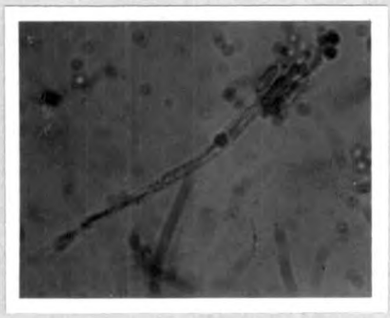


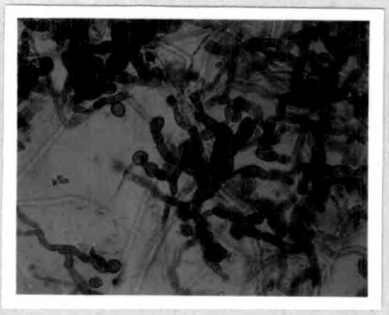
PLATE-XIV

1

2



3



4