UNIVERSITY OF RAJPUTANA STUDIES

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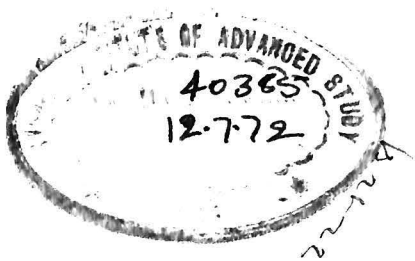

CONTENTS

On the Morphology of the Scorpion,

PALAMNAEUS BENGALENSIS

Part 1. External Morphology

By

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1. INTRODUCTION

Palamnaeus bengalensis belonging to the genus *Palamnaeus* is common in Rajasthan. It is for this reason that this type has been selected for working out the external and internal morphology.

In a fresh specimen the dorsal middle part of the body is deep blackish green which becomes a little fainter on the legs. The chaelae (mandibles or the second pair of appendages) are dark reddish brown but the fingers are deep blackish-green in colour. The tail is yellowish-white while the vesicle is yellowish red. Looked at from the ventral side the yellowish tinge is present every where, prominent chiefly at the vesicle, stigmata (4 pairs), genital operculum, sternum and the basal segments or coxae of the legs.

2. DIVISIONS OF THE BODY

The body is divisible into three regions (a) *Cephalothorax,* (b) *abdomen* & (c) the *tail.* (Fig. 1 & 2)

(a) **Cephalothorax:–** The first region, the cephalothorax consists of six somites and includes the region of the body anterior to the genital pore which is situated on the ventral side of the first abdominal segment. It is also known as the *'Prosoma'* or the pregenital region. On its dorsal surface, the cephalothorax is covered over by the unsegmented shield-like *'Carapace'*, which thus conceals the actual segmentation of this region. The segmentation is, however, made evident by the presence of six pairs of appendages, one pair corresponding to each somite.

(b) **Abdomen:**—The abdomen is made up of seven segments. It begins ventrally from the segment which contains the genital aperture covered by a movable lid, the *genital operculum.* The second segment bears ventrally a pair of comb-like appendages, the *pectines.* Except this, the rest of the abdominal somites, together with the tail segments, bear no appendages, but the segmentation is indicated ventrally by the presence of elongated apertures, the *stigmata,* one pair in each segment.

(c) **Tail:**—The last abdominal segments i. e. the VIIth., narrows downwards and is succeeded by the five tail segments, which are distinguished by their narrow size and presence of keels on the terga (the skeletal pieces of the dorsal surface). The fifth caudal segment is longer than the preceding four and ventrally, at its posterior end, is situated the anus. There is one post-anal segment in the form of a vesicle which is enlarged and globular ventrally and contains a pair of poison glands and ends distally in a curved pointed dark brown spine, the *aculeus.*

Cecil Warburton (Ref. Cambridge Natural History, Arachnida, Volume No. IV) has divided the scorpion's body into three regions viz. the anterior *prosoma,* the middle *mesosoma* and the posterior *metasoma.* The first consists of six segments and corresponds to the cephalothorax, the second extends from the genital pore to

six segments and corresponds to the abdomen proper. The rest of the body including the tail is the metasoma. According to this scheme the last abdominal segment (i. e. the seventh) is included in the metasoma or the tail.

3. APPENDAGES

(a) **On the Cephalothorax**—The appendages are all segmented, and every segment is joined to the adjacent part by an articular membrane. The appendages are :—

(i) **Chelicerae:**—Each consists of three segments, the basal being smaller and concealed under the anterior edge of the carapace. The second segment is larger than the others and is somewhat swollen. On the side nearer to the middle line of the body, it is produced torward into a claw-like prolongation which is known as the immovable finger. The third segment is known as the movable finger for it can move in a horizontal plane. The edges of both the fingers are armed with one set each of teeth on the concave side in such a way that the teeth of one fit exactly in the corresponding concavity of the other. This mechanism furnishes a greater stronghold upon the object caught by it. The undersurface of these chelicerae is provided with thin yellow bristles.

(ii) **Chelae** or **Pedipalps**—These appendages are also chelate like the first pair. These, like the sting, are the most prominent part by which a scorpion can be recognised from a distance. Each pedipalp is made up of six parts termed as follows from the base to the tip-the *coxa*, the *trochanter*, the *humerus*, the *brachium*,the *hand*, and the *movable finger*. The *coxa* lies on each side of the mouth where it is produced in a circular edge provided with fine teeth. These projections act as jaws (like gnathobase of maxilla) in the mouth cavity. The *trochanter* is a small piece with tubercles along three keels. The surface of the *humerus* is coarsely granular and provided with keels. The *brachium* has two keels with tubercles in the

anterior surface and three on its posterior surface. Two and three keels occur on the brachium on the inner and outer surface respectively, but on the external and under surface of the brachium the keels are very feebly developed. The surface of the brachium is almost smooth, with a few granules on the inner surface. The hand is the largest and most conspicuous part of the chela. Its upper surface is evenly convex and is separated from the undersurface (or under hand) by a strong keel situated on the external surface of the hand (i. e. the side away from the body) and below the movable finger. There is no finger keel on the hand running into the immovable finger but the latter has a feebly developed crest. The upper surface of the hand is covered with low anastomising tubercles, the tubercles being more distinct externally and internally. Outer portion of the upper surface is strongly convex. Four smooth feeble ridges run longitudinally on the upper surface of the hand. The inner edge of the hand is short and is furnished with small tubercles. The under surface is very weakly granular and three longitudinal weak crests run on it. The two fingers, viz. movable and immovable, are provided with teeth along their biting edges.

(iii) **Legs:**-These are the locomotory appendages and all of them are practically similar. The length increases as we go posterior. Each is made up of seven segments which named from base to apex are as follows: The *coxa* the *trochanter, the femur,* the *patella,* the *tibia,* the *protarsus* and *tarsus*. On each side, the coxae of the first and second pairs are produced forward towards the mouth into a triangular maxillary process lying immediately below the mouth. The coxae of the second pair of legs meet each other in the middle line but those of the third and the fourth pairs do not meet on account of the pentagonal sternum. The whole tarsal segment may be distinguished

into two lateral lobes on the lower edges of which occur the black spines in a row of six on the lobes. At its distal end the tarsus forms a claw lobe which projects over the base of the two well-developed movable superior claws borne on the distal end of the tarsus. There is one inferior claw also which is less prominent and is often worn down. From the soft arthroidal membrane, between the protarsus and the tarsus, proceeds one brown claw-like spur known as the *'pedal spur'*.

(b) **On the abdomen :-**

(i) **Pectines:**-These are the remarkable comb-like appendages of the abdomen, borne on the small sternum of the second abdominal somite. Each is made up of a tri-segmented shaft with its base attached to the small sternal plate by an articular membrane and the teeth arranged in a comb-like fashion. The teeth start at a distance from the point of attachment of the pectines. In between the teeth are small triangular pieces of the nature of skeleton known as the 'fulcra'.

(ii) **Other abdominal appendages :**—The genital operculam, situated anterior to the pectines, is also of the nature of segmental appendages, being paired in origin and developing in relation with the first abdominal somite. The sterna of the third, fourth, fifth and sixth abdominal segments, which bear the stigmata in the adult, are said to have the corresponding segmental comb-like appendages in the young, each of which is made up of a base bearing teeth. These are the respiratory organs of the younger stage which later on sink into the body in the pulmonary sacs or book-lungs.

4. EXTERNAL APERTURES

(i) The **mouth:**—This is a small opening at the anterior end on the ventral side.

(ii) The **Genital pore:**—This is a median opening, lying at the base of the genital operculum.

(iii) The **respiratiory stigmata:**—These are the four pairs of lateral openings in the form of oblique slits situated on the sterna of the third, fourth, fifth and sixth abdominal segments. These slits lead into the book-lungs.

(iv) **Anus:**—This is an opening on the ventral side, lying at the root of the sting.

(v) **Opening of the poison ducts:**—The openings of the two ducts from the two poison glands are situated at the tip of the spine.

5. INTEGUMENT

The integument of the scorpion, like that of all other Arthropods, is well-adapted to protect the body by being modified into an exoskeleton. This skeleton is present all over the body and on the appendages, both dorsally and ventrally. The soft material, if any, is to be found only at the joints. The exoskeleton in the scorpion is made up of :—

(i) **Terga** :-These are series of dorsal plates occurring metamerically on the dorsal surface from head to tail. According to the number of segments, they ought to be eighteen but the first six tergal plates have fused to form the large *'Carapace'*. The carapace is divided into two, the right and the left frontal lobes, by a notch in the middle of the anterior edge. The surface of the carapace is granular laterally as well as on the anterior side along the anterior edges of the frontal lobes. The rest of the carapace is smooth. In the centre of the carapace is a slightly depressed area bearing the two median eyes. There is a group of three eyes lying on each of the antero-lateral angle of the carapace. They are between the three groups of eyes-the two lateral and one median-forms a triangle the *frontal area* or the *anteocular triangle*. The first tergum of the abdominal segment is much narrower than the rest. The length gradually increases in the following segments and is the maximum in the last i.e. 7th abdominal segment. All terga, except the first second and the last are convex posteriorly and concave anteriorly. Usually a tergum over-laps a little of the tergum following it.

The last abdominal tergum is triangular for its sides taper abruptly and its posterior edge is deeply concave both ventrally and dorsally so as to fit itself with the first tail segment. Lateral edges of all the terga are convex. Lateral portions of the terga are finely granular to touch and these granules are more prominent in the seventh tergum. Middle parts of the terga are smooth. Each tergum shows a pair of parallel white markings at the middle anterior region and the surface at this place is a little depressed. In between the two white markings lie in the middle line, the keels on each tergum. At the anterior border of each tergum, just above the white marking, is a distinct groove which is concave anteriorly. These median keels become more and more prominent as we proceed backwards so that on the 6th and 7th segments they are quite distinct to the naked eye. The hairs or spines are absent on all the abdominal terga.

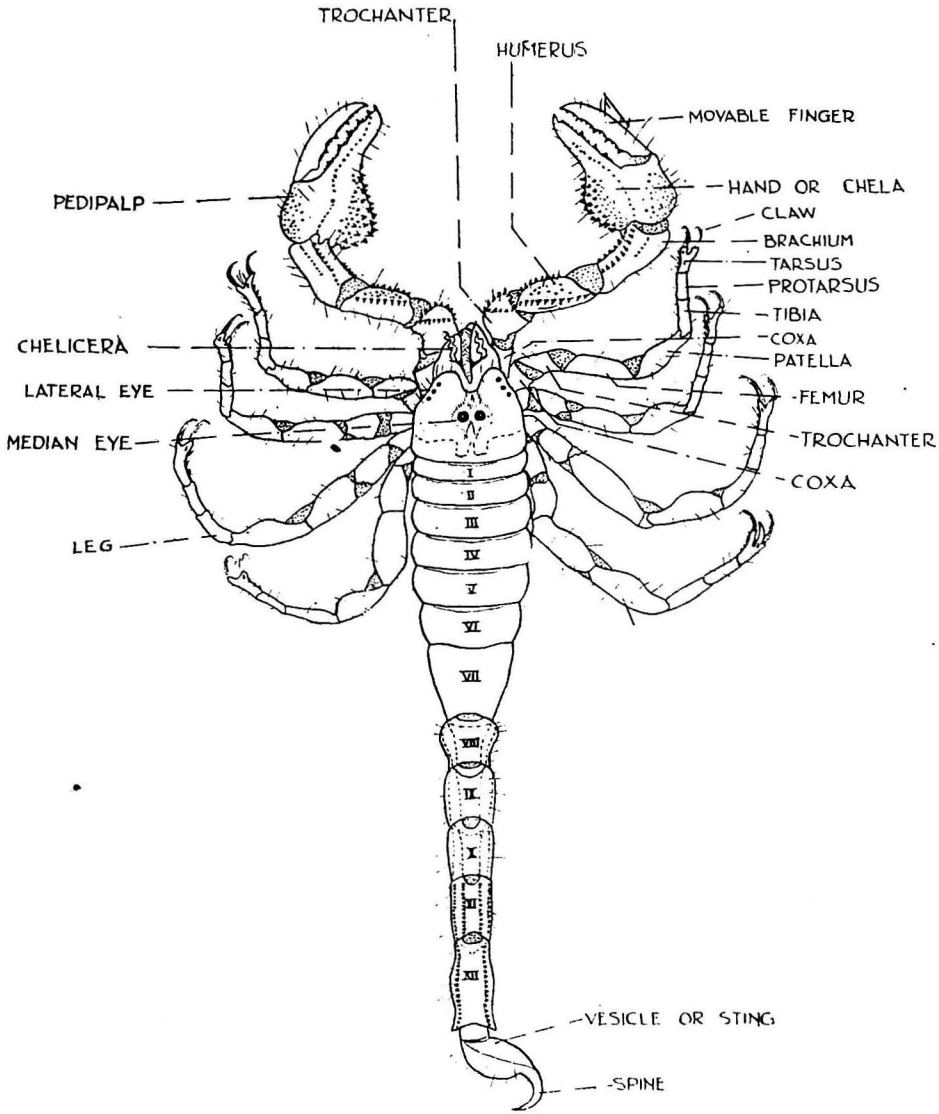
(ii) **Sterna :**—The ventral side of the abdomen is provided with plates called 'sterna' which correspond to the terga above. The ventral surface of the cephalothorax is made up of the ingrowths of the basal segments. Bounded by the bases of the second pair of legs anteriorly and the bases of the third and the fourth pairs of legs laterally, lies the so-called *'sternum'*-a distinctly five sided figure with its base meeting the place where the genital operculum is attached and its anterior vertex abutting against the coxae of the second pair of legs.

The somite bearing the *pectines* has a very small sternum. Each of the four sternal plates, that lie ventrally anterior to the last abdominal segment, bears a pair of *stigmata* which are elongated apertures and subserve respiratory function. The ventral surface is all along smooth and the only armature it possesses is the presence of small hairs on the posterior and lateral edges of the sterna or here and there on the surface, compared with the surface of the abdomen, the ventral surface is more convex and the middle area lying between the stigmata is marked from the rest by

slight depressions at its sides. Each *anterior* plate overlaps the anterior border of the posterior plate following it. The last abdominal segment differs from the preceeding abdominal segments but resembles the following, namely the tail segments in being enclosed in a complete ring of chitin. In the abdominal segments these rings are not complete for a little soft space intervenes between the terga and the corresponding sterna.

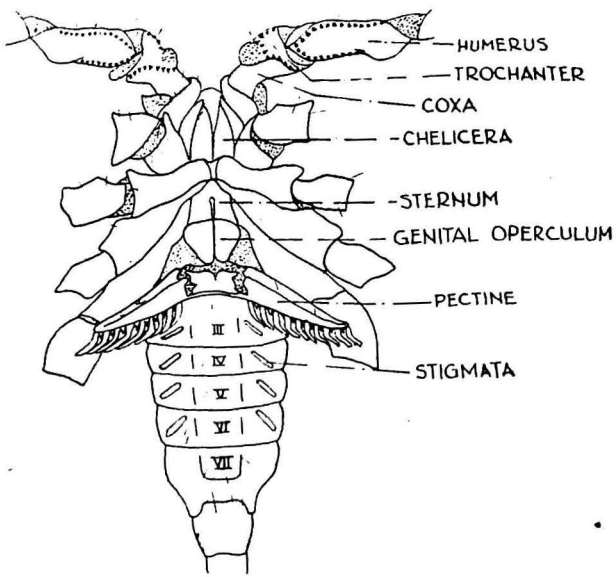
The complete skeletal rings of the tail somites are conspicous by their armature exhibited in the form of ridges and keels or crests. The fifth caudal segment is charecterised by its greater length as well as by the presence of seven keels, three keels less than those on four segments. The keels of the first four segments are named as follows from above downwards on each side—superior, superior lateral, median lateral, inferior lateral, and inferior median. Of these the second and the fourth keels are denticulate in the 1st, 2nd, 4th and 5th segments and only faintly denticulate in the third segment. The inferior median of the fourth segment is also denticulate, while all the keels of the fifth segment are denticulate. Thus the denticulation of the keel is the maximum in the last tail segment while in the first tail segment the keels are faintly toothed. The sternal surface or the tail segment is traversed by reticulate lines with a few fine granules here and there which are visible under the binocular and are smooth both above and below but finely granular at the sides, specially at the posterior edges. Large stiff brown hairs are borne on the caudal segments, chiefly along the ridges and are usually seen to come out between the two teeth.

The *vesicle* is granular ventrally along five or six lines on the globular part along which are long hairs. The dorsal surface of the vesicle, like that of other keel segments, is flat and the ventral surface is convex all along the tail. (as is also the case in the abdomen). The vesicle is more appropriately called in connection with the skeletal system as the postanal sclerite or skeletal



Dorsal view of Palamnaeus bengalensis.

Fig. 1.



Ventral view of Palamnaeus bengalensis.

(With appendages in part only)

FIG.2.

piece, being situated posterior to the anal opening. The integument of the vasicle is as hard in consistency as the rest of the exoskeleton although by looking at it one is apt to think it to be soft part due to its light reddish-yellow colour which imparts a little of transperency to it. The vesicle distally bears the acutely pointed and curved dark brown sting or *vesiculer spine.* Long hairs occur on the spine also.

The integument of the appendages is also hardened and chitinised. The surface of hand is granulated and traversed by ridges and keels. The edges of the fingers are produced into teeth like processes. Other segments of chela are also granulated. Long brown hairs and black thick spines occur on the segments of the appendages. Besides these, the distal end of the legs ends in three claws at the tip, each bearing two rows, one of 4 and the other of 6, thick black spines. One palerbrown dark-tipped claw-like 'pedal spur' is attached to the articular membrane between the apical segment of the leg and the one preceding it. The hairs on the chelae and legs are much longer than those found on the trunk. The hairs and spines all emerge from circular pits in the integument with thickened rim.

6. SUMMARY

The external features of *Palamnaeus bengalensis* namely the colouration of the body, the three divisions of the body and their appendages, the external apertures and the exoskeleton which strengthens the body, have been dealt with.

The Biological Spectrum of the Flora of Mount Abu

By

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INTRODUCTION

The dependence of plant form upon climate has been recognised. Humboldt [11] (1806) was the first to formulate the concept of life forms. He had used the term *vegetative form* while describing the vegetation. Building upon Humboldt's ideas, Grisebach [9] (1872) attempted to draw up a relationship between vegetative form and climatic factors. Warming [20] (1909) Raiter [15] (1885) and Drude [7 & 8] (1880, 1913) contributed many of the essentials of the modern systems. Conclusions of Drude are of great ecological significance. Pound and Clement [14] (1900) modified the system of Drude somewhat in applying it to American vegetation. Raunkiaer [16 & 17] (1936) has advanced considerably the knowledge of life forms and their phyto-sociological significance. The different systems differ greatly as to the manner of classification but agree in essentials. Raunkiaer's system of life forms is the most compact and consistent. This system is simple, based mainly on only one feature-*the protection of the bud of the shoot apices during the unfavourable season or seasons.* Thus it is possible to describe a region in terms of the plant world. A statistical survey of the life forms of the flora of a region reveals in a way the plant climate.

In India the study of the vegetation on the basis of Raunkiaer's system of life-forms has been very limited. Borgesen [5] studied in 1929 the vegetation of Dwarka with reference to Raunkiaer's life-forms and statistical methods. Bharucha has given an encouraging lead in India to ecological studies in general and particularly to the study of life forms. Bharucha and Ferreira[1,2] gave in 1941 the Biological Spectrum of Madras Flora and the Biological Spectra of

Matheran and Mahableshar Flora. Bharucha and Dave [3] (1944) presented the Biological Spectrum of Grassland Association. Srivastava [18] described in 1943 the Spectrum of the Allahabad Flora. Das and Sarup[6] studied the Biological Spectrum of the Indian Desert Flora and further intensive work on the desert flora is in progress at the Jodhpur School. The work of these authors indicates that Raunkiaer's system of classification of Life forms could be applied in distinguishing various types of tropical and subtropical vegetation in India with reference to their climatic factors. Extensive work on these lines should be planned and carried out in different key places. A reference may be made to the Ecological work of Mukerji.[13] In his ecological studies of the vegetation of the Vindhayas, he had reached the conclusion that Raunkiaer's statistical methods may perhaps be successfully applied to the study of European or American plant communities but they do not give tangible results here. He found serious difficulties in determining the degree of frequencies of species composing a mixed formation. Future work will show what modifications are necessary in Raunkiaer's methods to suit Indian conditions; whatever work has been done so far illustrates that the Biological Spectra obtained by this method do give a fairly correct idea of the nature of the vegetation.

With a fairly comprehensive and representative Spectra of vegetation it would be possible to establish Iso-biochores or lines which will connect places having the same type of vegetation (comparable to Isotherms).

Except the work of Sutaria [19] (and Macdam [12]) no work on the vegetation of Mt. Abu has perhaps been published. He has continued his studies of the flora of Mt. Abu for more than 25 years. The author was also attracted by the vegetation of Mt. Abu and thought it desirable to make a bio-statistical study of the flora on the basis of Raunkiaer's life forms system. Recently Mahable & Kharadi 12 A. have worked on some Ecological features of the Vegetation at Mt. Abu.

The definitions of these life forms which have been found useful for the present work are given below :—

No.	SYMBOL	LIFE FORM	DEFINITION
1.	TH	Therophytes.	Annual plants.
2.	G	Geophytes.	Phanerogams with vegetative organs in the soil.
3.	H	Hemicryptophytes.	Phanerogams with vegetative buds at the level of the ground or substratum.
4.	CH	Chamaephytes.	Phanerogams with vegetative organs 20-30 cm. above the soil.
5.	L	Lianas	Climbing phanerogams.
6.	N	Nana-phanerophytes.	Phanerogams with vegetative organs less than 2 meters above the soil.
7.	Ph	Phanerophytes.	Phanerogams with vegetative organs 2 meters above the soil.
7. a.	M	Micro-phanerophytes.	Phanerogams with vegetative organs 2-8 meters above the soil.
7. b.	MM	Meso-phanerophytes.	Phanerogams with vegetative organs 8-30 meters above the soil.
8.	P	Parasites	Parasitic plants.

2. PHYSICAL FEATURES

TOPOGRAPHY:

Mount Abu is situated in 24°36' N & 72°43' E. Although regarded as a part of the Aravalli range, it is completely detached from the main chain by a narrow valley, 7 miles across through which flows the western Banas. It rises suddenly from the surrounding plain like a rocky island lying off the sea coast of a continent. It is long and narrow and at the top it spreads into a picturesque plateau nearly 4000 ft. above the sea, about 12 miles in length and 2 to 3 miles in breadth. Its highest peak, *Guru Shikhar,* (the hermit's pinnacle) situated towards the northern end is 5,650 ft. above sea level. It is the highest point between the Himalayas and the Nilgiris. The natural features of Abu are very bold and the slopes especially on the western and northern sides are extremely precipitous, on the east and south the outline is more broken by spurs and there are deep valleys in between. This isolated hill naturally forms a floristic subdivision and its floral spectrum would be an interesting study.

CLIMATE:

Abu is on the border of the arid region of Western Rajputana, having a typical climate of the North Tropical region with extremes of hot and cold season. On account of its elevation it is much cooler than the surrounding plains during summer. May is the hottest month. The mean temperature during May is 82·2° F—Maximum 88·2° and Minimum 76·2.° The highest readings have varied from 93° to 101° F in different years. The nights however are cool. The mean temperature at Jodhpur 26·18° N and 73·1° E during the hottest month (May) is 93·4°F—Max. 106·5° and minimum 80·2°. In January the coolest month of the year, the mean temperature at Abu is 58·45°F. The lowest reading varies widely in different years but does not fall below 32°F. The temperature figures are given in table I below.

TABLE I

Mt. Abu

TEMPERATURE

MONTH	TEMPERATURE			
	Max. o F	Min. o F	Mean o F	Mean o C
January	65·9	51·0	58·45	14·69
February	67·7	53·1	60·4	15·77
March	76·9	61·2	69·05	20·58
April	84·8	68·7	76·75	24·36
May	88·2	76·2	82·2	27·38
June	83·6	68·5	76·05	24·47
July	75·2	65·9	70·55	21·41
August	72·0	64·4	68·2	20·11
September	75·1	64·6	69·85	21·12
October	79·2	64·5	71·85	22·13
November	73·7	58·3	66·0	18·88
December	68·3	53·0	60·65	15·91
ANNUAL	75·9	62·0	68·9	29·5

TABLE II

Mt. Abu

RAINFALL

MONTHS	RAINFALL IN INCHES.	RAINFALL IN Cms.
January	0·26	0·67
February	0·23	0·57
March	0·17	0·32
April	0·11	0·27
May	0·93	2·32
June	4·65	11·62
July	21·99	53·97
August	22·75	9·75
September	9·37	23·42
October	0·76	1·9
November	0·22	0·55
December	0·12	0·3
Annual	61·56	153·9

RAIN FALL:

The rains in the area are mainly due to the Arabian Sea Monsoon during the months of June to September every year. The annual rainfall is about 61 inches, more than two thirds of which is precipitated in July and August. The record of the monthly and annual rainfall is given in Table 2 and in figures I & II. It will be seen that about 95% of the rainfall occurs during June to September. During the monsoon the rains are torrential and considerable soil erosion takes place. The greatest rainfall in any one year recorded so far is 123 inches and the least 19·2 inches.

HUMIDITY:

The mean monthly and annual humidity is given in the following table No. 3.

Jan.	Feb.	Marc.	April	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average
47	46	38	31	39	74	94	96	83	57	48	47	58

Humidity

Table No. 3. Percentage at 8 hrs. I.S.T.

The lowest humidity is in the months of March, April and May. During April & May the temperature is also the highest. From June onwards humidity increases being the highest in July-August. The annual mean humidity is 59%.

WINDS:

During the greater part of the year January to October there is a constant breeze from the South West reaching a velocity of over 20 miles per hour during May, June and July.

SEASONS:

The climate is markedly periodic and can be divided into 3 seasons, Rainy, Winter and Summer, corresponding with the climatic seasons there are three distinct vegetational seasons.

THE HYDROTHERM FIGURES:

The hydrotherm figure for any region, according to Raunkiaer is a figure showing the relationship between the temperature curve plotted in degrees centigrade and the rainfall curve plotted in centimeters in the same graph.

Hydrotherm figure for Mount Abu is given in Fig. 1. Figures for rainfall and relative humidity are plotted in figure II.

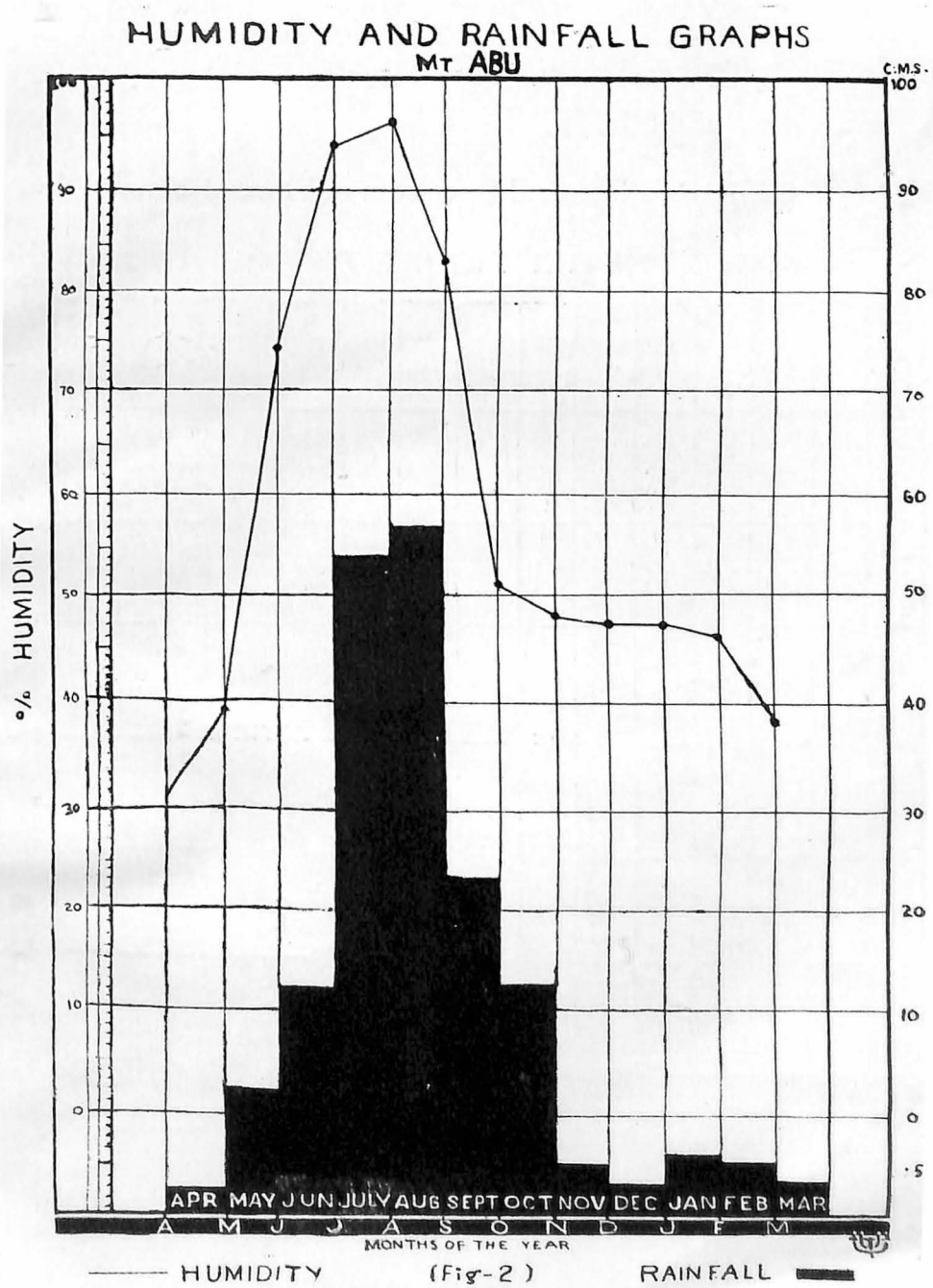
From Tables I,II & III and Figures I,II it is clear that the mean temperature varies from 14·69° C in January and 27·88 in May to 24·47° C in June. There is a conspicuos trough in the months of December and January in the temperature curve.

The rainfall ranges from a little above. 3 cm to about 53·97 cm. in July and 56·87 cm. in August when it reaches its maximum. The rainfall curve shows two troughs, one in November-December and the other in March-April when the rainfall is less than a cm. The humidity is lowest in April and highest in July-August.

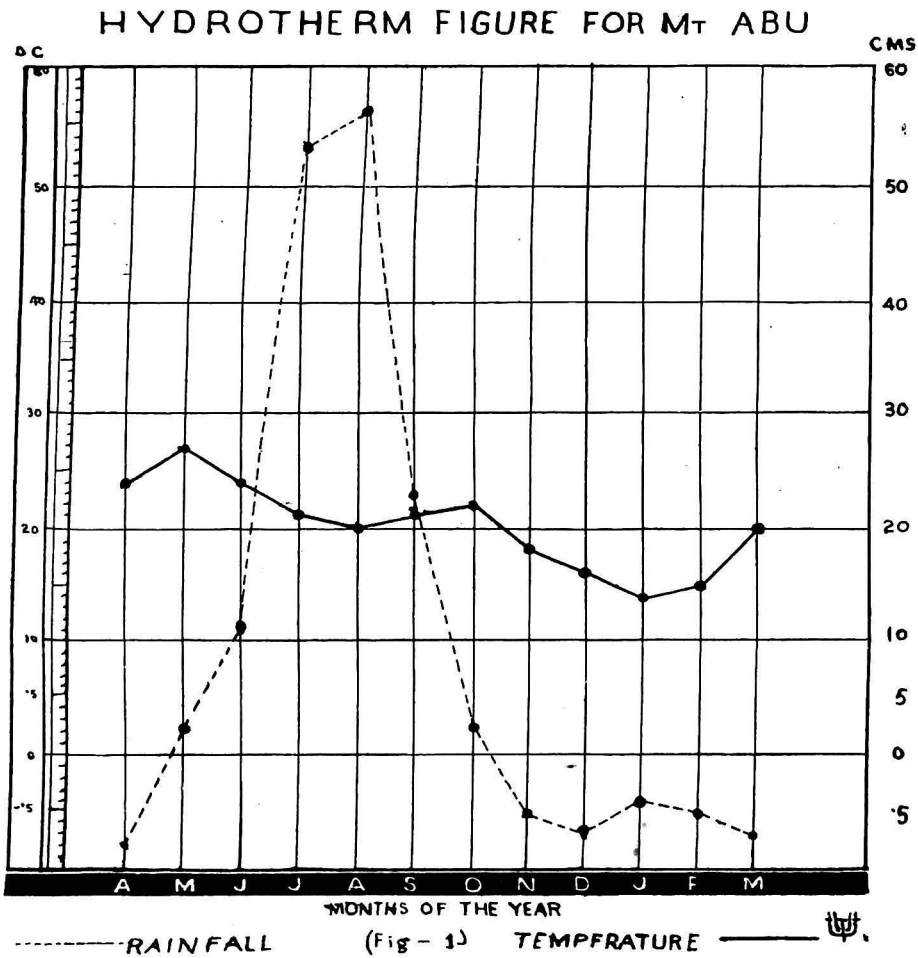
The trough of the precipitation curve occurs at different season from that of the temperature curve, so that there is a dry summer and slightly humid-winter. There are three seasons, dry summer, (Humid) rainy season and slightly humid winter. There are two growth seasons, (1) the rainy season, (2) humid spring February, March. The unfavourable seasons are (1) from April to middle June when the temperature is the highest and precipitation the lowest. (2) January, when the temperature is lowest.

4. THE BIOLOGICAL SPECTRUM

In such subtropical regions, with a dry summer slightly humid winter and practically long rainy season in between the two seasons, the plant climate according to Raunkiaer should be Therophytes which is very well supported by the figures in Table No. IV below. In ordinary words there is preponderance of the annuals. Therophytes survive in the unfavourable season in the form of seed and complete their life cycle within a single favourable season.


HUMIDITY AND RAINFALL GRAPHS
MT ABU
C.M.S.
100
90
80
70
60
50
40
30
20
10
0
·5
% HUMIDITY
APR MAY JUN JULY AUG SEPT OCT NOV DEC JAN FEB MAR
A M J J A S O N D J F M
MONTHS OF THE YEAR
HUMIDITY
RAINFALL

(Fig-2)


HYDROTHERM FIGURE FOR MT ABU
D C
CMS
60
50
40
30
20
10
5
0
-5
A M J J A S O N D J F M
MONTHS OF THE YEAR
RAINFALL
TEMPERATURE

(Fig - 1)

TABLE IV

Biological Spectrum.

Region	Number of Species	The percentage distribution of species among the life forms.								
		MM	M	N	Ph	L	CH	H	C	TH
Mt. Abu	245	5·3	17·9	11·4	6·0	8·5	2·4	2·4	0	46·71
Allahabad	628	3	17·6	11·6			9·2	3·4	8	41·6
Western Indian Desert	538	2·3	2·2	4·6	5·2	7·8	18·9	15·5	3·4	40·1
Normal Spectrum	1000	8	18	15	46		9·0	26·0	6·0	13·0

In the above table are given the Biological Spectra of Mt. Abu, Allahabad, the neighbouring western India Desert and the Normal Spectrum. It will be seen that the life form which is most preponderating in the percentage number of plants in the spectrum for Mt. Abu is Therophytes 46.71 which is more than three times that of the Normal Spectrum 13% and slightly more than that of the neighbouring western India Desert and Allahabad a representative place in the Gangetic plain.

The groups next in importance respectively are the Micro-phanerophytes 17·9% Nana-phanerophytes 11·4% Lianas 8·5% and Mesophanerophytes 5·3%. The percentage of the Microphanerophytes is just equal to that of the normal spectrum, the percentage of the Nana-phanerophytes and Mesophanerophytes is slightly less than the corresponding percentage in the normal spectrum. Therefore, the important life forms are the Therophytes; Microphanerophytes and Nana-phanerophytes. The percentage number of Therophytes in Mt. Abu is slightly more than the adjoining territory. The plant climate of Mt. Abu therefore, is chiefly characterized by Therophytes. The modification of the climate due to altitude and greater rainfall is conducive to supporting Micro-phanerophytes and Nanaphanerophytes.

Raunkiaer's hypothesis is in perfect harmony with the nature of vegetation inside the area.

5. SUMMARY & CONCLUSIONS

1. A bio-statistical study of the flora of Mt. Abu was made on Raunkiaer's life forms system.
2. The climate is markedly periodic as in the subtropics and there are three seasons-rainy, winter and the summer.
3. The plant spectrum has been correlated with topographical and climatic factors.
4. The area shows decidedly a therophytic plant climate with a percentage of about 46·7%. Plants next in importance are Micro-phanerophytes and Nana-phanerophytes.
5. Raunkiaer's hypothesis is able to reveal the true nature of the vegetation of the area.

Acknowledgement

I thank the Deputy Director General of Observatories (Climatology and Geophysics). Poona who kindly supplied the meterological data embodied in this paper. I am indebted to Prof. R. N. Sutaria for kindly supplying me his published and unpublished work on the flora of Mt. Abu.

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A Preliminary Pharmacological Study of Topicaine Hydrochloride ("P-169"): A NEW LOCAL ANAESTHETIC.

By

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&

V. N. Sharma, M.B., B.S.*

INTRODUCTION

This report is concerned with the pharmacological properties of Topicaine hydrochloride (P"-169») which is chemically 2-di-ethylamino-ethyl dl-p-n-hexyloxybenzilate hydrochloride. The compound has been prepared in the research laboratories of Pitman Moore Co., Indianapolis and was supplied to us on request.

The present study is based entirely on experiments done on laboratory animals, mostly dogs, which were anaesthetised with ether and barbitone Na (150 mgm/Kgm, I.V.), and all the injections of the drug were made through the cannulated femoral vein.

PHARMACOLOGY.

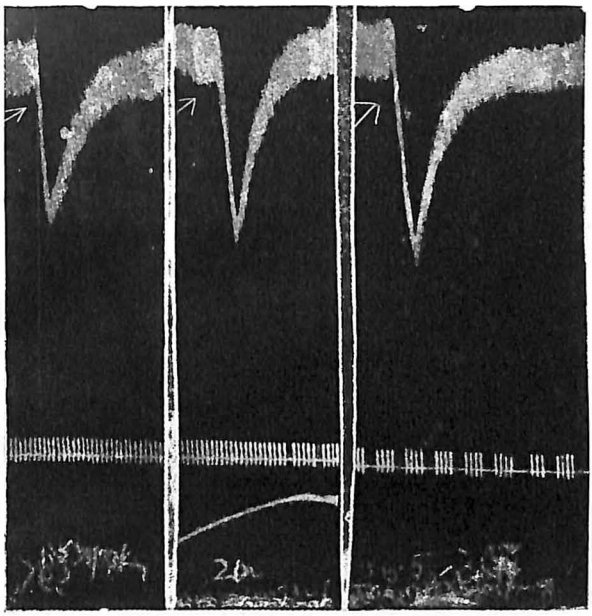
Action on cardiovascular system :—

Blood pressure studies :—The result of P-169 on the arterial pressure recorded through the common carotid of the anaesthetised dogs is tabulated as follows—

TABLE 1

Dose of the drug (mgm/Kgm. I.V.)	Average fall in B.P. (mm.Hg.)	Average initial B.P. (mm.Hg.)
0·25	10	115
0·5	20	
1·0	34	
1·5	40	
2·0	50	
2·5	60	
6·0	80	
10·0	110	

* From the Department of Pharmacology, S. M. S. Medical College, Jaipur.



a b c

Fig 1 :—Effect of P—169 on the arterial pressure of anaesthetised dogs.
(a) after 1 mgm/kgm.
(b) after 1·5 mgm/kgm.
(c) after 2 mgm/kgm.

Fig 2 :—Cardiac irregularities as seen from B. P. tracings after 6 mgm/kgm P—169 in anaesthetised dogs.

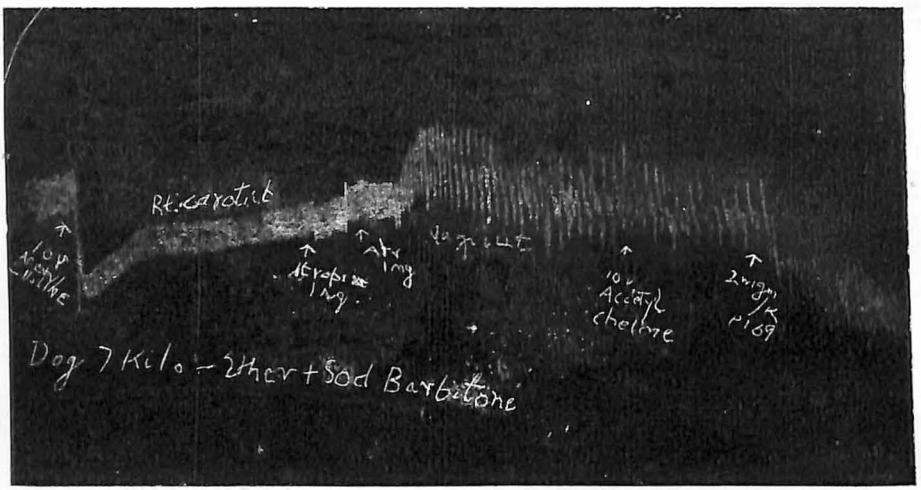
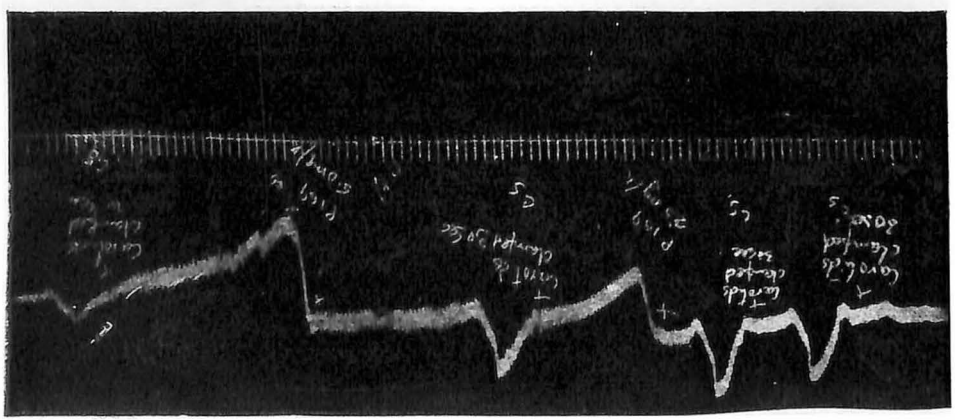
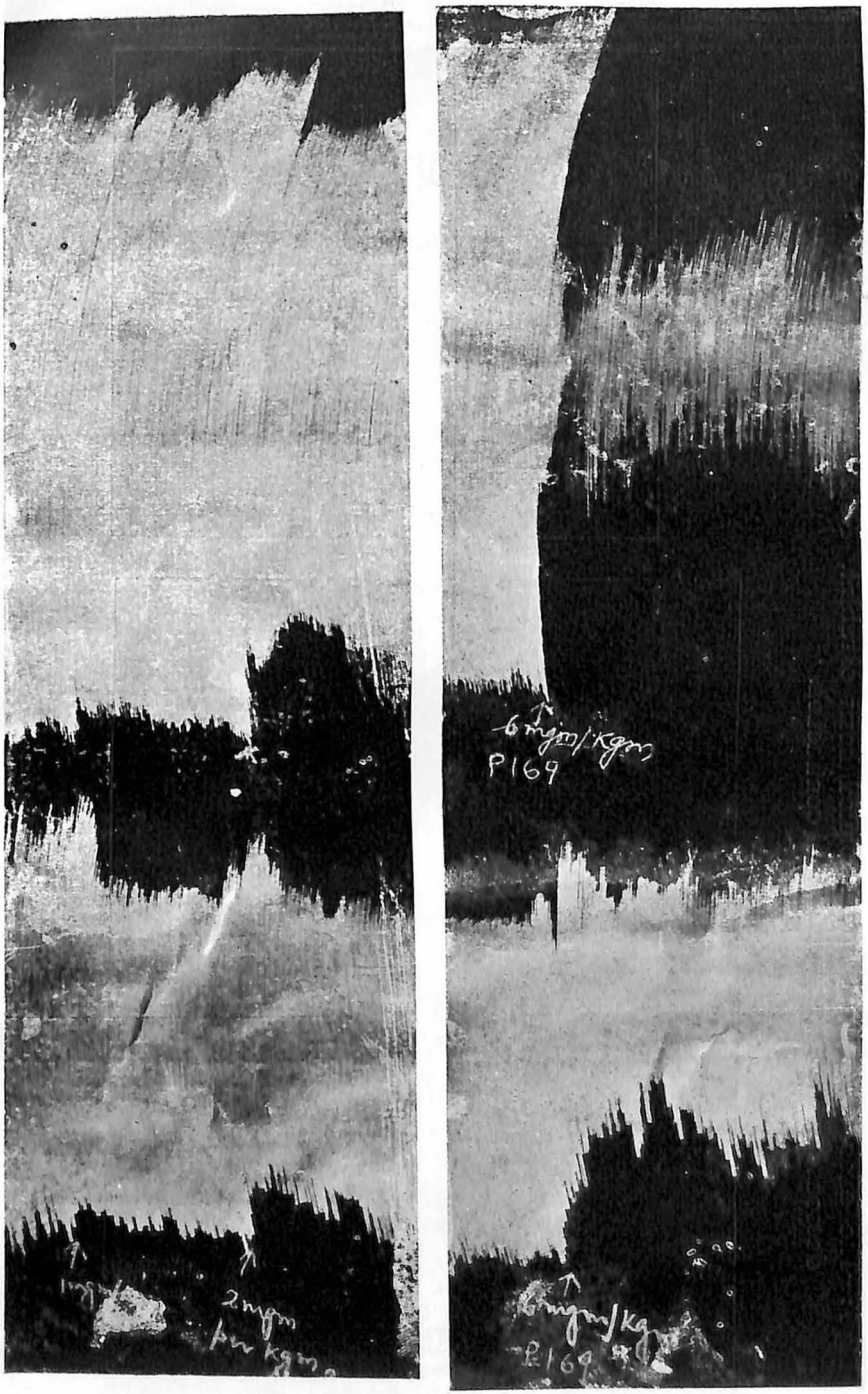


Fig 3 :—Note that vagotomy has no effect on the fall produced by P—169.

Fig 4 :—The depressant action of P—169 on the V.-M. centre is marked with 5 mgm/kgm. in dogs





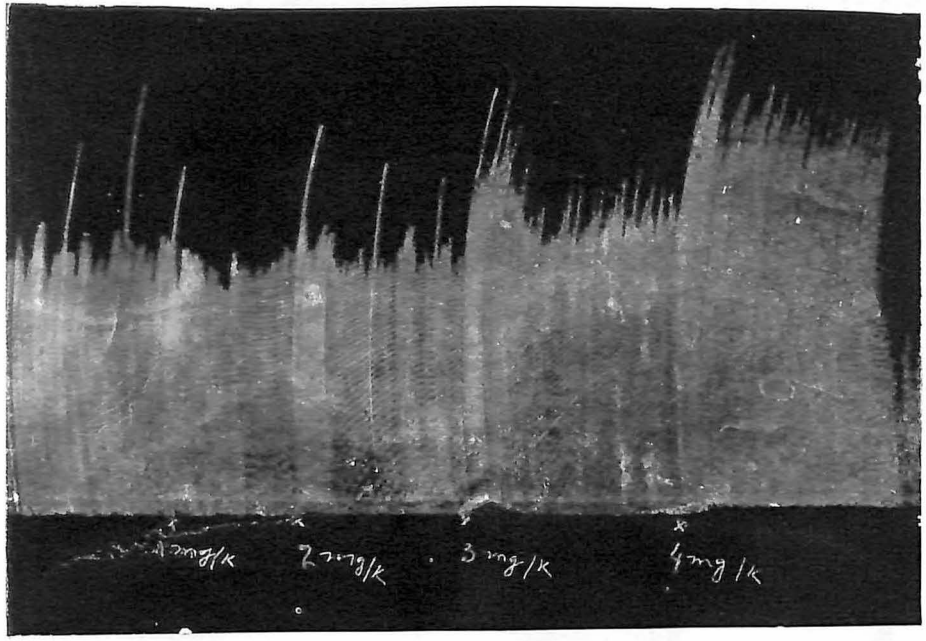
a b

Fig 5 :—The effect of P—169 on the intact heart of anaesthetised dogs. The upper tracings are auricular and lower venticular.

(a) after 1 and 2 mgm/kgm

(b) after 6 mgm/1 kgm.

Fig 6 :—The effect of P—169 on the isolated heart of rabbit. Note the decrease in rate and amplitude of contraction.



a b c d e

Fig 7 :—Effect of P—169 on respiration of anaesthetised dogs.

(a) after 1 mgm/kgm
(b) after 2 mgm/kgm
(c) after 3 mgm/kgm
(d) after 4 mgm/kgm
(e) after 6 mgm/kgm.

It was observed that there was transient to prolonged depressor responses depending upon the dose used (fig. 1). All the animals survived even after 10 mgm/Kgm. I.V. dose, though at this dosage level it took about an hour for the blood pressure to return completely to the pre-injection normal level.

Atropinization or vagotomy did not produce any change on the fall of blood pressure (fig. 3).

The cardiac irregularities as evidenced by the blood pressure tracings were observed in a few dogs when 2 mgm/Kgm. was injected intravenously (fig. 2). However, 4 mgm/Kgm. always produced cardiac arrhythmias which disappeared when blood pressure returned to the control level.

Action on Vasomotor centre :-Experimental procedure-The arterial pressure of the anaesthetised dogs was recorded through cannulated femoral artery. The two common carotid arteries were exposed and were clamped for half a minute and the rise in arterial pressure was recorded from the femoral artery. If after the injection of the drug, the clamping of both the carotids jn the neck would result in a lowered rise of blood pressure—the drug will cause a depression of Vasomotor centre in the medulla.

It was found that Vasomotor centre depression commenses at 3·5 mgm/Kgm. and that 5 mgm/Kgm of P-169 caused a marked depression (fig. 4).

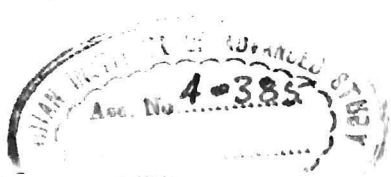
Action on blood vessels :—In the following experiments the hind limbs of the dogs were perfused with oxygenated defibrinated blood of the same dog and venous output was measured at regular intervals to see that the output was constant prior to injection of the drug.

1 mgm/Kgm. on an average increased the outflow of perfusion fluid from 30 c.c. per minute to 47 c.c. per minute.

Action on heart in situ :—

(a) Amphibian heart—It was found by the method of heart perfusion that both the frequency and amplitude are decreased markedly when 1 mgm. of P-169 was given through injection.

(b) Mammalian heart :—Effects of doses ranging from 1 mgm. to 6 mgm/Kgm. of P-169 were studied on



auricular and ventricular tracings of the anaesthetised dogs. 1 mgm/Kgm. was found to be the minimum dose which caused depression as evidenced by decrease in rate and amplitude of contraction. There was also an indication of dilatation of ventricles (fig. 5). 6 mgm/Kgm. produced marked depression with a more marked dilatation of the ventricles (fig. 5).

Action on isolated mammalia heart :—Isolated heart of rabbits weighing between 1 and 2 Kgm. were used. P-169 in doses of 0·25 and 0·5 mgm. produced definite decrease in the rate and amplitude of contraction (fig. 6.) 2·5 mgm. doses in some stopped heart beating instantaneously which did not recover.

Action on Respiration :—

Dogs upto 2 mgm/Kgm. of P-169 did not produce any effect on the respiration of the anaesthetised dogs which was recorded through trachea. 3 and 4 mgm/Kgm. showed some stimulation of respiration as evidenced by increase in amplitude of the respiratory tracings. Higher dosages depressed respiration which was very marked with 6 mgm/Kgm doses as evidenced by a decrease in the rate and amplitude of the respiratory tracings (fig. 7).

Action on the smooth muscles : —

Effects of P-169 were studied on the isolated strips of jejunum of albino rats and rabbits as well as on the isolated uterine horns of albino rats, suspended in Dale-Burns bath.

Different doses of the drug solution were added into the oxygenated Ringer solution contained in the inner bath.

Doses as small as 200 Y caused diminution in tone as well as amplitude of the intestinal contractions (fig. 8 & 9).

50 Y of P-169 caused a diminution in the amplitude of rhythmic uterine contractions. (fig. 10).

Local Anaesthetic action :—

1. Surface anaesthesia : – Action on Guinea pig's cornea.

After clipping the lashes the cornea was rinsed thoroughly for 60 seconds with the aqeous solution of P-169. The anaesthetic duration was determined at 5 minutes intervals by noting abolishment of the corneal reflex to

stroking with the blunted point of a lead pencil; sufficient pressure was applied to produce a definite dent in the cornea. The other eye was similarly tested after instilling distilled water which served as control.

Results were compared with cocaine hydrochloride-2% solution, adopting the above technique.

An average protocal is shown below :—

TABLE 2

P-169% in dist. water	Average anaesthetic duration in mts.	Remarks	Cocaine HCl 2% in water
0·005	0	No effects	Average anaesthetic duration 20 minutes in 8 Guinea pigs. Mydriasis was seen in all animals.
0·01	15	Analgesia	
0·02	25	Complete Anaesthesia	
0·03	40	" & mydriasis	
0·04	60	" "	
0·05	70	" "	
0·1	105	" "	-

Higher concentrations of 0·5% and onwards produced irritation as evidenced by cloudiness and congestion of the cornea of Guinea pigs.

2. Infiltration anaesthesia :—

Guinea pig intradermal wheal :—The technique of Bulbring and wajda (1945) was employed and procaine hydrochloride was used as standard for comparison.

The results are tabulated as follows :—

Minutes after injection	*Left side*-Procaine HCl 1% in distilled water. *Animals* :-			*Right side*-P-169 0.1% in distilled water. *Animals* :--		
	1	2	3	1	2	3
5	5	6	5	2	4	3
10	6	6	6	2	3	2
15	6	6	6	0	4	2
20	6	6	6	2	4	3
25	6	6	6	5	2	2
30	6	6	6	0	1	0
	35	36	35	11	18	12
	Average index 35			Average index 13		

Similar results were obtained when 2 c. c. of 0·1% aqueous solution of P-169 was infiltrated into the subcutaneous tissues of Guinea pigs' abdomen and compared with aquous solution of Procaine HCl-2 c. c. 1%.

RESULTS AND DISCUSSIONS.

The Pharmacology of a new local anaesthetic agent P-169 (Topicain HCl) is presented with anticipation of its being clinically screened in human beings as a topical anaesthetic as well as antispasmodic.

1. P-169 was found to be a transient to prolonged depressor substance by the dog blood pressure method. 0·25 mgm/Kgm. to 10 mgm/Kgm. doses were employed I.V. and the fall in blood pressure was from 10 mm Hg. to 110 mm Hg. according to the dose.

Vagotomy or atropinization produced no influence on the fall in B. P. The hypotensive effect of the drug was due to a direct depression of V-M centre as evidenced by carotid sinus experiments, myocardium and the smooth muscles of the blood vessels.

Doses onwards 2 mgm/Kgm. caused cardiac irregularities which disappeared with the recovery of B. P. to the original normal level.

2. P-169 was found to depress respiration in doses onwards 4 mgm/Kgm.

3. P-169 was found to be a powerful relaxant of the smooth muscles of the intestines and uterus of albino rats and rabbits.

4. P-169 was found to have potent anaesthetic properties as seen in Guinea pigs.

As a surface anaesthetic it had a more potent and lasting anaesthetic effect on Guinea pigs' cornea than cocaine HCl though the onset of action was slow. It had approximately a cocaine index of 150 (Table 2). 0·01% was found to be the minimum effective anaesthetic concentration for Guinea pig's cornea. Concentrations upto 0·1% were tolerated without any signs of corneal irritation. Higher concentrations 0·5% and onwards showed signs of corneal irritation. The mydriasis was noticed with 0·03% and onwards.

P--169 was found to be a weaker agent than Procaine HCl for infiltration anaesthesia.

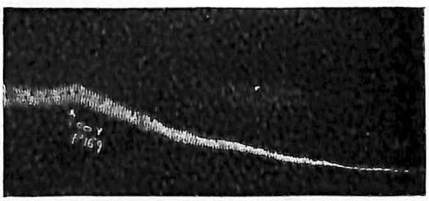


Fig 8 :—The effect of P—169 on the isolated strips of jejunum of albins rats. Note the relaxation produced by 100 microgram.

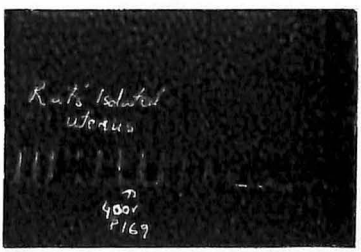


Fig 10:—The effect of P—169 on the isolated uterine horn of albino rat. Note the diminution in the amplitude of uterine contractions after 400 microgram.

From mammalian experiments it seems that concentrations ranging from 0·02 to 0·1% of P--169 produces corneal anaesthesia deep enough for surgical interference without any evidence of systemic toxicity.

Acknowledgments :—

We are indebted to Dr. Carl A. Bunde, Director and Dr. B. E. Abreu, Associate Director of Research, Pitman Moore Co., Indianapolis, Indiana, U. S. A., for sending this new compound P–169 for our studies and for the kind help we received from them.

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Fauna of Jodhpur
I. Butterflies of Jodhpur

By

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INTRODUCTION

Very little is known about the fauna of Jodhpur and the need for atleast a list was being felt for a long time. The present paper,- the first of the series dealing with the fauna of Jodhpur-is based on an extensive field collection of Jodhpur and its environs (over 15 miles radius) during the years 1948, 52. The material comprises 17 species representing 9 genera of the families *Papilionidae, Pieridae, Danaidae, Satyridae and Nymphalidae.*

LIST OF BUTTERFLIES BELONGING TO FAMILIES— PAPILIONIDAE, PIERIDAE. DANAIDAE, SATYRIDAE & NYMPHALIDAE

I. Family PAPILIONIDAE Leach.

(i) **Polydorus aristolochiae aristolochiae** (Fabricius)
Common name:—'Red-bodied Swallow-tail'.
It is abundant from March to May and from September to November.

(ii) **Papilio polytes romulus** Cramer
It is common during October.
Common name:—'Common mermon

(iii) **Papilio demoleus demoleus** (Linnaeus)
Common name:—'Lime or lemon butterfly'
Common from July to November.

II. Family PIERIDAE Duponchel

(iv) **Calotis calais amata** (Fabricius)
Common name:—'Small salmon Arab'
Abundant from June to October.

(v) **Calotis vestalis vestalis** (Butler)
Common name:—'White Arab'
Common during September and October.

(vi) **Colotis phisadia protractus** (Butler)
Common name:—'Blue Spotted Arab'
Collected in July & August.

(vii) **Clotis danae danae** (Fabricius)
Common name:—'Crimson tip'
Collected in July.

(viii) **Catopsilia pyranthe pyranthe** (Linnaeus)
Common name:—'Mottled emigrant'.
Common throughout the year.

(ix) **Catopsilia crocale crocale** (Cramer)
Common name:—'Common emigrant'
Abundant during August to October.

(x) **Catopsilia pomona** (Fabricius)
Common name:—'Lemon emigrant'
It has been collected in July & August.

III. Family DANAIDAE

(xi) **Danais chrysippus** (Linnaeus)
Common name:—'Plain tiger' and' Akk butterfly'
Found throughout the year.

(xii) **Danais plexippus** (Linnaeus)
Common name:-' Common tiger'
Collected during July & August and February to April.

(xiii) **Danais limniace mutina** (Cramer)
Common name:—'Blue tiger'
Found from July to November and March to May.

(xiv) **Euploea core core** (Cramer)
Common name:--'Common Indian crow'
Common during April and July to November.

IV. Family SATYRIDAE

(xv) **Melanitis leda ismene** (Cramer)
Common name:—'Common evening brown'
Collected during August to October.

V. Family NYMPHALIDAE

(xvi) **Hypolimnas misippus** (Linnaeus)
Common name:—'Danaid egg fly'
Collected during August to December.

(xvii) **Precis orithya swinhoei** (Linnaeus)
Common name:—'Blue pansy'
Abundant during July to October.

Vitamins A and A_2 and Allied Compounds

By

P. D. Dalvi

M. Sc., A. I. I. Sc., F. R. I. C. (Lond.) Ph. D. (Liv.)

The knowledge that foodstuffs are necessary for animal life is as old as anything that can be called knowledge. The diet of wild animals was necessarily uncooked, intrinsically natural material and thus its nature remained essentially the same although local and seasonal differences in quality and quantity undoubtedly occurred. In the case of man whose diet consisted in a large part of cooked and in recent times "processed" food, the whole matter of nutrition gained an importance because in many countries population increase tended to outstrip food production.

In ancient Sanskrit literature it was enjoined that one should eat as far as possible raw uncooked foodstuffs, thereby conserving the 'Pranas', literally translated-'lives' or essences of the food stuff. Whether these injuctions imply that the destruction of some vitamins by cooking had been obscurely sensed, it is difficult to say. It cannot be doubted, however, that the concept of 'Pranas' in some measure anticipated the modern vitamin concept.

Man with his highly developed brain began to think of eating as a pleasure as well as a means of sustaining life. Perhaps undue attention was given to palatability and this, together with the fertility of the human race and its tendency to engage in pursuits other than agricultural, led to unbalanced diets and scarcity. As a result, many parts of the world contain large sections of people who are generally underfed and often suffer from preventible deficiency diseases.

BALANCED FOOD

In the early part of the century, workers in the field of nutrition felt that a great part of the world's population was not getting enough to eat, at any rate for full health and activity. At that time, the main concept in nutrition was crudely quantitative one of energy requirement. It was held

that the amount of energy for the maintenance of nutritional equilibrium could be calculated in terms of calories. The balanced diet of the period, differed from the present-day ideas in that it did not (and, of course, it could not) reckon with the accessory food factors or vitamins with which a new generation of researchers were to be preoccupied. The existence of a great body of knowledge about vitamins should not, however, lead one to underrate the importance of carbohydrates, fats, proteins and minerals. In fact, the balanced diet in respect of these major factors is often the main problem, but discussion of this matter is outside the scope of this article.

1. Vitamin A

Lunin (1881), experimenting with mice, showed that they were not able to grow naturally on diets containing purified fat, carbohydrate and protein with a salt mixture. But if small quantity of milk is added to such diets, the mice grew normally.

Takaki (1885), eliminated beriberi from the Japanese navy by giving increased quantities of meat, barley and fruit. He wrongly ascribed the effect to the meat, supplement but he was right in supposing that a food deficiency was a casual factor for beriberi.

Eijkman (1897) fed birds with decorticated (polished) rice and induced a condition closely simulating human beriberi, whilst Holst and Frolich (1907) produced the disease in guinea pigs by feeding them a cereal diet deficient in 'greens'.

The effect of milk earlier shown by Lunin, was substantiated by Hopkins (1906). Later (1912), he showed that the active fraction containing the substances he named as 'accessory food factors' could be extracted with alcohol.

Steppe (1909, 1911 and 1912) showed that mice that could live satisfactorily upon wheat, bread made with milk were unable to live longer than a month when fed on the same diet after it had been extracted with alcohol and ether. He surmised that the indispensable substance was possibly in solution with lipids.

'The accessory factors' of Hopkins were termed 'vitamines' by Funk (1911). Later, the final 'e' was dropped to

remove the implication that the active substances were amines.

McCollum and Davies (1913) and Osborne and Mendel (1913) showed that the activity of the material extracted with alcohol was due to two factors :--

(1) fat soluble A and (2) water soluble B

These two substances were later renamed as vitamin A and vitamin B.

McCollum, Simmonds, Becker and Shipley (1922), showed that the antixerophthalmic factor was vitamin A; and that xerophthalmia was a symptom of vitamin A deficiency was also proved by Emmet (1920), Osborne and Mendel (1921, 1924) and Mori (1923).

Many years ago, before the discovery of vitamin A, it was believed by some that night blindness was of dietary origin. Aykroyd (1944) referred to a journey of Bishop Heber in India during the years 1824-25. The Bishop met a beggar with night blindness and was told that Sepoys suffered frequently from this condition and that they knew it was due to bad and insufficient food. This might be the earliest recognition of the relation between night blindness and dietary deficiency.

Fridericia and Holm (1925) showed that vitamin A deficient rats placed in the dark after exposure to light showed delayed dark adaptation. It was also shown that vitamin A deficient rats developed a well defined hemeralopia which disappeared 2 or 3 days after the administration of vitamin A.

Holm (1929) stated that the retinal tissues were a rich source of vitamin A or its provitamin carotene. Wald (1934-35) gave figures for the vitamin A content of various ocular tissues. Wald (1935) further showed that vitamin A is in some ways related to visual purple.

There is acute difference of opinion concerning the alleged anti-infective properties of vitamin A, although it seems to be agreed that the avitaminotic animal easily contracts infections, possibly because keratinized epithelial cells are an early result of deficiency.

2. Carotenoids

A close connection between carotene and vitamin A was observed in feeding experiments on rats. It was seen

that the deficiency syndrome could be cured by substances containing vitamin A itself and by extracts of green plants whose activity could be correlated with the amount of carotene present.

Carotenoid pigments occur in many vegetable and animal fats. Carotene was first isolated by Wackenroder (1831) from common-carrots. Zeise (1847) gave it an empirical formula C_5H_8 and Willstatter (1907) modified it to $C_{40}H_{50}$. Kuhn and Winterstein (1933) separated carotene chromatographically into three isomers, α, β and r. β-Carotene is most active when fed to vitamin A-deficient rats. Zechmeister and Cholnoky (1928) showed that β-carotene contained 11 double bonds since catalytic hydrogenation yielded perhydro-β-carotene, $C_{40}H_{78}$. Evidently since the latter is $C_n H_{2n-2}$, β-carotene contains two rings and 11 double bonds. Its colour suggests that the double bonds are conjugated.

Some time passed before the definite relationship between the coloured carotene and colourless fat soluble vitamin A could be established. Rosenheim and Drummond (1920) thought that the fat soluble vitamin could not belong to the lipochrome pigment without first assuming the existence of a leuco-base.

Moore (1930) admitting that carotene was not itself vitamin A proved that it was a *precursor,* since administration of carotene resulted in considerably increased storage of vitamin A (recognized by its spectroscopic properties) in the liver of the rat.

The provitamins are listed below:-

Provitamins A

Naturally occurring	Partly synthetic	Synthetic
α-Carotene	β-carotene monoxide	Vitamin A—* methyl ether
β-Carotene	β-oxy-carotene semi-p. carotene monoxime	vitamin A acid
r-Carotene		
α-Carotene epoxide		
Cryptoxanthin		
Aphanin		
Echinenone		

*These substances are only provitamins A, if it is assumed that they are converted in the body to the biologically active substance.

3. Detection and Estimation of β-carotene and vitamin A

The ability of the animal body to use β-carotene and also the other two isomers in the place of vitamin A, put these substances on the list of accessory food factors. It follows that for research and for food testing, trustworthy, qualitative and quantitative methods for provitamin A and vitamin A are very necessary.

For the determination of β - carotene the following figures obtained on pure β-carotene are used. The absorption maximum for β-carotene in petrol (40-60°) is 448-449 mu. and E1%/1cm. max.=2500. The ratio between the values at the maximum and second maximum at 473-475 mu. is 1 : 1·12—1·14

Salkowski's (1872) reaction in which conc. H_2SO_4 is used, gives a red-purple colour with a chloroformic solution of cholesterol, was tried by Drummond and Watson (1922) on liver oils. Later, Rosenheim and Drummond (1925) made use of $AsCl_3$ (liquid). It gave a blue colour but was very unpleasant to use. Carr and Price (1926) substituted a saturated solution of $SbCl_3$ in chloroform in place of $AsCl_3$ with equal success and more convenience. Fearon (1925) used P_2O_5 and pyrogallol with trichloroacetic acid to detect vitamin A in liver oils. He believed that the vitamin entered into the formation of a pigment, probably by condensation with sterol. That this reaction was not specific of vitamin A was shown by Rosenheim (1929). A red colour was obtained with trichloroacetic acid on coprosterol and other sterols with a double band in the position $C_4 : C_5$, adjacent to the hydroxyl in C_3. Heilbron and Spring (1930) mentioned a number of derivatives with conjugated double bonds such as cholesterilene, ergosterol, etc., that give colour with trichloroacetic acid.

Morton and Heilborn (1928) showed that vitamin A concentrates exhibited a well defined ultra violet absorption band with a maximum at 328 mu., and that the intensity of absorption at that wave length ran parallel with the $SbCl_3$ colour test and the biological potency in oils and concentrates.

Later, Drummond and Morton (1929) found even for fish liver oils not differing widely in vitamin content good

agreement between spectroscopic, colorimetric and biological estimates of potency.

4. Other vitamin A and allied compounds

Vitamin A_2.

Heilbron, Gillam and Morton (1931) made known the presence of a new substance in certain liver oils. This gave an absorption maximum at 693 mu. with $SbCl_3$. The 693 mu. chromogen often accompanied vitamin A and this suggested to some that it was even due to vitamin A. This idea was dispelled by the observation of Heilbron, Morton Rea, Webster and Drummond (1932) that mammalian liver concentrates did not contain this new chromogen.

An important contribution to the establishment of the 693 mu. chromogen as a definite entity (as vitamin A_2) was made by Lederer and Rozanova (1937) who showed that liver oils from several Russian river fish contained the 693 mu. chromogen, preponderating over vitamin A as measured by the absorption maximum at 620 mu. They found the ultra violet absorption maximum to be at 340-350 mu. Wald (1937) observed that certain fresh water fish have 'visual purple' system which differs from that found in man and most other animals, and the eye-tissues of marine fish contain vitamin A and those of fresh water fish vitamin A_2. Later, Edisbury, Morton and Simpkin (1937) found the unsaponifiable fractions of gold fish eye to give the ultra violet maximum and subsidiary maximum at 350 mu. and 288 mu. respectively. 'Cyclization' by anhydrous alcoholic hydrogen chloride gave a product showing maxima at 391, 369, 349 and 334 mu. the maximum at 369 mu. being the greatest.

Embree and Shantz (1940) showed that the fish-perch, was very rich in vitamin A_2. The ratio of vitamin A_2 to A_1 was 22·5 : 1.

Nearly pure vitamin A_2 was obtained by Karrer and Bretcher (1942, 1943) by molecular distillation of pike liver oil. The purified vitamin A_2 concentrate gave E1%/1cm. 345 mu. 1450. and the corresponding blue value, 2300. They stated vitamin A_2 to have 10% of the biological value of vitamin A.

Recently Shantz (1948) enriched vitamin A_2 concentrate by centrifugal molecular distillation and later purified the concentrate chromatographically. The value of the purified vitamin A_2 was E1%/1cm. 352mu.=1460, with a subsidiary peak at 287 mu. with E1%/1cm.=820. The $SbCl_3$ blue value at 693 mu. was 4100.

Nothing definitely is known about the precursor of vitamin A_2. Morton and Creed (1939) demonstrated that fishes, perch and dace, could utilize β-carotene to increase the storage of vitamin A_2.

Kitol, Hepaxanthin, sub-vitamin A and neo-vitamin A

Morgan, Edisbury and Morton (1935) found that whale liver oils gave biological potencies lower than expected from the spectroscopic E1%/1cm. 325 mu. values. The work of Pritchard, Wilkinson, Edisbury and Morton (1937) indicated discrepancies between biological and physico-chemical methods of vitamin assays. When rich vitamin A concentrates were separated into two fractions by exhaustive extraction with 83% alcohol/petrol, the ethanol soluble fraction generally corresponded with the spectroscopic and chemical criteria of vitamin A. The insoluble fraction, however, was abnormal with greater biological activity than what was expected from the blue value.

The latter fraction exhibited a maximum at 285-290 mu. in the ultra violet spectrum without even an inflexion at 328 mu. The biological activity was about 1/20th of vitamin A. The $SbCl_3$ product had absorption bands at 594 mu. and 496 mu. It did not react with alcoholic anhydrous hydrogen chloride. Further recognition of this substance was found in the report of Drummond and Haines (1938) and Willstaedt and Jensen (1939). These investigators prepared chromatographically a concentrate which had an absorption maximum at 293 mu. and $SbCl_3$ colour reaction at 570 mu. The biological potency of the material was 51300 i.u./g. The results though contradictory, suggested the presence of a new substance with vitamin A activity.

Embree and Shantz (1943) who worked on whale liver oils found two substances with absorption maximum at 290 mu. One had vitamin A activity and the other had little or no vitamin A activity. The latter substance was

chromatographically purified and was designated kitol. The molecular weight of kitol was found to be 575 and E1%/1cm. 286 mu.=580. Later Baxter, Clough, Kocher and Robeson (1947) claimed to have isolated kitol in crystalline form (Formula $C_{40}H_{58}(OH)_2$.) It is a provitamin A in the strict sense of the word as it has by itself no biological activity, but on heating to 200°, it gives vitamin A.

Examination of pike liver oil revealed the presence of kitol$_2$, a provitamin A_2

Eckelon, Emmerie, Julius and Wolff (1932) referred to a substance showing a maximum at 270 mu. in the ultra violet and $SbCl_3$ test at 570 mu. Karrer and Morf (1933) isolated a substance also absorbing at 270 mu. in the ultra violet and named the substance hepaxanthin. Embree and Shantz (1943) added some data by reporting two fractions from the chromatographic fractionation of fish liver oil. One of the fractions showed an absorption maximum at 270 mu. in the ultra violet and $SbCl_3$ product at 580 mu, and sometimes at 620 mu; the other fraction containing 'a vitamin A' which showed absorption maximum at 270-280 mu. in the ultra violet and $SbCl_3$ product at 580 mu. Previously, Kringstad and Lie (1941) had shown that the 570-574 chromogen when heated under vacuum yielded vitamin A and later, a little yield of oxygen. Later Karrer and Jucker(1945)reported the presence of a vitamin A derivative (or hepaxanthin) in whale liver oil with an ultra violet absorption maximum at 272 mu. and $SbCl_3$ product at 575 mu. which changed to 620 mu. after a short time. On the basis of the findings of Kringstad and Lie and the analysis of the product, they assigned to this new substance-hepaxanthin or epoxide of vitamin A, the formula, $C_{20}H_{30}O_2$. They suggested that the O atom was attached to the carbons 5 and 6 of the ring, as it was in the epoxide of carotene. This view was later changed by Karrer and Jucker (1947), who thought the O atom was attached to the carbon atoms in the chain, thus leaving only three conjugated double bonds in the vitamin A epoxide molecule. These investigators reported another substance showing a maximum at 339 mu. in the ultra violet and in the $SbCl_3$ colour test a maximum at 575 mu. which did not change like that of hepaxanthin.

Sub-vitamin A was reported by Embree and Shantz (1943 a) in a chromatographic fractionation of a shark liver oil. The most potent fraction had a E1%/1cm. 290 mu.= 150. The $SbCl_3$ colour test maximum was 617 mu. Anhydro sub-vitamin A gave maxima at 322 mu. 348 mu. and 369 mu. while the $SbCl_3$ product gave a maximum at 617 mu. and an inflexion at 580 mu.

An important addition to the vitamin A substances was neovitamin A, which was discovered by Robeson and Baxter (1945) and studied further by Dalvi and Morton. (1951)

5. Sources of Vitamin A and A_2 and Physiological Functions of the Vitamins

Plants have been found devoid of vitamin A and precursor of vitamin A and probably vitamin A_2. The principal sources of vitamins are the liver lipids, those of shark and halibut for vitamin A, and of ling and pike of A_2. It is thus the animal kingdom that provides the vitamins. The regions of the animal body where vitamins are found in concentration and the percentages of the vitamin to the total lipids, differ in different animals. The intestines of mammals contain little or no vitamin A (as alcohol or ester), but those of fish-halibut-contain about 50% of the total lipids extract (Morton and Glover, 1948).

The importance of vitamin A in promoting growth is known, but the mode in which it is utilized is not yet fully understood. The only information available is :--

1. Vitamin A content of various organs such as eye,intestines etc., is different in different animals.
2. Distribution of the fat in the intestines runs parallel with that of vitamin A.
3. Carotene and vitamin A are absorbed through the intestinal wall. Also carotene is transformed into vitamin A in the small intestine.

As regards the third observation, Thompson, Braude, Cowie, Ganguly and Kon (1948) recently reported that the presence of fat was not essential for the absorption of vitamin A acetate (synthetic) by the rat.

Another important function of vitamin A is in connection with photoreception. It has been found that there is a close parallelism between vitamin A and vitamin A_2, and what is applicable to vitamin A as a growth promoting factor in connection with photoreception generally holds good in the case of vitamin A_2.

6. Vitamins A and A_2 : their constitution

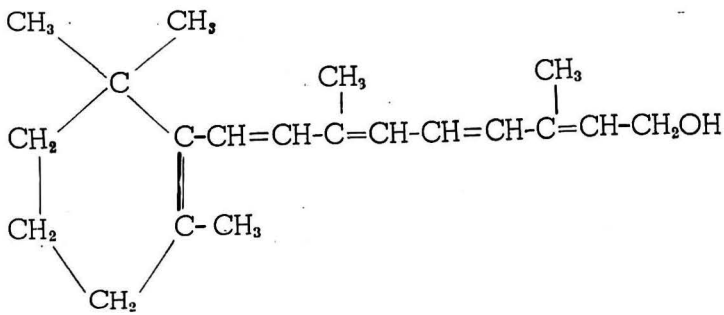
After the existence of vitamin A was definitely established, attempts were directed towards its isolation and later, assigning it a constitution.

Abortive attempts of Takahashi, Nakamiya, Kawakami and Kitusato (1925), Drummond and Baker (1929) and other investigators, were followed by the successful results of Karrer and his co-workers (1931). These workers saponified halibut liver oil. Sterols were removed by cooling the unsaponifiable fraction in methyl alcohol to 60° and the desterolated unsaponifiable fraction was purified by fractional absorption on fibrous alumina and a faintly yellow viscous oil, containing about 50% of vitamin A, was obtained. This concentrate contained about 5% vitamin D. A concentrate prepared from the liver oil of mackerel had similar properties to that from halibut liver oil but was found free from vitamin D. The purified concentrate yielded uncrystallizable vitamin A acetate and p-nitrobenzoate, the elementary composition of which agreed with the formula $C_{20}H_{30}O$ for vitamin A itself.

Heilbron, Morton and Webster (1932) dehydrogenated vitamin A with selenium and isolated 1 : 6 dimethyl naphthalene, thus determining the relative positions of the gem-dimethyl group and the first side chain methyl group.

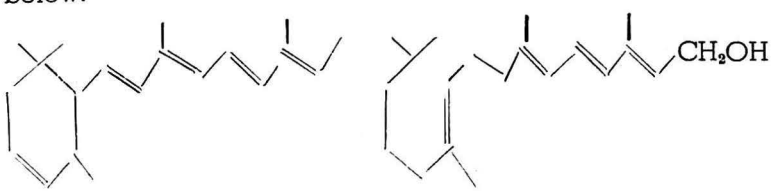
Karrer amd Morf (1933) established the structure of vitamin A through the synthesis of perhydro vitamin A. This was effected in 8 step reaction starting from β-ionone. Nine years later, Baxter and Robeson (1942) crystallized vitamin A as yellow prism m. p. 63-64°. Synthetic vitamin A was prepared by Isler, Huber, Ronco, and Kofler (1947), starting from β-ionone.

The following constitutional formula put forward by Karrer has been universally accepted.



Vitamin A $C_{20} H_{29} OH$

In spite of the importance of vitamin A_2, in all fields where vitamin A has a place, its structure has remained unsettled. The most likely formulae for vitamin A_2 put forward are two, i. e. those of Karrer and Bretcher (1943) na dMorton, Salah, and Stubbs (1949). They are mentioned below:—



Vitamin A_2 (Morton) Vitamin A_2 (Karrer)

The arguments that prompted the authors to put forward these formulae will be discussed in a later article.

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Lobed fruits of CARICA PAPAYA LINN

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A recent note (2) on half apocarpy in *Carica papaya Linn.*, is a record on an interesting subject, which needs further elucidation in the light of my observations on the development of some abnormal fruits of *Papaya.*

Abnormal fruits of *Carica papaya Linn*, have been recorded previously also. According to Biswas, (1) 'some palm shaped and other curiously shaped fruits' of this plant have been recorded by G. P. Mazumdar *(6). The internal condition of these abnormal fruits has probably not been described by him. Khan (5) while recording the internal proliferation in papaya observed three secondary fruits and one male flower within the seed cavity of the parent fruit. However it may well be interpreted that the gynaeceum of a single flower may have developed into a three fingered abnormal fruit, having separate stigmatic lobes. This assumption is supported by the fact that these fruits remain united at the base. Very similar external condition has been observed by the writer recently in some of the fruits. Cheema & Dhani (3) have reported that overcrowding deforms the *Papaya* fruits. Similarly according to Head (4) the cultivation of *Papaya* without thinning results in smaller and badly shaped fruits.

Some abnormal fruits were first noticed by the writer on 29th Feb. 1952 on the plants growing at the Government Sewage Farm, Jodhpur. Since then the abnormalities of these plants were studied and efforts made to find an explanation of the probable causes which might have led to this effect, by casual visits to the Farm.

*The paper was not available to the writer.

TABLE No. I

Analysis of the Papaya Plants of Sewage Farm, Jodhpur

Serial No. of Plants examined	Plants with normal (N) abnormal(A) & no fruits	Nature of plants–Male (M) Female-(F)& Polygamous-(P)	Age of the plants in 4 years on 13-2-52. appro.	Approximate No. of fruits on each plant on 13-2-52	Nature of plants branched (B) unbranched(U)
1	N	F	3	15	U
2	N	F	3	10	U
3	A	P	3	50	B
4	N	F	3	20	U
5	A	P	3	60	B
6	N	F	2½	5	U
7	N	F	2	2	U
8	N	P	1½	3	U
9	...	M	2	...	U
10	N	F	3	2	B
11	N	F	3	1	B
12	...	Burnt	3	Burnt	B

Abnormalities have been analysed in Table No. 1 and a short description of the same is given below.

Out of the total 12 plants growing in the Farm, only two plants bore the abnormal fruits along with the normal ones. The abnormalities were present even in the early development of the flowers which later resulted in abnormal fruits. Most of the plants were nearly three years old in 1952 and since then, they have produced some % of abnormal fruits every year. It is believed that the % of the abnormal fruits have increased with the advance in age of the plants.

Abnormalities arise very early with the development of the flower and continue till the maturation of the fruits. Therefore the floral abnormalities and the abnormal fruits have been described separately. Normally the Papaya plants are dioecious, with staminate and pistillate flowers produced on two different plants. In addition to this, many intermediary stages are also not uncommon. The twelve plants growing in the Sewage Farm, may be divided according to the nature of their flowers in the following three catagories :--

1. Dioecious pistillate plants, with large female flowers in the axil of the leaves. This is the normal pistillate type and there were seven such plants growing at the Sewage Farm.

2. Dioecious staminate plants with long, narrow tubular male flowers arranged on long branching peduncles, growing from the axil of the leaves. This is the normal male type and there was only one such plant there.

3. Polygamous plants with male, female and hermophrodite flowers on the same plants. Hermophrodite flowers again were of two kinds; some with ten stamens and others with only five stamens.

It is interesting to note that the abnormalities are associated with the sexual nature, as is evident by the table; only the polygamous plants bore the abnormal fruits. The normal pistillate flowers on these polygamous plants developed into normal fruits.

The abnormalities are evident even in the flowers, (fig.3) Separate stigmatic lobes can be distinguished on separate lobes of the carpels, all of which remain united at the base. (fig. 3) In some abnormal flowers which, of course are harmophrodite, there are ten stamens in two rows. One whorl of stamens remains attached to the outer wall of the carpels and the basal portions of filaments of these swell to become five finger like lobes (fig. 4,6) which, though, remain comparatively smaller in size are quite conspicuous otherwise. These lobes which are swellings of the basal portion of the staminal filaments, are always devoid of placentae and generally remain conspicuous (fig. 4,6).

But the abnormalities of the young and mature fruits are wide and varied. (fig. 2,4,5,6,8,10 & 11) The lobed fruits though numerous on the plants, giving it a very crowded appearance, generally remain very small and stunted. (fig,10) They ripe and become yellow and orange at this very stage.

The outward appearance of these fruits is quite conspicuous since structures of various shapes and curious forms are produced as is evident from the figures. These varying number of finger like lobes may be produced as minute outgrowths towards the apex of the fruits or they

may start right from the base of the fruits, in different directions. In the later case which has been recorded in 4-5 fruits, as many as ten lobes can be distinguished—the five outer and smaller, alternating with the other five which are bigger and more distinct. (fig. 6) Separate stigmatic lobes have been observed on some of these fingers. (fig. 2,4,5 & 8)

On cutting the transverse section of some of these fruits placentae have been observed in more than one locules. (Fig. 7 & 9) The maximum number of these locules, were eight in one fruit, showing a tendency towards the development of as many as eleven locules (fig. 9) The distribution of the lobes without locules and locules without lobes have been observed. But in no case more than one locule has been observed in any normal fruit. (fig. I)

The distribution of placentae in these locules is very interesting. Tracing and counting the number of these placentae is possible if the number of locules is only 2--3 but is difficult when locules are many.

The orientation of the placentae of the lobes without locules is in the direction of those lobes. This is because that the lobes sometimes start from a lower level than the placenta.

This irregular distribution of the placentation has led to the condition midway between 'apocarpous and syncarpous', By a careful examination it has been observed in some of the fruits that the placentae fuse to form one locule in the middle of the fruits, whereas towards the two ends there is a tendency of forming separate locules. Thus it may be described as a syncarpus condition tending to become apocarpus towards the two ends.

The causes which led to these abnormalities, are of some interest, since the result is the production of a reduced crop and consequently a great monetary loss. With this view in mind an attempt has been made to determine the exact causes of the abnormalities. The probable causes given below are based on personal observation, as well as on the information available about these plants from the gardener of the Sewage Farm, for which I am thankful to him.

Out of the twelve plants now growing in the Sewage Farm, eleven were strictly female plants (bearing exclusively pistillate flowers) in the first year of their growth and there was only one male plant. In January 1950 some plants were scorched due to temperature. These were later beheaded. As a result of this next year some of the decapitated plants became branched and three kinds of flowers developed on them. (Polygamous plants).

It is interesting to note that all the abnormalities were confined to some of these polygamous plants only. Normal and abnormal fruits were simultaneously borne on them, the former developing from the unisexual female flowers and later from the hermophrodite flowers. It is therefore probable that decapitation may be the cause of these abnormalities. Decapitation might have led to the change of sex. Ocasional change of sex (of male plants) by beheading has been reported previously too, by Shanti Sarup (7 & 8) and also by Wilcox (9) Here the female plants have been changed into polygamous plants. However, this change of sex due to decapitation has been noticed only in few cases.

Another cause which may be assigned to this abnormality is the increase in growth due to decapitation. This increased growth activity is evident on at least three plants recorded here. Leaves are borne very near to each other, on these plants. From the axil of each leaf arises an inflorescence consisting of 5-6 flowers and each of which tend to develop fruit. As a rule, in the normal female plants, 3, or 4 flowers develop in the axil of each leaf and only the terminal one develops into a fruit of natural size. Here, since all the flowers in the axil of a leaf develop fruits, overcrowding results. This overcrowding, in a limited space available, sets in a compitition for sunlight. In this struggle for existence some of the fruits peep out wherever they get space and sunlight. Thus some fruits do not develop properly and remain small, compressed and deformed.

From the various reasons given above, it is clear that the effect of light due to increased growth activity may be the probable cause of malformation. Further study, particularly the effect of light on the control of sex in Papaya is likely to be fruitful. Observatios on these and other lines are being continued in this laboratory.

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M. M. BHANDARI - LOBED FRUITS OF CARICA PAPAYA LINN.

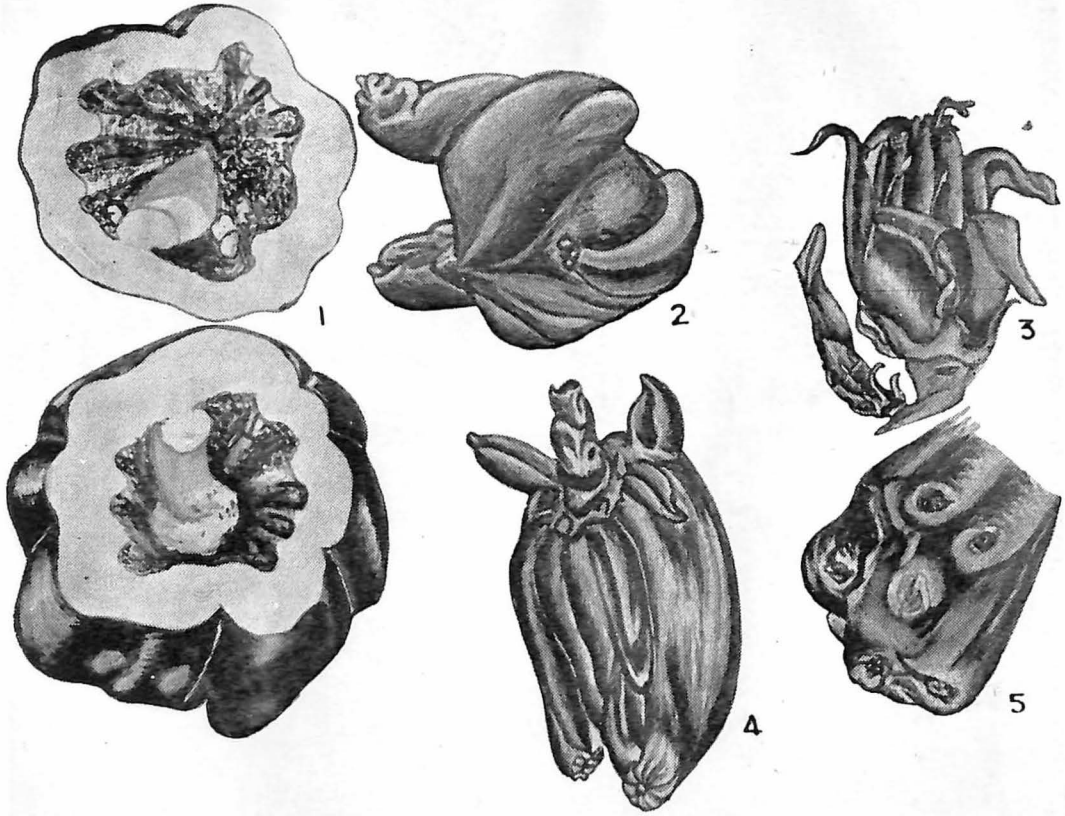

Fig. 1. T. S. of an externally normal fruit showing internal abnormal swellings.
Fig. 2,4,5 & 8 Lobed fruits showing separate stigmatic filaments on each lobe.
Fig. 3. An abnormal flower.

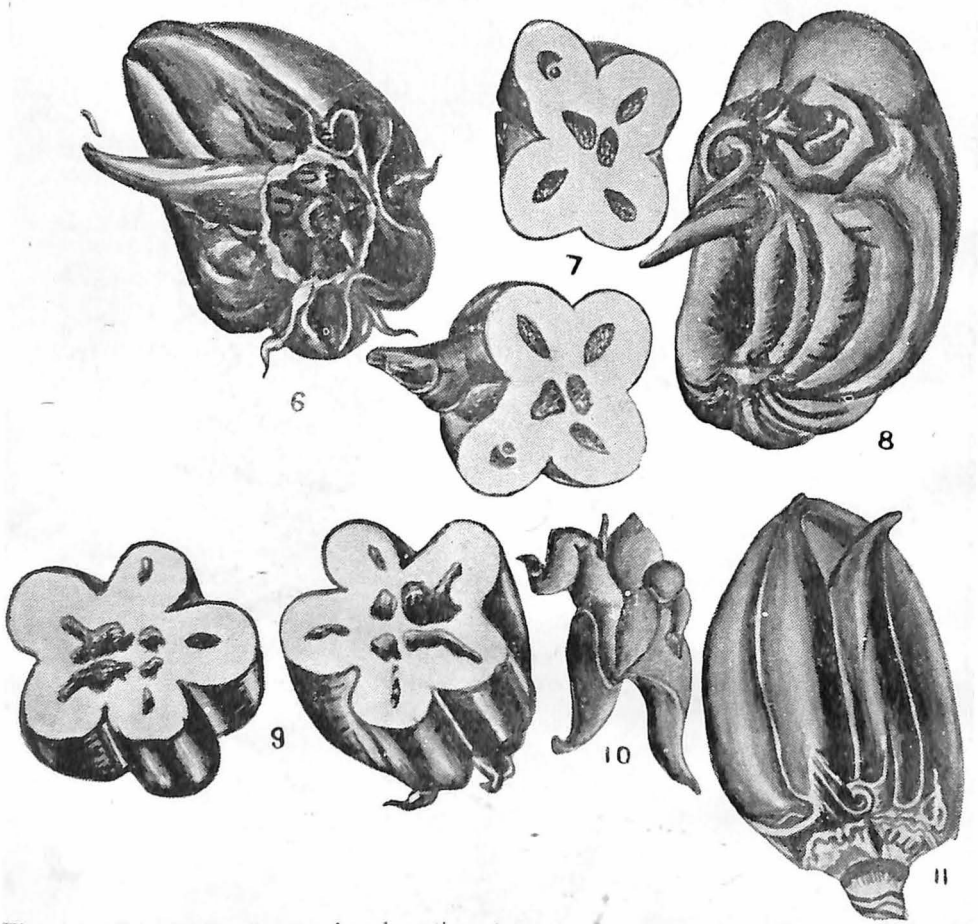

Fig. 4,6 & 11. Fruits showing basal portion of the staminal filaments forming lobes.
Fig. 7 & 9. T. S. of abnormal fruits showing distribution of placentae in many locules.
Fig. 10. A very much compressed, stunted and fingered fruit.

Alternaria And Its Pathogenicity

By

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INTRODUCTION

Alternaria forms one of the most important plant pathogens and is widely distributed on a variety of plant hosts. At times some of the species of this genus have assumed serious proportions on some of the important crop plants, for example *Alternaria solani* (Ell & M). Jones and Grout on Solanaceous plants, *Alternaria brassiceae* (Berk) Sacc., *Alternaria Oleracea* Milbr., *Alternaria dauci* (Kuhn) Grove., *Alternaria Circinens*(Berk)Bolleyon various cruciferous plants and *Alternaria brassiceae* (Berk) Sacc. Var *microspora* on linseed, are well known plant pathogens which cause heavy damages to these crops in different parts of the World, getting suitable environmental conditions for their action. Besides, there are numerous other species reported on many plants causing minor losses to them.

The studies conducted in other countries on this genus by Saccardo, P.A., Elliott, J.A., Weimer, J.L., Young P.A, Wiltshire, S.P. and Groves, J. W. and A. J. Skolko, reveal that the pathogenicity of the organism manifests itself in a variety of ways on different hosts.

SYMPTOMS

The common conception that the characteristic symptoms of the diseases caused by *Alternaria,* are the production of target board type of spots with zonation as described by Saccardo (1886) in his description of *Alternaria brassiceae* (Berk) Sacc., can no longer be called as universal. In the case of *Alternaria* on Crucifers itself large number of variations in the symptoms have been described by different workers.

Elliott (1917) while working with a large number of species of *Alternaria* on different hosts found that *Alternaria*

brassiceae (Berk) Sacc. Var. *nigrescens* on *cucumis melo* produces only black dots on the infected leaves. Similarly *Alternaria fasciculata* produces on the leaves of cabbage very small pricked type of dotted spots.

Milbrath (1922) found another species of *Alternaria* which he named as A. *Oleracea* Milbr. the symptoms described by him are, "small sunken spots ranging from ·5 to 1·0 mm. in diameter. The spots are circular, black with purplish cast, the centre being darker than the margin."

Weimer (1924) while working with *Alternaria* leaf spot and brown rot of cauliflower, described the symptoms as follows, "On the leaf lamina the spots remained small (1 mm.) and dark brown, developing but little after the first three days. Later on they enlarged, forming lesions somewhat circular in outline from 10-50 mm. or more in diameter and greyish to brown in colour, in the centre of these lesions were dark fructfying areas. Some times these lesions coalesced, forming large irregular areas.

Bolley (1924) while working with *Alternaria Circinens* (Berk & Curt) Bolley found that the diseased spot is covered by a low, black fungus coating, on which the conidia appear in rings.

Dey (1933) reported a new *Alternaria* disease on linseed and found that the disease was essentially of the floral infection, although fungus was capable of infecting leaves as well.

The author while carrying out detailed studies in the linseed blight caused by *Alternaria brassiceae* (Berk) Sac var. *microspora* Brun. (unpublished) confirmed the symptoms observed by Dey (1933).

An outline of the symptoms may be given as follows :—

A. Floral parts :—The disease manifests its symptoms in three sharply defined stages of floral life.

(1) Before the fertilization of the ovule when the flower is in its bud stage.

(2) Just after the fertilization of the ovule.

(3) After the maturation of the capsule (fruit).

1. The first symptom of the attack is the failure of the bud to open during the day. Minute black spots appear

near the calyx. The spots enlarge, deepen in colour and spread all over the bud, passing into the pedicel, which also turning darker in colour shrinks, resulting generally in the collapse of the entire flower bud.

2. At the second stage where the infection takes place just after the fertilization of the ovule, the capsule develops normally, but it is very much reduced in size. The whole capsule becomes dark brown in colour, showing minute dark spots of the Alternaria attack. The sepals present a burnt appearance. In such cases either grain formation does not take place or the grains are extremely distorted and shrivelled.
3. At the third stage, apparently the infection remains confined to the outer layers of the capsule as the dark spots. In this case also the sepals give a 'burnt' appearance, but since by this time the grain formation has already taken place, no appreciable damage is caused.

B. Leaves :—In the young erect leaves, infection starts from the base showing dark-brown spots which spread over and pass into the stem. The leaves ultimately get dried up and curled.

In the lower older leaves infection starts from the tips and margins because they remain in contact with the soil and get the required humid conditions for infection.

PATHOLOGICAL STUDIES

Seedling infection :–It is evident from the work done by various workers on different species of *Alternaria* that the damage done to the plants is not merely due to its infection only on the leaves, flowers and fruits.

Tervet (1937) while testing the effect of some species of *Alternaria* on the seedlings of flax, found that some of the isolates were able to infect the roots, the infection in such a case was evident by stunting of the plants and damage to the root system, the injury to the roots was confined to the formation of reddish lesions mainly on the tap root.

Rangel (1945) found that *Alternaria brassiceae* (Berk) Saco. could successfully infect the seedlings of *Brassica* Spp. and also caused damping off of the young seedlings.

In the case of *Alternaria* on linseed also seedling infection could be affected by inoculating the first cotyledons and maintaining saturated humid condition for 72 hours.

Artificially inoculated seeds, gave substantially reduced germination, as is evident from the data in the table I.

TABLE I

Effect of seed infestation on the germination of seed of linseed.

Seed condition	No. of seeds sown.	No. of seeds germinated.	Percentage of seed germination.
Infested seed.	80	15	18·7
Healthy seed.	80	68	85·0

Infested seeds which did not germinate were dug out and it was found that in most cases the plumules and radicles were rotting due to the attack by the fungus.

Leaves and floral infection :-Technique of inoculation followed by different workers has been either to place the inoculum in the inner axil of the leaves or in the axil of the sepals without causing any injury to the inoculated parts or to spray the inoculum with the help of an atomizor. The author used both the methods in carrying out the infection studies.

It was found that under optimum conditions 72 hours constant saturated humid conditions were necessary for successful infection. It was also found that the incubation period was also not more than 72 hours.

Infection Histology :- No detailed information is available about the infection histology of different species of *Alternaria*. The author carried out this study in the case of *Alternaria* on linseed. Free hand sections of the leaves, 48 hours after inoculation, were cut. The study revealed that the germ tube enters the host either through stomata or by penetrating through epidermis. There is no appresorial formation; the germ tube is sufficiently pointed just when it penetrates the epidermis. Mycelium inside the host tissue is intracellular.

Factors affecting infection :- For the normal progress of different stage of infection i.e. establishment of contact of the parasite with the host and the incubation period, envi-

ronmental factors have their important role to play. In the case of *Alternaria* detailed factorial study is lacking, still in literature there are few citations, where some workers have laid emphasis on this kind of study.

Effect of Temperature :- Weimer (1924) while working with *Alternaria brassiceae* (Berk) Sacc. on Cauliflower, studied the effect of temperature on infection in detail and found that the optimum temperature varies from 25° to 30°C.

In the case of *Alternaria* on linseed, it was found that the maximum amount of infection i.e. 100 percent occurred during the month of January when the temperature varies between 50°-90°F with more inclination towards maximum. At this temperature the incubation period of infection was only three days which was found to be minimum.

During December on the other hand, when the temperature range was 39° - 74° F with more inclination towards minimum, only 21·5 percent infection could be obtained and the incubation period was also of five days.

During April and May, when the prevailing temperature was 80° - 105° F with more inclination towards maximum, no infection occurred.

The results of the representative experiments are given in the table II.

TABLE II

PERCENTAGE of infection at different temperature conditions.

Date of Expt.	Max temp. in °F.	Min. temp. in °F.	No. of buds.		1% of infection.	Incubation period in days.
			inoculated	Infected		
16.12.49.	74	39	70	15	21·5	5
23.12.49.	82	42	70	19	27·5	5
12.1.50.	92	50	33	33	100·0	3
22.2.50.	88	44	50	35	70·0	4
13.4.50.	102	80	30	0	0	...
1.5.50.	105	82	30	0	0	...

Effect of moisture :- In order to study the influence of moisture on the intensity of the disease, in the case of *Alternaria* on linseed, inoculated plants were kept for different periods in the humid chamber in which moist conditions

were maintained almost to a saturation point by means of frequent sprays with the hand pressure sprayer. After a fixed time, for a particular set of inoculated plants, they were shifted to other glass cages, where no artificial humidity was given to them. To serve as a control simultaneously healthy plants were also subjected to the same kind of treatment in other glass cages placed side by side.

During the experimental period the glass cages recorded 92°F as the Maximum and 52°F as the minimum temperatures.

The results of representative experiments as furnished in the table III show the maintenance of saturated humid conditions for 72 hours have resulted in cent percent infection; while reducing the period of humidity, has adversely affected the infection percentage. Plants in the control remained healthy.

TABLE III

Influence of moisture on the percentage of infection by changing the period of saturated humidity.

Period of saturated humidity in hours	No of buds		Percentage of infection
	Inoculated	Infected	
6	40	0	0·0
12	35	2	5·0
24	40	3	8·0
48	40	30	75·0
72	38	38	100·0

Host relationship of the fungus—

The study of the host relationship of the fungus is of major importance so far the recurrence and control of the pathogen is concerned. In the case of *Alternaria*, although some workers have taken keen interest on this aspect of the problem, yet the work done is of preliminary nature. Elliott (1917) & Young (1924) carried out detailed studies of the nature in the case of a number of species of *Alternaria*.

An attempt was made to determine the host range of *Alternaria* on linseed.

The results obtained are given in the table IV, represented by + or — meaning thereby positive or negative results. + + in the table indicates heavier infection than +.

TABLE IV

Host range of the fungus *A. brassicaeae* Var. *microspora* Brun. an isolate from linseed.

Name of the host plant	Reactions
1. *Brassica oleracea* Var. Capitata (Cabbage)	+ +
2. *Brassica oleracea* Var. botrytis (Cauli flower)	+
3. *Brassica oleracea* Var. calorapa (Knol-Khol)	+
4. *Brassica campestris* Var. sarson (mustard)	+ +
5. *Solanum tuberosum* (Potato)	—
6. *Lycopersicum esculentum* (Tomato)	—
7. *Nicotiana rustica* (Tobacco)	—

Reactions obtained indicate that the fungus is able to infect all the cruciferous plants tested.

Discussion.

The object of carrying out pathological studies of an organism is to correctly identify the organism and secondly to devise methods for the control of the disease caused by it. Going through the available literature about *Alternaria* it is evident that the genus has not been studied elaborately so far its pathological aspect is concerned. Most of the workers have laid much emphasis on the morphological aspect of the fungus and consequently their identification is to a very great extent based on the fungal morphology. This has led to a considerable amount of confusion in the nomenclature of different species of *Alternaria*. Take for instance the case of *Alternaria brassiceae* (Berk.) sacc.

Saccardo (1886) isolated this fungus from old leaves of *Brassica oleracea*. Berkley (1833) had described this fungus earlier as *Macrosporium brassiceae* Berk.

Elliott (1917) grouped the isolates from *Brassica* spp. into three species or forms.

1. *Alternaria brassiceae* (Berk) Sacc.
2. *Alternaria herculea* (Ell. & Mart) Elliot.
3. *Alternaria brassiceae* (Berk) Sacc. Var. *Microspora*.

Milbrath (1912) created another species *Alternaria Oleracea* Milbr. making isolation from *Brassica oleracea*.

Bolley (1924) questioned the valiidty of Saccardo's species and said that he was not handling the same specimen as that of Berkley and hence changed the authority as *Alternaria brassiceae* (Berk.) Bolley.

Groves and Skolko (1944) are also of the opinion that probably Saccarde misdetermined the species of his fungus and according to them *Alternaria Brassiceae* (Berk.) Sacc. should be referred to Elliott's *Alternaria herculea* (Ell. & Mart.) Ellioltt. and the small spored *Alternaria* as *Alternaria oleracea* Milbr.

Similarly Elliott has found some differentiation in *Alternaria solani* (Ell. & M.) Jone Grout also.

In the case of *Alternaria tenuis* Nees, Groves & Skolko (1944) are of the opinion that this is a vast group which includes both saprophytes and facultative parasites, according to them many fungi that would fall within this concept have been described as distinct species, often because they happen to occur on different hosts.

However, validity of such a conception can be proved only by further extensive work in the subject.

Summary

1. Wide variation in the symptoms of diseases caused by *Alternraia* has been recorded.
2. General damage to the plants is due to infection on leaves and flowers, but seedling infection has also been recorded.
3. Temperature and moisture play an important role in infection.
4. Fungus has got specialization in its activity.

Acknowledgments

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Presence of Velamen in the Earth Roots of Some Species of the Genus Asparagus Linn.

By

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1. INTRODUCTION

Sometime back while taking sections of *Asparagus racemosus*, Willd. root for class work in Karachi, it was found that the terrestrial roots of these plants show a tissue like velamen of the epiphytic orchid roots. Preliminary observations showed that this tissue may be like velamen tissue of orchid in structure and function. It was decided, therefore, to investigate the species of this genus thoroughly.

The genus has about 120 species spread throughout the tropics and temperate zones, according to Hooker (1894) Out of these species about 19 occur in India. These are distributed from the Himalayas to Ceylon. *Asparagus racemosus*, Willd. ascends in the Himalayas to about 4000 feet and *Asparagus zeylinicus*, (Hook.) ascends also to about 6000 feet at Nawara Elisa in Ceylon. Some species are present in the planes of Deccan and Bengal. They also occur in almost xerophytic conditions like *Asparagus dumosus*, Baker found near Karachi in Sind and *Asparagus officinalis*, L. found in Rajputana desert.

The roots of these species of this genus *Asparagus* are very important medicinally. Roots of *Asparagus filicinus*, Ham. found in tropical Himalayas and cultivated elsewhere are given into the hands of patients as a curative measure against smallpox. They are also considered as vermifuge in Assam. They are also used in cholera. *Asparagus racemosus*, Willd. roots are used in diseases of the blood, eye, in tuberculosis, leprosy, night blindness, and gonorrhe-

oea. For the last named disease *Asparagus officinalis*, L. is also useful. In America *Asparagus* is thought to be sedative and pallative in heart affections attended with excited action of the pulse.

II. HISTORICAL ACCOUNT

The earlier workers to observe velamen and to report about it were Chatin (1856), Duchartee (1856), Oudemans (1864), Leitgeb (1864), Baker (1875), Nabokich (1899), and Leavitt (1900). All of them belong to the later half of the 19th century. The only account that is classical and exhaustive is by Leitgeb (1864). Harberlandt (1914) has used mainly Leitgeb's account in his "Physiological Plant Anatomy."

In the 19th century no account of the presence of velamen in the terrestrial roots was available. In the 20th century some observations have been made on the presence of velamen in the terrestrial roots, but such accounts are few. The earliest worker was Holm (1904), who reported the root structure of North American Orchidaceae and described the presence of velamen in them. Curtis (1917) studied the root structure of six epiphytic species of New Zealand Orchids and reported the presence of velamen. The occurrence of velamen in epiphytic roots was thus known to many workers, but Goebel (1922) was the first scientist to publish a note on the presence of velamen in earth roots. The recent researches of Moss (1923) have confirmed and emphasised the fact that both in Orchidaceae and elsewhere the velamen may be present in earth roots. Engard (1944) has published a note on the morphological identity of velamen and exodermis in Orchids.

There is a fragmentary account of the velamen found in terrestrial roots of *Asparagus sprengeri* (Reg.) by Arber (1925). She mentions that there is a tissue similar to that of velamen found in Orchid roots. In recent years Narayan Swami (1950) has reported the presence of velamen in the roots of a terristrial Orchid *Spiranthes australis*. Laxmi narayan and Venkateshwarlu (1950) have described velamen to be present in terrestrial species of *Eulophia* Rbr.

Some other plants like

(1) *Semele Androgyna* Kunth.
(2) *Crinum Powelli* Hort.
(3) *Aspidistra elatior* Blume.
(4) *Crinum species.*
(5) *Blettia species.*
(6) *Spiranthes cernua.*
(7) *Eulophia species.*

also show velamen in their subterranean roots.

III. Materials and Methods.

(i) Materials.

Nine different species of *Asparagus* were collected out of which four were identified and the rest of the species remained unidentified, due to the want of proper material.

The identified species were

(1) *Asparagus officinalis*, L.
(2) *Asparagus laevissimus*, Steud.
(3) *Asparagus racemosus*, Willd.
(4) *Asparagus splengeri.*

(ii) Methods.

Root tips were sectioned longitudinally and transversely. The transverse and longitudinal sections of mature material were also taken and permanent slides were prepared in the usual way. Many single stains as well as stains in combinations were tried. The staining combinations tried were.

(1) Saffranin and Fast green.
(2) Saffranin and Crystal violet.
(3) Saffranin and Delafields haematoxyline.

Out of these combinations, first two gave quite good results.

The maceration method was also used and found suitable. The ordinary maceration method for hard tissues and the method recommended by Foster (1949) for soft parenchymatous tissues was also tried.

A new method of maceration gave quite satisfactory results. The liquid used for this method consisted of 50%

of glycerine and 50% of lactic acid mixed in equal quantities just before use. The material was kept in this liquid in tubes in an incubator at a temperature of 40°C for twenty four hours and then teased. Also instead of using the small pieces of materials transverse and longitudinal sections of materials were used for maceration.

Another method for maceration was also tried. Sections were kept in tubes in Lactophenol at a temperature of 40°C in an incubator for 48 hours. This proved useful in revealing quite satisfactorily the pit pairs in the cortical cells of the parenchyma.

IV. OBSERVATIONS.

All observations were made on the material fixed in 70% alcohol. Care was taken to choose the material approximately ot the same diameter and probably therefore of the same age. Observations were made on the above mentioned species and their transverse sections and longitudinal sections were studied.

All of these species show valamen. This tissue velamen shows in broad outline some common characters in all the species. However the velamen also differs in some minor characters. Not only on velamen but observations were made on cortical tissues lying below the velamen and also the central cylinder, since it seemed that they influence the structure of the velamen.

The observations are tabulated separately for each species and at the end of the observations the common features and the differences in the nature of the velamen are summarised, in the discussion chapter.

A common feature of most of these species of *Asparagus* is the presence of pits in the cells of the cortex. There is also a jacket of, from moderately thick walled to much thickened cell walls surrounding the endodermis. In this jacket there are gaps at certain places. The cells of the pith are also often pitted.

The cells of the velamen show all the characters that have been observed so far in a typical velamen. They also show many other interesting characters and these are described and discussed in the next chapter.

VI. DISCUSSION

To come at proper understanding of the structure and functions of the velamen in *Asparagus* roots, it is necessary that the different types of cells in these roots are studied A table summarising the characters found in these roots is therefore reproduced here.

Name of species	*Asparagus officinalis*	*Asparagus laevissimus.*	*Asparagus racemosus.*	*Asparagus splengesri.*
pith.	Thick walled cells.	Thick & thin walled cells.	Cells thin walled.	Thick & thin walled.
Endod. ermis.	Not well defined. Passage cells present.	Well defined. Passage cells present.	Not well defined.	Well defined. Passage cells Present.
Jacket.	Two or three layers surrounding the endodermis.	Two layers. Thick walled pitted with gaps.	No jacket.	No jacket.
Cortex	Cells moderately thick walled. Pit pairs present.	Moderately thick walled Pit pairs. present.	Moderately thin & round with pit pairs.	Comparatively thin walled with pit pairs.

VELAMEN No. of larers.	Eight layers.	Five layers.	Five layers.	Eight layers.
Thick or thin walled.	Two or three outermost layers thin walled & then they become progressively thicker & after reaching maxm. thickness they again become thin walled.	Comparatively thin walled. Follow the same pattern of thickness as in *A. officinalis.*	Thick walled, fibrous. Follow the same pattern of thickness as in *A. officinalis.*	Comparatively thin walled. Follow the same pattern of thickness as in *A. officinalis.*
Longitudinal thickenings.	Annular thickenings on longitudinal walls.	——	Annular thickenings.	Annular thickenings.
Internal thickenings	——	Peg like thickenings. Walls folded.	——	Not with many folds.
Nature of transverse walls.	Walls thin.	Openings on transverse walls.	Walls thin.	Walls thin.
Remarks.	It is possible that openings are present on transverse walls.	Openings on transverse walls.	——	Pits were not observed.

It has been observed that the pith cells in the various species of *Asparagus* may be thick walled or thin walled or a mixture of the two. These cells of the pith which are slightly thick walled, or uniformly thick walled, always show pits, and these pits are often of the bordered type. These cells are somewhat elongated longitudinally or along the longitudinal axis of the root.

Another feature of a great interest is the jacket of pitted cells which in most cases surrounds the endodermis. Whether these cells should be called sclereids, fibres, fibre-tracheids or tracheids is a matter of opinion. If we summarise the known facts about these structures we find.

(1) Walls of sclereids are very thick, strongly lignified and occasionally suberised or cutinised. These cells may have the shriveled remains of protoplasm The pits on the walls have round apertures. They may be numerous but often few in numbers.

(2) Fibres are excessively thick walled cells and pits occur on them only as vestigeal structures. The lumen is narrow and this may be blocked in spots, so that there is little or no conduction of water.

(3) A fibre tracheid is established when the lumen of the fibre becomes wider; the walls become less thick and there is an increase in the number of pits.

(4) Tracheid is an elongated cell having tapering end walls, and without protoplast when mature. The walls are not very thick and they are usually lignified. The lumen of the tracheid is large and it has no contents of any kind. These tracheids have numerous pits.

According to Eames & Mc Danials (1947) and Foster (1949) pitted tracheids can be distinguished from non-conducting elements by the fact that the pitted tracheids have bordered pits. According to Haberlandt (1914) tracheids may have simple or bordered pits and no sharp distinction can be drawn between vessels and tracheids in respect of either length or diameter.

This discussion is necessary because it is to be decided as to what status should be given to the cells of the jacket

which surrounds the endodermis. In this jacket of cells there occur elements no doubt like tracheids, and like fibre tracheids, and in extreme cases like fibres. If we study the jacket where there are more than five or six layers in the jackect, the above mentioned fact is more clear. The jacket layers abutting on the cortex are no doubt comparatively thin walled. Their cell lumina is quite broad, the cells quite elongated in the direction of the root, and they have numerous big oval simple pits. As we go inwards from this jacket layer to the next layers of the jacket, the thickness of the cell walls increases progressively. The lumen becomes less and less wide and pits also decrease in number. In such conditions it is difficult to call these elements tracheids. As we pass to the next layers the lumen of the cell becomes comparatively wider; there is a decrease in the thickness of the walls and increase in the number of pits. All these elements have no protoplasmic contents. Their function no doubt appears to be water conduction and it seems fit to call these layers as a jacket of tracheids.

In connection with the development of these tracheid like cells outside the vascular cylinder it must be noted that in the absorbing roots of *Monstera deliciosa*.Liebm, which grow vertically downwards and finally enter the soil, the stele is supplemented by numerous wide vessels and sieve tubes scattered throughout the pith. Many plants that grow in dry, sunny situations are provided with tracheids which have no connection with the vascular system; which means that the structure of the vascular strand is generally correlated with its functions.

Haberlandt (1914) describes conducting parenchyma which comprises of a variety of parenchymatous tissues which all perform essentially similar functions. This tissue is found in parenchymatous bundle sheaths and forms the bulk of the cortical parenchyma of petiole and stem. It is always composed of thin walled more or less elongated cells which contain living protoplasts, and their transverse walls are usually furnished with simple pits for greater ease of diffusion. Eames and Mc Daniels (1947) mention a "Pitted Parenchyma" which they describe to occur in wood parenchyma and wood rays, with conspicuously thickened lignified walls showing pits. They also observe

that for the formation of the pits the deposition of the secondary wall is necessary.

The parenchyma which is found in the cortex of *Asparagus* is sometimes thick walled, sometimes moderately thick walled and sometimes thin walled. Whenever parenchyma is thick walled it shows simple big pits on the transverse walls as well as on the longitudinal walls. When the parenchyama is moderately thick walled there are also pits but not so numerous as in the first case, and in parenchyma with thin walls the pits may be absent.

Pitting of cells is a method which is fully utilised by these plants for the transfer of water. Sometimes even the pericycle cells become pitted.

The outermost cortical layer, the exodermis occurs beneath the velamen and it is a sheath of cells with a wall strongly thickened by cutin or cork. This exodermis has two different sorts of cells. Those of the first type are more or less elongated. Their outer walls are thickened, but never pitted. Among these cells at intervals occur thin walled cells with adundant protoplasmic contents, usually in vertical series. These are called "Transfusion cells" or "Passage cells" and they are supposed to serve as passage ways for the water from velamen to the cortex. Sometimes the elements of the velamen which over lie the passage cells of the exodermis are distinguished by the presence of a very remarkable disc shaped, spherical local thickenings on their walls called "Fibrous bodies". This "Fibrous body" is a highly porous structure which absorbs and retains any water that reaches it, and from where it is transformed subsequently to the underlying passage cells. Haberlandt (1914) considers that these minute bodies are efficient condensing organs. Some Botanists however deny the condensing capacity of this body and consider the "Fibrous body" to be a protective plug, serving to retard evaporation from the thin passage cells.

The external cell layer of young roots, in a purely tropographical sense certainly represents an epidermis which consists of uninterrupted cells devoid of cuticle and stomata. In majority of cases this outermost layer is uniseriate; however, it may die off in older portions of the root or may be sloughed off as a result of the secondary growth.

Epiphytes show diverse adaptations for absorbing and storing water, and many tropical orchids and, aroids, possess epiphytic roots having specialised absorbtive organs. This absorbtive tissue has long been known by names of "Root sheath" or "Wurzel Hulle" or "Velamen radicum" or "Veil" or simply as "Velamen". Velamen is product of the protoderm, which, close behind the root tip, becomes many layered by tangential division. It is not that velamen is always many layered. It may be one layered as in *Vanilla planifelia, Vanilla aphylla, Dendrocolla terra,* and others. Velamen may have layers upto 18 as in *Cypripedium species.* However velamen layers are usually constant in number within a single species. The shape varies to a considerable extent. Sometimes they are isodiametric but sometimes they are elongated radially as seen in transverse sections. In other cases their long axes are parallel to the long axis of the root itself. Cell walls of the velamen are strengthened in a great variety of ways but most often by spiral thickening fibrers. These may be parallel to one another or they may enclose meshes of varying diameter or they may form broad bands, reticulate thickenings are less common than that of spiral type; however, they occur in *Dendrocolla terra* and *Vanda furva.* In a few cases there are no thickenings at all and cell walls are thin throughout. All these may occur together, while types of thickenings on different sides of the cell may differ as in *Ranenthera sp.* and *Matutina sp.* Between the thickening fibres the cell walls are often perforated by holes. These holes are not only confined to the adjoining cells but occur also in the outer walls of the superficial layer. At maturity the velamen cells are dead, and the velamen layer appears to be silvery white.

The presence of perforations in this velamen is supported by the fact, that minute algae are found inside the velamen cells. These algae belong to genera *Protococcus,* and *Raphidium.* Algae belonging to the genus *Pleurosaccus* is present in the velamen of the *Aspargus.*

It is a surprising fact that the velamen found in the *Aspargus* subterranean roots is like the velamen found in the roots of epiphytic orchids. However there are certain differences which are merely structural than functional.

The velamen of the *Asparagus* roots has a limiting layer which is always composed of thin walled parenchymatous cells without any cutinisation at least in young roots. The layers of cells next to this layer are progressively thick walled, and when the extreme limit of the thickness of the walls is reached, they again become thin walled progressively towards the cortex, and the innermost tangential walls of the last layer of velamen cells are almost unthickened. The first part of this mode of thickening namely the increasing of thickness in successive layers is spread comparatively in more layers, than the second part namely that of the progressive thinness which is spread comparatively only in a few layers. In general velamen may give the appearance of being extremely thick walled or thin walled.

The second layer of velamen which comesi mmediately below the limiting layer may have cells elongated in the directions of the root or they may be like the limiting layer almost square. The cells of the layer coming next to this are invariably elongated in the direction of the root and the length of these elongated cells varies in different species. So far no internal thickenings have been noted in the cells of the velamen. In the species of *Asparagus* these internal thickenings are present. These thickenings are of the following nature.

(1) Foldings of the longitudinal walls which favours retention of water in its folds.

(2) Development of the thickened annular fibres on the longitudinal walls.

(3) Development of the fibres in the cavities of the cells.

(4) Development of the infernal fine hairs in the cell cavities.

(5) Serrations on the longitudinal walls of the velamen.

(6) Peg like outgrowths of the longitudinal walls of the cells.

(7) Hook like or spine like stiff internal projections in the cavities of the cells.

(8) Development of plenty of fibres and hairs near the thin transverse walls.

According to Duchartee (1856), Schimper (1888) and Goebel (1822) the velamen is regarded as an absorbing tissue. Water is taken up with rapidity when the velamen is dry. This process is regarded as a capillary phenomenon comparable to absorption of water by blotting paper. According to Unger (1854), Chatin (1856) and Leitgeb (1864) the spongy tissue of the velamen enables it to condense water vapour and other gaseous constituents and make them available for the benefit of shoot. It is said that the histological structure of velamen supports the condensation theory. The delicate fibres of cell walls are in considerable number, and they are regarded as an adaptation for condedsing water vapour. There is also another view that they may be considered as useful adaptations for retaining water after it has been once absorbed by the velamen. The structural features of the epiphytic velamen and the land velamen are almost the same. If these features are meant for condensing water vapour there is no reason why these should be developed in land velamen. This fact goes against the condensation theory. Moreover the experiments which have been carried out as regards condensation of water vapour by various investigators in green houses and in laboratories have yielded negative results.

The known functions of the velamen are

(1) Velamen takes only a small part in anchorage.

(2) It acts as a protection against transpiration.

(3) In plants showing velamen the roots are the chief food making organs.

(4) Velamen serves for the absorption of dew and rain.

(5) Velamen is an organ of water vapour condensation.

(6) It can retain water for a long time.

The land velamen takes up water with rapidity when dry, the process being the same as that of the epiphytic plants. The transfer of water to the inner layers of velamen is no doubt facilitated by the systems of openings on the longitudinal and transverse walls. The rain water in such localities where some of these plants exist must be going down to the deeper layers of soil, pretty quickly, and the velamen must make the best use of a few opportunities of

absorbing and storing as much water as available to it, in a small duration of time. Thus the water is absorbed and stored in velamen or passes or to the cortex.

The exodermis is rightly considered as a second and outer endodermis encircling the cortex. This barrier is necessary as check against outgo of water from the cortex. In the land velamen there is no exodermis. How can we explain the absence of a well defined exodermis in these plants ? If we look to the structure of the velamen we will see that there is no need of a well defined exodermis. The following devices are used to check the outgo of water from the cortex.

(1) The walls of the internal layer of the velamen are considerably thick.

(2) The first few layers of thick walled cells of the velamen are elongated in a longitudinal direction.

(3) Whenever the openings are present on the walls they always open to the inner layers, and round about these openings there are developed plenty of fine fibres and delicate hairs.

(4) Where the transverse walls of the velamen cells are comparatively thin, these collapse more or less when there is no water in the cell. There are also fibres developed near these transverse walls which prevent the outgo of water.

There is also a possibility that sometimes water absorbed by the velamen may be forced upwards by the force of absorbed water through the openings in the transverse walls of the velamen, from where again it can pass on to the cortex by the system of the openings present at this level.

The cortical cell layers near the innermost cell layers of the velamen are comparatively elongated and they are full of protoplasm and must be exerting considerable osmotic pressure on the innermost layer of the velamen cells, the inner tangential walls of which are thin. Thus the water is passed to cortical cells. From the outer cortical cells the water passes to the inner cortical cells by osmosis and through pit pairs present on the lateral and

transverse walls of these cells. The pit pairs in the cortical cells must be very useful for this process. Thus the water is brought near the jacket surrounding the endodermis. This jacket consists of tracheids and fibre tracheids again facilitating the transfer of water from jacket of the passage cells of the endodermis from where it is passed on to central cylinder. In the central cylinder also there is an ample development of bordered pitted tracheids from where no doubt water passes to the shoot.

Goebel (1922) and Moss (1923) have emphasised in recent researches that both in Orchidaceae and elsewhere velamen may be abundantly present in earth-roots. The view, that the velamen is a special adapta tion of epiphytic life, therefore, demands considerable revision.

The land velamen found in the *Asparagus* roots has the same structural devices for absorbing and storing water as in the velamen of the epiphytic roots; it is interesting to note that this land velamen also functions like the velamen of the epiphytic roots.

ACKNOWLEDGMENT

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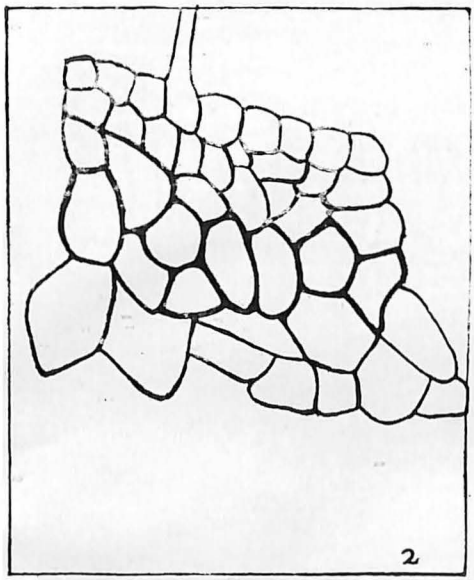
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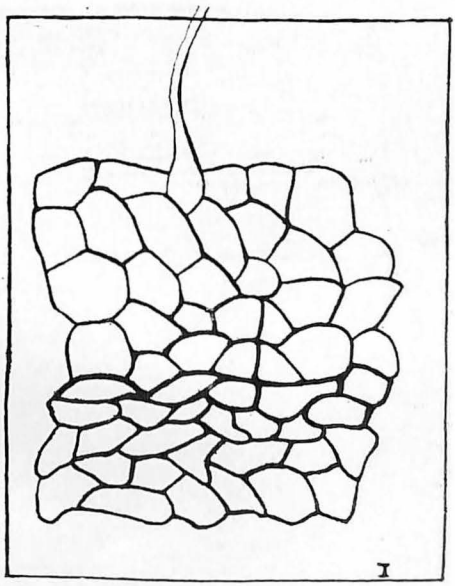
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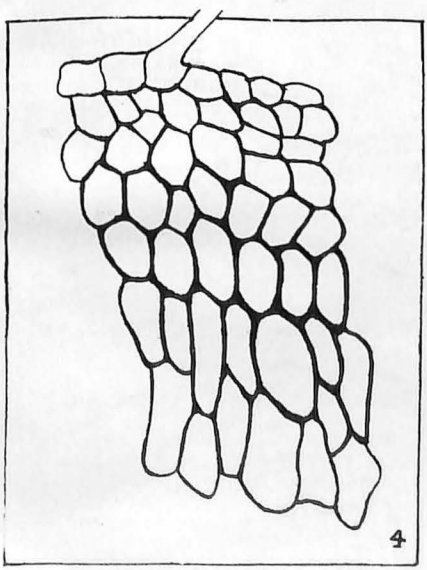
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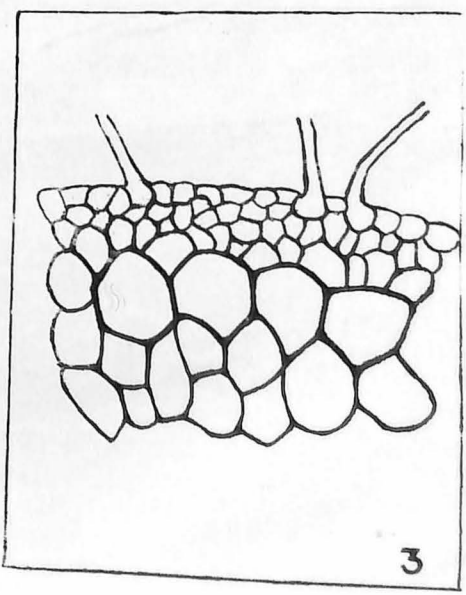
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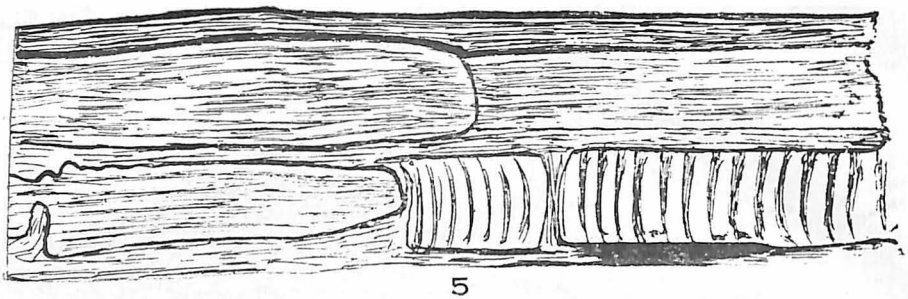

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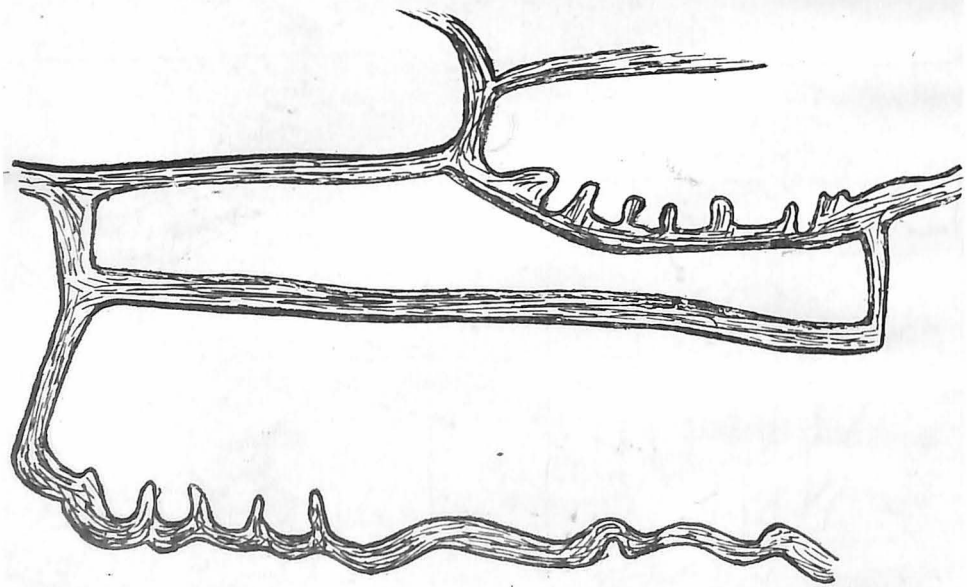

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EXPLANATION OF FIGURES

Figure 1. Velamen of *Asparagus officinalis* in transverse section. X 176.

Figure 2. Velamen of *Asparagus laevissimus* Stend, in transverse section. X 176.

Figure 3. Velamen of *Asparagus racemosus,* Willd. in transverse section. X 176.

Figure 4. Velamen of *Asparagus splengeri* in transverse section. X 176.

Figure 5. Longitudinal section through velamen of *Asparagus officinalis* showing annular thickenings. X 756.

Figure 6. Longitudinal section through the velamen of *Asparagus laevissimus* showing peg like in growths. X 790

Preliminary studies on the Pharmaceutical value of Solanum nigrum Linn. & S. xanthocarpum Sachrad & Wendl.

By

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Both *Solanum nigrum* and *S. xanthocarpum* are the members of the family *Solanaceae* to which belongs a vast group of temperate and tropical herbs, shrubs, of various horticultural adaptabilities, comprising ornamentals, vegetables like tomato, potato, egg plant, red pepper etc. and various medicinal plants.

Various parts of both the plants, are used as ingredients of native medicine.

Solanum nigrum Linn

Hindi-*Makoi*-Sanskrit-*Kakmachi*

Distribution.-The plant is herbaceous, flowering usually in cold season in the plains. It is found as a common weed throughout India. Afganistan, Baluchistan and Ceylon.

Morphology & Anatomy.-It is an erect nearly glabrous annual herb or suffrutescent in warm climates with much branched and somewhat angular stem.

Root:-Tap root: Since little or no food material is stored in the root system, there are no prominently thickened portions except for the enlarged primary root. From this arise many smaller secondary roots, which in turn are branched and rebranched. The T.S. of root shows prominent secondary growth (Fig. 1). The epiblema is ruptured due to the formation of cork. Endodermis and pericycle are not distinct. Vascular bundles are exarch. After the formation of secondary tissues due to the activity of cambiun, primary phloem is

in a disorganised state. Primary xylem bundles come to lie in centre and are not well marked. Medullary rays are one cell thick.

Stem:-The stem is much branched, somewhat angular and solid. Transverse section of the stem shows (Fig. 2) the presence of stomata in epidermal region. The epidermis consists of a single layer of cells having a thin cuticle. Above and below it lies one or two layers of cells, bearing chloroplast i.e. chlorenchyma. Cortex is collenchymatous in the outer part and parenchymatous internally. There is a conspicuous endodermis surrounding the vascular bundles which are arranged in a ring and are bicollateral. It shows prominent secondary thickening. Xylem is a continuous cylinder traversed by narrow medullary rays. Vessels are with simple perforations. Secondary phloem is devoid of fibers. Strands of intra-xylary phloem are present at the periphery of pith. The cells of the pith are unlignified. Sand crystals are found in cortex and pith.

Leaf:-Leaves are simple, petiolate, ovate or oblong, having entire or lobed margin. They are 1-3½ inches long. Petiole is about ¾" long.

Internal structure (Fig. 3) shows the presence of stomata on lower surface. Palisade parenchyma is found below the upper epidermis only and the rest of the mesophyll tissue consists of spongy parenchyma traversed by veins.

Flowers:-Flowers are small and white produced on drooping sub-umbellate or rather stout axillary peduncles. Flowers are without bracts. The sepals are five, united, green, small, glabrous and is about 1/8" long. Corolla is white sometimes purple, rotate and of about ½" in diameter, stamens are five inserted on corolla. Filaments short and hairy at base. Anthers are oblong bicelled, yellow, opening by means of pores. Ovary is superior, bi-celled and globose. Style is hairy towards base. Ovules are many.

Fruit:-Fruit is a Berry, of about 1/4" diameter, supported by a saucer-shaped calyx. They are smooth, shinning and green but red when mature.

Medicinal value. All parts of plant are used in medicine in various forms, such as decoction and electuary. The

drug extracted from all parts of plants, the leaves, stem, and fruits is used in doses of 1-2 drachms or 5 to 10 tolas, for medicinal purposes in enlargement of liver, kidney diseases, dropsical swelling, enlarged spleen etc.

It is also used for the treatment of rheumatism and gonorrhoea and in small doses in chronic skin diseases.

Application :-The juice is extracted and after extraction it is warmed in an earthen vessel until the green colour disappears and it becomes reddish brown. It is strained when cooled and administered in the morning. Freshly prepared extract should be used, as it will not keep long and soon becomes mildewed.

The species is extremely variable and much difference of opinion exists in regard to the poisonous qualities of the berries. As a result of eating the fruits of *Solanum nigrum* three children are reported to have met their death in the Punjab. Eating of fruits first causes vomiting, nausea, griping pain, thirst, unconciousness and finally collapse and death. Hence they should be used carefully. The fruits have diuretic and alterative properties and are useful in heart diseases. Local practitioners consider fruits to be useful in fever, diarrhoea and ulcers. They are used externally and internally in disorders of the eye sight and in hydrophobia.

The paste of this plant is locally applied in oedema. It is also taken as vegetable in some diseases. The leaves and tender shoots are boiled like spinach and eaten in many parts of India.

Different views have been expressed by different authorities regarding the medicinal value of this plant.

According to Dr. Mukand Lal of Agra the whole plant is used as an article of diet for dropsical patients and for those suffering from chronic inflamation of the liver. Surgeon H. W. Hill mentions that the decoction of roots mixed with little *"gur"* is administered to produce sleep. According to Dr. Ashworth the extract of leaves, fruits and tender portions of stem was shown to be a very useful and effective laxative. It was also known to be diuretic especially in dropsy connected with heart diseases. According to Dr.

Bhagwandass of Rawalpindi-the above extract was also found to be useful in hepatic dropsy.

Chemical composition:-An alkaloidal glucoside was first obtained from *Solanum nigrum* in 1820 by Defosses of Biscancon. The substance has been named "Solanine". This compound is intermediate in nature between alkaloids and glucosides. Solanine is a poisonous alkaloidal glucoside with a saponin like action which is also found in other members of solanaceae.

The alkaloid crystallises with water in slender needles. It is readily solube in hot alcohol but almost insoluble in ether or chloroform. It has a bitter taste and is hardly alkaline to litmus.

Solanine is toxic and occasional cases of poisoning by fruits of *Solanum nigrum* are usually attributed to its presence.

Identification:-When sections of the plant parts are mounted in a solution of 1 part of ammonium vanadate in 1000 parts of a mixture of 49 parts of sulphuric acid with 18 parts of water, the cells containing solanine take on a yellow colour which changes successively to orange, various shades of red, blue, violet, greyish-blue and then disappears.

The methods for its detection has been recently studied by Rooke, Bushill, Jackson etc. and recommend that devised by Pfankuch. According to which estimation of solanine depends on measurement of the purple colour formed by these alkaloids with sulphuric acid and formaldehyde.

Investigations were carried out in laboratory for the arbitrary estimation of the active principle "Solanine" in various parts of plants, the leaves, stem, root and fruits. Results were as follows :—

Leaves :-Sections turn purple as soon as sulphuric acid and formaldehyde was introduced and the colour disappears afier a few seconds.

Stem :-In this case purple colour disappears after some time.

Root :-When the sections were treated with sulphuric acid and formaldehyde the purple colour appear in them after a considerable time and persists for a much longer period.

Fruits :-Sections show the purple colour after some time which persists for a considerable period.

The above results show that the amount of solanine is greater in fruits and roots being the storage organs while stem and leaves have little amount of solanine.

SOLANUM-XANTHOCARPUM, SACHRAD AND WENDL.

Hindi- *Kateli.* Sanskrit- *Kant-Kari.*

S. xanthocarpum is distributed throughout India from the Punjab and Assam to Ceylon. It is growing abundantly along the road-sides and on waste ground.

Morphology and anatomy :-The plant is very prickly bright green perennial herb. Young parts are stellate and tomentose. Its root resembles that of *S. nigrum* (Fig. 4) anatomically and morphologically.

Stem :-The stem is flexuose, woody at base and much branched. It is armed with compressed or somewhat curved yellow shinning prickles which are about ½" long. Transverse section *(Fig. 5)* shows small openings (Stomata) in the epidermal region. The epidermis is single layered with a thick cuticle. Cortex consists of chlorenchymatous and parenchymatous cells. Chlorenchyma is two to three layered. There is a distinct endodermis and pericycle enveloping the vascular cylinder. Pericycle consists of strands of sclerenchyma and parencyhma. Vascular bundles are bicollateral and endarch. Cambium is 3 to 4 layered. When the secondary growth takes place xylem forms a continous cylinder, interrupted at intervals by narrow medullary rays one to two celled thick. Intraxylary phloem is found below the protoxylem groups. Pith is parenchymatous.

Leaf :-Leaves are exstipulate, alternate, often in unequal pairs and 3-5" long. They are subpinnatifid, and unequal sided at the base. Leaves are clothed especially beneath with stellate hairs. The midrib and main lateral nerves are armed with long straight yellow spines. They are isobilateral. Stomata occur on both the surfaces of the leaf. The palisade tissue is well developed under the upper and lower epidermis (Fig. 6) Spines are composed of elongated lignified cells.

Petiole is about 1" long. In T. S. it shows median arc shaped bicollateral vascular strands usually accompanied

by small 1-4 bundles on either side of the groved adaxial surface. Crystals of sand are found in the cells of the mesophyll tissue.

Flowers :-Flowers are few and in extra-axillary cymes or solitary. Pedicels are usually curved and stellately hairy. Flowers are ebracteate and bisexual, of bluish-purple colour. Calyx is small persistant and 1/5"-1/2" long. It is densely hairy and prickly. Corolla is rotate, of bluish purple colour and of 1" to 1½" diameter. Lobes are hairy outside. Stamens are inserted on corolla, filaments are glabrous and short. Anthers are large, yellow forming a cone, dehiscing by means of apical pore. Ovary is ovoid, superior and bicelled.

Fruits :-Fruit is a berry 1/2"- 3/4" in diameter. It is yellow or white streaked with green. Seeds are many and glabrous.

Medicinal Importance:-The decoction of roots and fruits are given in medicine and is usually prescribed in combination with the decoction of the roots of *Tinospora cordifolia* as a tonic in fever and cough. The roots and fruits of this plant may be used in form of powders for medicinal purposes. *Vaids* use the root of this species as one of the important medicinal ingredients, in the treatment of asthma, cough and pain in the chest. Seeds are very hot and useful in Diarrhoea and cause abortion. Fumigations with the vapour of the burning seeds also cures toothache. Due to the carminative and bitter qualities of the fruits, flowers and stems, they are useful as a remedy for burns. In some places the seeds are eaten.

According to Brander the decoction of *Kant Kari* is much used as a diuretic in both active and passive dropsies Further it is advantageous to administer it with alcohol and other mineral diuretics and during its use milk-diet should be prescribed.

Forsyth describes it as a strong diuretic in cases of dropsy and useful in chronic diarrhoea. Mukherjee mentions that the decoction of the plant is a febrifuge. Major Thomson describes that "the pods freed from seeds and boiled with salt and butter milk, dried in sun and soaked again in butter milk over night, the process being repeated

for 4 or 5 days and then fried in ghee and eaten"-possesses stomachic and antibilious properties.

According to Robb, the seeds are rubbed with water and applied over local inflammations and swellings.

Chemical Analysis:-The various parts of *Solanum xanthocarpum* were tested for the alkaloidal glucoside 'solanine' and positive tests were obtained for it in the various parts of the plant.

The juice from the various parts was extracted which is bitter and in all the parts the extracted juice was found to be alkaline except in roots where it had given an acidic reaction with litmus paper.

The formaldehyde-sulphuric acid test employed to detect the presence of solanine in root, stem, leaf and fruit, showed that the substance was present in larger quantities in root and fruit, the storage organs, while in the leaf and stem, solanine was present in comparatively low amounts.

Discussion:-Work on the pharmaceutical value of Indian medicinal plants has received little attention in our country. There are a number of indigenous drug plants which are widely used by the *Vaids* (physicians) in different parts of the country. The nature of chemical ingredients in the various plants or parts of plants is not fully known in many cases. Further most of the active principles in many of the drug plants are products of metabolism of the green plants. Metabolism is different in different phases of development of individual plant species and the effect of environment plays a prominent role in this connection. It would be interesting to study the constituents of the active principles in various plant parts in different phases of development and in different seasons in the growth of the plant. For this autoecological studies may prove very useful.

I am very grateful to Prof. Shanti Sarup for his valuable suggestions and help.

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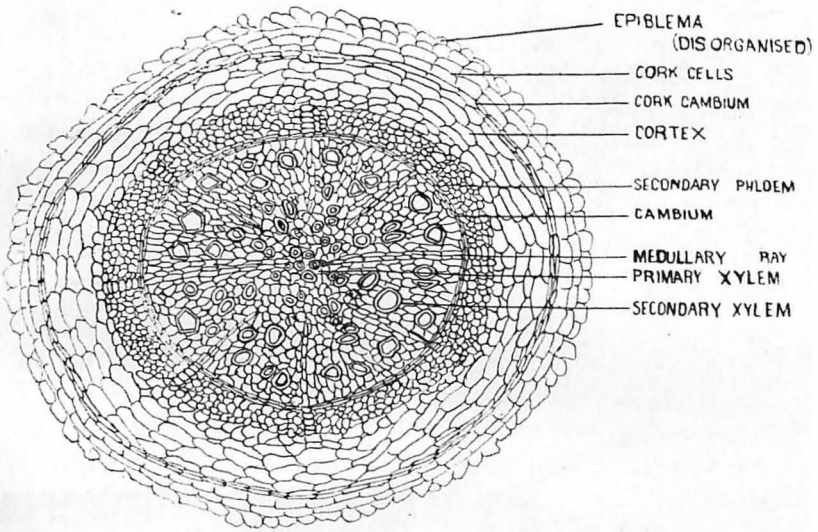
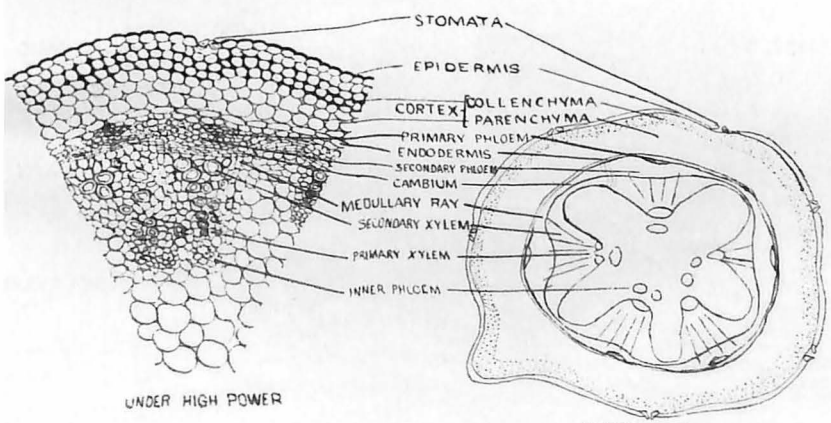
SOLANUM NIGRUM



T. S. ROOT.

Fig: 1

SOLANUM NIGRUM



T.S. STEM.

Fig: 2.

SOLANUM NIGRUM.

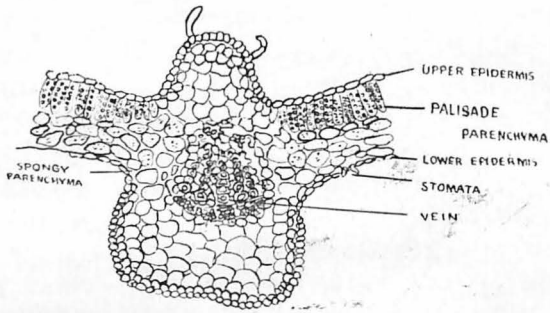
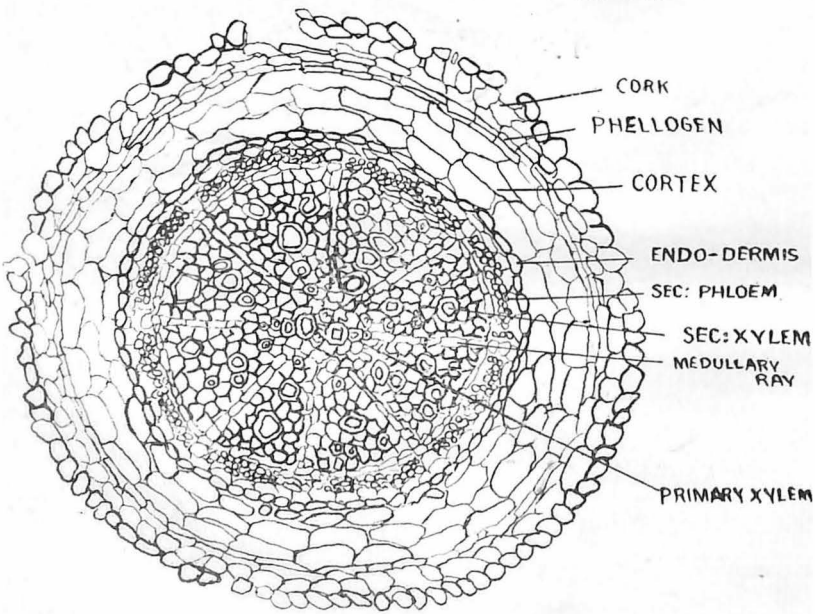


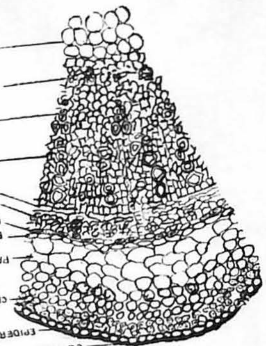
Fig-3.
T.S. LEAF.

SOLANUM XANTHOCARPUM



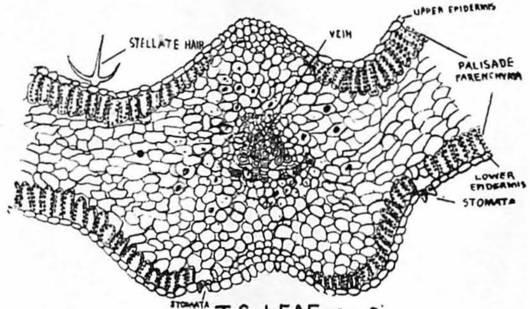
T. S. ROOT. Fig-4

T.S. STEM
Fig-5

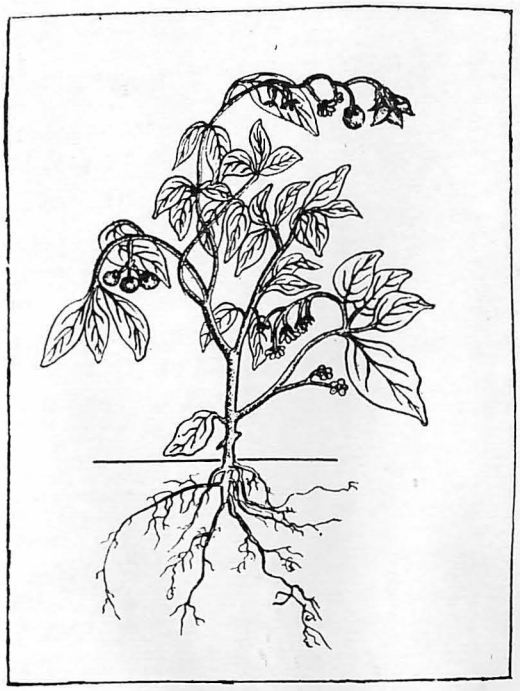


SOLANUM XANTHOCARPUM

SOLANUM XANTOCARPUM



T.S. LEAF. Fig-6



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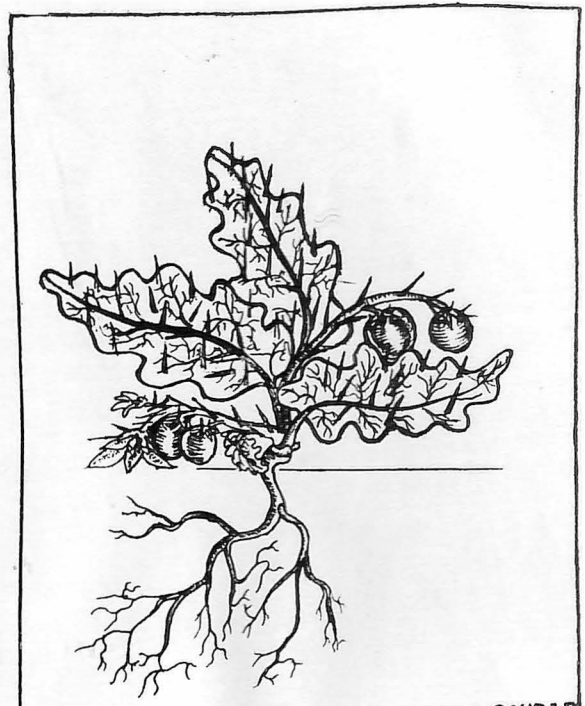

SOLANUM XANTHOCARPUM-SCHRAD

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Actinomycosis

By

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This term is used to indicate infections usually of a chronic nature caused by a number of allied species of fungi called Actinomyces. The latter is now-a-days also the generic name and bears the synonym Streptrothrix.

The disease while being more common in domestic animals like horses, cattles, pigs, etc. (where it causes lesions like woody tounge and lumpy jaw) is by no means uncommon in man where it produces chronic granulomatous lesions, like those found in tuberculosis and leprosy, but which are more suppurative in character. A short classification of the various fungi will not be out of place:—

A. Pseudomycetes

(a) Schizomycetes.....Bacteria

1. Actinomyces
2. Nocardia

(b) Myxomycetes.....Slime molds

B. Euymycetes

(a) Phycomycetes.....water molds

1. Rhizopus
2. Mucor

(b) Ascomycetes.....sac fungi

1. True yeasts
2. Highly organised forms producind ascospores i. e., spores produced in a sac, the ascus.
3. Basidiomycetes .....Club fungi, Mushrooms
4. Fungi imperfecti.....fungi lacking complete life-cycle i. e., sexual spores

Fungi known to be pathogenic for man and animals are found in only two of the groups namely, Schizomycetes,

and the fungi imperfecti. In the former group, Actinomyces is by far the most common and is mainly of four varieties:—

A. Actinomyces bovis
B. " graminis
C. " muris
and D. " asteroides.

A. Actinomyces bovis. It was first described by Bollinger in 1877, as the organism producing large hard sarcomatous like masses in cattle and in the following year, Wolf and Israel, found the same organism in human cases. The Typical lesion is a nodule which is hard, cuts with a grating sensation and consists of several colonies of parasite which under the microscope consist of a dense felted mass of filaments in the centre (Gram positive) with radiating clubs at the periphery (Gram negative). The mycelial threads rarely exceed 1μ in diameter, usually ·5 to ·8.μ The clubs are 10-20μ long and 8-10μ wide. The clubs are believed to be accretions from the tissues. Another theory is that the club formation is the result of a swelling of the sheath of the filaments at the extrimity as a protective reaction on the part of the organism against the tissues of the host, a sort of defensive mechanism. The colonies of the parasite exist in the form of yellow sulphur granules which measure at the most ·75μ in diameter. It is non-motile and does not form spores and is not acid fast.

According to the oxygen requirements the fungus may be divided into two varieties viz., the aerobic and the anaerobic. The aerobic type also called the Bostroem type, is found as a saprophyte in the soil or elsewhere or as parasites on the plants, grains and gram etc. The anaerobic type, also called the Wolf and Israel type, is a strict parasite. The parasite is more microaerophilic than anaerobic.

It grows fairly well on ordinary media. Growth is better in media enriched by blood, or glycerol and in an atmosphere of reduced oxygen tension or containing 10% of carbon dioxide. On agar, the colonies are raised and nodular, cream coloured, opaqe discs showing a rosette or clubbed form and firmly adherent to the medium. In broth, there is no turbidity or pellicle formation. In glucose agar shake, the upper 1cm. of the medium is free from growth, then

where microaerophilic conditions prevail, there is a dense band of colonies and below this, the colonies are few but larger in size. Growth appears at 37°C, in 3-6 days in infusion broth or agar under a ph. of 7·2—7·6. Brain heart infusion medium containing 2% agar is useful for plating. Another medium is the Sabouraud's medium and Chorio allantoic membrain of chick embryo.

It ferments dextrose and other hexoses with the production of acid but no gas. The organisms are killed within one hour at 60-65°C, but may remain alive for several months when dried in vaccuum and stored in the refrigerator.

The mode of infection is not very clear. The fungus probably becomes an inhabitant of the mouth or intestine, for example, by eating infected grain or in some cases the habit of keeping infected wool in the mouth, and then enters the tissues through some break in the suface, for example the root of a carious tooth or an extraction wound. Some forms of actimomyces which under certain circumstances, may become pathogenic, have been found about the teeth, between the gums, in the tartar of teeth and the gastro intestinal tract in some cases.

The disease can affect people at any age but is most popular with the young men in the grain raising areas of the World. Secondary invasion by the pyogenic organisms is very common and the latter by reducing the Oxygen tension further help in the growth of the parasite.

The lesions produced are :—

I. **Alimentary System :**—1. Actinomycotic ulcers, though rare, on the tongue may cause dysphagia.

2. When the tongue gets involved, there may be a mechanical difficulty in swallowing resulting in excessive salivation or ptyalism which is more apparent rather than real.

3. Perforation of the palate may at times be due to actinomycosis.

4. Intestines may be involved either by an infection from within or secondarily. In the former case, nodular foci are formed in the mucous and submucous tissues which break down into ulcers with undermined edges. In the secondary type, the ileo coecal region is the favourite site. There is great thickening by fibrous tissue and fistulous tracts

into the lumen of the intestines may develop. In such cases, if the abdomen is opened a permanent fistula is likely to result. The mass, which is firm and tender has to be differentially diagnosed from chronic appendicitis with mass, Tabes mesenterica, cancer coecum, regional ileitis, distension of the coecum and sarcoma of the intestine. From the region, the infection may spread to the adjacent peritoneum, abdominal wall or the liver. The liver may however, be involved without obvious intestinal infection for example from the lung or the haematogenous route. A liver abscess results (which gives a typical honey comb appearance).

5. Actinomycotic ulcers in the rectum may cause bleeding per rectum and occult blood in the stools.

6. Anorectal abscess may at times be due to actinomycosis and unless, bacteriological investigations are carried out, the diagnosis is likely to be missed. A case of primary anorectal actinomycosis has been reported by Morris Gordon (A.J. of Cl. Pathology). The disease was of 30 years duration and had involved both the buttocks and considerable portion of the thighs and had resulted in limitation of movements due to the formation of dense scars. It was, however, important to note that the disease spread only by contiguity. The case was first treated for piles. And it was suggested that the infection started in the devitalised tissues of the haemorrhoids, resulting in the fistula-in-ano with the subsequent formation of numerous fistulons tracts and draining sinuses. Diagnosis could be made certain only after culture.

Primary actinomycosis of the rectum usually starts as a local perianal or ischio rectal abscess, which ruptures, spontaneously (Cope). The process which is always subacute or chronic tends to spread backwards and laterally, often extending to the gluteal region.

II. **Respiratory System.** Inhalation of the fungus provides another mode of Infection. In some, the symptoms resemble those of chronic bronchial catarrh and the fungus may be recovered from the sputum. In others and more severe cases, nodular foci are formed which suppurate and break down forming cavities. They may coalesce forming bigger cavities and causing symptoms not unlike pulmonary

tuberculosis. And unless the disease is kept in mind, it is likely to go unnoticed and undiagnosed. The abscesses may burrow deep and in various directions and involve the pleura (causing effusion and even empyema) or the chest wall or even the subcutaneous tissues and skin. Ultimately fibrosis may cause bronchiectasis (with its own complications) and deformity of the chest.

When the upper part of the lung gets affected the same by involving the left recurrent laryngeal nerve may cause Unilateral paralysis of the vocal cord resulting in a change in the character of the voice of the patient.

III. **Skeletal System :**—1. Jaw (especially the lower) is a favourite site of the disease, infection obviously entering through some carious tooth or extraction wound. Supprative osteomyelitis is set up and sequestra are formed. Sinuses develop which discharge the typical yellowish sulphur granules with thick pus.

2. The infection may spread to the tonsils and a peritonsillar or a retro pharyngial abcess amy follow.

3. Rarely, the spine may be affected. Spinal caries is the resuli and paraplegia may follow. Symptoms simulate those of tuberculosis or new growth, until discharging sinuses are formed and the ray fungus discovered.

4. Dorsal kyphos is due to the decay of the vertebrae and tenderness of the spine may be due to actinomycosis.

IV. **The Skin** :—Cervico-facial region (Neck and scalp) is the part most often affected. 1. Lesions may occur alone. To begin with they are nodules of chronic nature, which as the time progresses, tend to ulcerate, discharging pus which contains the tell-tale granules, characteristic of the lesion. At a still later stage, the condition may resemble a chronic carbuncle or a suppurating gumma.

2. Similar lesions may appear in association with primary infections of deeper structures, these superficial lesions having the significance of metastatic pyaemic deposits.

V. **Nervous System :**—Direct spread may occur from the jaw to the base of the brain or a cerebral abscess or mening it is may follow a pulmonary lesion. Infection may also

spread from the naso pharynx along the olfactory nerves to the brain causing an isolated lesion near the pituitary.

Diagnosis of Actinomyces bovis :—The chief reason why the disease goes unrecognised is that the possibility of its existence is overlooked. All materials from a suspected case, for example pus, pleural exudate, sputa, material from liver puncture, excised lymph gland etc., should be carefully examined for the presence of the fungus.

The pus may be spread in a sterile petri dish and if necessary, mixed with some sterile salt solution or water. The granules are easily seen and should be examined wherever available. Place the nodule on a slide and put a drop of 10% Sodium or Potassium Hydroxide. In case the granules are calcified, a drop of concentrated acetic acid may be added to dissolve a way the calcareons material. Put another slide over it and crush the granules, leave for 5-10 mts. and then examine, stain the slide by Gram's method and again examine.

The granules, after they have been freed from the pyogenic cocci by putting them in absolute alcohol for 2 mts. may be cultured on two agar plates, one incubated aerobically & the other anerobically. Other media mentioned already may be used.

Nitrogen mustard (Methyl Bisamine Hydrochloride a vesicant, has powerful bacteriscidal properties, in concentenations of 1000 to 1500 mgms. per litre of culture medium (Alan Raftery). It appears to be a valuable aid in the isolation of the fungi and its use has made possible the cultural study of the grossly contaminated material (American Journal of cl. Pathology).

Microscopic picture :—A section stained with H & E shows in the centre several colonies of the streptothrix. The mycelia of each colony take the form of rounded, granular reddish purple masses, while its clubs are arranged peripherally in radiate fashion and appear as hyaline structures. Surrounding these, is a collection of closely packed and frequently degenerated polymorphs. This is again surrounded by granulation tissue (Hence called an infective granuloma), in which the capillaries are congested and are lined by swollen endothelium and surrounded by poliferated

fibroblasts or hyaline stroma. In this stroma, polymorphs, lymphocytes, plasma cells and few giant cells are also present.

This granuloma differs from tuberculosis and syphilis in that the granulation tissue has no specific features and is the sequal of frank suppuration.

Electron microscope and the flourescence microscope have recently been used to study the ultra-structure of the fungi.

B. Actinomyces graminis :—This causes Mycetoma or Madura Foot; which was first described in 1877 by Carter. In India, parts most affected are Madura (South India), Delhi, various places in Punjab, Kashmir and Rajputana. Mycetomas are divided into 2 main groups.

1. Actinomycosis, with granules composed of very fine non-segmented filaments and with illdefined walls.

2. Maduromycosis:—With granules containing large segmented mycelia, with well defined walls. The granules may be black, yellow or red in colour. Yellow granules are produced by *Actinomyces madura* and the black granules by *Madurella mycetomi.* The granule of the latter measures from 1-2 mm. in diameter, is hard and brittle. The surface is irregular and presents pointed eminences. The hyphae are bigger than those of A. bovis and measure 1-1· 5 m in diameter.

The red granules are produced by *Actinomyces Pelletieri* The granules are quite small. The type is met with in certain parts of Africa.

Leisons:—The leison is of the nature of chronic inflammation, usually infecting the foot through some crack in the skin There is hypertrophy of the soft tissues swelling and appearance of nodules which ulcerate leaving sinuses which discharge the granules. The under lying bone may also undergo necrosis. In advanced cases, there may be a network of sinuses and cyst like dilatations which are filled with a viscid fluid packed with the fish roe. granules in the pale variety or of the gunpowder granules in the black variety.

Microscopically :—In the early granulamatous lesions, there are found the actinomyces like colonies in the centre

surrounded by an area of mononuclear and polymorphonuclear leucocytic infilteration. Giant cells are occasionally found. Externally, there are connective tissue cells.

Blood vessels show endothelial proliferation and thrombosis, visceral metastases do not occur as seen in A. bovis.

The hyphae of mycetoma do not show branching and this helps to differentiate from the A bovis.

'C' Actinomyces muris :—This is the cause of one variety of rat bite fever. It is a normal parasite of rats and is present in the nasopharynx.

It is an aerobe, gram negative and very pleomorphic consisting of irregular chains of bacilli interspersed with beaded swellings. Cocco-bacillary and filamentous forms may also be seen.

It requires serum or commercial soluble starch (1 gm. in 1000 ccs.) for growth. High moisture content is necessary for optimum growth on solid media. Therefore the petri dishes should be sealed with paraffin or adhesive tape.

In fluid media, the organism grows in the form of fluffy balls at the bottom and the side of tube, the supernatent fluid remaining clear. Colonies on agar are raised and granular and measure 3--5 mm. in diameter.

Morphological details are better seen in preparations stained with Giemsa than Gram's stain.

Klieneberger observed that all available strains of strepto bacilis moniliformis (which is also the synonym for A. muris), are associated with a pleuro-pneumonia like component designated as L_1 which has a distinct antigenic structure, but which is not pathogenic by itself.

Lesions :—The syndrome following the rat bite occurred as a milk borne epidemic at Haverhill. Hence it is also called the Haverhill fever or Erythema arthriticum epidemicum. After the rat bite, the wound heals quickly but within 2--5 days, there is high fever, severe arthritis and some times painful nodules in the muscles and rash on the skin. There is often secondary anaemia and polymorphonuclear leucocytosis. In fatal cases, ulcerative endocarditis or myocardial abscesses are prominent lesions. The disease responds to penicillin. For diagnosis blood and joint fluid cultures

on special media should be done. Mice innoculation may be carried out.

Agglutination tests are also useful. And a titre of 1 in 80 or above is considered specific, highest level being expected one to 3 months after infection.

D. Actinomyces asteroides :—This was originally isolated from a brain abcess by Epinger. It is pathogenic to rabbits and guinea pigs.

It is an aerobe, Gram positive and weakly acid fast. The mycelial threads are thicker and break up easily into bacillary forms especially in fluid cultures.

Smears stained with the acid fast staining reveal only the bacillary forms resembling Tubercle bacilli. Culture and guinea pig innoculation, however, help in distinguishing the two.

STUDIES ON RAJASTHAN ACRIDIDAE

1. Feeding and Breeding Habits of Poecilocerus *Pictus* Fabr.

By

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[Birla College, Pilani.]

CONTENTS

INTRODUCTION.

This paper is based on some observations of the feeding and breeding habits of *Poecilocerus pictus.* It is always important to study the feeding and breeding habits of insects especially of harmful insects to tackle effectively the problem of their erradication. The desert locust feeds on almost all plants cultivated by man. But there are some grass hoppers which have got a very interesting habit of feeding on some specific plants only. Still there are many plants never eaten by grass hoppers. Afzal Hussain, C. B. Mathur and M. L. Roonwal, (1946) in their paper have dealt in detail with the food and feeding habits of the desert Locusts. *P. pictus* on

which the present studies are made seem to be not very dangerous to agriculture. In this paper some observations about the breeding habits of *P. pictus* are also given. This paper is only a preliminary note to the work namely, 'The Bionomics and Ecology of Acrididae found in Rajasthan.'

This work is being done in the Zoology Department of Birla College Pilani. I am extremely thankful to Prof : A. R. N. Iyer, for his valuable guidance and interested attention throughout my work. My thanks are due to Prof : S. N. Mathur, for his encouragement, and Mr. Gopinath for his assistance in making the diagrams.

MATERIAL AND METHODS.

The specimens for the present study were collected from Pilani and its neighbouring villages. These were kept in cages and were fed with their natural food. For the study of their food preference, different plants were tried. For their breeding habits males and females were kept in varying proportions in different cages The cages were provided with moist sand and leaves.

DESCRIPTION.

Kirby (1914) in the fauna of British India has described this grass hopper. It is greenish in appearance with yellow markings and red wings. The elytra is green in colour which suits the environments. Antennae is filiform and blue black with white or yellow bands beyond the basal one third of the length. The head is deeply hypognathous and it makes an angle of forty degrees with the dorsal line as the base. The mouth parts are of the biting type. The labrum is well developed and bilobed. The mandibles are beset with cutting edges, (Plate I Fig. 1 and 2 and Plate II.) These insects are found very commonly on Calotropis plants in the month of July and August, but towards the end of September, their number decreases appreciably and by November it is very difficult to find even a solitary mature individual. The sexual dimorphism is very well pronounced. The females are larger and sluggish. The external genitalia exhibits many differences between the male and female.

Pruthi & Nigam (1939) reported P. pictus feeding on brinjal, castor and tomato when the supply of Calotropis was exhausted.

In the male the genital segment is the ninth. The sternum of the ninth segment is modified to form the subgenital plate and the tenth segment is represented as a suranal plate. (Plate IV Figs. 1, 2, and 3.) In the females the genital segments are the ninth and tenth. The external genitalia forms the ovipositor. The ovipositor is composed of three pairs of components whose shafts are termed as valves. The three pairs are :—

1. Ventral
2. Inner
3. Dorsal.

The inner pair of valves are rudimentary. (Plate, No. III, Figs. 1, 2, and 3).

FEEDING HABITS

P. pictus feeds on Calotropis plants. In these parts of Rajasthan, Calotropis plants grow widely. It seems that the milky juice of this succulent leaves are highly palatable for these insects. Afzal Hussain, C. B. Mathur and M. L. Roonwal (1946) recorded, some valuable observations about the food-preference of the desert Locusts. Volkonsky (1937) and Roomwal (1938) have noted the avoidance of Calatropis and Melia by the Desert Locusts, in Algeria and India respectively. Bhatia (1940) has confirmed Roonwal's observations. Haroonkhan (1946) however reports that Calotropis leaves are sometimes eaten. Chauvin (1946) has stated about the active principle of *Melia* which is responsible for its avoidance by Locusts. K. B. Lal (1951) reports that the adults of desert locusts are not averse to feeding the Neem leaves or of onion leaves. The present author has observed the total avoidance of Calotropis leaves by *Schistocerca gregaria*. In this context it will be interesting to note that *P. Pictus* feeds only on Calotropis plants in their natural haunts, which are at the same time rejected by many other larger grasshoppers. Another important point is that the leaves afford the necessary amount of watery food, since they are very rich in latex. Further investigations are to be made, as to find out why this calotropis plant is rejected by Locusts and at the same time relished by *P. pictus*.

Apart from the field observations some laboratory tests were also conducted. Starved grasshoppers were given leaves of different plants, grown wild here such as *Boerhavia*, *Aaruva*, and some cultivated plants like, *Penisitum*. In one extreme case of starvation, it was observed one grasshopper eating a bit of *Boerhavia* leaves, but of course left it very soon after the first attempt. But as soon as Calotropis leaves were dropped, these insects, began feeding voraciously. Experiments with other leaves like *Neem*, were not conducted because these insects were not at all observed on taller trees. Moreover it is almost certain from observations that these insects will not attack other trees, when its natural food is readily available. But all herbiverous grasshoppers are potentially dangerous since when it lacks its natural food it may turn to field crops.

It seems these hoppers are not fond of migration. When once they settle on some plants, they were found to be sticking on them.

BREEDING HABITS

Bellard (1932), Pospelov (1934), and Hamilton (1936) have worked on the sexual life of the Desert Locusts. Recently Afzal Hussain and C. B. Mathur (1945) recorded their observations, about the sexual life of *S. Gregaria*. The latter authors had pointed out some observations, which are in desparity with those of Bellard's. In confinement it had been noted by them that just before pairing when the mature male and the female attained proximity the male showed signs of excitement, a general restlessness, flipping of the palpi, frequent up and down quick movements of the antennae. P. pictus even when it was placed at a distance was able to feel the presence of the female near about its vicinity. It gradually moved about towards her side, flaunting its antennae in a graceful way, displaying all sorts of its colour and splendour. Bellard observed males courting females by their antennae. Hussain and Mathur had not observed any type of courting in the case of the desert locusts though it was reported to have been observed by Bellard. In *P. pictus* there exists some type of courtship. Bellard had again reported that a female actively helps the male in getting the copula by twisting the abdomen sideways

and by raising the terminal segments of the abdomen. Afzal and Mathur were very doubtful about such a phenomena. They are of opinion that males by a quick jump ride over females and later on adjust themselves to attain the right position. The quick jump reported by the above workers was not at all observed in *P. pictus*. The male instead of quick jump climbed over the female and then adjusted themselves to get a convenient position. Again it was observed the female bending the abdomen slightly sidewards and contracting the terminal segments so that the terminal part is raised a little upwards in such a way that her mate may get the copula easily. When the female does not want to mate she uses to kick the obstinate males out.

Polygamy and Polyandry.

Experiments were conducted on similar lines adopted by A. F. Hussain and C. B. Mathur (1946). It was observed the same male (identification marks were given) mating with four females within a period of seven days. When the male population is larger than the female, the same female was found to be mating with different males. In one case it was seen four males trying to kick out another male who was already in copulation with the female. Moreover the males in such cages were found to be mutilated either in wings or genae. Anyhow no fighting among the males was noted.

Duration of Copulation.

The average time of copulation was about six hours. The copulation record of eleven pairs is tabulated below. The duration of copulation varied with the individual. These insects were kept in small cages, a pair in each cage. They were supplied with enough food and were provided with a layer of moist sand suitable for oviposition. The beginning of the copulation was noted. The copulation began at different times. The maximum time taken by them according to results was six hours and forty minutes and the minimum was four hours forty three minutes. The average time taken by them was about five hours and fifty minutes.

Table showing the copulation record of Eleven Pairs of P. pictus recorded on August 22nd 1952.

Cop-Pairs	Time at which Copulation has begun.	Time at which it ended.	Total hours.
1a1b	8.30	3.15	6' 40"
2a2b	9.15	2.0	4' 45"
3a3b	9.30	3.5	5' 35"
4a4b	8.30	2.17	5' 15"
5a5b	9.30	3.25	5' 35"
6a6b	9.42	4.7	6' 25"
7a7b	2.0	7.12	5' 12"
8a8b	9.30	2.45	5' 45"
9a9b	9.17	2.	4' 43"
10a10b	8.25	3.	6' 35"
11a11b	8.30	2.35	6' 5"

Influence of Disturbance on Copulating Pairs.

The copulating pairs of grasshoppers cannot be disturbed very easily. A copulating pair can be handled without any apparent disturbance of the coitus. In one case a fine pin was introduced into the thoracic part of the female, but still the copulation went on unhampered. But on the other hand a slight pinprick on the part of the male was enough to dislodge the male from the back of the female. This shows either the incapability of the female to free herself from the male or her insensibility to pain on account of the sexual excitation. Which of these things is correct is difficult to conclude.

At the time of copulation the females feed on leaves as usual and male goes on without food. In the females normal functions of excretion and digestion take place and dropping of excretory pellets were observed at the time. But with the males these things were not at all observed.

Oviposition.

The females after copulation will be very busy in finding out suitable cradles to deposit her eggs. She drills cylindrical holes about four to five inches in depth. It was observed that a single individual digging as many as a dozen holes

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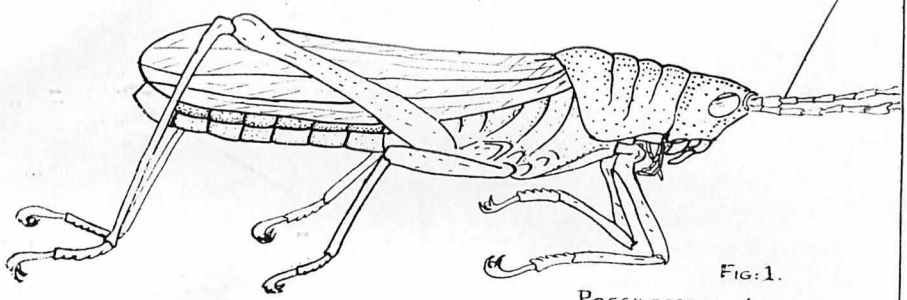
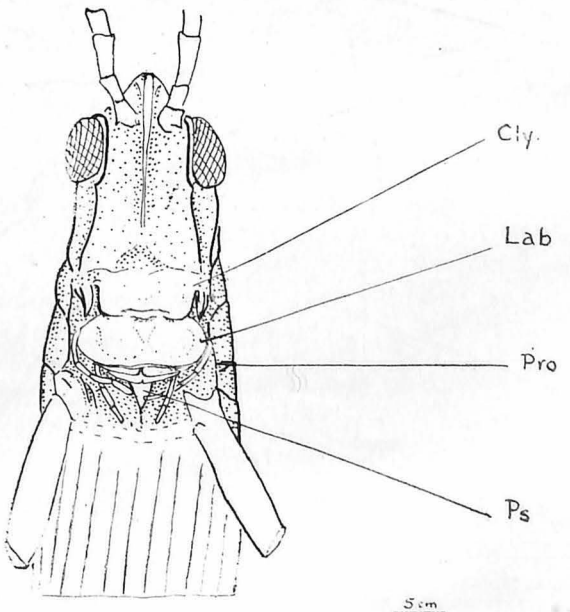


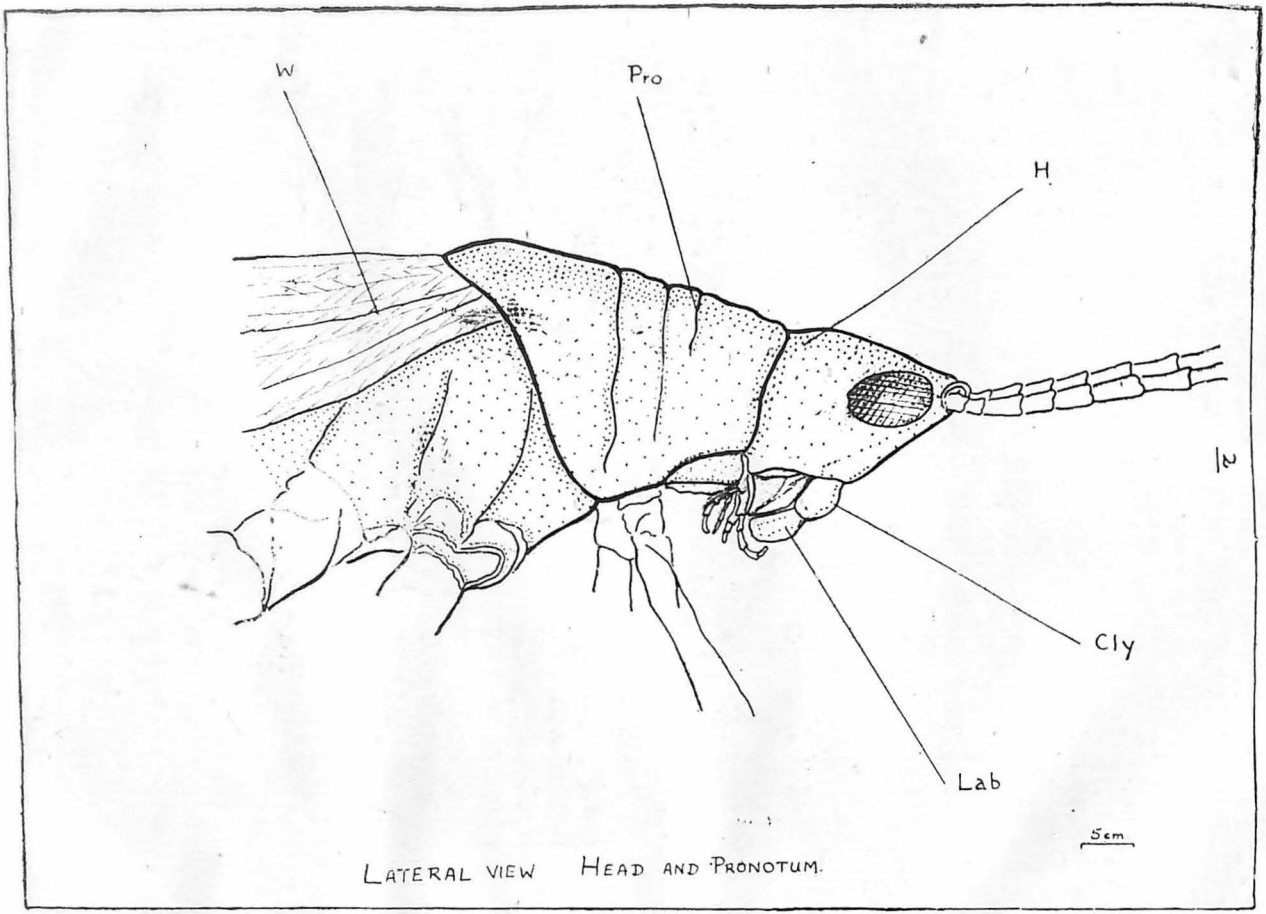
2cm

FIG: 1.
POECILOCEROUS PICTUS
MALE

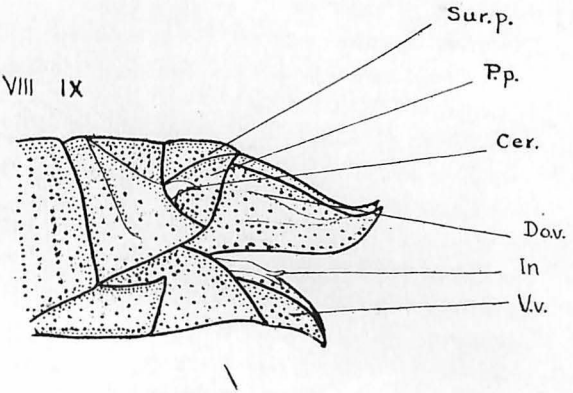
FIG. 2
FRONTAL VIEW



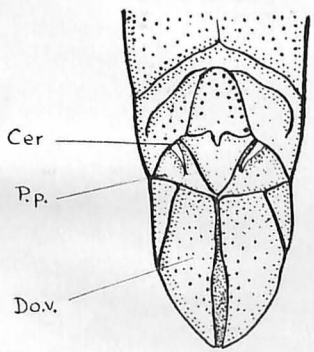
5cm



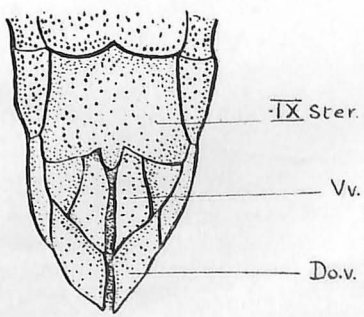
LATERAL VIEW HEAD AND PRONOTUM.



LATERAL
FIG: 1.



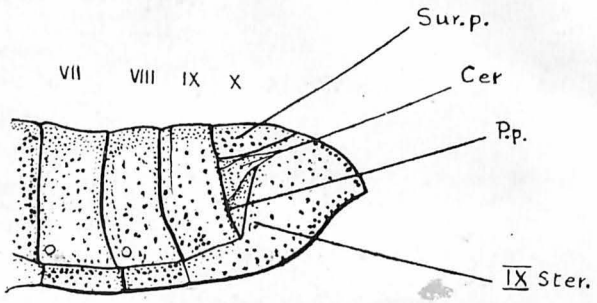
DORSAL
FIG: 2.



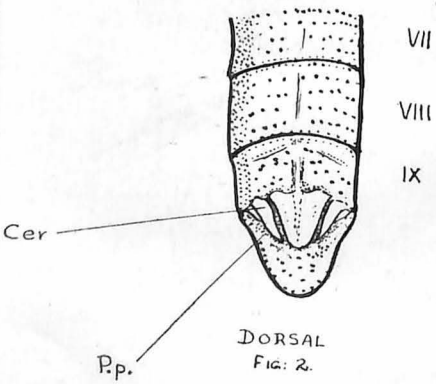
VENTRAL
FIG: 3.

5 cm

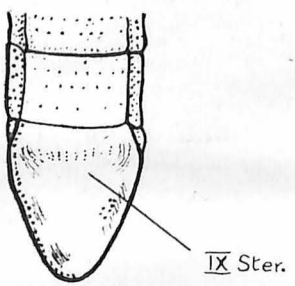
FEMALE - TERMINAL ABDOMINAL SEGMENTS.



LATERAL
FIG: 1.



DORSAL
FIG: 2.



VENTRAL
FIG; 3.

5cm.

MALE - TERMINAL ABDOMINAL SEGMENTS

but eggs were not laid in all of them. The depth of the soil, the moisture of the soil etc., were almost similar in the cage. Then why these insects select one or two holes as ideal places for laying their eggs are not clear. In one case the hole was nearer to the glass wall so that it was convenient to notide the process of egg-laying. The abdominal segments were enormously elongated by the help of which it drills its hole. At the time of egg-laying a wavy movement starts from the anterior to the posterior end by the force of which the eggs are eschewed out, embeded in a whitish jellylike mass. The egg mass takes the shape of the cylindrical hole. At the cessation of egg-laying the abdomen was contracted and insect came out from the hole. The jelly by which the eggs were cemented are whitish yellow in colour when they are fresh but later on as it hardens it becomes dark-brown. The freshly laid eggs are also whitish in colour which later on become brown. One egg pod usually consists of some eighty to hundred eggs.

Hatching of Eggs.

The eggs were placed in pots with sand which were covered by cylindrical glass tubes. The sand was moistiened by water. Some eggs which were laid by August 24th were hatched out by October 8th.

In natural conditions the eggs remain in the sand till the winter elapses. But here stray hatchings of eggs were noted even in October and some instars were collected. Generally winter hatchings are rare in these forms. The hatched insects were conspicuously coloured, the red being the prominent colour. The instars curiously enough had shown reluctance in taking food.

Fate of Male and Females

Soon after the copulation the males were found to be losing their vigour and vitality. They showed a marked reluctance in feeding and within a period of two weeks most of them were dead. After oviposition the females were also dying one by one. This means the average span of life of *P. pictus* is only near about one year.

SUMMARY.

1. A brief description of the insects is given.
2. Feeding habits with special reference to Food-Preference are discussed and compared with S. gregaria.
3. The state of the Male and the Female before and after copulation are recorded and compared with S. gregaria.
4. The oviposition, hatching of the eggs etc., are mentioned.

EXPLANATION OF FIGURES.

Ant—	Antennae.	P p—	Paraproct.
Cly—	Clypeus	H —	Head.
Lab—	Labrum.	W —	Wings.
Pro —	Pronotum.	Do V-	Dorsal Valves.
Ps —	Pro sternal spine.	V V—	Ventral Valves.
Surp-	Suranal plate.	In —	Inner Valves.
Cer—	Cerci.	IX stev-	Ninth sternun.

Roman numbers—indicate segments.

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Abnormal Flowers of *Delphinium ajacis Linn.*

By

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The "Larkspur"—*Delphinium ajacis Linn,* is a common garden ornamental herb grown in many parts of India. In one of the plants growing in the Botanical gardens, Jaswant College, Jodhpur, the occurrence of double-spurred flowers in some racemes was observed. To the best of my knowledge since this abnormality has not been reported so far in this species, the present note is intended to describe it.

It is interesting to note that the above abnormality was noticed in the flowers of a single plant in the whole population of about some two hundred plants. Further the youger racemes of the plant under consideration showed greater number of abnormal flowers while the older racemes had comparatively less number of such abnormal flowers.

In a normal flower of *Delphinium ajacis Linn.*[1] the sepals are five and unequal. The odd sepal[2] is posterior and it is prolonged into a spur at the base In the abnormal flowers under consideration, one of the sepals placed immediately lateral to the odd sepal is also prolonged into a spur (Fig. 1. C.D.E & F.) Another interesting fact noted was that the abnormal spurs were sometimes right to the odd sepal and at other times to the left of the odd sepal (Fig. E.F.G.) Thus the position of the abnormal spur was not constant in all the abnormal flowers. The disposition of the abnormal flowers in the raceme in relation to the normal flowers does not follow any definite pattern as evident in Fig 2.

The abnormal spur was in almost all cases shorter than the normal one-generally half its size and in few cases even

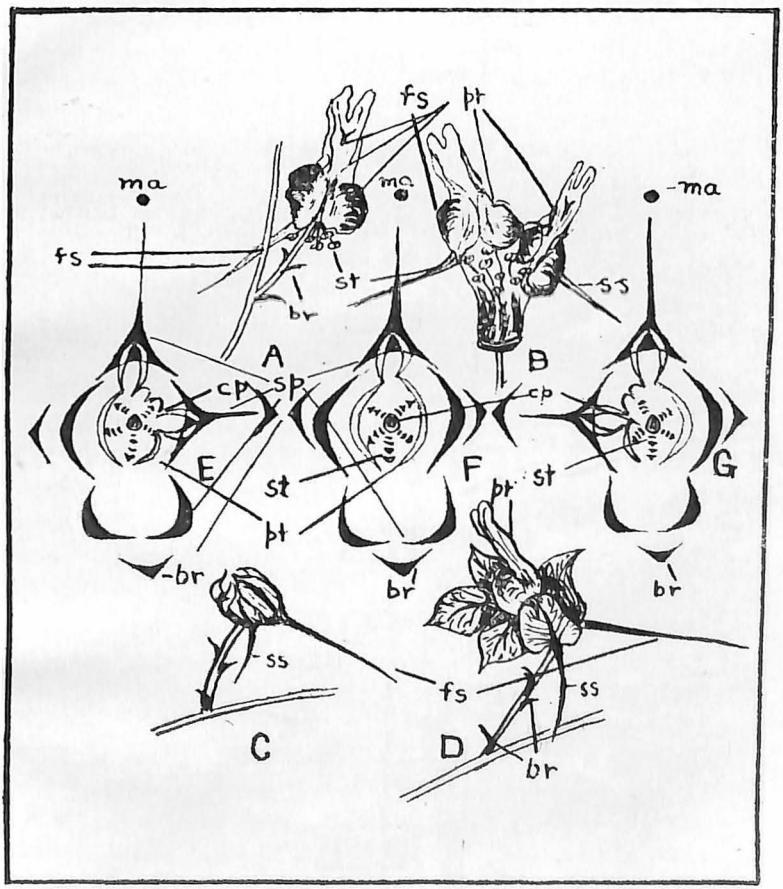
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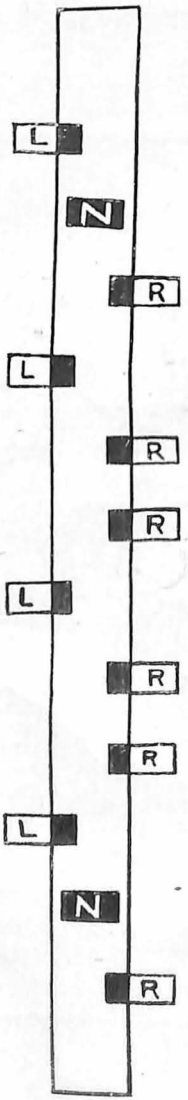
Fig. 1.



Fig, 2.

one-fourth of the normal size (Fig. C.E. G.). In some of the abnormal flowers the second spur was much reduced in size—about only one millimeter in length. The normal spur is approximately 2 c.m. in length.

The whorl of petals also showed some interesting deviations from the normal ones. In a normal flower there are four petals-the anterior one missing; they are all united with each other irregular and unequal. The upper pair (posterior) is prolonged backwards into long spur and is enclosed in the sepaloid spur (Fig. A & C). The other pair of petals is without a spur.[1]

The abnormal flowers show a duplication of the number of petals (Fig. B.) The two sets of petals are in one whorl and remain united with each other—the line of fusion being along the fourth of the first set and the first of the second set of petals. The petals along the line of fusion were equal in size while the opposite petals of the same pair were unequal. (Fig. E & G.) In many cases the abnormalities in the sepals were associated with those of the petals. Some of the flowers did not show any abnormality in the petaloid whorl though it was present in the sepaloid whorl (Fig. D.)

The androecium and the gynoecium did not show any anamolous features in the abnormal flowers.[2]

The occurrence of double-spurred flowers in occasional racemes of *Delphinium ajacis Linn.* and the abnormality in the whorl of petals is an interesting feature of considerable morphological and biological significance. Since the plant in question was quite healthy and in view of the fact that the above floral abnormalities are met with in racemes having normal flowers, we cannot attribute it to pathological causes. On the other hand the occurrence of the abnormal features in various degrees show that it may be due to developmental causes. This fact may be proved further on the basis that the abnormality became less conspicuous with the age of the plant. Moreover the abnormality in the petaloid whorl may or may not be accompanied by the abnormality of the sepaloid whorl.

Another possibility may be to trace the relationship between *Delphinium* and *Aquilegia*[3], another genus of the

same family-*Ranunculaceae* in which all the five petals are prolonged into spurs.[3] It might be regarded as a case of reversion to ancestral stock.

The probable causes of these abnormalities may be either physioecological or mutations serving as biological purpose. It is however to be seen, if this acquired character continues in the subsequent generations.

In conclusion, I have pleasure in expressing my gratitude to Professor Shanti Sarup, M.A., M.Sc., for his interest and encouragement. I am also indebted to Prof. B.V. Ratnam for his useful suggestion and advice in preparing this note.

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Fig. 1.

A. Normal flower with calyx removed.
B. Abnormal flower with duplicate whorl of petals (calyx removed.)
C. A bud with double spurs.
D. An abnormal flower with double spurs.
E., F., & G., Floral diagrams-E. & G. of abnormal flowers & F. of normal flower.

fs— first spur; sp-sepals; pt-petals; br-bracts; SS-Second spur; st—stamen; ma-mother axis; cp-carpels;

Fig. 2.

Distribution of single and double spured flowers of a raceme.

N—normal flower.
R—flowers showing second spur on the right of the first spur.
L—flowers showing second spur on the left of the first spur.
A—axis.

A preliminary note on a collection of Algae from Jodhpur and environs.

By

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[Jaswant College, Jodhpur.]

INTRODUCTION.

The systematic study of Algae in India dates as old as about the year 1780 but so far no work on the Algal Flora of Rajasthan and particularly the desert areas of this province has been done. Blatter and Hallberg (1918-24) in their 'Flora of the Indian Desert' have reported a few species of *Chara* among the 'masses of algae' from a water reservoir near Jodhpur. That is the only record of Algae from this part of India. Ratnam (1943) in an investigation upon the Algal Flora of the Sambhar Lake reports a few species of Algae belonging mainly to *Myxophyceae* and also to *Chlorophyceae*. Godbole (1951) while tracing the origin of the salt in Sambhar lake mentions five species of algae present in the Sambhar Lake, as identified by Prof. M.O.P. Iyengar. But none of these, is a systematic study of Algal Flora of this province. A preliminary attempt, in this investigation, has therefore been made towards a detailed study of the Algae of this province, which is being continued.

COLLECTION AND SEASONS.

The area under consideration has a typical desert climate and consequently the Algal Flora may be of some interest. The existing climate is characterised by high temperatures, lack of rains, violent winds, the absence of forests and similar factors. The sub-aerial algae may be of considerable ecological importance. I have tried to collect and study the various species of algae with their ecological adaptations. The forms recorded here have all been collected by the writer in the last two years. They have been kept

well preserved for further study. The various species recorded here have been colleted from the tanks, ponds, pools, puddles, lakes, 'Baories' and other such water reservoirs as also the sub-aerial habitats, within a radius of five miles, from Jodhpur city.

SITUATION AND CLIMATE.

Jodhpur is the capital city of former Jodhpur state and a Divisional Head Quarter of the present Rajasthan Union. It lies between 26°.18' North latitude and 73°.1' East Longitude. It is nearly 300 miles from the Arabian Sea and approximately four times that distance from the Bay of Bengal.

The area under consideration is ecologically a semi-arid region and the topography of the region is but important for the growth of any flora. The climate of the place is at all seasons dry and salubrious due to its situation geological record and absence of the forests. The area is beyond the range of full force of south west Monsoon from the Arabian Sea and is also remote from the effect of South-east Monsoon from the Bay of Bengal. This results in scanty rainfall. The temperature variations reach the extremes during winters and summers. Even the diurnal range of temperature is very wide. In summer the climate is very dry and hot; in winter it is much cooler. Hot winds and dust storms are experienced in summers. But when these winds are cooled down by Monsoon and the blowing sand is stopped by the moisture and the sprouting vegetation, climate becomes often pleasant towads the end of July and remains so for five-six months.

The average rainfall under normal conditions is 10 to 12 inches a year. Consequently there is shortage of water. This water shortage led to the construction of huge Bunds, big artificial lakes, numerous capacious tanks and other temporary and permanent water reservoirs as shown in the Map. Water is thus collected artificially and is supplied to the city, when required. These reservoirs provide excellent harbouring places for the various species of algae. There are more than 150 such artificial water reservoirs i.e. lakes, 'Bunds', tanks, ponds, pools, puddles, 'Baories', etc. Some of them extend over several square miles, offering a considerable algal habitat.

Kailana is one such big tank situated outside the city amidst the hills. It has a capacity of about 80,000,000 c.ft. and commands a catchment area of about 15 sq. miles. With many depressions and rocky projections here and there, it offers a nice home for algae. Another such big reservoir is Takat-Sagar situated very near the former and having nearly double its capacity. Balsamand (a small sea) and Umed-Bund are other big water reservoirs. They are all largely filled with sub-merged vegetation and a considerable part is covered with floating islands formed of living and decayed planktons.

The number of smaller tanks and ponds, most of which have been located in the map, are too numerous to mention here. But apart from these there are many "Baories" 'Jhalaras', 'Kuas', Bheras', and 'Bheries'. Of about thirty 'Baories' and 'Jhalaras' in and around the city, most of them are very deep and some with a never failing supply of water. Their construction is such that direct sunlight hardly reaches the water level, if at all it does. Such situations do not favour abundant algal growth, though an unusual algal home. The number of wells ('Kuas', 'Bheras' and 'Bheries') within and out side the city wall are more than 200. But only few of them are sweet-water wells otherwise majority of them contains hard, brackish water. This again offers unusal algal flora.

So despite the above mentioned adverse climatic factors for the growth of algae, the artiticial construction of water reservoirs, play a great role in sustaining algal life. The periodic fluctuating changes in temperature, the ph of water and the light intensities, all have a marked effect on the growth and development of the various forms of algae in this region.

ECOLOGICAL NOTES.

Various species of algae are found in diverse habitats in all seasons of the year.

Swiftly running waters are almost absent in this region and the only algal flora of the flowing waters is constituted by slow moving streams and that too in the rainy seasons. *Tatrasporidium, Stigeoclonum, Ulothrix, Zygnemataceae* and species of *Oeaogonium* are common in this type of

habitats. Species of *Cladophora* and *Hydrodictyon* occur in very slow moving waters. But the most interesting of all the algae of the flowing water is *Characiosiphon.* It has been observed in the month of August, 1952 growing in small clusters, on tiny stones and pebbles in a stream, few inches deep, starting from Moti-Kund and ending in Sursagar.* Previously, this alga was found by me in a different habitat, a permanent stretch of standing water the Umed Bund. It was growing here on stones and pebbles, decaying twigs, snails and other such substrata under water more abundantly on the rocky sides of the Bund, where water level rises and falls.

In lakes, ponds, pools, puddles and other standing waters the algae may remain free floating or attached. In the former habitats constituting the planktons, unicellular or colonial forms such as *Desmids, Diatoms, Scenedesmus, Pediastrum, Pandorina, Gonium, Chlamydomanas,* and *Volvox* are more common. *Volvox* is more abundant in various stagnant clear waters soon after the rains. *Pithophora, Cladophora, Hydrodictyon, Draparnaldia, Zygnemataceae, Anabaena, Nostoc,* have been found frequently as free floating masses in the standing waters. *Sphaeroplea* has been once recorded from Kailana, in the same habitat. *Gongrosira, Stigeoclonium, Chaetaphora Spirogyra, Calothrix, Nostoc* etc. may occur in the standing waters,attached to the sides or the side-walls and other submerged stones.

Among the epiphytic algal flora *Coleochaete, Stigeoclonium, Bulbochaete, Aphanochaete, Oedogonium,* and many a species of *Diatons* have been recorded. *Coleochaete* occurs on *Vallisnaria* in Kāilana and Takat Sagar. *Bulbochaete* and epiphytic species of *Oedogonium* also occur in the same localities, on the species of *Chara* and *Nitella.*

The occurrence and development of the subaerial algal flora of the region is controlled to a great extent by the clima e and the environmental factors the brief account of which has been given above. Yet inspite of these unfavourable conditions there is a good record of the subaerial algae on moist mud, walls and rocks. The most frequently

*Exactly similar habitat has been recorded by M.O.P. Iyengar, the only previous record of this peculiar alga.

encountered and commonly growing are species of *Botrydium* and *Protosiphon* found on the drying margins of the water reservoirs. *Vaucheria* occurs in almost all moist, shady, subaerial situations. *Rhizoclonium* is also often very common throughout the year in such habitats. *Fritschiella tuberosa* is not uncommon just after the rains inhabiting the drying margins of the pond. A species of *Cylindrospermum* is met sometimes on the wet grounds intermingled with the grasses. *Spirogyra* has always been found in conjugating stage when occurring in terrestrial habitats. But the most common algae in the wet garden lawns, fields, damp pastures and diverse other moist places are species of *Diatoms*, *Oscillatoria*, and *Phormidium*. *Scytonema* and *Tolypothrix* are common on damp rocks and moist gravels. Often in the rainy seasons, the white washed walls and plastered roofs become entirely greenish-black, due to the growth of these forms.

None of the parasitic algae has been observed so far in this region. But the zooalgal growth is common. Unicellular and colonial forms grow abundantly with the association of *Sponges* submerged in standing waters attached to stones and twigs etc. *Oedogonium*, *Cladophora* and *Characium* have been observed growing on snails. Some species have been recorded in association with the freshwater *Polyzoa*.

CHECK LIST OF THE JODHPUR ALGAE

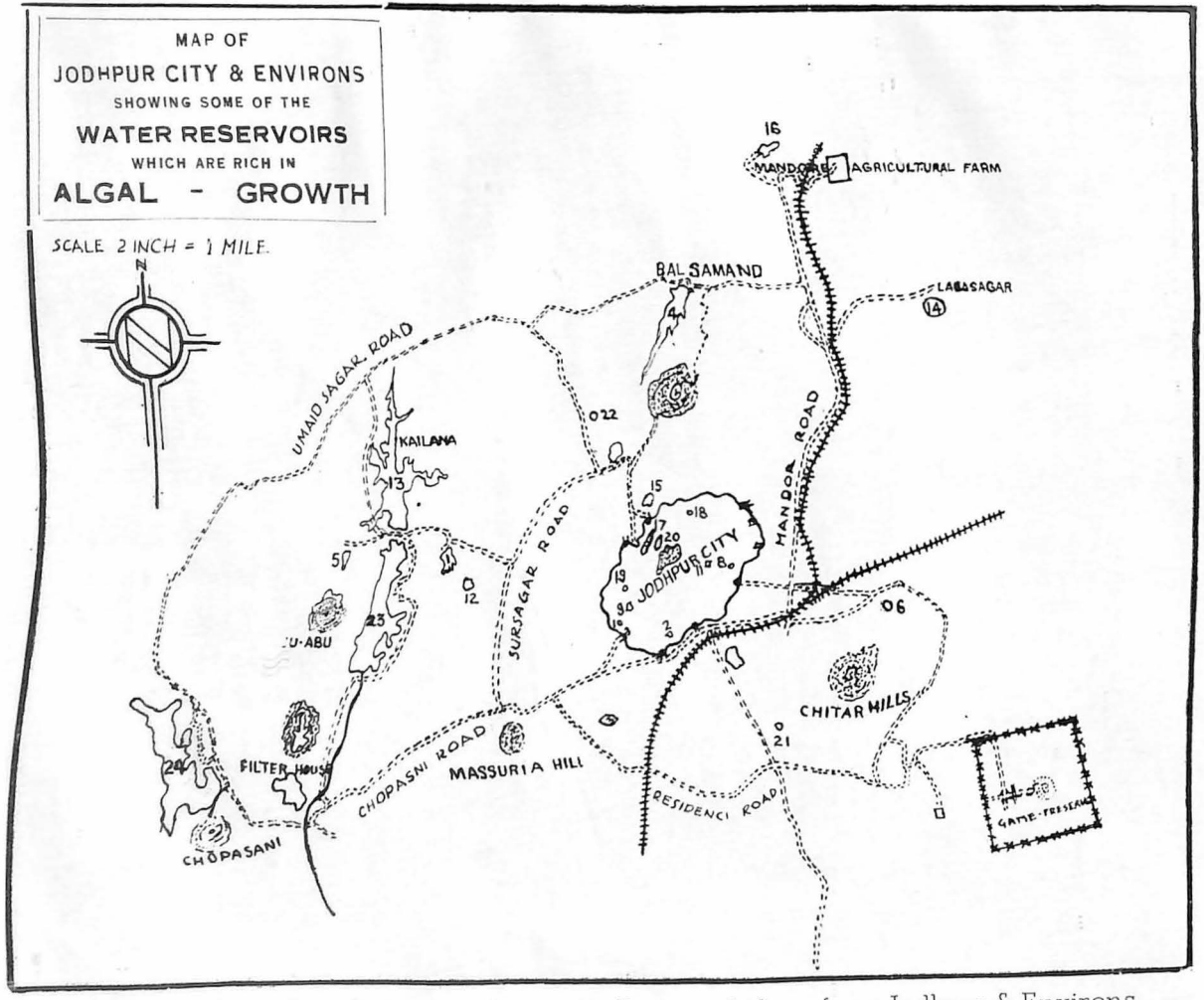
The collection of the algae listed here has been made with in the last two years. The preliminary identifications,* of the various species and their respective families, have been made with the help of the publications given in the Bibliography.

The classification has been followed after Fritsch. So far 77 Genera 107 species, covering 33 families and representing most of the orders of the classes *Chlorophyceae*, *Myxophyceae*, *Baciliariophyceae* and *Xanthophyceae* have been recorded. The Check-list of the various forms collected, with their months of collections, locality and habitats is given here under:—

*I am personally responsible for all identifications same of which are tentative.

CHLOROPHYCEAE GREEN ALGAE.

No.	Classified list of algae.	Month of Collection.	Locality.	Habitat.
	ORDER VOLVOCALES. SUBORDER. CHLAMYDOMONADINEAE. FAMILY. CHLAMYDOMONACEAE.			
1.	*Chalamydomonas* Sp.	Dec.	Ganeshgardh Gangelaw.	Free floating & on submerged soil.
2.	*Gonium pectorale* Muell.	Nov., Dec.	Many places.	Sparingly intermingled with other algae of the pools and ditches.
3.	*Gonium formosum* Pascher.	Nov., Jan.	Many places	
4.	*Pandorina morum* Bory.	Throughout the year.	Many places.	Frequent but rarely abundant.
	FAMILY. SPHAERELLACEAE.			
5.	*Volvox*. Sp.	July., Sept.	Ratanada. Ganeshgardh.	Generally abundant free floating colonies.
	SUBORDER. TETRASPORINEAE. FAMILY. PALMELLACEAE.			
6.	*Tetrasporidium javanicum* Moeb.	Aug. & Sept.	Very common.	Free floating & attached.
	ORDER CHLOROCOCCALES. FAMILY. PALMELLACEAE.			
7.	*Characium terreteris* Iyeng.	Aug., Oct.	Gangelaw.	On stones & submerged twigs with *Stigeoclonium*.



M. M. Bhandari—A preliminary note on a collection of algae from Jodhpur & Environs.

1. Akhey Rajji's Tank.
2. Bai-Ji-ka Talab.
3. Bakhat Sagar.
4. Balsamand.
5. Bizolai.
6. Chitar Tank.
7. Deo Kund.
8. Fateh Sagar.
9. Gangelav.
10. Ganesh-gardh.
11. Gulab Sagar.
12. Guran-ka-Talab.
13. Kailana.
14. Lal Sagar.
15. Moti Kund.
16. Nag-kund.
17. Padam Sagar.
18. Partap Sagar.
19. Phulerao.
20. Ranisar.
21. Ratanada.
22. Sursagar.
23. Takhatsagar.
24. Umed Bund.

No.	Classified list of algae.	Month of Collection.	Locality.	Habitat.
8.	*Charcium* sp.	Oct., Dec.	Ganeshgarh & a cattle watertrough	Attached to twigs etc. in great abundance.
9.	*Characium rivularis* Iyeng.	Aug. July.	Chopasni-bundh & Motikund.	Attached to stones & twigs in a tank as well as in slow moving water.
10.	*Chlorococcum hemicolum* Rabh	Aug., Dec.	Common.	Damp soils & brick work etc, subaeria
	FAMILY. CHLORELLACEAE.			
11.	*Chlorella vulgaris* Bey.	Throughout.	Common.	In sponges etc.
	FAMILY HYDRODICTYACEAE.			
12.	*Hydrodictyon reticulatum* Lag.	Aug., Dec.	Common.	Abundant nets in slow moving water.
13.	*Padiastrum boryanum* Menegh.	July., Dec.	Common.	Free floating.
14.	*Padiastrum simplex* Rab.	Nov.	Common.	Intermingled with other algae.
	FAMILY. COELESTRACEAE.			
15	*Scenedesmus obliqus* Kutz.	Throughout.	Akheyraj-ji-Tank	Most collections from various aquatic habitats contain one or more species of Scenedesmus.
16.	*Scenedesmus dimorphus* Kutz	Throughout.	Common.	
17.	*Scenedesmus denticulatus* Hans.	Throughout.	Common.	
18.	*Scenedesums qudriquada* Smith.	Throughout.	Mandore.	
19.	*Scenedesmus armatus* Smith.	Throughout.	Akheyraj-ji-Tank: Bijolai.	
20.	*Tetradesmus* sp.	Nov.	Akheyraj-ji's-Tank	Free floating with other algae.

No.	Classified list of algae.	Month of Collection.	Locality	Habitat.
	ORDER-ULOTRICHALES. SUBORDER-ULOTRICHINEAE. FAMILY-ULOTRICHACEAE.			
21.	*Ulothrix zonata* Kutz.	Aug. Sept.	Ratanada & Motikund.	Attached; running water.
22.	*Ulothrix* sp.	Sept., Oct.	Ganeshgardh.	In standing water with *Schizomeris.*
23.	*Schizomeris leibleinii* Kutz.	Aug., Sept.,	Ganeshgardh.	Rare but abundant.
	FAMILY. MICROSPORCEAE.			
24.	*Microspora* sp. ?	Nov., Dec.	Umedbandh.	Attached with soil particles.
	SUBORDER-SPHAEROPLENEAE. FAMILY-SHAEROPLEACEAE.			
25.	*Sphaeroplea annulina* Ag.	Nov., Dec.	Kailana.	Free floating; rare,
	ORDER-CLADOPHORALES. FAMILY-CLADOPHORACEAE.			
26.	*Cladophora* sp.	Nov., Dec.	Mandore.	On stones in slow moving stream.
27.	*Cladophora* sp.	June, July.	Kailana.	Attached to stones and Snails. etc.
28.	*Pithophora* sp.	Nov , Jan.	Ranisar.	Free-floating
29.	*Rhizoclonium* sp.	Throughout.	Mandore.	Attached in flowing water and subaerial. habitats

No.	Classfied list of algae	Month of Collection	Locality	Habitat
	ORDER-CHAETOPHORALES FAMILY-CHAETOPHORACEAE			
30.	*Chaetophora* Sp.	Jan.	Takatsagar	Attached to stones & sub-merged walls, in stagnant water.
31.	*Draparnaldia* Sp.	Nov.	Lalsagar	Attached to submerged plants in clear, cool, standing water.
32.	*Fritschiella tuberosa* Iyeng.	Aug. Oct.	Kailana	Subaerial on drying margins of lake.
33.	*Stigeoclonium* Sp.	Oct.	Chopasani	Attached and free floating.
34.	*Stigeoclonium* Sp.	Oct. - Dec.	Gangalaw	Attached to stones.
35.	*Aphanochaete* Sp.	Oct. - Dec.	Mandore	Epiphytic on decaying submerged twigs etc.
36.	*Gongrosira* Sp.	Oct.	Gangalaw	On submerged stones.
	FAMILY-COLEOCHAETACEAE			
37.	*Coleochaete scutata* Breb.	Feb., Dec.	Kailana	Epiphytic on *Vallisnaria.*
	FAMILY-PLEUROCOCCACEAE			
38.	*Pleurococcus virdis* Ag.	Common	Throughout	On moist stones walls and flower pots etc. forming a green coating.

No.	Classified list of algae	Month of Collection	Locality	Habitat.
	ORDER-OEDOGONIALES. FAMILY-OEDOGONIACEAE.			
39.	*Oedogonium* Sp.	Sept.	Motikund	In flowing stream.
40.	*Oedogonium* Sp.	Oct.	Bijolai	On rock cliff, moistened by the spray of water.
41.	*Oedogonium* Sp.	Nov.	Lalsagar.	Free floating and attached to-*Ceretophyllum* etc.
42.	*Oedogonium* Sp.	Sept.	Ratanda	Free floating masses etc.
43.	*Oedogonium* Sp.	Feb. March	Takatsagar	Attached to *Chara*.
44.	*Bulbochaete* Sp.	Feb. March	Takatsagar	Attached to the young *Nitella* branches,
	ORDER-CONJUGALES SUB-ORDER-ECONJUGATAE FAMILY-MESOTAENIOIDEAE			
45.	*Cylindrocystis* Sp.	Aug.	Akhey Raj's Tank	Damp soils.
46.	*Netrium* Sp.	Throughout	Common	Sparingly mixed with other algae.
	FAMILY-ZEGNEMOIDEAE.			
47.	*Spirogyra* Sp.	June	Takatsagar	This alga is common every where.
48.	*Spirogyra* Sp.	Oct.	Motikund	Subaerial drying margins of tank.

No.	Classified list of algae	Month of Collection	Locality	Habitat.
49.	*Spirogyra* Sp.	Nov.	Balsamand	Floating in stagnant water.
50.	*Zygnema* Sp.	Nov.	Kailana	Free floating; slow-moving water.
51.	*Mougeotia* Sp.	Nov.	Balsamand	Slowly moving water.
52.	*Sirogonium* Sp.	Sept.	Chopasani.	Rare; free floating.
	FAMILY-DESMIDIOEDEAE.			
53.	*Closterium* Sp.	Throughout	Common	Common in association with other algae
54.	*Closterium* Sp.	Throughout	Common	
55.	*Cosmerium reniforme* Arch.	Throughout	Common	
56.	*Euastrum* Sp.	Nov.	Akhey Raj's Tank	
57.	*Microastrias* Sp.	Nov.	Akhey Raj's Tank	
58.	*Staurastrum* Sp.	Nov.	Akhey Raj's Tank	
	ORDER-SIPHONALES FAMILY-POTOSIPHONACEAE			
59.	*Protosiphon botryoides* Klebs.	Nov.	Kailana, Bijolai, etc.	Sub-aerial; on drying margins of tanks.
	FAMILY-VAUCHERIACEAE.			
60.	*Vaucheria* Sp.	Dec.	College Garden Bijolai etc.	Subaerial; on damps grounds.
	ORDER-CHARALES FAMILY-CHARACEAE			
61.	*Nitella hyalina* Ag.	Nov.	Kailana	Deep, on finely divided mud.

No. Classified list of algae	Month of Collection	Locality	Habitat.
62. *Nitella* Sp.	Feb.	Takatsagar	Not very deep with other aquatic Plants.
63. *Chara braunii* Gmel,	Nov.	Lalsagar	Submerged; shallow waters on rocky substratum,
64. *Chara corallina* Willd.	Dec.	Kailana	Slowly moving water.
65. *Chara zeylanica* Willd.	Nov.	Lalsagar	Sub-merged; shallow water.
66. *Chara* Sp.	March	Takatsagar	Sub-merged; shallow water with other plants.
67. *Chara* Sp.	Oct.	Akhey Raj Ji's Tank	Small plant on finely divided mud.
68. *Chara* Sp.	Jan.	Ranisar	On shallow mud.
69. *Chara* Sp.	Jan.	Mandore	Slow moving, clean, shallow, water.
MYXOPHYCEAE (BLUE-GREEN ALGAE.)			
ORDER CHROOCOCALES. FAMILY. CHROOCOCACEAE.			
70. *Aphanocapsa* Sp.	Oct.	Akhey Raj Ji's Tank	Attached to submerged vegetation.
71. *Microcystis* Sp.	Throughout	Ranisar, Padamsar.	Planktonic: causingn water blooms; commo

No.	Classified list of algae	Month of Collection	Locality	Habitat
	ORDER NOSTOCALES			
	FAMILY OSCILLATORIACEAE			
72.	*Lyngbya* Sp.	Sept.	Bhimbarak	Subaerial; blue green patches in damp places.
73.	*Lyngbya* Sp.	Sept.	Many places	Aquatic with *Oscillatoria.*
74.	*Microcoleus* Sp.	Oct.	Luni River	Forming felts in the river bed on stones.
75.	*Oscillatoria* Sp.	Aug.	Deo-kund	Attached and floating.
76.	*Oscillatoria* Sp.	Sept.	Sewage farm	Attached.
77.	*Phormidium* Sp.	Aug.	Mandore	Flowing water,
78.	*Phormidium* Sp.	June	City drains	Intermingled with *Oscillatoria* on damp places near drains.
79.	*Spirulina* Sp.	Aug.	Akhey Raj Ji's Tank.	Some filaments with other algae.
	FAMILY NOSTOCACEAE			
80.	*Anabaena* Sp.	Nov.-Dec.	Motikund	Free floating masses.
81.	*Aulosira* Sp.	Oct.	Takatsagar	Free floating; felts.
82.	*Cylindrospermum* Sp.	Sept.	Motikund	Terrestrial on damp grounds covered with grasses.
83.	*Nostoc* Sp.	Aug.-Sept.	Common	Terrestrial, with *Riccia.*
84.	*Nostoc* Sp.	Nov.	Balsamand	Attached on submerged stones etc.

No.	Classified list of algae.	Month of Collection	Locality	Habitat.
85.	*Nodularia* Sp.	Dec.	Kailana	Attached to Chara and floating with other algae.
	FAMILY RIVULARIACEAE			
86.	*Gleotrichia* Sp.	Nov.	Kailana	Free floating & sessils on chara & Nitella.
87.	*Rivularia* Sp.	June	Takatsagar	Attached to submerged water plants.
88.	*Calothrix* Sp.	Nov.	Mandore	Attached to submerged rocks stones etc. in flowing water.
	FAMILY SCYTONEMATACEAE			
89.	*Scytonema* Sp.	Aug.	Common	Subaerial;felty masses.
90.	*Tolypothrix* Sp.	Nov.	Balsamand	Subaerial; damp walls

XANTHOPHYCEAE (YELLOW-GREEN ALGAE)

	ORDER HETEROSIPHONALES.			
	FAMILY BOTRYDIACEAE.			
91.	*Botrydium tuberosum* Iyeng.	Dec.	Bijolai	Muddy banks of Tank
92.	*Botrydium granuatum* Grev.	Dec -Jan.	Akhey Raj Ji's Tank	Same habitat

BACILLARIOPHYCEAE (DIATOMS)

No.	Classified list of algae	Month of Collection	Locality	Habitat.
	ORDER CENTRALES. FAMILY DISCOIDEAE.			
93.	*Cyclotella* Sp.	Jan.-Feb.	Rare.	Inter mingled with other free floating algal threads.
94.	*Melosira* Sp.	Oct. Jan.	Mandore	Slowly moving waters.
95.	*Stephenodiscus* Sp.	Oct.	Akhey Raj Ji's Tank	Damp ground (Rare)
	ORDER PENNALES FAMILY FRAGILARIOIDEAE			
96.	*Asterionella* Sp.	Nov.-Jan.	Common	Attached to submerged vegetation.
97.	*Synedra* Sp.	March	Mandore	Attached to submerged plants.
98.	*Tabellaria* Sp.	Nov.-Jan.	Common	Intermingled with other algae.
	FAMILY ACHANTHOIDEAE.			
99.	*Achnan hes* Sp.	Oct -Jan.	Common	Epriphytic & intermingled with submerged plant.
	FAMILY NANICULOIDEAE.			
100.	*Amphora* Sp.	Dec.	Motikund.	Intermingled with other free floating algae.

No.	Classified list of algae.	Month of Collection	Localite.	Habitat.
101.	*Cymbella* Sp.	Jan.	Mandore	Intermingled with other free floating algae.
102.	*Gomphonema* Sp.	Dec.	Lalsagar	Epiphytic on cladophora.
103.	*Navicula* Sp.	Throughout	Common	Free floating with other algae
104.	*Navicula* Sp.	Oct.	Balsamand	Rare with other algae.
105.	*Gyrosigma* Sp.	Throughout	Common	Free floating with other algae.
106.	*Pinnularia* Sp.	Do	Common	Sub-aerial
	FAMILY NITZSCHIOIDEAE.			
107.	*Nitzeschia* Sp.	June	Mandore	Sub-aerial

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