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CONTENTS

Food of Certain Insectivores and Rodents in Captivity

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INTRODUCTION

Food has prime importance in the scarcity items of a desert. Due to low rainfall, the desert is poor in vegetation. There is a strong belief that hedgehogs do a great damage to vegetation while our initial observations (Krishna & Prakash, 1956) showed that they did not accept any plant matter. The Department of Agriculture and Forests consider the gerbilles as the greatest foe of the vegetation and have been complaining to us about the loss due to these. Therefore, the hedgehogs (*Hemiechinus auritus collaris* and *Paraechinus micropus micropus*) and the gerbilles (*Tatera indica indica* and *Meriones hurrianae*) collected from the Rajasthan Desert were selected for the detailed study of their food and feeding habits. In combination with these studies their behaviour in captivity was also studied (Prakash, 1958 a).

For the study in captivity the hedgehogs and the gerbilles were kept in cages (90″ × 30″ × 30″). These cages had a thick bottom of sand in which the insectivores and the gerbilles could dig their burrows. The cages had three chambers. One of them was completely dark and was inter-communicable.

The hedgehogs were quite comfortable in captivity and so were the Indian gerbilles, *T. i. indica* but the desert gerbilles took about a week in adjusting to the captive conditions. The hedgehogs and gerbilles dug their burrows in cages and they used to come out of their subterranean 'homes' only at their feeding time. For the experiments, however, they were kept singly in smaller cages (20″ × 20″ × 20″). Some hay and paper cuttings were placed in them so as to provide them with some dark place during the day. Quite a large variety of food was tried and their choice was observed. The food items were left with the animals for 24 hours. Water was always given to the animals

The choice of the food has been considered in four categories: (1) 'most preferred', (2) 'preferred', (3) 'less preferred',

and (4) 'not taken'. These have been expressed in Tables 1 and 2 by the symbols : /, o, *, x repectively. Each symbol also denotes one trial with one individual. Since all observations were conducted by the writer, the 'personal factor' was common to all the observations. Both the species of hedgehogs were studied separately. They gave identical results. Hence the observations recorded in Table 1 are true for both. The food of the gerbilles is recorded in Table 2.

TABLE 1

(Showing the food provided to the hedgehogs, *Hemiechinus auritus collaris* and *Paraechinus m. micropus* and their preference for it)†

Food items provided	Trials	Remarks
Earthworm, *Pheretima posthuma*, living	xxxxxx	
chloroformed	xxxxxx	
Leech, *Hirudo medicinalis*, living	oo	
chloroformed	oo	
Pila globosa, living	xxxxxxx	The hedgehogs tried to devour but failed due to the shell, which could not be broken by them.
chloroformed	xxxxxx	
shell removed	ooooxoo	
Other snail, living	xxxxx	
chloroformed	xxxxx	
shell removed	ooooxxx	
Spiders, many species, living	xxxxx	
chloroformed	xxxxx	
Scorpion, living	xxxxx	
chloroformed	///////	Even the sting was eaten
Centipede, living	xxxx	
chloroformed	xxooo	
HYMENOPTERA		
Mustard Saw Fly, *Anthiala proxima*	xxxx	

† / most preferred; o preferred; * less preferred; x not taken.

Food items provided	Trials	Remarks
Ichneumoid wasp, *Pimpla punctata*	xxxx	
Potter wasp, *Eumenes esuriens*	xxxx	
Vespa orientalis	xxxx	
Pollistis harbraeus	xxxx	
Ant, *Dorilus labiatus*	xxxx	
Monomorium indicum	xxxx	
COLEOPTERA		
Anthia sexguttata	/////	
Eudema angulatum	/////	
Water Scavanger Beetle, *Hydrophilus olivaceus*	oooo	
Septum punctata	o	
Juliodes atkinsoni	/////	
Canthris hirticornis	xxxx	
Batocera ruba	oo	
Helicopris buciphalus	/////	
Onthophagus longicornis	/////	
Onticellus cinctus	//////	
ORTHOPTERA		
Locust, *Schistocerca gregaria*	/////	
Phadka, *Hieroglaphus negeroriphletus*	///////	
Painted Grass hopper, *Poecilocerus pictus*	xxxxx	
Acridia exaltata	////	
Periplanata sp.	/////	
Mantis, *Hirodula codurctota*	////	
Cricket, *Grylus domesticus*	/////	

Food items provided	Trials	Remarks
ISOPTERA		
White ant, *Anacanthotermes macrocephalus*	/////	
HEMIPTERA		
Fresh water bug, *Belastoma indica*	oooo	
Water Scorpion, *Laccotrephes maculatus*	*****	
Bed bug, *Cimex rotundatus*	xxxxx	
DIPTERA		
Midges, *Chironomas* sp. (larva)	xxxxxxx	
Crane fly, *Pselliophora laeta*	xxxxxxx	
Fruit fly, *Dacus cucurbita*	xxxxxx	
Blood sucking insect, *Hippobosca equina*	xxxx	
LEPIDOPTERA		
Brown-hairy caterpillar, *Amsacta lectinea*	xx	
Spotted ball-worm of cotton, *Earias insulana*		
caterpillar	oooooo	
adult	///////	
Brinjal leaf roller, *Eublema olivacae*	xxxxxxx	
Hawak moth, *Heres convoluli*	oooo	
Brinjal stem borer, *Euzophera perticella*		
caterpillar	xxxxxx	
adult	******	
Papilio domoleus	///////	
Calotis vestalis	///////	

Food items provided	Trials	Remarks
Akk butterfly, *Danis chrysippus*	//////	
Common tiger, *Danis plexipus*	//////	
Blue pansy, *Precisarithya swinhoei*	//////	
AMPHIBIA		
Rana tigrina, living	////////	Bones were also eaten.
chloroformed	////////	
Bufo arnarius, living	//////	
chloroformed	//////	
LACERTILIA		
Mabuya macularia, living	xxxx	The lizards climbed over the meshes of the cage and thus could not be captured.
chloroformed	oooooo	
Hemidactylus flaviviridis ventrally incised	//////	
Uromastix hardwickii, living	//	Only the tails of the living lizards were taken.
ventrally incised	///////	The skin was not taken.
Varanus griseus, living		The tail of the 1½ feet long *Varanus* was caught in between the jaws by a hedgehog. It then rolled, The lizard attacked the hedgehog furiously; in doing so, however, the *Varanus* was seriously injured.
OPHIDIA		
Eryx johnii (juvenile) living	/	The entire reptile was eaten.
Eryx conicus, living	xx	The *Eryx* was attacked but was not killed. Only the general viscera was taken.
ventrally incised	ooo	
Cobra, *Naia tripudians*, living	x	When the snake was introduced in the cage, the hedgehogs rolled after hearing the loud hissing noise of the Cobra (Prakash, 1958a).
ventrally incised	***	

Food items provided	Trials	Remarks
Viper, *Echis carinata* (13"), living	xxx	The hedgehog attacked the snake very carefully, pulling the crown of the spines over the snout, but the viper was also careful and escaped with a loud hiss which made the hedgehogs roll.
chloroformed	oooo	For the first 24 hours the snake was not noticed after which the hedgeohgs began eating it from the tail end, They continued till half was finished.
Python morulus, living	x	The snake was offered to the hedgehog in a large cage. The 8 feet long *Python* was very active and alert. It moved its head along with the moving hedgehog and in no time caught the latter in its mouth (the hedgehog rolled immediately) and placed it into the constriction of the body. As the snake constricted the spines of the hedgehog pierced into its body and the hedgehog was set free. Thrice the *Python* repeated this.
AVES		
White-eared Bulbul, *Pycnonotus leucogenys*,		
flesh	//////	
entire bird	//////	
Red-vented Bulbul, *Pycnonotus cafer*,		
flesh	///////	
entire bird	///////	
Ring Dove, *Streptopelia risoria*,		
living	//////	
entire bird	//////	
Common House Crow, *Corvus splendens*,		
flesh	oooooo	
entire bird	******	

Food items provided	Trials	Remarks
Rose-ringed Parakeet, *Psittacula krameri*,		
flesh	oooooo	
entire bird	oooooo	
King Crow, *Dicrurus macrocercus*,		
flesh	ooooo	
entire bird	*****	
Jungle Babbler,		
Turdoides somerville, flesh	/////	
entire bird	/////	
Common Babbler,		
Turdoides caudata, flesh	/////	
entire bird	////	
Common Myna,		
Acridotheres tristis, flesh	////	
entire bird	ooooo	
Grey Shrike, *Lanius excubitor*,		
flesh	*****	
entire bird	ooooo	
House Sparrow,		
Passer domesticus, flesh	//////	
entire bird	//////	
Green Bee-eater,		
Merops orientalis, flesh	ooooo	
entire bird	*****	
Blue-tailed Bee-eater,		
Merops superciliosus, flesh	ooo	
entire bird	****	
Hoopoe, *Upupa epops*, flesh	////	
entire bird	ooooo	
Pied Bush-chat, *Saxicola caprata*,		
flesh	/////	
entire bird	oooooo	
Rose-coloured starling,		
Sturnus roseus, flesh	//////	
entire bird	//////	

Food items provided	Trials	Remarks
Spotted Owlet, *Athene brama*,		
flesh	****	
entire bird	ooooo	
Grey Partridege, *Francolinus*		
pondiceirianus, flesh	//////	
entire bird	//////	
Common sandgrouse,		
Pterocles exustus, flesh	//////	
entire bird	//////	
Red-Wattled Lapwing,		
Hoplopterus indicus, flesh	//////	
entire bird	//////	
Coot, *Fulica atra*, flesh	////	
entire bird	ooo	
Blue Rock Pigeon,		
Columba livia, flesh	//////	
entire bird	//////	
MAMMALIA		
Long-eared hedgeohog,		
Hemiechinus a. collaris	//	Two of them were noticed attacking a young one, which was on move. The point of attack was the posterior limb, which were latter chewed. After a short while the attackers succeeded in getting the young unrolled and started eating the abdomen (Prakash, 1953).
chloroformed	/////	Starting point was the posterior limbs, after which the abdomen was poked and the visecra was eaten. (Fig.1)
ventrally incised	/////	Prakash (1953) observed that both the types of cannibalism are present among the hedgehogs; feeding on a dead companion, killing it and then feeding on it. However, when properly fed, the animals do not molest one another. Later Prakash (1955) observed that the mother also feed over its own newly born young.

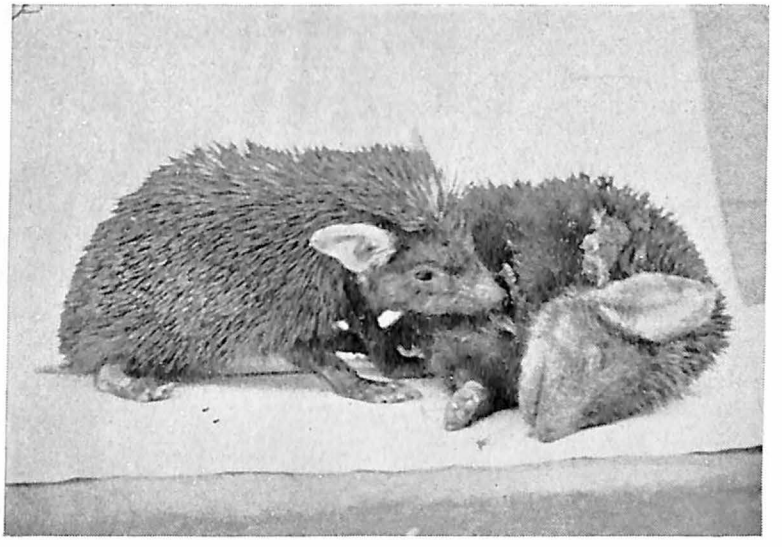

Fig 1. The hedgehog, *H. a. collaris,* feeding over its companion—Cannibalism.

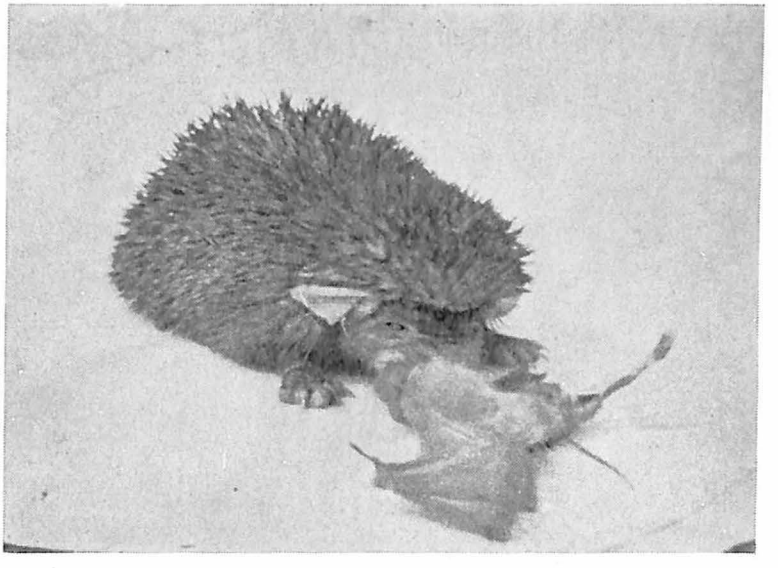

Fig. 2. *H. a. collaris* feeding on a bat, *Rhinopoma kinneari.*

Food items provided	Trials	Remarks
Indian Hedgehog,		
Paraechinus m. micropus, chloroformed	/////	The feet were chewed, the abdomen was poked and the visecera eaten.
Bats,		
Rhinopoma kinneari (Fig. 2)	////	
Rhinopoma h. hardwickei	////	
Megaderma lyra lyra	oooo	
Taphozous k. kachhensis	////	
Taphozous p. perforatus	////	
Rhinolophus l. lepidus	oooo	
Pteropus g. giganteus	/////	
Fox, *Vulpes v. pusilla*,		
living	xx	
ventrally incised	///	
Mongoose,		
Herpestes edwardsi ferrugineus, living	xx	Three hedgehogs were provided to one adult mongoose. During the day nothing happened. After dusk the hedgehogs became active and chased the mongoose which was too fast for them. Anyhow one caught hold of the hind foot of the latter. The mongoose attacked the hedgehog furiously. The hedgehog rolled and continued doing so for three days. The mongoose was attacked several times by other hedgehogs but with no results.
chloroformed	oo	
flesh	//	
Flesh of Goat	//////	
Desert hare,		
Lepus nigricollis dayanus flesh	////	
Squirrel, *Funambulus pennanti*		
living	xxx	
flesh	//////	
Porcupine, *Hystrix i. indica*		
flesh	////	

Food items provided	Trials	Remarks
Indian Gerbille, *Tatera i. indica*, flesh	ooooo	
living	xxxx	The rodent was too agile for the hedgehogs.
Indian Desert Gerbille, *Meriones hurrianae*, living	/////	After dusk the gerbille was chewed from the feet and the viscera was taken.
flesh	////	
House Rat, *Rattus r. rufescens* living	/////	One was caught, killed and eaten,
flesh	/////	
Milk of cow, Buffalo, Goat ane Sheep	/////	All the hedgehogs were fed over milk which they took readily in captive and semi-captive conditions.
SEEDS		
Wheat, *Trticum vulgare*	xxxxxxxx	
Barley, *Hordeum vulgare*	xxxxxxxx	
Millet, *Setaria indica*	xxxxxxxx	
Rice, *Oryza sativa*	xxxxxxxx	
VEGETABLES		
Potato, *Solanum tuberosum*	xxxxxxxx	
Ginger, *Zingiber officinale*	xxxxxxxx	
Mango, *Mangifera indica*	xxxxxxxx	
Tamarind, *Tamarindus indica*	xxxxxxxx	
Coriander, *Coriandrum sativum*	xxxxxxxx	
Pumpkin, *Lagenari vulgaria*	xxxxxxxx	
Carrot, *Daucus carota*	xxxxxx	
Melon. *Cucumis melo*	xxxxxx	
Lemon, *Lemu* sp.	xxxxxx	
Ground nut, *Arachis hypogea*	xxxxxx	
Lufla actongula	xxxxxx	
Morinda citrifolia	xxxxxx	
Allium cepa	xxxxxx	
	xxxxxx	

Food items provided	Trials	Remarks
ENTIRE PLANTS		
Capparis aphylla	xxxxxxx	
Tephrosia perpurea	xxxxxx	
Leptadenia spartium	xxxxxx	
Zizyphus numularia	xxxxxx	
Calotropis procera	xxxxxx	
Prosopis juliflora	xxxxxx	
Prosopis spicigera	xxxxxx	
Euphorbia nerilifolia	xxxxxx	
Cynodon dactylon	xxxxxx	
Eragrostris ciliaris	xxxxxx	
Cenchrus catharticus	xxxxxx	
Trianthema monogyna	xxxxxx	
Corchorus sp.	xxxxxx	
Boerahaavia diffusa	xxxxxx	
Spirobolus sp.	xxxxxx	
Cucumis terigonus	xxxxxx	
Citrullus colocynthis	xxxxxx	
Citrullus vulgaris	xxxxxx	
MISCELLANEOUS		
Sweets, bread and other available things in the market	xxxxxxx	

TABLE 2

(Showing the food provided to gerbilles, *Tatera indica indica* and *Meriones hurrianae* and their preference for it). †

Food items provided	Trials T. i. indica	Trials M. hurrianae
SEEDS		
Pea, *Pivum sativum*	/////	////
Wheat, *Triticum vulgare*	OOOOO	OOOOO
Millet, *Pennesetum typhoideum*	OOOOO	OOOOOO
Gram, *Cicer arietinum*	OOO	****
Lentil, *Lens esculenta*	XXXXX	XXXXX
Moong, *Phaseolous mungo*	XXXX	XXXXX
Tamarind, *Tamarindus indica*	XXX	**
Prosopis juliflora	OOOO	OOOOO
Senegal persica	***	**
Calotropis procera	XXXX	XXXXXX
Capparis aphylla	OOOO	//////
Salvadora persica	////	////
Tephrosia perpurea	//////	//////
Cenchrus catharticus	//////	//////
Cynodon dactylon	//////	//////
LEAFY VEGETABLES AND OTHER PLANTS		
Pea, *Pivum sativum*	///	////
Coriander, *Cariander sativum*	/////	//////
Cauli flower, *Brassica oleracea*	OOOO	OOOOO
Mint, *Mentha virdis*	OOOO	OOO
Cabbage, *Brassica* sp.	XXXX	XXXX
ENTIRE PLANTS		
Prosopis juliflora	***	****
Senegal persica	***	**
Calotropis procera	XXXX	XXXX

† / most preferred; O preferred; * less preferred; X not taken

Food items provided	Trials T. i. indica	M. hurrianae
Zizyphus numularia	////	//////
Tephrosia perpurea	//////	//////
Acacia senegel	**	****
Trianthema monogyna	////	//////
Calligonum polygonoides	//////////	//////
Eragrostris ciliarias	////	//////
Cenchrus catharticus	//////////	//////
Justica sp.	ooo	oooo
Beorhaavia diffusa	oooo	oooo
Crotolaria burhia	////	oooo
Farsetia jaquemontii	oooo	//////
Cynodon dactylon	//////	//////
Triticum vulgare	//////	//////
Cucumis terigonus	////	////
Citrullus colocynthis	////	////
Citrullus vulgaris	////	////
Cauliflower, *Brassica oleracea*	//////	//////
FRUITS & MISCELLANEOUS		
Mango, *Mangifera indica*	xxxx	***
Brinjal, *Solanum melogena*	xxxx	***
Ladies finger, *Hisbiscus esculentus*	xxxx	xxxx
Pumpkin, *Cucurbita maxima*	***	****
Pomagranate, *Punica granatum*	xxx	xxxx
Orange, *Citrus aurantium*	xxx	xxxx
Tamato, *Lycopersicum esculentum*	ooooo	oooo
Cucumber, *Cucumis sativus*	//////	//////
Apricot, *Prunus armeniaca*	**	oooo
Onion, *Allium cepa*	**	xxx
Potato, *Solanum tuberosum*	////	//////
Ground nut, *Arachis hypogea*	//////	//////
Carrot, *Daucus carota*	ooo	////

Food items provided	Trials T. i. indica	M. hurrianae
Sweet potato, *Ipomea batatus*	oo	////
Memordica charantia	oooo	oooo
Sugar	////////	////////
Wheat flour	oo	oo
Milk	////	////
INVERTEBRATES		
Earthworm, *Pheretima posthuma*, living	xxxx	xxx
chloroformed	xx	xxx
Snail, *Pila globosa*, shelled	xxxx	xxxx
shell removed	////	xxx
Spiders, living	xxx	xxx
chloroformed	xxx	xxx
Scorpion, living	xxx	xxx
chloroformed	ooo	xxx
Centipede, living	xxx	xxx
chloroformed	ooo	xvx
INSECTS (chloroformed)		
Mustard saw-fly, *Anthialia proxima*	xxx	xxx
Ichneumoid wasp, *Pimpla punctata*	xxx	xxx
Potter Wasp, *Eumenes esuriens*	xxx	xxx
Ant, *Dorilus labiatus*	xxxx	xxxx
Monomorium indicum	ooo	////
Anthia sexguttata	////	xxxx
Water scavanger beetle, *Hydrophilus olivaceus*	oooooo	xxxx
Juliodes atkinsoni	oooo	xxxx
Helicopris buciphalus	////	xxx
Onthophagus longicornis	////	xxx
Desert locust, *Schistocerea gregaria*	//////	//////

Food items provided	Trials T.i. indica	M.hurrianae	
Painted grasshopper, *Poecilocerus pictus*	xxxx	xxx	
Mantis, *Hirodula condyrctota*	oooo	***	
Cricket, *Gryllus domesticus*	oooo	****	
White ant, *Acanthotermes macrocephalus*	/////	/////	
Fresh water bug, *Belastoma indica*	xxx	xx	
Brown hairy caterpillar, *Amsacta lectinea*	ooo	oxx	
AMPHIBIA			
Bull frog, *Rana tigrina*, living	***	xxxx	
Toad, *Bufo arnareus*, living	oooo	xxxx	
REPTILIA			
Mabuya macularia, living and killed	oo	xxxx	(The head of *M. macularia* was eaten, an also the tail of *U. hardwickii*)
Uromastix hardwickii living and killed	ooo	xxxx	
Hemidactylus flaviviridis living and killed	xxxx	xxxx	
Varanus griseus living and killed	xxx	xxxx	
Eryx johnii living and killed	xxxx	xxxx	
Echis carinata living and killed	xxx	xxxx	
AVES			
20 species of birds which were also given to the hedgehogs, killed	x	x	
MAMMALIA			
Hedgehog, *H. a. collaris*	xx	xxxx	
Bats, *Rhinopoma kinneari*	o	xxxx	
Rhinopoma hardwickei	oo	xxxx	

Food items provided	Trials T.i. indica	M.hurrianae	
Megaderma lyra	xxx	xxxx	
Pteropus giganteus	xxx	xxx	
Fox, *Vulpes v. pusilla*, chloroformed and flesh	xx	xxxx	
Mongoose, *Herpestes e. ferrugineus*, chloroformed and flesh	xxx	xxxx	
Flesh of goat	//////	xxxxxx	
Squirrel, *Funambulus pennanti*, living	/////	xxxxx	(After dusk the squirrels retired in a corner of the cage. The gerbilles attacked them on their neck and head and ate only the skull and brain).
chloroformed	////	xxxx	(In addition some flesh from thighs was also eaten).
ventrally incised	////	xxxx	(Liver and lungs were also eaten).
Gerbille, *T. i. indica*, living	////	xxxx	(The young were attacked on their necks. Entire animals except skin were eaten).
chloroformed	oooo	xxxx	
Rattus r. rufescens, living	///	xxx	
chloroformed	///	xxxx	

CONCLUSIONS AND SUMMARY

1. The hedgehogs (*Hemiechinus auritus collaris* Gray and *Praechinus micropus micropus* Blyth) and the gerbilles (*Tatera indica indica* Hardwickei and *Meriones hurrianae* Jerdon) were selected for the study of their food and feeding habits.

2. A large variety of food material was given to them and their choice for food was considered in four categories: most preferred, preferred, less preferred and not taken.

3. The food was studied in nature, semi-captivity and coptivity. The present paper deals with the observation in captivity.

4. **Hedgehogs :**—The hedgehogs show less inclination for the Invertebrates, except the insects. Among them too, insects belonging to Coleoptera and Orthoptera were preferred. Amphibians and lizards have a good place in their menu. They could not, however, be killed when alive, but were eaten when given chloroformed and ventrally incised. Snakes also give a good fight to the hedgehogs which are sometimes killed and eaten. Interesting duels between snakes and hedgehogs have been observed.

5. They are cannibals. It has been observed that both types of cannibalism are present among them : feeding on a dead companion and killing it and then feeding on it.

6. The hedgehogs show a definite rating for birds and their flesh.

7. Birds of larger size and of lighter shades were preferred.

8. There was considerable diversity in rating of the entire birds and their flesh.

9. Birds tasty to man are also held as preferred by the hedgehogs.

10. **Gerbilles :**—The gerbille, *Tatera indica indica* has more varied diet than the *Meriones hurrianae.* The latter prefers seeds while the former likes insects and flesh. Sometimes the *Meriones* feed on insects particularly the locusts. The *Meriones* prefer dry food on succulent food.

The results of the study on foods of these gerbilles are being published elsewhere (Prakash, 1959 a).

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Studies on the Digestive Physiology of Leucinodes orbonalis Guen.

(Lepidoptera, Pyraustidae)

By

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INTRODUCTION

The study of the nutritional requirements of insects has attracted the attention of many workers but our knowledge is largely confined to those insects which feed on stored products because they can be easily fed on synthetic diets. However, recently some work has been done on phytophagus insects by Brown (1930, 1937), Evans (1938, 1939), Crowell (1941) and Saxena (1954, 55). The insect under study, commonly known as the brinjal borer, is a serious specific pest of brinjal and exercises a strong varietal preference. The study of its nutritional requirements has been taken up and observations on the pH and quantitative estimation of enzymes in the gut of *L. orbonalis* are being presented here.

MATERIAL AND TECHNIQUE

The brinjals infected with the larvæ were collected from the field. The larvæ were taken out from these and were reared in the laboratory. Only the full grown larvæ and the newly emerged imagoes were employed for the purposes of various tests.

The study of the H-ion concentration is important for the study of digestive physiology because different enzymes act at different pH. Hence only these two aspects of digestive physiology viz. H-ion concentration and the qualitative estimation of the enzymes of various parts of the alimentary canal have been studied. The techniques employed for each have been given under their respective headings.

OBSERVATIONS

I. ANATOMY OF THE DIGESTIVE ORGANS

LARVA

The alimentary canal of the larva (Fig. 1) is almost a straight tube having a wide lumen. It is nearly as long as the body of the larva and is divisible into three distinct regions, the foregut, the midgut and the hindgut. The foregut starts from the level of the mouth and extends backwards upto the end of the meta-thoracic segment. The mesenteron is the largest and occupies almost the whole of the abdominal region extending upto the sixth or seventh abdominal segment.

In early stages it appears as a uniform straight tube but as the larva grows older it increases in size resulting in numerous infoldings both lengthwise and crosswise, the latter being more conspicuous. The hindgut extends from the posterior end of the midgut to the anus. The posterior limit of the midgut and the anterior end of the hindgut are easily distinguishable because of the presence of the malpighian tubules at their junction.

IMAGO

Like the alimentary canal of the larva the gut of the imago (Fig. 2) is also distinctly divisible into the foregut, the midgut and the hindgut and is much longer than the larva, being about double the length of the insect itself. The foregut continues upto the first abdominal segment. Its various parts viz. pharynx, œsophagus and crop are clearly distinguishable from one another. The ball-shaped pharynx continues posteriorly into a slender tubular œsophagus extending beyond the thoracic segments. The sac-like crop is connected to the posterior portion of the œsophagus by a short narrow duct. The midgut is comparatively smaller and extends from the first to the fourth abdominal segment, lying a little obliquely. The hindgut which is divisible into intestine and rectum is very long and lies coiled in the posterior abdominal segments.

II. DETERMINATION OF THE H-ION CONCENTRATION

As the quantity of secretion available from the gut wall is extremely little, the pH comparator and the pH meter methods were abandoned in favour of indicator paper method. Merk's indicator papers were employed and only conductivity water was used, whenever necessary, for the determination of pH.

The indicator paper feeding method did not give satisfactory results as the larvæ did not feed on it. The larvæ were dissected after about eight hours starvation and the adults after about four hours starvation to clear the gut of the food contents. Different parts of the alimentary canal were ripped open and the food present in it was removed. Then the inner layer of each part was slightly teased and brought in contact with the indicator papers of different ranges. The results obtained are given below :—

Table No. 1; pH in different regions of the alimentary canal of *L. orbonalis*.

Region.		pH. (larvæ)	pH. (Imago)
Food substance	...	5.0	...
Salivary glands	...	6.0	6.0
Foregut	...	6.4	6.0
Midgut	...	6.4	6.2
Hindgut	...	6.2	6.0
Excreta	...	4.8 to 5.0	5.7 to 6.0

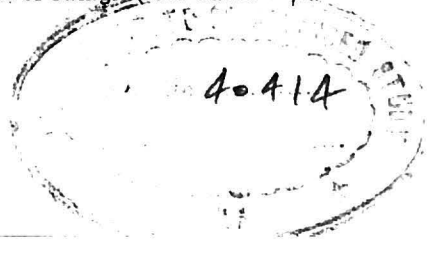
III. QUALITATIVE ESTIMATION OF ENZYMES.

Preparation of the extract: The full grown larvæ and the newly emerged imagos were chloroformed, thoroughly washed in distilled water and dissected immediately in distilled water. The alimentary canal was taken out from the body and was straightened on the slide. It was made free from the adhering tissues and was once again washed well with distilled water. The salivary glands and the different parts of the alimentary canal were then separated and ground with glycerine. The extracts thus obtained were filled in the microtubes to about one-third of their capacity, the remaining two third being filled with toulene, to prevent the bacterial and fungal growth. The extracts were then subjected to suitable chemical tests. All the tests were accompanied by controls.

AMYLASE

Test* (1) Tissue suspensions of each part, i.e., salivary gland, foregut, midgut and hindgut of both the larvæ and the adults and the food contents of the larval midgut were taken separately

* Tests for proteases were performed on the lines of Hinmann (1933) and the rest on the lines of Swingle (1928 and 1931).



in two microtubes each. One of each set of respective specimens was thoroughly boiled to be used as control. Two drops of 0.5% boiled soluble starch solution were now added to each tube and the rest of the tube filled with toluene and incubated from 72 to 96 hours, to enable complete decomposition of starch. After 96 hours potassium iodide iodine test was performed. Two drops of potassium iodide iodine solution (0.5% iodine solution in 1.5% potassium iodide solution) were added to each test and control microtube.

Observation—The test microtubes containing the salivary glands, the midgut extracts and the midgut food contents of the larvæ did not turn blue, the rest turned blue.

Inference—Amylase is secreted in the salivary glands and the midguit. It is also present in the midgut food contents of the larva.

Test (ii) The solutions which did not turn blue with potassium iodide-iodine solution (incubated solutions of the extracts of the salivary gland, midgut and midgut food contents of the larvæ) were further tested for the presence of maltose, the decomposition product, by the picramic acid test. Four drops of the incubated solution, one drop of 10% NaOH solution and two drops of a saturated aqueous solution of picric acid were placed in a microtube in the order mentioned. The tube was then placed in an electric oven at 60°C.

Observation—The colour of the yellow picric acid was changed to reddish brown picramic acid.

Inference—Maltose is formed as a result of hydrolysis of starch by the amylase present in the salivary gland, midgut extract and midgut food contents of the larvæ.

Test (iii)—For further confirmation, Fehling's test and Fluckiger's test for sugar were performed.

Fehling's test—A few drops of Fehling's solution No. 1 were taken in a test tube and added to Fehling's solution No. II drop by drop till the precipitate that appeared in the beginning disappeared. To a few drops of the mixed Fehling's solution two drops of the incubated solution which had given test for the presence of amylase were added separately, heated and allowed to stand.

Observation—Within five minutes of heating, reddish brown precipitate of copper appeared.

Inference—Sugar present.

Fluckiger's test—Further confirmation was made by Fluckiger's test. A drop of 20% NaOH was mixed with an equal quantity of powdered copper tartrate upon a slide until copper was dissolved. A drop of incubated starch solution was now added to it and the slide is then gently heated.

Observation—Red precipitate of copper appeared.

Inference—Reducing sugar present. Thus the presence of amylase was finally confirmed in the salivary glands of the larvæ.

MALTASE

Test (1)—A few drops of 15% maltose solution were incubated separately with the tissue suspensions of different parts of the gut of the larvae and adults. After forty eight hours or more of incubation a part of each of the incubated fluid was tested for the presence of glucose by osazone test. For this, 1 gm. of phenyl hydrazine hydrochloride was ground with 10 c.c. of glycerine till it dissolved and then filtered through glass wool. A drop of this phenyl hydrazine hydrochloride solution was mixed with a drop of sodium acetate solution in glycerine (1 gm. in 10 c.c.) upon a slide, a drop of solution to be tested was added to it and then covered with a cover galss. The slide was then heated on a water bath at 100°C for 15 minutes.

Observation—An hour after cooling, glucose osazone appeared in the incubated tissue suspension of midgut of the larvæ only.

Inference—Maltose has been hydrolysed to glucose by maltase of the midgut of the larvæ.

Test (ii)—Barfoed's test for monosaccharides was performed. A small quantity of CH_3COOH was added to a solution of copper acetate. (If the solution was too alkaline disaccharide was hydrolysed to glucose and the presence of glucose detected even in the absence of Maltase, hence the mixture of acetic acid and copper acetate was tested with a solution of Maltose to see if maltose is hydrolysed to glucose or not).

Observation—A reddish brown precipitate appeared on heating in the case of the midgut extracts of the larvæ only.

Inference—Maltase is present only in the larval midgut,

INVERTASE

Test (1)—A few drops of 15% sucrose solution were incubated with the tissue suspensions of gut. After incubating for 48 hours or more, a drop was tested for the presence of fructose and glucose by osazone test and for reducing sugars by Fluckiger's test.

Observation—Fructose-osazone appeared immediately and glucose osazone upon cooling in the midgut extracts of the larvæ and the adults. Other parts failed to react properly.

Inference—Invertase is present only in the midgut of the larvæ and adults.

LACTASE

Test (1)—A few drops of 15% lactose solution were incubated with the tissue suspensions of different parts of the gut of the larva and the adults for 90 hours and then tested for glucose by osazone test.

Observation—Glucose osazone appeared an hour after cooling in the midgut extracts of the larvæ only.

Inference—Lactase is present only in the midgut of the larvæ.

Alternative test—A drop of 15% lactose solution and two drops of glycerine extract of diflerent parts of the gut of the larvæ and the adults were placed in microtubes, the remaining parts of the microtubes were filled with toluene, incubated for 72 hours at room temperature and tested for glucose by osazone test.

Observation—Glucose osazone appeared in the extracts of the midgut of the larvæ only. It gave positive results in Barfoed's test also.

Inference—Lactase is present only in the midgut of the larvæ.

LIPASE

Test (1)—Lipase was tested by using condensed milk. Two drops of bromothymol blue were added to 25 C.C. of 10% solution of condensed milk. Powdered $NaHCo_3$ or 15% NaOH was gradually added to the solution till it turned light blue. Now 1.0 C.C. of blue milk solution and two drops of the extract were

placed in a microtube and the rest of the tube filled with toluene as usual and incubated for 24-48 hours at room temperature.

Observation—After 48 hours the colour of blue milk changed to yellow only in the extracts of midgut of the larva.

Inference—The presence of lipase in the midgut of the larva was thus confirmed.

PROTEASE

Test (1)—The white of hen's egg was taken in a test-tube and drawn into fine capillary tubing. The two ends of the tube were sealed by heating in a flame and then it was transferred to a water bath and heated slowly to coagulate albumen without air bubbles. On cooling the tubing was cut into pieces of about 1 cm. each. One piece was immersed in each of the gut extracts. The pH of the extracts was adjusted to 8.0 and 6.4 to make the medium alkaline and acidic respectively by suitable buffer solutions.

Observation—The digestion of albumen was readily visible in the test microtube of only the midgut extract of the larva.

Inference—Protease is present only in the midgut of the larva.

DISCUSSION

Hydrogen Ion Concentration

Regarding the pH of the different parts of the gut it has been noted that in both the larva and the adult the gut is slightly acidic. This fact is in agreement with the observations of Wigglesworth (1950), according to whom the pH of different parts of the gut particularly of the midgut in insects in general varies slightly from neutrality. Deviation from this general rule has been recorded in a few cases e.g, the blowfly larvæ and adults, housefly larvæ (Hobson, 1931 and Waterhouse, 1940), aphids (Brametedt, 1948) and adult mosquitoes (MacGregor, 1931). Shinoda (1930) observed some cases of lepidopterous and trichopterous larvæ where pH varies from weakly alkaline to strongly alkaline. Waterhouse (1949) working on two species of carnivorous lepidopterous larvæ and forty species of adult Lepidoptera and on the basis of the previous available records for phytophagous, wool-eating and wax-eating lepidopterous larvæ, generalized that the midgut alkalinity is the characteristic of Lepidoptera,

Thus the author's observations are not in agreement with Shinoda (1930) and Waterhouse (1949). The possibility of the acidity of the gut of the lepidopterous larvæ and the adults has not been ruled out even by Waterhouse himself as in his own words "midgut of some lepidopterous larvæ and the adults yet to be investigated may be found neutral or acidic." Jameson and Atkins (1931) also reported the midgut of *Bombyx mori* adult to be acidic.

The effect of starvation on the pH of the gut of the insects is also a controversial issue. Bodine (1925) has noted that the pH values of starved insects were similar to those of the normal ones. The author, however, feels that the insects should be partially starved before noting the pH in order to clear the gut of the food contents to a very great extent, although total starvation is likely to effect the pH of the alimentary canal.

Digestive Enzymes.

The qualitative tests for enzymes have revealed that the foregut and the hindgut of both the larva and the imago are free from enzymes. The salivary glands of the larva contain a single enzyme amylase, but the salivary glands of the adult are devoid of any enzyme. Wigglesworth (1950) has also noted that in the salivary secretion of insects either amylase is present or no enzyme at all. As the secretion of the midgut of the adult has also been noted to be devoid of amylase, it is clear that the adult does not utilise starch. Ulmann (1932) has demonstrated that the intestinal juices of a number of phytophagous insects are unable to dissolve starch granules, but can quickly hydrolyse boiled soluble starch which also is only partly utilized. Crowell (1941) has noted that lepidopterous larvae *Prodenia eridania* do not utilise starch inspite of the presence of amylase both in the salivary glands and the midgut. For this purpose, besides testing the salivary glands and midgut tissue suspensions of the larva for amylase, the food of the midgut was also tested. Starch gave positive test with the contents of the larval midgut showing thereby that amylase is at least secreted and as it is secreted it is very unlikely that starch in the midgut remains unacted. The midgut of the larva besides secreting amylase, also secretes lactase, maltase, invertase, lipase and protease. The presence of amylase, maltase, invertase and lactase indicates that the larva can utilise carbohydrates. The presence of lipase shows that it needs fat also

for its nutrition. Brown (1937) has noted complete absence of protein from the excreta of the grasshopper *Melanoplus*, showing thereby that it has been utilised by the insect. Hinmann (1933) and Bradstedt (1948) have also reached the conclusion that in the phytophagous insects protein is the chief dietary factor and is completely utilised along with soluble sugars. The presence of protease in the midgut of this insect goes to show that like other phytophagous insects it also needs protein for its nutrition.

The reduction of enzymes from six in the larva to one in the adult is an interesting feature. During metamorphosis the entire midgut of the larva degenerates and the imaginal midgut is formed by the few interstitial cells which lie scattered in the bases of the larval epithelial cells. It appears, therefore, that during this replacement of the larval midgut into the adult midgut the change in the capacity of enzymes secretion also takes place. The change in the number of enzymes from six in the larval midgut to one in the imago is correlated with the difference in the food and the feeding habits of the larva and the imago. The larva feeds on the brinjal pulp while the adult is only a nectar feeder. Evidently, therefore, the adult insect does not need to have the full set of enzymes which are possessed by the larva as they are entirely unnecessary. Nectar contains sucrose and glucose only, hence for utilising sucrose only the invertase is necessary, which readily converts sucrose of the nectar into glucose and fructose.

SUMMARY

The salivary glands and the various parts of the gut are slightly acidic both in the larva and the adult. Contrary to the earlier generalisation that the lepidopteran midgut is alkaline, that of *L. orbonalis* is found to be a weakly acidic.

The only enzyme present in the salivary glands of the larva is amylase, those of the adult are devoid of it. The larval midgut secretes amylase, lactase, maltase, invertase, lipase and protease while the adult midgut secretes only the invertase. The extracts of foregut and the hindgut in both the larva and the adult react negatively to all the enzyme tests.

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DESCRIPTION OF FIGURES

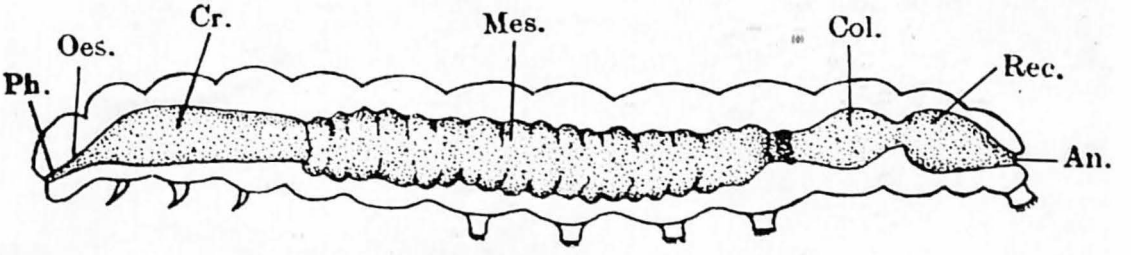

Fig. 1

Alimentary canal of the larva showing gross anatomy.

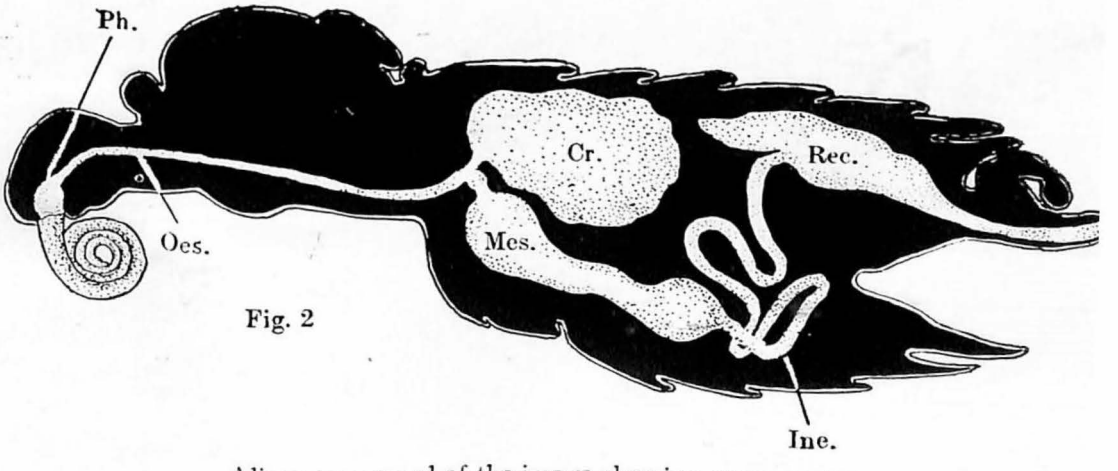

Fig. 2

Alimentary canal of the imago showing grass anatomy.

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DESCRIPTION OF FIGURES

Fig. 1, Alimentary canal of the larva showing gross anatomy.

Fig. 2, Alimentary canal of the imago showing gross anatomy.

Abbreviations used :

An., Anus; Col., Colon; Cr., Crop;

Ine., Intestine; Oes., Oesophagus;

Mes., Mesonteron; Ph., Pharynx; Rec., Rectum.

Checklist of the Mammals of Rajasthan Desert

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During a Project to study the vertebrates of the desert of Rajasthan, about 500 mammals belonging to 38 species and subspecies were collected and studied. Results of the study have been published (Krishna & Prakash, 1955, 1956; Prakash, 1955-56, 1956, 1958, 1958a, 1958b), and others are in the process of publication (Krishna & Prakash, 1959, 1959a; Prakash, 1959, 1959a-f).

This paper presents a checklist of mammals studied from the Rajasthan desert. The arrangement of orders, species and subspecies has been followed from Ellerman & Morrison-Scott (1951). An attempt has been made to compile relevant synonimies from works which are available to a young zoologist. Sometimes a non-specialist is confused by not finding an animal's zoological name in recent checklists, which have been used by earlier workers such as Jerdon, Sterndale, Blanford. The distribution given is on the basis of our findings in the desert. Their range in India and in Palaearctic region has also been given.

It is hoped, therefore, this checklist will be of use, particularly to non-specialists.

Acknowledgements.—The Project was financed by UNESCO and the author is thankful to the Organisation. It was supervised by Dr. Daya Krishna, to whom author's respectful thanks are due.

(A) Order 1. INSECTIVORA

(a) Family 1. ERINACEIDAE (Hedgehogs)

Genus 1. *Hemiechinus* Fitzinger, 1866

1866. *Hemiechinus* Fitzinger, S. B. Akad. Wiss. Wien, 54, 1:565.

1. **Hemiechinus auritus collaris** Gray, 1830

(The long-eared Hedgehog)

1830. *Erinaceus collaris* Gray in Hardwicke, Illustr. India Zool. 1.Pl. 8 (Doab, between the rivers Jamuna and Ganges, India).

1832. *Erinaceus spatangus* Bannett, Proc. Zool. Soc., 123 (Himalayan mountains).

1832. *Erinaceus grayi* Bennett, Proc. Zool. Soc., 124 (Himalayan mountains).

1833. *Erinaceus indicus* Royle, Illustr. Bot. Himalaya, 6, (Delhi, India).

1867. *Erinaceus collaris* Gray and Hardwicke, in Jerdon, Mammals of India: 62 (Doab).

1882. *Erinaceus grayi* Bennett, in Dobson, Monograph Insectivora: 17 (Ajmer).

1888-91. *Erinaceus collaris* Gray and Hardwicke, in Blanford, Fauna Brit. India, Mamm. : 215 (Punjab, Sind, North Western India to Fatehpur).

1918. *Hemiechinus collaris* Gray, in Wroughton, J. Bombay nat. Hist. Soc., 26:31 (Punjab, Sind and Northwestern India).

1951. *Hemiechinus auritus collaris* Gray, in Ellerman and Morrison-Scott, Checklist Palae and Indian Mamm.; 25 (Northern India and Afghanistan).

DISTRIBUTION

The subspecies is spread all over the desert region of Rajasthan. The population is thickest in the Ratanpur and Jhunjhunu area. They are found in the Jaipur division also. Their range extends to punjab, Cutch, Sind, Bhawalpur and upto Kanpur. The distribution of Hedgehogs has been discussed in detail in a separate paper (Krishna & Prakash, 1955).

Genus 2. *Paraechinus* Trouessart, 1879

1879. *Parachinus* Trouessart, Rev. Zool. Paris, 7:242.

2. **Paraechinus micropus micropus** Blyth, 1846
(Indian Hedgehog)

1846. *Erinaceus micropus* Blyth, Jour. Asiat. Soc., Bengal, 15: 170 (Bhawalpur, Punjab, Northern India).

1867. *Erinaceus micropus* Blyth, in Jerdon, Mamm. of India: 63 (Madras).

1872. *Erinaceus* (*Hemiechinus*) *pictus* Stolizka, J. Asiat. Soc. Bengal, 41:223 (Western Part of Cutch).

1882, *Erinaceus micropus* Blyth, in Dobson, Monograph of Insectivora : 14; in Blanford, Fauna Brit. India, Mamm : 218 (Plains of southern India); in Wroughton, J. Bombay nat. Hist. Soc., 26:31 (Punjab, Rajputana, Cutch, Sind and Kathiawar), 1918.

1951. *Paraechinus micropus micropus* Blyth, in Ellerman and Morrison-Scott, Checklist Palae. and Indian Mamm. : 28 (as Wroughton, 1918).

DISTRIBUTION.

P.m. micropus are not so widely distributed in the desert area as the *H.a. collaris*. They are found only in Ratangarh and Jhunjhunu area. Jerdon (1867) and Blanford (1888-91) did not record *P.m. micropus* from Rajasthan, and have mentioned that this variety occurred only in South India (Trichnopoly and Coimbatore etc.). At that time the sub-species *micropus* and *nudiventris* were not separated and were included under a common name *micropus*, which had a full specific rank. The accounts of Jerdon (1867) and Blanford (1888-91) are correct for the *Paraechinus micropus nudiventris* Horsfield but not for *Paraechinus m. micropus*. The other reason for their omission could be that they collected material from Barmer, Jaisalmer and Ganganagar only, where we have not observed this subspecies. Later Wroughton (1918) recorded the presence of *P.m. micropus* from this northern part of Rajasthan and has described Bhawalpur as its type locality (Krishna and Prakash, 1955, Prakash, 1955-56).

(b) Family 2. SORICIDAE (Shrews).

Genus 1. *Suncus* Ehrenberg, 1833.

1833. *Suncus* Ehrenberg, Symb. Phys. Mamm.: 2.

3. **Suncus murinus sindensis** Anderson, 1877.

(The house Shrew)

1877. *Crocidura (Pachyura) sindensis,* Anderson, J. Asiat. Soc. Bengal. 46:266 (Sind, Kathiawar, Rajputana and Cutch).

1888-91. *Crocidura caerulea* Kerr, in Blanford, Fauna, Brit. India, Mamm.:236 (India, Ceylon and Burma).

1929. *Suncus caeruleus sindensis* Anderson, in Lindsay J. Bombay nat. Hist. Soc., 33:326 (Kathiawar, Sind-desert areas).

1951. *Suncus murinus sindensis* Anderson, in Ellerman and morrison-Scott, Checklist Paæ. and Indian Mamm., 67 (Karachi, Kathiawar, Rajputana, Cutch).

DISTRIBUTION.

This shrew was collected from Bikaner division only. The same sub-species has been, however, reported from non desert regions also (Jaipur and Udaipur divisions). Prakash (1958) mentioned that this shrew has suffered a great extermination by merciless killing by man, inspite of the fact that it helps mankind by eradicating noxious insects.

(B) Order 2.—CHIROPTERA.

(a) Family 1. PTEROPODIDAE (Flying fox, Fruit bat).

Genus 1. *Pteropus* Brisson, 1762.

1762. *Pteropus* Brisson, Regn. Anim., 13:153-155.

4. **Pteropus giganteus giganteus Brünnich,** 1782. (Indian Flying Fox).

1782. *Vespertilio gigantea* Brünnich, Dyrenes Historie, 1:45 (India).

1825. *Pteropus medius* Temminck, Monograph Mamm. 1:176 (Calcutta and Pondicherry).

1851. *Pteropus edwardsi* Horsfield, Catalogue Mamm. Mus. East India Company : 28. 1867 in Jerdon, Mamm. of India : 18.

1876. *Pteropus medius* Temminck, in Dobson, Monograph Asiat. Chiroptera : 18.

1888-91. *Pteropus medius* Temminck in Blanford, Fauna Brit. India, Mamm. 257 (India).

1918. *Pteropus giganteus giganteus* Brünnich, in Wroughton, J. Bombay nat. Hist. Soc., 25:547 (Ceylon, Peninsular India, north to Punjab and eastward to Sikkim and Bhutan).

DISTRIBUTION.

Anderson (1912) gave its range as "Indian Peninsula, south of Punjab, Himalaya and Ceylon". Blanford (1888-91) mentioned that they are distributed all over India but are "rare in Western Rajputana, Cutch and Sind and not known to occur in Punjab".

Later they were recorded from Punjab by Wroughton (1918) and Breadon (1932—probably wrongly identified as *Pteropus giganteus leucocephalus)*. The bat has been collected only at Jodhpur in the desert region. Blanford's *(loc. cit.)* statement is supported by our survey that they are not well distributed in Western India.

(b) Family 2. RHINOPOMATIDAE (Rat-tailed Bats).

Genus 1. *Rhinopoma* Geoffroy, 1818.

1818. *Rhinopoma* Geoffroy, Description de l'Egypte, 2:113.

5. **Rhinopoma kinneari** Wroughton, 1912.
(Rat-tailed Bat)

1912. *Rhinopoma kinneari* Wroughton, J. Bombay nat. Hist. Soc., 21:767 (Bhuj, Kutch).

DISTRIBUTION.

According to Wroughton (1918) and Ellerman and Morrison-Scott (1951) their distribution is limited to Cutch, Kathiawar, Nimar and Bengal. Khajuria (1953) examined material from Nagpur, Madhya Pradesh. During this study the bat was collected from Jodhpur, Barmer, Jaisalmer and Pilani. The occurrence of *R. kinneari* in the desert region fills up the lacuna in their distributional record. Considering this its distribution is all over Northern India, from Kathiawar to Bengal; upto Nagpur in South.

6. **Rhinopoma hardwickei hardwickei** Gray, 1831.
(Lesser Rat-tailed Bat).

1831. *Rhinopoma hardwickei* Gray. Zool. Miscl. 37 (India).

1951. *Rhinopoma hardwickei hardwickei* Gray, in Ellerman and Morrison-Scott, Checklist Palae. and Indian Mamm. 102 (Rajputana, U.P., Sind, Cutch, C.P. & Bengal).

DISTRIBUTION

The bat is evenly distributed in the desert region, although it is not so abundant as *R. kinneari*. The species has a very wide distribution—from Palaearctic deserts to Lower Siam.

(c) Family 3. EMBALLONURIDAE (Sheath-tailed Bats)

Genus 1. *Taphozous* Geoffroy, 1818

1818. *Taphozous* Geoffroy, Description de 1' Egypte, 2:113.

Subgenus *Taphozous*

7. **Taphozous perforatus** Geoffroy, 1818

(Tomb Bat)

1818. *Taphozous perforatus* Geoffroy, Description de 1' Egypte, 2:113 (Egypt).

1951. *Taphozous perforatus perforatus* Geoffroy, in Ellerman & Morrison-Scott, Checklist Palæ. Indian Mamm. : 105 (Egypt, Cutch and Kathiawar).

DISTRIBUTION

Wroughton (1918) and Ellerman and Morrison-Scott (1951) mention that the species is distributed in Egypt, Cutch and Kathiawar. During our survey the bat was collected from Jodhpur and Barmer and was not collected at Jaisalmer, Bikaner, Ratangarh and at Sikar. The occurrence of this bat in the desert region extends its distributional range towards East in India.

Subgenus.—*Liponycteris* Thomas, 1922

1922. *Liponycteris* Thomas, Ann. Mag. Nat. Hist., 9 : 267.

8. **Taphozous kachhensis kachhensis** Dobson, 1872

(Cutch Sheath-tailed Bat)

1872. *Taphozous kachhensis* Dobson, J. Asiat. Soc. Bengal, 41 : 221 (Cutch, India).

1876. *Taphozous nudiventris kachhensis* Dobson, in Dobson, Monograph Asiatic Chiroptera : 172.

1888-91. *Taphozous cachhensis* Dobson, in Blanford, Fauna Brit. India, Mamm., 349 (Sind and Cutch).

1918. *Taphozous kachhensis kachhensis* Dobson, in Wroughton, J. Bombat nat. Hist. Soc., 26 : 25 (Sind, Cutch, Kathiawar, Mysore, Bengal and Sikkim).

DISTRIBUTION

The bat has been collected from Jodhpur only. Previously it was not reported from places between Sind and Bengal.

(d) Family 4. MEGADERMATIDÆ (False Vampire)

Genus 1. *Megaderma* Geoffroy, 1810

1810. *Megaderma* Geoffroy, Ann. Mus. H. N. Paris 15 : 197.

Subgenus *Lyroderma** Peters, 1872

1872. *Lyroderma* Peters, Mber. Preuss. Akad. Wiss, 195.

9. **Megaderma lyra lyra** Geoffroy, 1810
(Indian False Vampire)

1810. *Megaderma lyra* E. Geoffroy, Ann. Mus. Nat. Hist. Paris, 15 : 190 (India)

1839. *Vespertilio (Megaderma) carnatica* Elliot, Madras J. Litt. Sci., 10 : 96 (Dharwar, Southern Mahratta, India).

1844. *Megaderma spectrum* Wagner, in Hugeb Kashmir, 569 pl. (Kashmir).

1847. *Megaderma schistacea* Hodgson, J. Asiat. Soc. Bengal, 16 : 889 (Northeastern Bengal).

1918. *Lyroderma lyra lyra* Geoffroy, in Wroughton, J. Bombay nat. Hist. Soc., 25 : 581 (Secunderabad, Palanpur, Khandesh, C. P. Mysore, Bengal, Bhutan).

1951. *Megaderma lyra lyra* Geoffroy, in Ellerman and Morrison-Scott, Checklist Palæ and Indian Mamm. : 109 (As Wroughton 1918 and Burma).

DISTRIBUTION

Jerdon, (1874) and Blanford (1888-91) mentioned its distribution rather vaguely by stating "India". It appears to occur in the wooded land and is not found in the deserts of the Palæarctic region. It meets its Western boundary in Sind (Murray, 1884) through the desert of Rajasthan, from where it has been reported for the first time. It was collected from Jodhpur only.

(e) Family 5. RHINOLOPHIDÆ (Horse-shoe Bat)
Genus 1. *Rhinolophus* Lecepede, 1799

1799. *Rhinolophus* Lecepede, Tabl. Mamm. : 15.

10. **Rhinolophus lepidus lepidus** Blyth, 1844
(Little Indian Horse-shoe Bat)

1844. *Rhinolophus lepidus* Blyth, J. Asiat. Soc. Bengal, 13 : 486 (Calcutta).

1888-91. *Rhinolophus minor* Horsfield, in Blanford, Fauna Brit. India, Mamm. : 276 (Mussoorie, Nepal, Garo hills, Malabar, Peninsular India).

* Wroughton (1918) recognised this species under the genus *Lyroderma*, which is now valid as a subgenus (Simpson, 1945).

1918. *Rhinolophus lepidus lepidus* Blyth, in Wroughton, J. Bombay nat. Hist. Soc., 25 : 574 (Ganges valley, C.P., Kanra, Kumaon, Bengal).

DISTRIBUTION

The bat was collected from Bikaner only, which extends its range considerably to West. It is interesting to note that this bat, an inhabitant of humid areas, is also found in the desert. Wroughton (1918) mentions its type locality to be "Calcutta" while Tate (1939) gives "Ganges Valley".

(f) Family 6. VESPERTILIONIDAE (Pipistrelle and Yellow bat)

Genus 1. *Pipistrellus* Kaup, 1829

1829. *Pipistrellus* Kaup, Skizz. Europ. Thierw. 1:98

11. **Pipistrellus mimus glaucillus** Wroughton, 1912 (Indian Pigmy Pipistrelle)

1912. *Pipistrellus mimus glaucillus* Wroughton, J. Bombay nat. Hist. Soc., 21 : 769 (Multan, Punjab).

DISTRIBUTION

Wroughton (1918) and Tate (1942) report this bat from Multan, Punjab and Sind. Later Khajuria (1953) examined material from N. W. Frontier (Pakistan). The bat has been collected from Jodhpur, extending its range considerably towards Southeast.

Genus 2. *Scotophilus* Leach, 1821

1821 *Scotophilus* Leach, Trans. Linn. Soc. London, 13 : 69.

12. **Scotophilus heathi belangeri** I. Geoffroy, 1834 (Greater Yellow Bat)

1834. *Vespertilio belangeri* Geoffroy, in Belanger, Voyage aux Indes-Orientalis, Zool. :87 (Towns near Pondicherry, Coromandel Coast, India).

1851. *Nycticejus luteus* Blyth, J. Asiat. Soc., Bengal, 20 : 157 (Bengal, Coromandal, India).

1851. *Scotophilus flaveolus* Horsfield, Cat. Mamm. Mus. East India Company : 37 (Many parts of Continental India).

1888-91. *Nycticejus kuhli* Leach, in Blanford, Fauna Brit. India, Mamm., 320 (The Oriental region, from Sind to Borneo).

1918. *Scotophilus kuhli* * Leach, in Wroughton, J. Bombay nat. Hist. Soc., 25 : 594 (Khandesh, Ajanta, Kanra, Bengal, Sind, Cutch, Mysore and Sikkim).

1942. *Scotophilus heathi belangeri* I. Geoffroy, in Tate, Bull. Amer. Mus. Nat. Hist., 80 : 221 (Pondicherry, Coromandel Coast).

DISTRIBUTION

Only one specimen was collected at Jodhpur. Tate (1942) states that this subspecies is found around Pondicherry. If "*kuhli*" is accepted as the synonym of *belangeri*—the range of the bat extends to Peninsular India, Bengal, Sind, Cutch, Palanpur, C.P., Kumaon, Sikkim and Bhutan).

(C) Order 3. PRIMATES
Suborder ANTHROPOIDEA

(a) Family 1. CERCOPITHECIDÆ (Macaques and Langur)
Subfamily CERCOPITHECINÆ
Genus 1. *Macaca* LACEPEDE 1799

1799. *Macaca* Lacepede, Tabl. Mamm., 4.

13. **Macaca mulatta mulatta** Zimmerman, 1780

1780. *Cercopithecus mulatta* Zimmerman, Geogr. Gesch. Mensch. 2:195 (India).

1792. *Simia (Cercopithecus) fulvus* Kerr, Anim. Kingd. 73 (India).

1798. *Simia rhesus* Audebert, Hist. Nat. Singes, fig-i.

1800. *Simia erythraea* Shaw, Gen. Zool. I:33.

1840. *Macaca (Pithex) oinops* Hodgeson, J. Asiat. Soc. Bengal, 9:1212 (Nepal Terai).

1840. *Macaca (Pithex) nipalensis* Hodgeson, J. Asiat. Soc. Bengal, 9:1212 (Nepal Terai).

1863. *Innus rhesus* Blyth, Catalogue Mamm. Mus. Asiat. Soc. :8.

1866. *Innus sancti-johannis* Swinhoe, Proc. Zool. Soc., 556 (North Lena Island, Honkong, China).

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* The status of *Scotophilus kuhli* Leach is not definite, Tate (1942) and Ellerman and Morrison-Scott (1951) are of the view that a full specific rank should not be given to it and, therefore, *S. kuhli* has been tentatively created a synonym of *S. h. belangeri*.

1867. *Innus rhesus* Blyth, in Jerdon, Mamm. of India, :11.

1868. *Macacus lasitus* Gray, in Proc. Zool. Soc. : 60, pl. 6 (Szechuan, China).

1872. *Macacus tcheliensis* Milne-Edwards, Rech. Mamm. : 227 (Mountains to the east of the Province of Tcheli, North-eastern China).

1888-91. *Macacus rhesus* Audeburt, in Blandford, Fauna Brit. India, Mamm. :13 (Northern India).

1909. *Pithecus littoralis* Elliot, Ann. Mag. Nat. Hist. 4:250 (Kuatun, Pulien, South-eastern China).

1909. *Pithcus brachyurus* Elliot, Ann. Mag. Nat. Hist. 4:251 (Hainan).

1917. *Macaca siamica* Kloss, J. nat. Hist. Soc. Siam, 2:247 (Meping Rapids, below Chieng-Eastern China).

1951. *Macaca mulatta mulatta* Zimmerman, in Ellerman and Morrison-Scott, Checklist Palae and Indian Mamm. :197 (Nepal, Bhutan. North Kamrup, Assam, Burma, Northern Peninsular India, Siam, Indo-China, Szechuan, Yunan, to Fukien and adjacent states in Southern China, Chihli, Hainan).

DISTRIBUTION

In the desert region they were observed only at Bikaner and Jodhpur.

Subfamily COLOBINAE

Genus 2. *Presbytis* Eschscholtz, 1821.

1821. *Presbytis* Eschscholtz, in Kotzebue Reise, 3:196.

14. **Presbytis entellus entellus** Dufresne, 1797
(Langur)

1797. *Simia entellus* Dufresne, Bull. Soc. Philom. 1,7:49.

1867. *Presbytis entellus* Dufresne, in Jerdon, Mamm. of India: 4 (Bengal, India).

1888-91. *Semnopithecus entellus* Dufresne, in Blanford, Fauna Brit. India, Mamm. :27 (North portion of Indian Peninsula, South and West Bengal, Orissa, C. P., Bombay, Gujerat, Southern Rajputana, Kathiawar and probably to Sind).

1918. *Pithecus entellus* Dufresne, in Wroughton, J. Bombay nat. Hist. Soc., 25:560 (Bombay, C. P., Kathiawar, Nimar, Berar, Bihar, Orissa, Bengal).

1928. *Pithecus entellus entellus* Dufresne, in Pocock, J. Bombay nat. Hist. Soc., 32:477.

1939. *Semnopithecus entellus entellus* Dufresne, in Pocock, Fauna Brit. India, Mamm. :98 (Northern Peninsular India, South of the Ganges from Bengal to Kathiawar).

1951. *Presbytis entellus entellus* Dufresne, in Ellerman and Morrison-Scott, Checklist Palae. & Indian Mamm. :204 (Bengal to Gujerat and Kathiawar).

DISTRIBUTION

These langurs were observed by this survey at Jodhpur, Bikaner and Barmer. They are profusely distributed on the east of Arawalli mountains.

(D) Order 4. PHOLIDOTA

(a) Family 1. MANIDAE (Pangolin)

Genus 1. *Manis* Linnaeus, 1758

1758. *Manis* Linnaeus, Syst. Nat. 1:36.

15. **Manis crassicaudata** Gray, 1827
(Indian Pangolin)

1827. *Manis crassicaudata* Gray, in Griffith's Cuvier Anim. Kingd. :90.

1867. *Manis pentadactyla* Linnaeus, in Jerdon, Mamm. of India :314.

1888-91. *Manis pentadactyla* Linnaeus, in Blanford, Fauna Brit. India, Mamm. :597 (India and Ceylon).

1920. *Manis crassicaudata* Linnaeus, in Wroughton, J. Bombay nat. Hist. Soc., 27:301-312 (India).

1948. *Manis crassicaudata* Geoffr. St. Hilaire, in Prater, Book of Indian Animals. Bombay.

1951. *Manis crassicaudata* Gray, in Ellerman Morrison-Scott, Checklist Palae. and Indian Mamm. : 215 (India).

DISTRIBUTION

Only one specimen was collected at Sadulpur, Bikaner Division, but its occurrence has been reported from all parts of desert.

(E) Order 5. CARNIVORA

(a) Family 1. CANIDAE (Wolf, Jackal & Foxes).

Genus 1. *Canis* Linnaeus, 1758

1758. *Canis* Linnaeus, Syst. Nat. 1:38.

16. **Canis lupus pallipes** Sykes, 1831
(Small Indian Wolf)

1831. *Canis pallipes* Sykes, Proc. Zool. Soc. :101.

1845. *Canis lupus* Blyth, J. Asiat. Soc., Bengal. 14:345.

1941. *Canis lupus pallipes* Sykes, in Pocock, Fauna Brit. India, Mamm. :90 (From Bengal to Sind and Baluchistan).

DISTRIBUTION

Information has been received from Barmer and Jodhpur regarding their existence. They were also found near Sambhar but have been exterminated (Pocock, 1941). Their range extends from Northern India to Bengal, South to Dharwar, also Baluchistan and thence westward to Iraq and Northern Arabia (Pocock, 1941).

17. **Canis aureus aureus** Linnæus, 1758
(The Asiatic Jackal)

1758. *Canis aureus* Linnæus, Syst. Nat. : 40.

1916. *Canis indicus kola* Wroughton, J. Bombay nat. Hist. Soc., 24 : 651.

1941. *Canis aureus aureus* Linnæus, in Pocock, Fauna Brit. India, Mamm. : 96 (Mesopotamia, Persia, Baluchistan and the deserts of Western India).

DISTRIBUTION

Only two specimens were collected from Bikaner, but it was observed throughout the desert region. It is a typically desert animal, since its range extends into the deserts of the Middle East,

Genus 2. *Vulpes* Oken, 1816

1816. *Vulpes Oken*, Lehrb. d. Naturgesh, 3 : 1033-1034.

18. **Vulpes vulpes pusilla** Blyth, 1854
(Common Red Fox, Desert Fox)

1854. *Vulpes pusillus* Blyth, J. Asiat. Soc. Bengal, 23 : 729 (Salt-Range, Punjab).

1854. *Vulpes leucopus* Blyth, J, Asiat. Soc. Bengal, 23 : 729 (Multan, Punjab).

1875. *Vulpes persica* Blanford, Ann. Mag. Nat. Hist., 16 : 310 (Shiraj, Persia).

1936. *Vulpes vulpes pusilla* Blyth, in Pocock, J. Bombay nat. Hist. Soc., 39 : 45 (Northwest India, Southern Baluchistan. Persia and Mesopotamia).

DISTRIBUTION

The fox is evenly distributed all over the desert area.

19. **Vulpes bengalensis** Shaw, 1800
(Bengal Fox)

1800. *Canis bengalensis* Shaw, Gen. Zool. q., 2 : 330 (Bengal)

1831. *Canis kokree* Sykes, Proc. Zool. Soc. : 101 (Deccan).

1833. *Canis (Vulpes) indicus* Hodgson, Asiat. Res. 18 : 237 (India).

1834. *Canis (Vulpes) rufescens* Gray, Hardwicke's Ill. Ind. Zool. 2. pl. 3 (India).

1837. *Canis chrysurus* Gray, *Vulpes hodgsonii* Gray, Charlesw. Mag. Nat. Hist., 1 : 577-78 (Nepal).

1838. *Vulpes xanthura* Gray, Proc. Zool. Soc., 68 (Nepal).

1951. *Vulpes bengalensis* Shall, of all recent authors, in Ellerman and Morrison-Scott, Checklist Palæ. and Indian Mamm. : 230 (Southern Peninsular India, Travancore, Northwards to Sind, Bihar and Orissa, Kangra in Punjab and Sikkim).

DISTRIBUTION

The fox is not as common as the previous one in the desert. Only one was collected from Bikaner. It is found near areas which have some vegetation and does not occur in deep tracts of the desert.

(b) Family 2. VIVERRIDÆ (Mongooses)

Subfamily. HERPESTINÆ

Genus 1. *Herpestes* Illiger, 1811

1811. *Herpestes* Illiger, Prodr. Syst. Mamm. etc., 135.

20. **Herpestes auropunctatus pallipes** Blyth, 1845
(Small Indian Mongoose)

1845. *Mangusta pallipes* Blyth, J. Asiat. Soc. Bengal, 14 : 346 (Khandar, Afghanistan).

1864. *Herpestes persicus* Gray, Proc. Zool. Soc., 554 (Western Persia).

1888-91. *Herpestes auropunctatus* Hodgson, in Blanford, Fauna Brit. India, Mamm. : 121 (The deserts of Noth-west India).

1914. *Mungos auropunctatus helvus* Ryley, J. Bombay nat. Hist. Soc., 22 : 661 (Deesa, Palanpur, Gejerat).

1918. *Herpestes auropunctatus pallipes* Blyth and *helvus* Ryley, in Wroughton, J. Bombay nat. Hist. Soc., 26 : 54 (Sind Frontier).

1937. *Herpestes javanicus pallipes* Blyth, in Pocock, J. Bombay nat. Hist. Soc., 39 : 242 (The deserts of Northwest India, Afghanistan, Persia and Mesopotamia).

1951. *Herpestes auropunctatus pallipes* Blyth, in Ellerman and Morrison-Scott, Checklist Palæ. and Indian Mamm. : 295 (Palanpur, Punjab, Sind, Baluchistan, Afghanistan, Iraq and Persia ?).

DISTRIBUTION

The mongoose is common in the Bikaner division, while in the Jodhpur division of the desert—*H. edwardsi ferrugineus* is evenly distributed.

21. **Herpestes edwardsi ferrugineus** Blanford, 1874
(Indian Gray Mongoose)

1874. *Herpestes ferrugineus* Blanford, Proc. Zool. Soc. : 661 (Sind).

1884. *Herpestes andersoni* Murray, Vert. Zool. of Sind : 34 (Sind).

1888-91. *Herpestes mungo* Gmel, in Blanford, Fauna Brit. India, Mamm. : 123 (North India).

1914. *Mungos mungo pallens* Ryley, J. Bombay nat. Hist. Soc., 22 : 660 (Palanpur, Northern Gujerat).

1915. *Mungos ferrugineus* Blanford and *pallens* Ryley, in Wroughton, J. Bombay nat. Hist. Soc., 24 ; 51-54.

1918. *Mungos mungo ferrugineus* Blanford, in Wroughton, J. Bombay nat. Hist. Soc., 26:56 (Sind, Northeast Provinces).

1936. *Herpestes griseus montanus* Bechthold, Zeitschr. Saug., 11:149.

1937. *Herpestes edwardsi ferrugineus* Blanford, in Pocock, J. Bombay nat. Hist. Soc., 39:217 (Desert region of northwest India).

DISTRIBUTION

In the desert of Rajasthan it has been reported from every part, but in the Bikaner division it is not so common as the former. In India it is restricted to arid regions only, extending towards West upto Arabia.

(c) Family 3. HYÆNIDÆ (Hyaena)

Genus 1. *Hyæna* Brisson, 1762

1762. *Hyæna* Brisson, Regn. Anim. 13 : 168.

22. **Hyaena hyaena hyaena** Linnæus, 1758

(Striped Hyæna)

1758. *Canis hyæna* Linnæus, Syst. Nat. 10th ed. 1 : 40 (Southern Persia)

1777. *Hyaena striata* Zimmerman, Spec. Zool. Geogr. :366.

1840. *Hyaena virgata* Ogilby, in Royle, Illustr. Bot. Himalaya : 65.

1951. *Hyaena hyaena hyaena* Linnæus, of all recent authors in Ellerman & Morrison-Scott, Checklist Palæ. & Indian Mamm. : 299-300 (Russia, Persia, Iraq, Syria, Palestine, Arabia, Afghanistan, Asia Minor, Kashmir to Nepal, Sind and Kutch to Nilgiri hills, Morocco, Algeria, Egypt, South of Sahara, Somaliland, Sudan and Kanya).

DISTRIBUTION

Hyæna has been reported from Barmer, Jodhpur and Bap. One specimen was examined in the Jodhpur Public Park. It was collected from Bap when it was a sub-adult.

(d) Family 4. FELIDÆ (Cats and Panther)

Genus 1. *Felis* Linnæus, 1758

1758. *Felis* Linnæus, Syst. Nat. 1 : 41.

23. **Felis libyca ornata** Gray, 1830
(Indian Desert Cat)

1830. *Felis ornata* Gray, Illstr. Ind. Zool. 1 pl. 2 (India).

1834. *Felis servalina* Jardine, Nat. Libr. Felinæ, 4 : 232 (India).

1863. *Felis torquota* Blyth, Proc. Zool. Sco : 185.

1888-91. *Felis ornata* Gray, in Blanford, Fauna Brit. India, Mamm. : 84 (Western India, from Punjab and Sind to Sagar and to the Gengetic valley).

1918. *Felis torquota* Blyth and *ornata* Gray, in Wroughton, J. Bombay nat. Hist. Soc. 26 : 41 (Rajputana, Kathiawar, Sind, Cutch and Central India).

1939. *Felis constantina ornata* Gray, in Pocock, Fauna Brit. India, Mamm : 287 (as in Blanford, 1888-91).

1951. *Felis libyca ornata* Gray, in Ellerman & Morrison-Scott, Checklist Palae, & Indian Mamm. : 304 (Punjab, Sind, Cutch, Rajputana and Central India).

DISTRIBUTION

The cat is found all over the desert of Rajasthan.

24. **Felis chaus prateri** Pocock, 1939

1939. *Felis chaus prateri* Pocock, Fauna Brit. India, Mamm. : 298 (Jacobabad, Sind, between the Indus and Kirthar range).

DISTRIBUTION

It appears to be distributed all over the desert of Rajasthan. The total dark variety are also not uncommon. This subspecies is restricted to Sind and Rajasthan desert. Its occurrence in the desert extends its range eastward.

Genus 2. *Panthera* Oken, 1816

1816. *Panthera* Oken, Lehrb. Zool. 3, 2 : 1052.

25. **Panthera pardus** *Linnaeus*, 1758
(Leopard)

1758, *Felis pardus* Linnæus, Syst. Nat. 1 : 41 (Egypt).

1816. *Panthera vulgaris* Oken, Lehrb, nat. 3 : 1058

1951. *Panthera pardus* Linnæus, in Ellerman & Morrison-Scott, Checklist palæ. & Indian Mamm. : 316 (Kashmir to Ceylon).

DISTRIBUTION

In the desert region they have been reported to occur only at Jodhpur. Adams (1899), however, wrote that they were common in Jodhpur, Barmer and Jaisalmer. Since then this Game-animal has suffered a great loss due to indiscriminate shooting (Prakash, 1958).

(F) Order,—ARTIODACTYLA
Suborder.—SUIFORMES, INFRAORDER.—SUINA
(a) Family 1. SUIDÆ (Wild Boar)
Genus 1, *Sus* Linnæus, 1758

1758. *Sus* Linnæus, Syst. Nat. 1 : 49.

26. **Sus scrofa cristatus** Wagner, 1839
(Wild Boar)

1839. *Sus cristatus* Wagner, Munch. Gelehrt. Anz. 9 : 435 (Malabar coast, India).

1842. *Sus aper* var. *aipomus* & *isonatus* Hodgson, J. Asiat. Soc. Bengal 10 : 911 (Nepal).

1843. *Sus indicus* Gray. List Mamm. Brit. Mus. 185.

1847. *Sus affinis* Gray, Cat. Osteol. Brit. Mus. 71 (Nilgiri, India).

1851. *Sus zeylonensis* Blyth, J. Asiat. Soc. Bengal 120 : 173 (Ceylon).

1860. *Sus bengalensis* Blyth, J. Asiat. Soc., Bengal, 29 : 105 (Bengal).

1951. *Sus scrofa cristatus* Wagner, in Ellerman & Morrison-Scott, Checklist Palæ. & Indian Mamm. : 345 (India and Ceylon).

DISTRIBUTION

Adams (1899) wrote that the boars were abundantly distributed in the desert. During this survey only one family of the boars consisting of parents and eight young was observed at Sardar-Samand, Jodhpur. This edible animal has been killed indiscriminately and should be given full protection (Prakash, 1958).

Suborder.—RUMINANTIA
Infraorder.—PECORA
Superfamily.—CERVOIDEA
Family.—CERVIDÆ
Genus. 1. *Cervus* Linnæus, 1758

1758. *Cervus* Linnæus, Syst. Nat. 1 : 66.

Subgenus.—*Rusa* H. Smith, 1827

1827. *Rusa* H. Smith, Griffith's Cuvier Anim. Kingd. 4 : 105.

27. **Cervus unicolor niger** (?) Blainville, 1816
(Sambhar)

1816. *Cervus niger* Blainville, Bull. Soc. Philo., Paris. 76 (North India)

1823. *Cervus aristotelis* Cuvier, Oss. Foss. ed. 2,4 : 503 (Nepal)

1823. *Cervus leschnaulti* Cuvier, Oss. Foss. ed. 2,4 : 506 (Coromandel, India).

1827. *Cervus hippelaphus* H. Smith, Griffith's Cuvier Anim. Kingd. 4 : 105 (Bengal).

1831. *Cervus jarai* Hodgson, Gleanings Science, 3 : 321 (Nepal).

1841. *Cervus heterocerus* and *nepalensis* Hodgson, J. Asiat. Soc., Bengal 10 : 722 & 914 (Nepal).

1867. *Rusa aristotelis* Gray, in Jerdon, Mamm. of India : 256 (India).

1888-91. *Cervus unicolor* Bachestein, in Blanford, Fauna Brit. India, Mamm. : 543 (India, wanting in Punjab, Sind and Western Rajputana; Ceylon).

1920. *Rusa unicolor unicolor* Kerr, in Wroughton J. Bombay nat. Hist. Soc., 27 : 304 (Peninsular India and Ceylon).

1951. *Cervus unicolor niger* Blainville, in Ellerman & Morrison-Scott, Checklist Palæ. & Indian Mamm : 362 (Peninsular India (apart from western desert and semi-desert areas) to Nepal).

DISTRIBUTION

A four years old male was examined in the Jodhpur Public Park. It was collected by an I.A.F. Officer near Kaylana when it was 3 months old. Horns of this animal were also collected from Gajner, Bikaner. The occurrence of this specimen and that of their horns at Bikaner was quite curious since Blanford (1888-91) and Ellerman and Morrison-Scott (1951) specifically mentioned their absence in the desert zone. Later on we were informed that the Late Maharaja of Jodhpur introduced certain number of Sambhar from Kota into the Kaylana reserve. They survived and reproduced well. Unfortunately, after the death of His Highness, shooting became un-restricted and these animals

were also exterminated from this region. The living specimen which was collected was probably the last surviving member of the species in the desert since nothing has been heard of them till now. At Bikaner, however, no information regarding their introduction could be collected.

Superfamily.—BOVOIDEA

Family.—BOVIDAE

Subfamily.—BOVINAE

Tribe.—BOSELAPHINI

Genus.—*Boselaphus* Blainville, 1816.

1816. *Boselaphus* Blainville, Bull. Soc. Philom. Paris, 75.

28. **Boselaphus tragocamelus** Pallas, 1766
(Nilgai, Blue Bull)

1766. *Antilope tragocamelus* Pallas, Misc. Zool : 5 (Peninsular India).

1777. *Antilope albiceps* Erxleben, Syst. Regn. Anim. :280 (India).

1777. *Antilope picta* Pallas, Spicil. Zool., 12:14 (India).

1827. *Damalis risia* H. Smith, Griffith's Cuvier Anim. Kingd., 4:363.

1837. *Tragelaphus hippelaphus* Ogilby, Proc. Zool. Soc : 136.

1846. *Portax picta,* in Jerdon, Mamm. of India : 272 (India).

1888-91. *Boselaphus tragocamelus* Pallas, in Blanford, Fauna, Brit. India, Mamm. : 517 (Himalayas to South Mysore, Punjab, North-west Province, Gujerat and C. P.).

DISTRIBUTION

A herd of nine animals was observed at a grass farm, about seven miles away from Jodhpur. Some solitary Nilgai were also observed on the Sheo-Jodhpur road. Blue bulls have not been reported from Bikaner and Ganganagar districts. In India it is distributed from the Himalayas to South Mysore and in Gujerat, E. Punjab and C. P.).

Subfamily.—ANTILOPINAE

Tribe.—ANTILOPINI

Genus 1. *Antilope* Pallas, 1766

1766. *Antilope* Pallas, Miscl. Zool. 1.

29. **Antilope cervicapra rajputanae** Zukowsky, 1927
(Black Buck, Indian Antelope)

1927. *Antilope rajputanae* Zukowsky, in Hegenbeck, Illustr. Tier. u. Menschenwelt. 2:125 (Bhawalpur, Rajputana and Punjab).

1951. *Antilope cervicapra rajputanae* Zukowsky, in Ellerman and Morrison-Scott, Checklist Palae. and Indian Mamm. : 387 (as above.)

DISTRIBUTION

In the desert region the bucks are restricted to the reserve areas of Gajner, Bikaner and Sardarsamand, Jodhpur and around the villages inhabited by a local tribe "Vishnoi" at Phalodi and Bap. This subspecies is endemic for the western arid tracts.

Genus 2. *Gazella* Blainville, 1816

1816. *Gazella* Blainville, Bull. Soc. Philom. Paris :75.

30. **Gazella gazella bennetti** Sykes, 1831
(Chinkara, Indian Gazelle)

1831. *Antilope bennetti* Sykes, Proc. Zool. Soc: 104 (Deccan).

1839. *Antilope arabica* Elliot, Madras J. Litt., 10:223.

1842. *Gazella christii* Blyth, J. Asiat. Soc. Bengal, 11:452 (Indian desert)

1847. *Antilope hazena* I. Geoffroy, in Jacquemont, Voy. India, 4: 74 (Malwa, C.P.).

1873. *Gazella fusiform* Blanford, Proc. Zool. Soc., 317 (Jalk, Seistein desert, Eastern Persia).

1908. *Gazella yarkendensis kennioni* Lyddeker, Field. 111:499 (Afghan Frontier of Persia).

1911. *Gazella hayi* Lyddeker, Proc. Zool. Soc., 961.

1951. *Gazella gazella bennetti* Sykes, in Ellerman & Morrison-Scott, Checklist Palae. & Indian Mamm.; 392 (Eastern Persia, Punjab, Sind, Nepal, U. P., Rajputana, Cutch, Kathiwar to Krishna River, Deccan).

DISTRIBUTION

Chinkara is distributed throughout the desert region. They are, however, densely populated in game-reserve areas.

(G) Order LAGOMORPHA

(a) Family.— LEPORIDAE (Hares)

Genus 1.— *Lepus* Linnaeus, 1758

1758. *Lepus* Linnaeus Syst. Nat. 1:57.

31. **Lepus nigricollis ruficaudatus** Geoffroy, 1826
(Indian Hare; Black-naped Hare)

1826. *Lepus ruficaudatus* Geoffroy, Dict. Class. H. N. 9:381 (Bengal).

1840. *Lepus macrotus* Hodgson, J. Asiat. Soc. Bengal 9:1183 (Gangetic Plain, India).

1844. *Lepus aryabetensis* Hodgson, Calcutta J. N. H. 4:293 (Nepal).

1854. *Lepus tytleri*, Ann. Mag. Nat. Hist. 14:176 (Dacca, Eastern Bengal).

1951. *Lepus nigricollis ruficaudatus* Geoffroy, in Ellerman & Morrison-Scott, Checklist Palae. & Indian Mamm. :436-7 (Orissa, Bengal, Gwalior, Kumaon, Nepal, Sikkim, Bhutan, Duars, Northern Kamrup, Central India, Rajputana).

DISTRIBUTION

The hare is distributed in the Northern Desert *ie* in Bikaner division. In the western part of the desert it is replaced by the desert form, *L. n. dayanus*.

32. **Lepus nigricollis dayanus** Blanford, 1874
(Indian Desert Hare)

1874. *Lepus dayanus* Blanford, Proc. Zool. Soc. :663 (Sukkur, Sind, India).

1884. *Lepus joongshaiensis* Murray, Vert. Zool. of Sind, 51 (Joongshai, Sind).

1951. *Lepus nigricollis dayanus* Blanford, in Ellerman & Morrison-Scott, Checklist Palae. & Indian Mamm. :438 (Sind, Cutch, Palanpur, Kathiawar to Mt. Abu, Rajputana).

DISTRIBUTION

This subspecies of Indian hare is found in the western Desert. Its occurrence in the desert region has extended its distributional range considerably to East.

(H) Order.— RODENTIA

(a) Family 1. SCIURIDAE (Squirrels)

Genus 1. *Funambulus* Lesson, 1835

1835. *Funambulus* Lesson, Illustr. Zool. :15, pl.43.

33. **Funambulus pennanti** Wroughton, 1905
(Northern Palm Squirrel)

1905. *Funambulus pennanti* Wroughton, J. Bombay nat. Hist. Soc., 16:411 (Mandvi, Surat district).

1905. *Funambulus pennanti argetescens* Wroughton, J. Bombay nat. Hist. Soc., 16:413 (Rawalpindi).

1916. *Funambulus pennanti lutescens* Wroughton, J. Bombay nat. Hist. Soc., 24:430 (Deesa, Palanpur).

1919. *Funambulus pennanti pennanti* Wroughton, J. Bombay nat. Hist. Soc., 26:376 (Central India).

1951. *Funambulus pennanti* Wroughton, in Ellerman & Morrsion-Scott, Checklist Palae. & Indian Mammals :495 (Baluchistan, Punjab, N. W. Frontier, Sind, Kumaon, Rajputana, Cutch, Kathiawar, Central India, Bengal, Nepal, Bombay to Dharwar).

DISTRIBUTION

This squirrel is found in habitats having trees. It is not found in bushy areas. It is spread from Rajasthan desert to Baluchistan and is not found in the deserts of the Palaearctic Region. In Rajasthan desert it is evenly distributed.

(b) Family 2. HYSTRICIDAE (Porcupine)

Genus 1. *Hystrix* Linnaeus, 1758

1758. *Hystrix* Linnaeus, Syst. Nat. 1:56

34. **Hystrix indica indica** Kerr, 1792
(Indian Crested Porcupine)

1792. *Hystrix cristata* var *indica* Kerr, Anim. Kingd. :213 (India).

1831. *Hystrix leucurus* Skyes, Proc. Zool. Soc., 103 (Deccan).

1851. *Hystrix zeylonensis* Blyth, J. Asiat. Soc. Bengal, 20:171 (Ceylon).

1865. *Hystrix malabarica* Sclater, Proc. Zool. Soc. :353 (Cochin)

1911. *Hystrix hirustirostris salunini. blanfordi, mersinae, acharonii, schmidtzi* Müller, S. B. Ges. Nat. Fr. Berlin: 117, 121, 122, 123, 126 (Caspian Sea, Baluchistan, Asia Minor, Palestine, Ain Scheir).

1912. *Hystrix cuniceps* Worughton, J. Bombay nat. Hist. Soc., 21:771 (Cutch).

1919. *Hystrix narynensis* Müller, S. B. Ges. Nat. Fr. Berlin, 67 (Region between lake Issyl and River Naryn, Russian Turkistan).

1920. *Hystrix mesopotamica* Müller, Zool. Anz. : 51198 (Jebel Abdul Azir; N. E. Syria).

1920. *Hystrix leucurus leucurus* Sykes and *l. cuniceps* Wroughton, in Wroughton, J. Bombay nat. Hist. Soc., 27 : 65 (Cutch, Sind, Kathiawar, Punjab, Rajputana, Central India, Nepal, Dharwar, Mysore).

1947. *Hystrix leucura leucura* Sykes, in Ellerman, J. Mamm., 28: 249 (Baluchistan to Nepal and Kashmir to Travancore).

1951. *Hystrix indica indica* Kerr, in Ellerman & Morrison-Scott, Checklist Palae. & Indian Mamm. : 519 (India, Arabia, Iraq, Persia, Turkistan, Asia Minor, Palestine and Syria).

DISTRIBUTION

Porcupines are distributed all over the desert region in the hilly areas. Several were noticed at Jaisalmer, Bikaner, Jodhpur and Pilani. Its range extends to the deserts of the Middle East in West and upto Nepal in East.

(c) Family 3.—MURIDAE (Rat, Mouse and Gerbilles)

Subfamily MURINAE

Genus 1. *Rattus* Fischer, 1803

1775. *Rattus* Frisch, Natur-System der vierfuss Thiere, 7 (This work is generally not available. This was decided by the International Commission at its meeting at Paris in July, 1948 (Ellerman & Morrison-Scott, 1951).

1803. *Rattus* Fischer, National Mus. Nat. Paris, 2 : 128.

35. **Rattus rattus rufescens** Gray, 1837.

(House Rat)

1837. *Mus rufescens* Gray, Ann. Mag. Nat. Hist., 1 : 585 (Dharwar),

1839. *Mus flavescens* Elliot, Madras J. Litt. Sci., 10 : 214 (Dharwar).

1863. *Mus infralineatus* Blyth, Catalogue Mamm. Asiat. Soc., 116.

1867. *Mus rattus rufescens* Gray, in Jerdon, Mamm. of India : 197.

1919. *Rattus rattus rufescens* Gray, in Wroughton, J. Bombay nat. Hist. Soc., 26 : 794 (Rajputana, Nilgiri, Kumaon, Cutch, C. P. Western Ghats, Mysore).

DISTRIBUTION

The rat is found all over the desert region. It is not found in wild state and is essentially dependent on man. Its range extends from Punjab to Peninsular India.

Genus 2. *Mus* Linnaeus, 1758.

1758. *Mus* Linnaeus Syst. Nat., 1 : 59.

36. **Mus musculus bactrianus** Blyth, 1846
(House Mouse)

1846. *Mus bactrianus* Blyth, J. Asiat. Soc. Bengal, 15 : 140 (Afghanistan).

1853. *Mus gerbillinus* Blyth, J. Asiat. Soc. Bengal, 22 : 410 (Punjab).

1853. *Mus theobaldi* Blyth, J. Asiat. Soc. Bengal, 26 : 421 (Aden).

1951. *Mus gentilutus* Thomas, J. Bombay nat. Hist. Soc , 26 : 421 Aden).

1919. *Mus musculus bactrianus* Blyth, in Ellerman & Morrison-Scott, Checklist Palae. & Indian Mamm. : 607 (Persia, Afghanistan, Kashmir, Punjab, Sind, Baluchistan and Aden).

DISTRIBUTION

The mouse has been collected from Barmer and Jaisalmer. It is distributed in the deserts of Middle East, upto Aden.

Subfamily.—GERBILLINAE

Genus 3, *Tatera* Lataste, 1882

1882. *Tatera* Lataste, Le Naturaliste, Paris, 2 : 126.

37. **Tatera indica indica** Hardwicke, 1807
(Indian Gerbille, Antelope Rat)

1807. *Dipus indicus* Hardwicke, Trans. Linn. Soc., London. 8 : 279 (U. P. & Northern India).

1838. *Gerbillus otarius* Cuvier, Trans. Zool. Soc. London, 2 : 144 (Peninsular India).

1867. *Gerbillus indicus* Hardwicke, in Jerdon, Mamm. of India, : 184.

1906. *Tatera persica* Wroughton, Ann. Mag. Nat. Hist., 17 : 477, 496 (Seisten, Persia).

1906. *Tatera bailwardi monticola* Wroughton, Ann. Mag. Nat. Hist., 17 : 477, 496 (Persia).

1917. *Tatera sherrini* and *dunni* Wroughton, J. Bombay nat. Hist. Soc., 25 : 43 (Jacobabad and Ambala respectively).

1919. *Tatera indica* Hardwicke, in Wroughton, J. Bombay nat. Hist. Soc., 26 : 781 (Nasirabad, Kathiawar, C. P., Bengal).

1951. *Tatera indica indica* Hardwicke, in Ellerman & Morrison-Scott, Checklist Palae. & Indian Mamm. : 636 (Nepal Terai, Punjab, Kumaon, Baluchistan, Sind, Gujerat, Kathiawar. Cutch, Bihar, C.P., to North Bombay, Persia).

DISTRIBUTION

This nocturnal species of the gerbilles is evenly distributed in the desert region.

Genus 4. *Meriones* Illiger, 1811

1811. *Meriones* Illiger, Prodr. Syst. Mamm. : 82

Subgenus *Cheliones* Thomas, 1919

1919. *Cheliones* Thomas, Ann. Mag. Nat. Hist. 3 : 265

38. **Meriones hurrianae** Jerdon, 1867
(Indian Desert Gerbille)

1867. *Meriones hurrianae* Jerdon, Mamm. of India : 186 (Hissar).

1919. *Cheliones hurrianae collinus* Thomas, J. Bombay nat. Hist. Soc., 26 : 726 (Kohat, N W.F.P.).

DISTRIBUTION

The gerbilles are distributed all over the desert of Rajasthan except in Ganganagar area. They have been known from this

region before the incoming of Ganga-Canal. Due to the changed soil conditions (Edaphic factors) they have either migrated or have succumbed to the change. Their range extends to Punjab, Sind, Cutch, Gujerat, Kathiawar, Afghanistan and Persia).

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The Vegetation types of the Indian Desert

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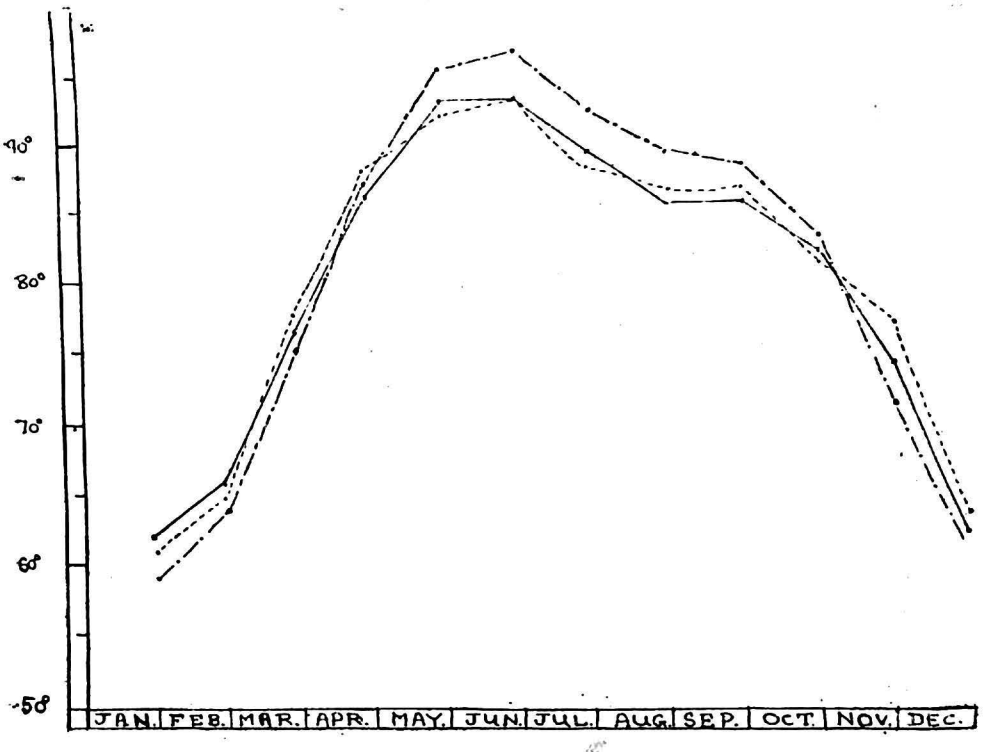
INTRODUCTION.

The Indian Desert lies between the Aravallis on the south and the Sindh Baluchistan hills on the North. On the west it continues into the Runn of Cutch (70°E) and approaches the fertile lands on the east (76°E) lying 150 miles away along the foot of the Himalayas. It is a low land covering 2,00,000 sq. miles.

The Indian part of the desert is spread principally in the West and North-west parts of Jodhpur (Jaisalmer) and Bikaner Divisions of Rajasthan and the Western half of the South-Eastern Punjab, with an area of about 90,000 sq. miles. It extends into the Bahawalpur State in the North and the Thar District in the Sindh on the West.

A range of 10° Latitude in the desert implies considerable amount of climatic diversity and although there is a great topographical variety the area is a natural entity of arid low land. The general slope is North East—South West from the Himalayas to the Arabian Sea. The highest lowland being in the N. E. which attains a general level of over 1000 ft. above sea grading down south-west wards. Except the fringe of Jaisalmer District and the basin of Luni river that drains south-east to Runn of Cutch, the Rajputana state stands well above 500 ft.

The general aspect of the desert is that of a succession of dry undulating plains and rolling sand-dunes of all sizes and shapes. The solid geology is exposed at widely separated areas in the west of Barmer and the north-east of Pokaran. There are a number of smaller plateaus, such as the Kailana, Jodhpur, Mandore, extending to the north of the city of Jodhpur, for many miles, and the plateau of Jaisalmer.



Jodhpur_____

Bikaner—·—·—·—·—

Pachphadra- - - - - - -

MEAN TEMPERATURE.

Fig. No. 1.

Most of the country is sterile and sandy. In the west and the north in particular, the quality of the soil is very poor. The Sambhar lake area and other small areas interspersed here and there have saline soils. *The Runn of Cutch* embracing about 8000 sq. miles, though an integral part of the desert, possesses a distinctive character.

No better description of the Indian desert may probably be found than the one given by Aldous Huxley in *Jesting Pilate*. He states that :—

"Once in every ten or twenty yards, some grey-green plant* deep-rooted and too thorny for even camels to eat, tenaciously and with a kind of desperate vegetable ferocity struggles for life. And at longer intervals, draining the moisture of a rood of land, there rise, here and there, the little stunted trees† of the desert. From close at hand the sparseness of their distantly scattered growth is manifest. But seen in depth down the long perspective of receding distance, they seem like, in fact, the remotely scattered stars of the Milky way—numerous and densely packed. Close at hand the desert is only rarely flecked by shade; but the further distances seem hedged with a dense dark growth of trees. The foreground is always desert, but on every horizon there is the semblance of shadow forests. The train rolls on, and the forests remain for ever on the horizon; around one is always and only the desert."

FACTORS INFLUENCING AND DETERMINING VEGETATION

The factors which determine the broad features of vegetation may be divided into three groups.

1. General Climatic factors. Temperature, Rainfall, Humidity, Wind etc.
2. Soil and pH.
3. Biotic factors.

Temperature :—The climate is that of the North tropical desert characterised by extremes of heat and cold. The mean daily temperature exceeds 92°F from May to July. Maximum temperature recorded so far is 120°F (At Jodhpur on 26th May 1912 and 24/25 May, 1932, 127°F at Jacoabad).

**Calligonum polygonoides, 'phog': Aerua lanata, 'bhui'.*

†*Prosopis spicigera,* camel thorn, *'Khejra'.*

As shown in Table I the highest temperature occurs in May and lowest in January. The mean minimum temperature is generally below 50°F but lower temperatures have been recorded, the lowest registered at Jodhpur being 28°F on 31st January, 1905.

The soil temperatures which directly influence the vegetations would be higher in summer and lower in winter than those given in Table I. Sinclair 1922 reported soil temperature values under desert conditions in Arizona. Just below the soil surface in June 1915, the maximum soil temperature was 71.5°C which was much higher than the maximum air temperature of 42.5°C. At 10 and 20 cms depth the maximum values were respectively 42° and 35°C. For the same two depths the annual range of values was approximately 40° and 30°C. Sudden diurnal variations in the soil temperatures are unfavourable and injurious to the vegetation.

Rainfall :—The area is beyond the full force of the S. W. North East monsoon rising from the Arabian sea, and is also removed from the influence of the SE. NW. monsoon blowing from the Bay of Bengal. The clouds before reaching the tract float above the vast arid treeless regions and thus they rise very high and are generally carried away from the area. Sufficient humidity is not there to start precipitation. Rainfall is generally the result of the two monsoons meeting as a result of the deflection of some clouds from the north. The annual rainfall, therefore, in the different parts of Rajasthan, is considerably variable and most of this is precipitated during a few sudden cloud bursts. In the North and North Western Rajasthan annual rainfall does not exceed 3" to 4". The rainfall gradually increases as we go towards the South and South East. In the central region, the average is about 13". In the south eastern parts of the Rajasthan near the foot of the Aravallis the annual rainfall generally exceeds 25". This sub-mountain area is not a part of the arid and semi arid region.

Ninety percent of the rainfall in the area occurs during the Monsoon season, that is from June to September. The winter showers are few and uncertain. The rainfall in the monsoon season is also precarious and may or may not be well distributed. There may be an interval of several days between the two successive rainfalls. This results in the desiccation of the soil and the

plants that have come up after the first or earlier showers may be scorched.

Wind:— The hot season in the area is long and there is a constant SW. NE. breeze during the greater part of the year i. e. from February to October. The wind velocity in the earlier months is 8 to 10 miles per hour. The velocity increases during May to 20 miles per hour and there is deflection from South West North East direction to West Easterly direction and dust storms are raised. The violent wind during the hot season causes considerable shifting of the soil which is loose and sandy.

In July and August the winds are charged with moisture which lowers the temperature and may have a beneficial effect on plant life, even though precipitation in the form of rain may be lacking. The velocity during the rainy season is also high causing shifting of loose and uncovered soil.

Table I for Wind Velocities at Jodhpur Frequencies of Wind Directions.

ANNUAL AND MEAN MONTHLY WIND VELOCITIES.

at 0830 & 1730 I S T respectively.

		N	NE	E	SE	S	SW	W	NW	Calm.	Velocity
June	'53	0	1	1	0	0	15	10	1	2	11 3
		0	1	2	1	1	14	8	1	2	11.5
July	'53	0	1	0	0	1	20	8	0	1	8.9
		0	2	1	0	3	19	3	3	0	9.0
Aug.	'53	0	2	0	0	2	14	7	0	6	5.7
		0	3	1	4	3	15	4	0	1	7.8
Sept.	'53	0	0	0	0	1	10	10	1	8	3.5
		0	1	0	0	1	18	6	2	2	5.5
Oct.	'53	0	10	0	0	0	3	1	0	17	1.8
		1	0	1	0	0	5	2	1	18	2.1
Nov.	'53	1	15	1	0	0	0	1	0	12	2.5
		1	9	0	0	0	2	3	1	14	1.8
Dec.	'53	4	15	0	0	0	0	0	0	12	2.3
		4	7	0	0	0	3	7	1	9	2.6
Jan.	'54	1	19	0	0	0	2	0	1	8	3.9
		2	9	2	1	1	3	5	5	3	5.1

Water economy of the plants of semi-arid regions near Jodhpur.

A very general feature of the lowland is the formation of depressions of various dimensions. In the region near about the town of Jodhpur a chain of low hills runs to the North East of

the city for many miles. To the south of this chain of hills are plains which are undulating and during the rainy season water drains to these basins. Sub-soil water of these depressions is thus put on a better basis than that of the neighbouring tracts.

There is a long depression to the North East of Jodhpur below the chain of hills, beyond the Mandore Railway Station (6 miles to the North of Jodhpur and continuing for a number of miles). The Railway line runs parallel to the south of these hills. The tract being slightly raised above the general level of the plain forms the southern boundary of the depression. At the foot of the hills water continues to come out at the base of the hills in very small quantity for many months.

In the area where there are large sand-dunes there are depressions in between the sand-dunes where the water is drained even though the rainfall may be scanty. Most of the villages are situated near such places where there is a big depression and the water is drained into the area from the neighbouring upland for many miles. This water may be collected either in surface tanks or wells may be dug in the depression.

Jaisalmer, situated in the heart of the desert owes its water supply to a general depression in its topography.

At a few places like Marwar Mathania 16 miles to the N. E. of Jodhpur the soil is only a few feet deep lying on solid sandstone and the aquifers feed the wells drilled into the sand stone and some agriculture is possible and crops are raised in both the seasons. A few small areas of this type are met with here and there in the semi-arid regions.

Run off in the greater part of the courses of the streamlets is torrential and causes great erosion of the loose soils. Infiltration is rapid.

Solar Radiation.—Intense solar radiation reaching the surface of the earth causes great evaporation of water from its surface. Evaporation figures for Kailana and Balsamand lakes in Jodhpur according to Ferguson (1944) is about 114" in a year. Raman Satakopan (1948) have given the figure as 181". Corresponding values for the American Desert is about 100".

Topography:—A vast tract of Western and South Western Rajasthan and the adjoining parts of Sindh covering an area 400 miles long and 100 miles wide constituting the desert is

covered for a depth of several feet by sand. In the greater part of the area the sands are piled up into dunes. Other lands are sandy to sandy loams. The desert sands are composed of rounded quartz grains admixed with those derived from felspar hornblende and limestone. Oldham 1893 believes that the sand of the desert is derived from the seashore. These were probably covered by the sea in the past tertiary times. According to Wadia 1919 a certain proportion of the desert sand is derived from weather debris of the rocky prominences of the tract which are subjected to great diurnal as well as seasonal alteration of temperatures characteristic of all arid regions. This leads to a greater mechanical disintegration and desquamation of the rocks, producing an abundance of loose debris, where there is no chemical (or humus) action to convert it into a soil cap. The surface of the soil is thus covered with sand or loess. Though loess can support agriculture, there is generall difficulty in obtaining water in the areas covered by it.

The large part of the desert is not a perfect wasteland. It supports some sort of scrubby and stunted vegetation

The sand lies over and covers an irregular rocky floor but rocky ridges and prominences crop up above the level of the sand. The oldest rocks are schists of Aravalli system. These are covered by rocks of the Mallani series which are of volcanic origin and these have conglomerate at the base. Upon these rest sandstones of the Vindhyan range. Thus the central area of Jaisalmer, Barmer and Pokaran is rocky with comparatively few and scattered sand hills. Sand forms a strip along the North of the Runn of Cutch, from which two arms run, one northwards by Umarkot and then turning north-east and running north of Jaisalmer to Bikaner; the other running eastwards between Barmer and Jodhpur and coalescing with the first about Bikaner.

Soils of Saline Lakes and Areas.

Alkaline soils are characteristics of regions where desert conditions prevail. The principal alkaline lakes are in Sindh and Rajasthan. The Sambhar lake 26°55′; 75°11′ in Ajmer Division is a potential source of large qnantities of salt, sodium sulphate and sodium carbonate. It has an area of 90 sq. miles when full during monsoon. There are other smaller lake

as at Didwana 27°23.; 74°35′ which covers an area of about 4 sq. miles; the salt basin of Pachpadra 25°50′; 70°10′ is about 12 sq. miles. Besides these regular lakes, there are other areas also where saline water of varying specific gravity is available. Some of these are Phalodi, Kanod, Bap, Pokaran, Deoria, Kachor, Rewana, Chanod, Lunkaransar, etc. The waters of the Luni river arising from the west of the Aravalli range are saline. It covers a big tract which is specially rich in salt from Pachpadra downwards to the south into the Runn of Cutch.

The Runn of Cutch:—According to Dr. Wadia 1919 the Runn of Cutch is a flat unbroken surface of dark silt, baked by the sun and blistered by saline incrustations; it is varied only by the mirage and great tracts of dazzling white salt or extensive but shallow flashes of concentrated brine. It is just possible that the river Luni has helped to raise the Runn of Cutch by the salt it has carried during thousands of years.

The reaction of the soils:—From soil analysis it is concluded that majority of the soils are slightly alkaline in nature, pH ranging from 7.5 to 9.5. The pH of rocky and sandy areas studied generally varies from 7.5 to 8, but the pH of the soil in the Luni river area during rainy season varies from 8 to 8.5, though it reaches 9 at lower depths. It becomes all the more alkaline during winter season when pH reaches 9 to 9.5. Lime deposited soils of Gottan are also alkaline and during winter the pH reaches 10.5.

The following generalizations about the nature of the soils of these areas might be noted. 1. *Rocky area.* There are variations in the structure, water content, porosity and aeration of the soils from different quadrats. The water content is poor. In the depressions in the rocks some deposit of clayey soils are met with and the water content of these soils may reach upto 15%. The humus percentage is very low. These areas have fair amount of carbonates, chlorides and nitrates which is generally higher than the amount found in the sandy soils. During winter there is decrease in water soluble salts and total cations.

2. *The Sandy areas.* The soils are single grained and loose. The humus content is very low. There is a further decrease of humus content in the lower layers. The water content of the surface soil is low. This increases slightly with depth. These soils are poor in carbonates, chlorides and nitrates. Calcium

content is also low while some potassium is present. The water soluble salts are slightly higher than the soils of the rocky areas.

3. *Luni River Bed soils* are saline and sandy and show single grained structure. The humus content is poor. The water holding capacity is comparatively higher, ranging from 10 to 20% and increases with depth. Carbonates and chlorides are present in these soils which however are poor in nitrates. Water soluble salts are present. The chlorides and carbonates are brought to the surface during winter. There is thus an increase in total cation contents, % of water soluble salts and pH which reaches 9.5 to 10. The soils are more alkaline during the winter and the following summer.

The soils are thus physically rocky, sandy and calcareous at some places. As the sandy soils are derived by the withering of the rocky areas both the types of soils are poor. In the depressions the soils are slightly better as rain water is conserved artificially or naturally. Some areas which are alkaline or calcareous contain chlorides and carbonates or sulphates of calcium, potassium, sodium and magnesium.

A consideration of the effect of these factors in determining the vegetation types characteristic of these areas follows later in the paper.

Biotic factors. The existing vegetation plays an important part in the regeneration and growth of plants. The existing plants provide anchor places for the organic matter and thus provide conditions for the germination and protection of plants during the early stages.

The population density in the arid regions is low. Jaisalmer has an over all density of 4 persons per square mile. Typical desert parts of Sind show a density of less than 20 per sq. mile; Bikaner has 28. The population is pastoral, keeping herds of sheep and goats, the most destructive of all cattle.

There are no grazing laws. The growth of the young plants is, therefore, greatly hampered and it takes many years for a plant to grow into a tree due to continual browsing. As some of these plants are thorny they are not entirely destroyed. The climax plants of *Zizyphus* and *Prosopis spicigera* do come up, in course of time. Some plants grow in association providing protection to non-thorny plants. *Acacias* and Neem trees are

thus found growing at many places inside *Euphorbia* bushes and even in the bushy growth of *Capparis aphylla.*

Besides the damaging effect of these, camels and other animals, their owners cut down all foliage and young shoots for fodder, fuel and fencing and collect foliage of *Zizyphus* (*Pala*) in cart loads for use as fodder in the off season. It is astonishing indeed that with these destructive agencies ever at work, natural vegetation does not come to a vanishing stage. The vegetation of the areas is so adversely affected by the other factors that unless this destruction stops, useful vegetation would practically disappear.

The desert locust, both in the hopper and adult stage destroys the annual and perennial plants, devouring the leaves and even the bark of the plants.

Rats, Rabbits and Squirrels do a lot of damage to the seeds and root-stocks of the plants. Ants carry the seeds to their nests. White ants destroy seeds and plant parts. Birds feed upon the seeds of the many plants. The population of the birds in the desert is very great.

Attempts are being made to introduce and grow *Prosopis juliflora* (*Prosopis glandulosa*) an interesting plant which is less woody than the native species but grows more rapidly. It coppices well and regenerates naturally. Its cultivation should be extended. In fact, large scale planting operations should be undertaken with the co-operation of the local population to afforest the desert areas, with this and other plants.

FLORISTIC COMPOSITION

Several interesting features are revealed by the study of the vegetation types of the Rajasthan Desert.

1. There are certain areas in the desert such as extensive sand dunes, sandy plains with ripples and rocky areas which are *devoid of vegetation.*
2. Other sand dunes have *Calotropis procera, Leptadenia spartium, Crotolaria burhia, Indigofera argentum* and a few other species mentioned below in the different plant associations. In some areas there are very interesting specimens of *Citrullus colocynthis* with spreading branches extending over large areas. During the rains and the following months

Aerua tcmentosa and *Aerua pseudotomentosa* cover up large areas, and a number of grasses such as, species of *Eleusine* and *Panicum turgidum* etc. come up.

3. The sandy plains in the semi desert areas have *Prosopis spicigera* growing at varying distances according to the moisture content of the soil. Aldous Huxley's description of the landscape is inimitable. Certain low areas are also cultivated during rains. Other perennial species scattered here and there are *Capparis aphylla, Leptadenia spartium, Crotolaria burhia, Salvadora oleodies Gymnosporia montana* and *Acacia senegal.* In some depressions localised pure formations of *Acacia arabica* occur. In the North and North-west areas patches of *Calligonum polygonoides* become more common and *Prosopis spicigera* gradually disappears. *Zizyphus rotundifolia, Z. numularia, Z jujuba* form the dominant feature of the vegetation. In the west of the desert grasses occur more abundantly. At a place *Elionurus hirsutus* Del. was observed for miles. Other grasses met with are:—*Panicum turgidum, Cenchrus cathartium, Pennesitum cenchorides, Aristida mutabilis, Eleusine flagifera, E. aegyptiaca, Cyprus arenarius, Andropogon contortus. Calortopis procera* grows gregariously in many areas. During the rains there is a carpet of greenary and the common plants covering the roadside, wastelands etc. are *Gyandropsis pentaphylla, Tephrosia, Trianthema monogyna, Tribulus terrestris, Capsella Bursa pastoris, Portulaca oleracea, Euphorbia hirta, Digera Arvensis, Achyranthes aspera.* Some other interesting species found are *Fagonia cretica, Corchorus antichorus, Cocculus villosus & C. laeba, Acacia rupestris, Anogeiosis latifolia, Tecomella undulata, Ephedra foliata, Chlorodendron phlomoides, Cistanche tubulosa, Plucaria wrightiana.*

4. The rocks are characterised by groups of *Euphorbia neriifolia* associated with which grow species of *Zizyphus, Sarcostema brevistigma, Capparis decidua, Rhynchozia minima* species of *Sida* and *Barleria, Asparagus racemosus, Achyranthes aspera, Grewia popalifolia, Cocculus leaba, Cleome viscosa, Gymnosporia montana, Ephedra foliata, Opuntia dillenii, Anogeissus pendula.*

Groups of *Euphorbias* growing on barren rocks appear as sentinels. They manage to send their roots in the crevices. Some other plants appear associated with these wherever slightest moisture is available.

5. **Saline areas**:—

In some of the saline tracts the concentration of the dissolved salts is high and a physiological drought prevails. *Tamarix dioca* Roxb and *T. gallica var articulata* Vahl are the only species which grow on the banks of the saline depressions and the Luni river bed. The twigs of the plants may be covered with saline efflorescence. In other saline tracts and farther from the river banks *Suaeda fruticosa* species of *Cyperus*; *Pluchea lanceolata*, *Trianthema monogyna*, and species characteristic of the sandy plains such as *Aerua tomentosa*, *Leptadenia spartium*, *Boerhaavia diffusa*, *Faresetia jaequemontia*, *Cleome papilosa* etc. are found in the plains. Some areas are characterised by some halophytic species such as *Suaeda fruticosa* Forsk, *Haloxylon recurvum* Bange and H *Salicornicum* Bunges and *Salsola foetida* De. *Atriplex cressifolia*.

In all about 500 species have been collected from the area in different associations.

PLANT ASSOCIATIONS ON HILLS

1. Euphorbia—Zizyphus Association.

Euphorbia royleana, Linn.	*d*
Zizyphus rugosa, Lamak	*co-d*
Sarcostemma brevistigma, Stock.	*r*
Asparagus racemosus, Willd.	*r*
Achyranthes aspera, Linn.	*a*
Tephrosia purpurea, Pers.	*a*
Grewia Asiatica, Wall.	*c*
Abutilon indicum, G. Don.	*c*
Cocculus leaeba, DC.	*a*
Capparis microphylla, Roth.	*c*
Cleome viscosa, Linn.	*a*
Triumfetta tomentosa, Bajes.	*a*
Fagonia cretica, Linn.	*r*
Tribulus terrestris, Linn.	*c*
Setaria glauca, Hochst.	*a*

Chloris barbata, Sw.	*a*
Cynodon dactylon, Pers.	*a*
Cenchrus biflorus, Roxb.	*a*

2. Euphorbia Royleana Boiss.

Pure association,	*d*

3. Opuntia-Euphorbia Association.

Opuntia Dillenii, Haw.	*d*
Grewia populifolia, Vahl.	*co-d*
Euphorbia Royleana, Boiss.	*d*
Abutilon indicum, G. Don.	*a*
Cenchrus biflorus, Roxb.	*a*
Eleusine indica, Gaertn.	*a*
Sida cordifolia, Linn.	*c*
Achyranthes Aspera, Linn.	*c*
Evolvulus alisinoides, Wall.	*a*
Malva parviflora, Linn.	*c*
Chloris barbata, Sw.	*a*

4. Euphorbia-Capparis Association

Euphorbia Royleana, Boiss.	*d*
Capparis aphylla, Roth.	*co-d*
Gymnosporia montana, Benth.	*a*
Ephedra foliata, Boiss.	*c*
Boerhaavia diffusa, Linn.	*a*
Abutilon indicum, G. Don.	*a*
Cocculus leaebea, DC.	*r*
Andropogon foveolatus, Del.	*a*
Cenchrus biflorus, Roxb.	*a*
Chloris barbata, Trin Swartz.	*a*
Digitaria Longiflora, Pers.	*a*

5. Euphorbia-Prosopis Association.

Euphorbia Royleana, Boiss.	*d*
Prosopis juliflora, DC. (=P. glandulosa)	*co-d*
Capparis aphylla, Roth.	*co-d*
Cocculus villosus, DC.	*a*
Abutilon indicum, G. Don.	*a*
Corchorus acutangulus, Lamk.	*r*
Corchorus Antichorus, Roeusch.	*c*
Abutilon Asiaticum, G. Don.	*c*

Tephrosia purpurea, Pers.	*a*
Trianthema monogyna, Linn.	*c*
Pentatropis cynanchoides, R. Br.	*r*
Aerua tomentosa, Forsk.	*c*
Andropogon annulatus, Forsk.	*a*

6. Salvadora-Euphorbia Association.

Salvadora persica, Linn.	*d*
Euphorbia Royleana, Boiss.	*d*
Barleria acanthoides, Vahl.	*co-d*
Cocculus villosus, DC.	*a*
Boerhaavia diffusa, Linn.	*a*
Euphorbia microphylla, Heyne.	*c*
Abutilon indicum, Sweet.	*c*
Cenchrus biflorus, Roxb.	*a*
Eleusine indica, Gaertn.	*a*
Aristida paradisea, Edgew.	*a*

7. Grewia—Asparagus Association.

Grewia populifolia, Vahl.	*d*
Asparagus racemosus, Willd.	*a*
Abutilon indicum, Sweet.	*co-d*
Tephrosia purpurea, Pers.	*co-d*
Anogeissus pendula, Edgew.	*c*
Euphorbia Royleana, Boiss.	*a*
Barleria cristata, Linn.	*a*
Tecomella undulata, Seem.	*c*
Phyllanthus Madaraspatensis, Linn.	*c*
Justicia procumbens, Wall.	*a*
Chloris virgata, Sw.	*a*
Eleusine indica, Gaertn.	*a*
Tridax procumbens, Linn.	*r*
Achyranthes aspera, Linn.	*a*

PLANT ASSOCIATIONS ON SAND DUNES

1. Capparis—Calligonum Association.

Capparis aphylla, Roth.	*d*
Calligonum polygonoides, Linn.	*co-d*
Leptadenia Spartium, Wight.	*a*
Calotropis procera, R. Br.	*c*
Crotalaria Burhia, Ham.	*a*
Abutilon indicum, Sweet.	*c*

Sida cordifolia, Linn.	*a*
Tribulus terrestris, Linn.	*c*
Mollugo nudicaulis, Lamk.	*c*
Tephrosia purpurea, Pers.	*a*
Gisekia pharnaceoides, Linn.	*c*
Digera arvensis, Forsk.	*a*
Phyllanthus Niruri, Linn.	*r*
Cenchrus biflorus, Roxb.	*a*
Chloris barbata, Trin Swartz.	*a*

2. Zizyphus – Calligonum association.

Zizyphus rugosa, Lamk.	*d*
Calligomum polygonoides, Linn.	*co-d*
Mimosa hamata, Willd.	*c*
Pupalia lappacea, Moq.	*a*
Sida rhombifolia. Linn.	*c*
Corchorus tridens, Linn.	*a*
Cenchrus biflorus, Roxb.	*a*
Eleusine aegyptiaca, Desf.	*a*

3. Gymnosporia–Ephedra association.

Gymnosporia montana, Benth.	*d*
Ephedra foliata, Boiss.	*c*
Calotropis procera, R. Br.	*a*
Mollugo nudicaulis, Lamk.	*a*
Spermacocee calyptra, Dene.	*c*
Coccinia indica, Wind & A.	*c*
Tribulus terrestris, Linn.	*a*
Achyranthes aspera, Linn.	*a*
Abutilon indicum, Sweet.	*c*
Eleusine aegyptiaca, Desf.	*a*
Cenchrus biflorus, Roxb.	*a*
Andropogon foveolatus, Del.	*a*
Eragrostis unioloides, Nees.	*a*

4. Crotalaria – Aerua association.

Crotalaria Burhia, Ham.	*d*
Aerua tomentosa, Forsk.	*co-d*
Polygala abyssinica, Fresen.	*a*
Heliotropium undulatum, Vahl.	*c*
Cenchrus biflorus, Roxb.	*a*
Eleusine aegyptiaca, Desf.	*a*
Chloris barbata, Trin Swartz.	*a*

Mollugo hirta, Thunb.	*c*
Tephrosia purpurea, Pers.	*a*
Trianthema monogyna, Linn.	*c*

5. Leptademia - Aerua association.

Leptadenia Spartium, Wight.	*d*
Aerua tomentosa, Forsk.	*co-d*
Crotalaria Burhia, Ham.	*a*
Corchorus tridens, Linn.	*c*
Sida cordifolia, Linn.	*a*
Mollugo nudicaulis, Lamk.	*c*
Amaranthus spinosus, Linn.	*c*
Convolvulus arvensis, Linn.	*c*
Boerhaavia diffusa, Linn.	*c*
Evolvulus alisinoides, Wall.	*a*
Tephrosia purpurea, Pers.	*a*
Cenchrus biflorus, Roxb.	*a*
Chloris barbata, Trin Swartz.	*a*
Eleusine flagellifera, Nees.	*a*

6. Calotropis - Leptadenia association.

Calotropis procera, R. Br.	*d*
Leptadenia Spartium, Wight.	*co-d*
Crotalaria Burhia, Ham.	*a*
Aerua tomentosa, Forsk.	*c*
Justicia simplex, D. Don.	*c*
Solanum nigrum, Linn.	*r*
Peristrophe bicalyculata, Nees.	*r*
Corchorus tridens, Linn.	*a*
Abutilon indicum, Sweet.	*a*
Sida Cordifolia, Linn.	*c*
Mullugo hirta, Thunb.	*c*
Achyranthes aspera Linn.	*c*
Chloris barbata, Trin Swartz.	*a*
Digitaria Longiflora, Pers.	*c*
Cynodon dactylon, Pers.	*a*

PLANT ASSOCIATIONS ON THE PLAINS

1. Gynmosporia-Capparis Association.

Gynmosporia montana, Benth.	*d*
Capparis aphylla, Roth.	*co-d*
Acacia rupestris, Stocks.	*co-d*

Ephedra foliata, Boiss.	*c*
Euphorbia Royleana, Boiss.	*c*
Coccinea indica, W. & A.	*c*
Boerhaavia grandiflora, A. Rich	*c*
Sida cordifolia, Linn.	*c*
Corchorus trilocularis, Linn.	*c*
Crotalaria Burhia, Ham.	*c*
Leptadenia Spartium, Wight	*c*
Trianthema triquetra, Rottl.	*a*
Mollugo hirta, Thunb.	*a*
Periploca aphylla, Dcne.	*r*
Commelina nudiflora, Linn.	*c*
Eleusine indica, Gaertn.	*a*
Aristida paradisea, Edgew.	*a*
Eragrostis unioloides, Nees.	*a*

2. Capparis – Leptadenia Association.

Capparis aphylla, Roth.	*d*
Leptadenia Spartium, Wight.	*co-d*
Gymnosporia montana, Benth.	*co-d*
Aerua tomentosa, Forsk.	*a*
Zizyphus rugosa, Lamk.	*c*
Crotalaria Burhia, Ham.	*c*
Boerhaavia grandiflora, A. Rich.	*a*
Boerhaavia diffusa, Linn.	*a*
Achyranthus aspera, Linn.	*c*
Solanum nigrum, Linn.	*r*
Mollugo hirta, Thunb.	*r*
Evolvulus alisinoides, Wall.	*c*
Boerhaavia repanda, Willd.	*c*
Coccinia indica, W. & A.	*a*
Tephrosia purpurea, Pers.	*a*
Gynandroposis pentaphylla, DC.	*a*
Abutilon indicum, Sw.	*c*
Abutilon asiaticum, G. Don.	*c*
Indigofera pauciflora, Delile.	*a*
Digera arvensis, Forsk.	*c*
Leucas aspera, Spreng.	*c*
Justicia procumbens, Wall.	*c*
Peristrophe bicalyculata, Nees.	*r*
Tridax procumbens, Linn.	*a*

Setaria glauca, Hochst.	*a*
Heteropogon contortus, Beauv.	*a*

3. Leptadenia-Aerua Association.

Leptadenia Spartium, Wight.	*d*
Aerua tomentosa, Forsk.	*co-d*
Crotalaria Burhia, Ham.	*co-d*
Corchorus Tridens, Linn.	*a*
Sida cordifolia, Linn.	*c*
Mollugo nudicaulis, Lamk.	*a*
Amaranthus spinosus, Linn.	*r*
Commelina benglalensis, Linn.	*c*
Conolvulus arvensis, Linn.	*c*
Boerhaavia diffusa, Linn.	*c*
Evolvulus alisinoides, Wall.	*c*
Tephrosia purpurea, Pers.	*a*
Cenchrus biflorus, Roxb.	*a*
Chloris barbata, Trin Swartz.	*a*
Eleusine flagellifera, Nees.	*a*

4. Calotropis-Leptadenia association.

Calotropis procera, Br.	*d*
Leptadenia Spartium, Wight.	*co-d*
Aerua tomentosa. Forsk.	*a*
Crotalaria Burhia, Ham.	*a*
Justicia simplex, D. Don.	*c*
Solanum nigrum, Linn.	*c*
Peristrophe bicalyculata, Nees.	*c*
Corchorus tridens, Linn.	*a*
Abutilon indicum, Sweet.	*a*
Abutilon fruiticosum, Guill & Perr.	*c*
Sida cordifolia, Linn.	*c*
Mollugo hirta, Thunb.	*a*
Achyranthus aspera, Linn.	*a*
Commelina bengalensis, Linn,	*a*
Chloris barbata, Trin Swartz.	*a*
Digitaria longiflora, Pers.	*a*
Cynodon dactylon, Pers.	*a*

5. Crotalaria—Aerua association.

Crotalaria Burhia, Ham.	*d*
Aerua tomentosa, Forsk.	*d*
Polygala abyssinica, Fresen.	*a*

Heliotropium undulatum, Vahl.	*a*
Cenchrus biflorus, Roxb.	*d*
Chloris barbata, Trin Swartz.	*a*
Eleusine aegyptiaca, Desf.	*a*
Mollugo hirta, Thunb.	*c*
Mollugo nudicaulis, Lamk.	*c*
Tephrosia purpurea, Pers.	*a*
Trianthema monogyna, Linn.	*c*

6. Tephrosia-Gynandropsis association.

Tephrosia purpurea, Pers.	*d*
Gynandropsis pentaphylla, DC.	*co-d*
Tribulus terrestris, Linn.	*a*
Euphorbia microphylla, Heyne.	*a*
Polygonum plebejum, Br.	*c*
Mollugo nudicaulis, Lamk.	*c*
Cenchrus biflorus, Roxb.	*a*
Eleusine aegyptiaca, Desf.	*a*
Chloris barbata, Trin Swartz.	*a*
Cynodon dactylon, Pers.	*a*

7. Solanum-Argemone association.

Solanum xanthocarpum, Schrade&Wende.	*d*
Argemone mexicana, Linn.	*co-d*
Solanum indicum, Linn.	*r*
Gynandropsis pentaphylla, DC.	*a*
Digera arvensis, Forsk.	*a*
Chenopodium album, Linn.	*c*
Amaranthus viridis, Linn.	*c*
Heliotropium indicum, Linn.	*c*
Cynodon dactylon, Pers.	*a*

8. Solanum-Trichodesma association.

Solanum nigrum, Linn.	*d*
Trichodesma indicum, R.Br.	*co-d*
Withania somnifera, Dunal.	*a*
Euphorbia hirta, Linn.	*a*
Heliotropium undulatum, Vahl.	*a*
Cynodon dactylon, Pers.	*a*
Boerhaavia diffusa, Linn.	*c*
Convolvulus arvensis, Linn.	*c*
Phyllanthus niruri. Linn.	*r*

9. Achyranthus-Trichodesma association.

Achyranthus aspera, Linn.	*d*
Trichodesma ampexicaule, Roth	*co-d*
Boerhaavia repens, Linn.	*a*
Setaria glauca, Hochst.	*a*
Eleusine flagellifera, Nees.	*a*
Evolvulus alisinoides, Wall.	*c*
Justicia simplex, D. Don.	*r*
Cleome viscosa, Linn.	*a*

10. Leucas-Corchorus association.

Leucas aspera, Spegn.	*d*
Corchorus acutangulus, Lamk.	*a*
Cenchrus biflorus, Roxb.	*a*
Chloris barbata, Trin swartz.	*c*
Cynodon dactylon, Pers.	*c*

11. Protulaca-Commenlina association.

Portulaca oleracea. Linn.	*d*
Commelina bengh. alensis, Hassk.	*co-d*
Trianthema monogyna, Linn.	*a*
Acalypha ciliata, Forsk.	*a*
Euphorbia hirta, Linn.	*c*
Cynodon dactylon, Pers.	*c*
Eleusine aegyptiaca, Desf.	*a*
Aristida paradisea, Edgew.	*a*
Phyllanthus Madraspatensis, Linn.	*a*

12. Aristolochia-Echinops association.

Aristolochia bracteata. Retz.	*a*
Echinops achinatus, D.C.	*d*
Boerhaavia diffusa, Linn.	*a*
Anticharis Linearis, Hochst.	*c*
Evolvulus alisinoides, Wall.	*r*
Euphorbia hirta, Linn.	*a*
Corchorus Antichorus, Roeusch.	*c*
Euphorbia microphylla, Heyne.	*c*
Sida rhombifolia, Linn.	*r*
Chloris barbata, Trin Swartz.	*a*
Cynodon dactylon, Pers.	*a*
Andropogon halepensis, Brot.	*a*

13. Gymnosporia-Salvadora association.

Gymnosporia montana,Benth	*d*

Salvadora oleoides, Dene.	*c*
Leptadenia Spartium, Wight	*a*
Tephrosia purpurea, Pers.	*a*
Mimosa hamata, Willd.	*a*
Aeruato mentosa, Forsk.	*c*
Abutilon fruticosum, Guill & Perr.	*a*
Achyranthes aspera, Linn.	*a*
Digera arvensis, Forsk.	*a*
Boerhaavia diffusa, Linn.	*c*
Mollugo hirta, Linn.	*c*
Trianthema monogyna, Linn.	*c*
Andropogon foveolatus, Del.	*a*
Chloris barbata, Trin Swartz	*a*
Aristida depressa, Retz.	*a*
Cenchrus biflorus, Roxb.	*a*
Fimbristylis dichotoma, Vahl.	*c*

MOIST ROCK, STREAMS ASSOCIATION

1. Cryptostegia-Sesbania association.

Cryptostegia grandiflora, Br.	*d*
Sesbania aegyptiaca, Pers.	*c*
Morinda indica, Linn.	*r*
Boerhaavia diffusa, Linn.	*c*
Cyperus compressus, Linn.	*c*
Heliotropium ovalifolium, Forsk.	*a*
Achyranthes aspera, Linn.	*a*
Trianthema monogyna, Linn.	*c*
Commelina benghalensis, Hassk.	*r*
Chloris barbata, Sw.	*c*
Eleusine aegyptiaca, Desf.	*a*

2. Hygrophylla-Sesbania association.

Hygrophylla longifolia, Kurz.	*d*
Sesbania aegyptiaca, Pers.	*c*
Amaranthus spinosus, Linn.	*c*
Boerhaavia diffusa, Linn,	*a*
Eclipta erecta, Linn.	*c*
Polygonum plebejum, Linn.	*c*
Mullugo trigonelloides, Linn.	*a*
Argemone mexicana, Linn.	*c*
Cynodon dactylon, Pers.	*a*

Chloris barbata, Trin Swartz.	*a*

Luni River Bed.

Trianthema monogyna, Linn.	*c*
Pentatropis cynanchoides, R.Br.	*a*
Tephrosia purpura, Pers.	*c*
Eragrostis tremula, Hochst	*a*
Eragrostis ciliaris, Linn.	*a*
Cenchrus catharticus, Deule.	*a*
Eleusine indica, Gaertn.	*c*
Boerhaavia diffusa, Linn.	*a*
Tribulus terrestris, Linn.	*c*
Cocculus indica, DC.	*r*
Corchorus acutangulus, Lamk.	*c*
Digera arvensis, Forsk	*a*
Portulaca oleracea, Linn.	*a*
Salvadora persica, Linn.	*co-d*
Phyllanthus niruri, Linn.	*c*
Pupalia lappacea, Moq.	*c*
Cyperus conglomeratus, Rottb.	*a*
Eragrostis poaeoides, Beauv.	*c*
Plucaria crispa,	*a*
Chloris virgata, Sw.	*c*
Cucumis callosus (Rottb), Cogn.	*r*
Tamarix gallica, Linn.	*d*
Ceratophyllum demersum, Linn.	*c*

Luni River Bank.

Tamarix dioeca, Roxb.	*d*
Pluchea lanceolata, Oliv	*co-d*
Farsetia Jacquemontii, Hook	*a*
Cleome papillosa, Steud	*a*
Calotropis procera, Br.	*a*
Calotropis gigantea, Br.	*r*
Aerua pseudo-tomentosa, Blatt & Hall.	*c*
Leptadenia Spartium, Wight.	*c*
Mollugo hirta, Thunb.	*a*
Prosopis juliflora, DC.	*co-d*
Coccinea indica, W&A.	*r*
Melothria madaraspatana, Cogn.	*r*
Barlaria acanthoides, Vahl.	*r*

PLANT ASSOCITIONS ON GRAVEL

1. Euphorbia-Prosopis Association:

Euphorbia Royleana, Boiss	*d*
Prosopis juliflora, DC.	*co-d*
Capparis aphylla, Roth.	*co-d*
Cocculus villosus, DC.	*c*
Sida cordifolia, Linn.	*c*
Abutilon indicum, G. Don.	*c*
Abutilon asiaticum, G. Don.	*c*
Corchorus Antichorus, Roeusch.	*c*
Corchorus acutangulus, Lamk.	*c*
Tephorsia purpurea, Pers.	*a*
Trianthema monogyna Linn.	*a*
Heliotropium zeylanicum, Lam.	*c*
Pupalia lappacea, Moq.	*a*
Achyranthus aspera, Linn.	*a*
Aerua tomentosa, Forsk.	*c*
Euphorbia hirta, Linn.	*c*
Andropogon annulatus, Forsk.	*a*

2. Euphorbia-Capparis Association.

Euphorbia Royleana, Boiss.	*d*
Capparis aphylla, Roth.	*co-d*
Gymnosporia montana, Benth.	*co-d*
Ephedra foliata, Willd.	*a*
Boerhaavia diffusa, Linn.	*a*
Boehaavia repanda, Willd.	*a*
Achyranthus aspera, Linn.	*c*
Abutilon indicum, Sweet.	*c*
Polygala erioptera, DC.	*a*
Abutilon fruiticosum, Gull & Perr.	*a*
Sida spinosa, Linn.	*c*
Corchorus tridens, Linn	*r*
Indigofera tinctoria, Linn.	*c*
Cocculus cebatha, DC.	*a*
Cocculus indica, DC.	*c*
Evolvulus alisinoides, Wall.	*a*
Tridax procumbens, Linn.	*c*
Andropogon foveolatus, Del.	*a*
Cenchrus biflorus. Roxb.	*a*

Chloris barbata, Trin Swartz.	*a*
Digitaria longiflora, Pers.	*a*

3. Gymnosporia - Capparis Association.

Gymnosporia montana, Benth.	*d*
Capparis aphylla, Roth.	*d*
Acacia rupestris, Stocks.	*co-d*
Ephedra foliata, Boiss.	*a*
Euphorbia Royleana, Boiss.	*c*
Coccinea indica, W. & A.	*c*
Boerhaavia grandiflora, A. Rich.	*c*
Sida cordifolia, Linn.	*a*
Corchorus trilocularis, Burm.	*a*
Crotalaria Burhia, Ham.	*c*
Leptadaenia Spartium, Wight.	*c*
Mollugo hirta, Thunb.	*r*
Periploca aphylla, Dcne.	*r*
Commelina nudiflora, Linn.	*c*
Eleusine indica, Gaertn.	*a*
Arsitida paradisea, Retz.	*a*
Eragrostris unioloides, Nees.	*a*

4. Capparis - Grewia Association.

Capparis aphylla, Roth.	*d*
Grewia populifolia, Vahl.	*co-d*
Zizyphus rotundifolia, Lamk.	*co-d*
Acacia arabica. Willd.	*a*
Euphorbia Royleana, Boiss.	*a*
Achyranthus aspera, Linn.	*a*
Barlaria acanthoides. Vahl, Symb.	*a*
Lepidegathis cristata, Wall.	*a*
Blepharis Sindica, Stock.	*r*
Peristrophe bicalyculata, Nees.	*a*
Abutilon indicum, Sweet.	*r*
Fagonia cretica, Linn.	*c*
Coccinea indica, W. & A.	*c*
Justicia simplex, D. Don.	*c*
Anisomeles ovata, R. Br.	*c*
Digera arvensis, Forsk.	*c*
Euphorbia prostrata, Ait.	*c*
Andropogon halepensis, Brot,	*a*
Brachiaria ramosa, (L) Stapf.	*a*

Aristida depressa, Retz.	*a*
Cenchrus biflorus, Roxb.	*a*

5. Ephorbia-Zizyphus Association.

Euphorbia Royleana, Boiss.	*d*
Zizyphus rugosa, Lamak	*co-d*
Sarcostemma brevistigma, W. & A.	*r*
Asparagus racemosum, Willd.	*r*
Achyranthus aspera, Linn.	*a*
Tephrosia purpurea, Pers.	*co-d*
Grewia asiatica, Linn.	*a*
Abutilon indicum, G. Don.	*r*
Cocculus Leaeba, DC.	*c*
Capparis aphylla, Roth.	*r*
Cleome viscosa, Linn.	*a*
Triumfetta tomentosa, Wall.	*a*
Tribulus terrestris, Linn.	*c*
Fagonia cretica, Linn.	*c*
Setaria glauca, Beauv.	*a*
Chloris barbata, Trin Swartz.	*a*
Cyndon dactylon, Pers.	*a*
Cenchrus biflorus, Roxb.	*a*

6. Capparis-Clerodendron Association.

Capparis aphylla, Roxb.	*d*
Clerodandron phlomoidis, Linn.	*co-d*
Balanites Roxburghii, Planch.	*r*
Euphorbia Royleana, Boiss.	*c*
Tephrosia purpurea, Pers.	*a*
Indigofera tinctorea, Forsk.	*a*
Pupalia lappacea, Moq.	*a*
Blepharis Sindica, Stocks.	*r*
Cleome viscosa, Linn.	*a*
Gynandropsis pentaphylla, DC.	*a*
Trianthema monogyna, Linn.	*c*
Euphorbia microphylla, Linn.	*c*
Phyllanthus madaraspatensis, Linn.	*r*
Eleusine indica, Gaertn.	*a*
Cenchrus biflorus, Roxb.	*a*
Aristida depressa, Retz.	*a*
Andropogon halepensis, Brot.	*a*
Digitaria longiflora, Pers.	*a*

7. Salvadora-Euphrobia Association.

Salvadora persica, Linn.	*d*
Euphorbia Royleana, Boiss.	*d*
Barleria acanthoides, Vahl. Symb.	*co-d*
Cocculus villosus, DC.	*a*
Boerhaavia diffusa, Linn.	*a*
Euphorbia microphylla, Linn.	*c*
Abutilon indicum, G. Don.	*c*
Cenchrus biflorus, Roxb.	*a*
Eleusine indica, Gaertn.	*a*
Aristida paradisea, Edgew.	*a*
Striga orobanchoides, Benth.	*a*
Cistanche tubulosa, Wight.	*r*

8. Tecomella -Cordia Association.

Tecomella undulata, Seem	*d*
Cordia Rothii, R. & Sech.	*co-d*
Anogeissus pendula, Edgew.	*r*
Lepidogathis trinervis, Nees.	*c*
Euphorbia Royleana, Boiss.	*c*
Barlaria acanthoides, Vahl. Symb.	*a*
Blepharis sindica, Stocks.	*r*
Abutilon indicum, G. Don.	*c*
Achyranthus aspera, Linn.	*c*
Sida cordifolia, Linn.	*c*
Coccinia indica, W. & A.	*a*
Chloris barbata, Trin, Swartz.	*a*
Cynodon dactylon, Pers.	*a*
Eleusine indica. Gaertn.	*a*

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Studies on the Vegetation of the arid Zones of India

(ii) The Distribution of some Desert Plants in various habitats in the Rajasthan State.

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Introduction :—

According to the recommendations of the Arid Zone Committee of the UNESCO, studies on desert vegetation were conducted at a number of places during the last 5-6 years. A flora of Rajasthan, west of the Aravallis has been prepared by Puri, Sarup, Jain and Kotwal, (1959). Further detailed studies on different aspects of desert vegetation have also been taken in hand. The present paper gives some details on the distribution of desert species in different habitats in the area since this information is of value to soil conservationists and others interested in increasing plant wealth of the desert.

The Rajasthan desert is not a true desert; there being a good deal of perennial woody vegetation (Puri & Jain, 1959). During the rains, in addition, a number of ephemeral plant species come up. The study of ephemeral plant species is of interest from phyto-geographical and other reasons. This is being done separately. Along the perennial vegetation, there are a number of tree species. Of these *Salvadora* spp., *Prosopis spicigera* and *Tecomella* are evergreen. There are quite a number of deciduous tree and shrub species. Most of the shrub species, if allowed to grow properly would develop into trees, e.g. *Capparis aphylla* is generally seen in the form of a shrub, but the plant grows into a big tree if protected from the biotic features. Similarly, various *Acacias, Grewias* are capable of growing in tree forms.

The studies have been made by means of quadrats and the species have only been recorded qualitatively and given as

abundant, common, dominant, co-dominant, present, rare, etc. The following habitats have been studied :—

(1) Hill (2) Sand dune (3) Plains
(4) Moist rocks and streams (5) Along river and
(6) Gravelly soil.

It is not necessary to give any detailed descriptions of these habitats since these have been given by the authors (Puri, 1952; Sarup, 1952, 1954). Further detailed studies on the vegetation of these habitats are in progress and the data will be published elsewhere. The distribution of constant species in various communities occurring in different types of habitats are shown in Table 1.

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TABLE I

THE DISTRIBUTION OF CONSTANT SPECIES IN A COMMUNITY

NAME OF THE PLANT COMMUNITY.	HILL							SAND DUNES						PLAINS												MOIST ROCK STREAM		LUNI RIVER-BED				GRAVEL							
	1 Euphorbia—Zizyphus	2 Euphorbia royleana (Pure)	3 Opuntia—Euphorbia	4 Euphorbia—Capparia	5 Euphorbia—Prosopis	6 Salvadora—Euphorbia	7 Grewia—Asparagus	1 Capparis—Calligonum	2 Zizyphus—Calligonum	3 Gymnosporia—Ephedra	4 Crotalaria—Aerua	5 Leptadenia—Aerua	6 Calotropis—Leptadenia	1 Gymnosporia—Capparis	2 Capparis—Leptadenia	3 Leptadenia—Aerua	4 Calotropis—Leptadenia	5 Crotalaria—Aerua	6 Tephrosia-Gynandropsis	7 Solanum—Argenome	8 Solanum—Trichodesma	9 Achyranthes-Trichodesma	10 Leucas—Corchorus	11 Portulaca—Commelina	12 Aristolochia—Echinops	13 Gymnosporia-Salvodora	1 Cryptostegia	2 Hygrophila—Sesbania	1	2	3	4	1 Euphorbia—Prosopis	2 Euphorbia—Capparis	3 Gymnosporia-Capparis	4 Capparis—Grewia	5 Euphorbia—Zizyphus	6 Capparis-Clerodendron	7 Salvadora—Euphorbia	8 Tecomella—Cordia
1. Abutilon asiaticum					C										C																	C							
2. Abutilon fruticosum																	C																a						
3. Abutilon indicum	c		a	a	c	c	Co d	c		c			a		c		a									a						c	c		r	r		c	c
4. Acacia arabica														Co d																				Co d		a				
5. Acalypha cilata																								a															
6. Achyranthes aspera	a		c				a			a			c		c		a					d				a	a												c
7. Aerua pseudotomentosa					c						Co-d	Co d	c		a	Co-d	a	d								C						c							
8. Aerua tomentosa										r																													
9. Aerua pseudotomentosa					c					r																													
10. Amaranthus spinosus																				c																			
11. Amaranthus viridis					a					a																a													
12. Andropogon annulatus				a																				a														
13. Andropogon foveolatus							c																															
14. Andropogon halepensis																																						
15. Anisomeles ovata																																						
16. Anogeissus pendula																																						
17. Anticharis linearis																																						
18. Ephedra foliata																																						
19. Argemone mexicana																																						
20. Aristolochia bracteata																																						
21. Aristida depressa						a																																
22. Aristida paradisea														a																								
23. Asparagus racemosus	r						a																															
24. Balanites roxburghii																																						
25. Barleria acanthoides						Co;d																																
26. Barleria cristata							a																															
27. Blepharis sindica																																						
28. Bœrhaavia diffusa				a		a							c		a	c							a	c	c	a	p											
29. Bœrhaavia grandiflora														c	a																		a	c				a	

NAME OF THE PLANT COMMUNITY	Hill							Sand dunes						Plains											M. R. S.		Luni Rvier Bed				General							
	1	2	3	4	5	6	7	1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	1	2	3	4	1	2	3	4	5	6	7	8
30. Bœrhaavia repanda															c																			a						
31. Bœrhaavia repens																																								
32. Brachiaria ramosa																																				a				
33. Calligonum polygonoides								Co d	Co d																				p										
34. Calotropis gigantea								C																					p										
35. Calotropis procera								d						Co d	d																		Co d	Co d	d	d	r	d	*	
36. Capparis aphylla	c			Co d	Co d			a	a	a	a	a				a		d	a			a			a				p					a		a	a	a	a	
37. Cenchrus biflorus	a			a																									p										
38. Cenchrus catharticus																														p									
39. Ceratophyllum demersum																				c																			
40. Chenopodium album																																		a						a
41. Chloris barbata	a		a	a	...			a			a	a	a			a	a	a	a				c		a	a	c	a	p					a			a			
42. Chloris virgata							a																																r	
43. Cistanche tubulosa																															p									
44. Cleome papilosa																						a															a	a		
45. Cleome viscosa	a																																					Co d		
46. Clerodendron phlomoides																																p			c	c				
47. Coccinia indica										c				c	a																			a						
48. Cocculus cebatha																													p					c						
49. Cocculus indica																																					c			
50. Cocculus laeba	a			r																													c					a		
51. Cocculus villosus					a	c				a		r	c			c		c	a					Co d			r		p										
52. Commelina bengalensis												c										c					c		p						c				
53. Commelina nudiflora																c		c					a		c		c		p				c						
54. Convolvulus arvensis					r																																			
55. Corchorus acutangulus					c			a				c	a			a		a																						
56. Corchorus antichorus																																								
57. Corchorus tridens										d	a	a	c	c	Co d	a	d			a	a																		
58. Corchorus trilocularis								a																			d												
59. Cordia rothii																													p										
60. Crotalaria burhia														a	a	a	a	a	a			c	c	a										a			a		
61. Cryptostegia grandiflora																											c		p										
62. Cucumis callosus																																								
63. Cynodon dactylon	a																																							
64. Cyperus compressus																																								
65. Cyperus conglomeratus																																								
66. Digera arvensis								a							c																								
67. Digitaria longifolia					a																																			
68. Echinops echinatus																																								
69. Eclipta erecta																																								

NAME OF THE PLANT COMMUNITY	Hill							Sand dunes						Plains												M. R. S.		Luni River Bed				Gravel							
	1	2	3	4	5	6	7	1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	1	2	3	4	1	2	3	4	5	6	7	8
70. Eleusine ægyptiaca									a	a	a							a	a					a															
71. Eleusine flagellifera														a		a						a					a												
72. Eleusine indica			a			a	a							a																									
73. Ephedra Foliata										c				c															p						a			a	a
74. Eragrostis ciliaris																													p					a	a				
75. Eragrostis foacoides																													p										
76. Eragrostis tremula														a															p										
77. Eragrostis unioloides										a																			p										
78. Euphorbia hirta						c															a			a	a										a				
79. Euphorbia microphylla																			a						c								c					c	c
80. Euphorbia prostrata													c																										
81. Euphorbia royleana	d	d	d	d	d	d	a					a			c	c					c				r							d	d	c	a	c	c	d	c
82. Evolvutus alsinoides			a																														a						
83. Fagonia cretica	r																																			c	c		
84. Farsetia jacquemontii																															p								
85. Ftmbristylis dichotoma																										c													
86. Gisekia pharnaceoides								c																															
87. Grewia asiatica	c																																			a			
88. Grewia populifolia			Co d				d							d	Co d																				Co d					
89. Gymnosporia montana				a						d				d	a				Co d	a					d								Co d	d					
90. Gynandropsis pentaphylla																				e																			
91. Heliotropium indicum																																							
92. Heliotropium ovalifolium																											a												
93. Heliotropium undulatum											c							a			a																		
94. Heliotropuim zeylanicum															a																		c						
95. Heteropogon contortus															a																								
96. Hygrophila longifolia															a																								
97. Indigofera paucifiora															c							r																	
98. Indigofera tinctoria													c																										
99. Justicia procumbens							a																																
100. Justicia simplex																																							
101. Lepidagathis cristata																																							
102. Lepidagathis trinervis																																							
103. Leptadenia spartium																																							
104. Leucus aspera								a				d	Co d	c	c	Co d	d	Co d								a					p			c					
105. Malva parviflora			c																				d																
106. Melothria maderaspatana																																p							
107. Mimosa hamata									c																														
108. Mollugo hirta											c		c	a	d		a	c							a													
109. Mollugo nudicaulis								c		a	c	c				a		c	a						c					p			r					
110. Mollugo trigonelloides																												a											
111. Morinda indica																										r													
112. Opuntia dillenii	d																												p										
113. Pentatropis cynanchoides					r									r																									
114. Periploca aphylla																																			r				

NAME OF THE PLANT COMMUNITY	Hill							Sand dunes						Plains											M. R. S.		Luni River Bed				Gravel						
	1	2	3	4	5	6	7	1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	1	2	3	4	1	2	3	4	5	6	7
115. Peristrophe bicalyculata													r		r		c							a												a			
116. Phyllanthus madraspatensis							c														r								p								r		
117. Phyllanthus niruri								r																							p									
118. Pluchea lanceolata											a							a																					
119. Polygala abssinica																																		a					
120. Polygala erioptera																			c									c											
121. Polygonum plebejum																			c					d					p										
122. Portulaca oleracea																																p	Co d						
123. Prosopis juliflora					Co d																								p										
124. Pulicaria crispa																													p									a	
125. Pulicaria sps.									a																				p				a						
126. Pupalia lappacea																										c													d
127. Salvadora oleoides						d																							p										
128. Salvadora persica	r																										c	c									r		
129. Sarcostemma brevistigma															a							a															a		
130. Sesbania ægyptiaca	a													c		c	c							r									c		a				
131. Setaria glauca			c					a				a	c																										
132. Sida cordifolia									c											r																			
133. Sida longifolia																													p										
134. Sida rhombifolia																																							
135. Sida spinosa																																							
136. Solanum indicum																																							
137. Solanm nigrum																																							
138. Solanum xanthocarpum																																							
139. Spermacoce calyptra																																							
140. Striga orobanchoides																																							
141. Tamarix dioeca																																							
142. Tamarix gallica																																							
143. Tecomella undulata							c																			a													
144. Tephrosia purpurea	a					a		Co d	a		a	a		a	a			a	d							c			p				a			Co d	a		
145. Trianthema accogyna											c							c						a			c		p	p			a				c		
146. Trianthema monogyna						c								a															p										
147. Trianthema triquetra									c		a								a																		a		
148. Tribulus terrestris	c																					Co d																	
149. Trichodesma amplexicaule																					Co d																		
150. Trichodesma indicum																												c											
151. Tridax procumbens								r							a																								
152. Triumfetta tomentosa	a																				a																		
153. Withania somnifera																																				Co d			
154. Zizyphus rotundifolia									d																												Co d		
155. Zizyphus rugosa	Co d																																						

Some studies on Powdery Mildew of Tephrosia Purpurea from Ajmer

By

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INTRODUCTION

Tephrosia purpurea is of common occurrence in Ajmer and its adjoining localities. Since 1957 the writer observed that the plants are being severely affected by the mildew. The writer, with the cooperation of his post-graduate students, has studied the symptoms, morphology of the fungus, spore germination studies, viability of the fungus and the efficacy of the sulphur dust against the parasite.

MATERIAL AND METHODS

Three localities, i.e. Lohagal village, Kishangarh road and Adarshnagar where large number of plants were affected were visited thrice a week to study the symptoms of the disease. The leaves, stem and the fruits affected by the fungus were fixed in 70% alcohol for histological study. For determining the viability of the spores, the fungus was kept in dry state in cellophane bags and for finding out the thermal death point of the fungus, the capillary tubes were used closed at one end. Sulphur dust was used to see the efficacy against this parasite on the host.

SYMPTOMS

In the month of January the mildew was observed on *Tephrosia purpurea* in the localities described above. A similar type of mildew has been described on *Cuminum cyminum* L. (Joshi 1955), *Anethum graveolens* (Joshi 1956) and *Foeniculum vulgare* (Joshi 1958). The disease appeared as small white greyish specks on the leaves, stem and pods. In earlier stage these specks were found on the lower surface. In some cases the fruits and pods got deformed and crinkled and were smaller in size. The infected plants were stunted. By the end of March black dot like bodies were noted which were the ascigerous stage of the fungus.

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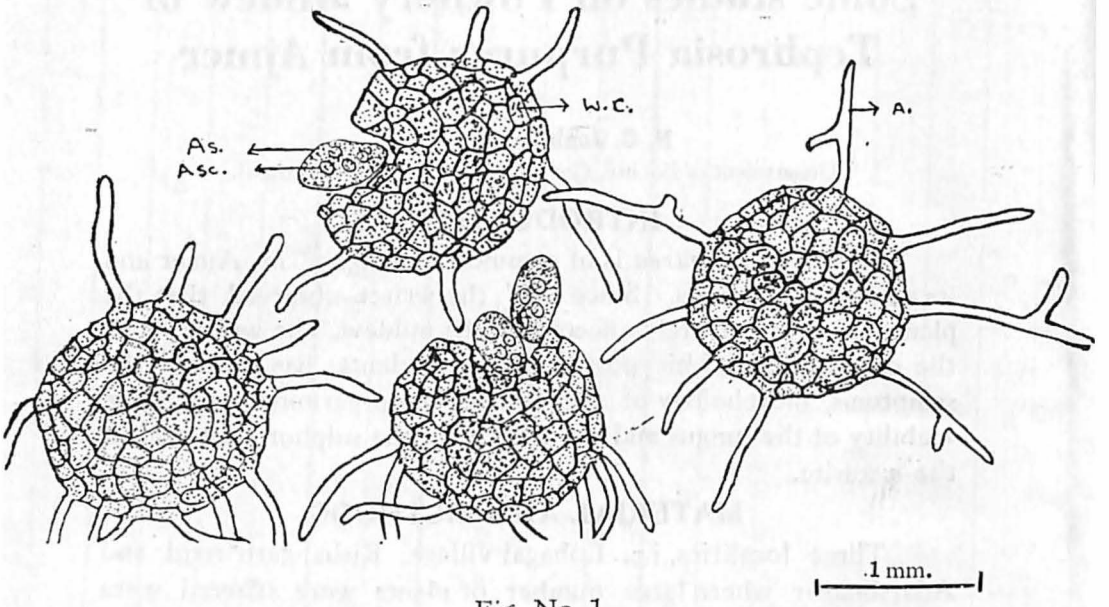

Fig. No. 1.

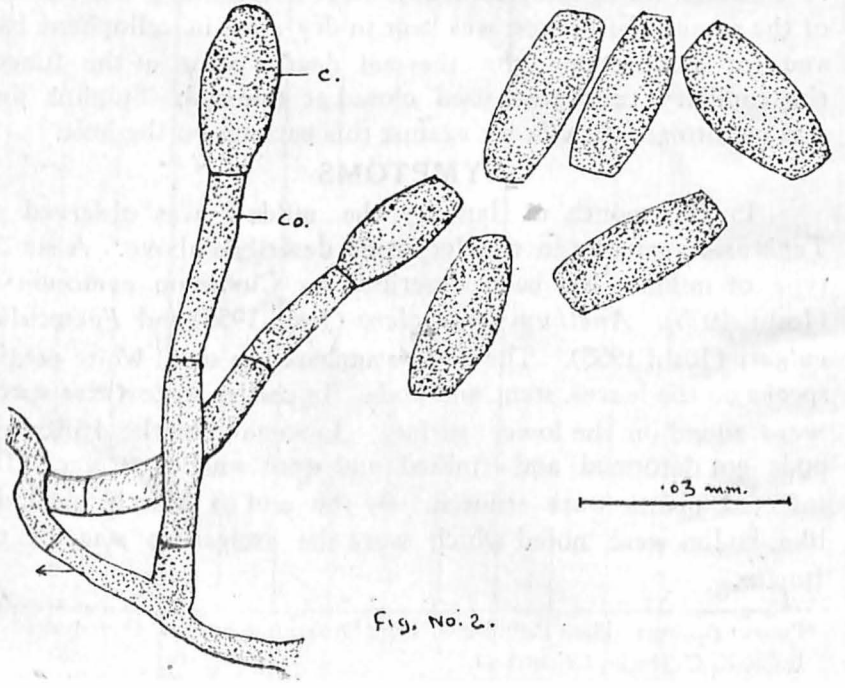

Fig. No. 2.

MORPHOLOGY OF THE FUNGUS

The microscopic characters of the fungus in the infected fruits, stem and leaves showed that it developed a network containing creeping hyaline, septate and ramified mycelium. The haustoria were present. The average thickness of the hyphae were 6 μ. Some hyphae gave short erect conidiophores. The conidiophores were stout and tall ranging from 120-180μ in thickness. The conidia were hyaline, elliptic in shape and are produced in chains of 4-6. Each conidium measured 27-34 x 13-15μ in dimension (Fig No. 2.). The cleistothecia were superficial, loose, and globose in nature. They were dark red in colour. Each cleistothecium measured 108-160 x 95-160μ in dimension (Fig. 1.) The appendages were five to ten in number and each measured 6μ in thickness. Usually 5 or 6 asci were present in each cleistothecium. The asci were hyaline, clavate and each measured 40-68 x 30-45μ in dimension. There were usually one to five ascospores in each ascus. The ascospores were oval and measured 20-32μ x 10-20μ in dimension.

SPORE GEMINATION STUDIES

The fresh conidia were germinated after 5 to 6 hours of their detachment from the conidiophores. They did not retain their viability after one month and a half. The spores were capable of germination only within a narrow range (as shown in table No. 1). The germination was optimum at 28°C, but below 12°C the percentage was below 10% and at 37°C there was no germination of the conidia.

Table No. 1 Showing the percentage of spores at different temperatures.

S. No.	Temperature	% of germination
1	12°C.	Below 10%
2	16°C.	12-24%
3	20°C.	16-40%
4	24°C.	44-50%
5	28°C.	48-62%
6	32°C.	10-12%
7	34°C.	Below 5%
8	37°C.	0%

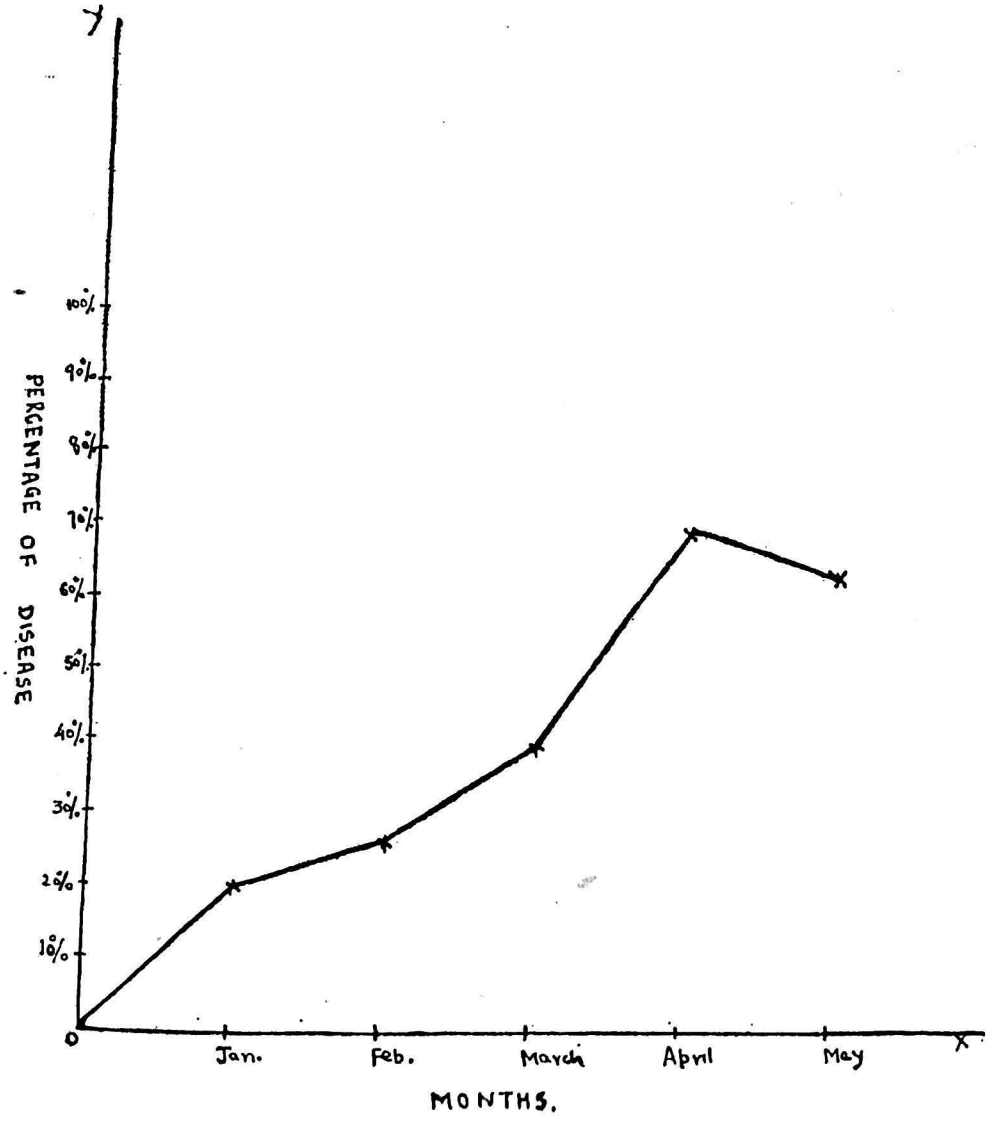

Fig. No. 3.

GRAPH SHOWING THE PERCENTAGE OF DISEASE IN THE MONTHS OF Jan., Feb., March, April and May 1958.

VIABILITY OF THE SPORES

In order to find out the viability of the conidia two types of experiments were performed which are as follows :

In the first case the infected plants were kept in cellophane bags in the month of April and in the month of June the conidia were tested for germination and it was found that not a single conidium germinated.

In the second set of experiment the conidial suspension was made and kept in a capillary tube and subjected to different high temperature for one hour. The result showed that the conidia lost viability at 37°C after an exposure for 30 minutes. At 39°C the viability was lost at an exposure of I5 minutes.

PHENOLOGICAL RELATIONS OF THE BLIGHT

In order to find out whether there is any relationship of powdery mildew with the daily weather condition during the growth period of the plants, it was noted that the atmospheric temperature exerts a considerable influence on the development of the disease. It was noted that the average temperature in the month of March and April did not fall below 75°F and in majority of the days it was between 75°-95°F. It becomes therefore clear that the dry weather of March and April preceded with slight rain helps in the development of the disease in 1958 (Fig. 3).

Table No. 2

Showing the frequency of favourable and unfavourable temperature of mildew during the year 1958.

Year	Number of days in each month with favourable and unfavourable temp. indicated.									
	Temperature below 75°F. (Unfavourable)					Temperature between 75-95°F. (Favourable)				
	Jan.	Feb.	March	April	May	Jan.	Feb.	March	April	May
1958	30	5	2	0	0	1	23	29	30	31

Rainfall Jan. 0.I5", Feb. nil, March 0.2", April nil; May nil. in the year 1958.

EFFICACY OF THE FUNGICIDE

For finding out the efficacy of sulphur dust against powdery mildew some experiments were conducted at Kishangarh road.

Adequate number of plants were kept as control. Some three applications, one in the month of January, another in the month of March, and the last in the month of April, were done. Approximately 20 lbs of sulphur powder was applied. It was noted that there was least disease in the treated plants while the control ones (untreated) were severely affected by the disease as shown table No. 3).

Table No. 3

Showing the amount of sulphur used in dusting the plants and the amount of disease in the experimental and the control plots.

S. No.	No. of plants dusted	Quantity of sulphur used	% of disease	No. of plants kept as control.	% of disease
1	1232	20 lbs.	2	1130	80

In becomes clear from the above table that the disease can be easily controlled by dusting the plants with sulphur powder at intervals before the appearance of the disease.

SUMMARY

A powdery mildew of *Tephrosia purpurea* caused by *Erysiphe polygoni* has been reported from Ajmer.

The symptoms of the disease, morphology of the fungus, spore germination, viability of the fungus, thermal death point and the phenological relations of the disease have been described.

Dusting the plants with fungicide (i. e. Sulphur) at the early appearance of the disease is the most practical control measure against the disease.

ACKNOWLEDGEMENT.

I am grateful to Dr. C. E. Yarwood of the University of California for sending relevant literature on powdery mildews. My thanks are also due to Principal and Prof. B. Tiagi for the laboratory facilities.

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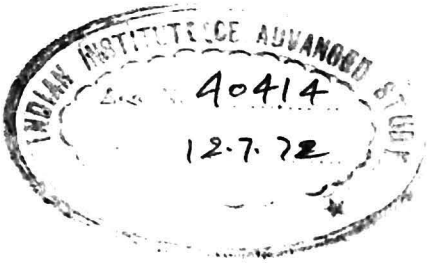
Explanation of figures:—

Fig. 1. Showing mature cleistothecia with prominent appendages. Asc–Ascospores; As–Ascus; Wc–Wall of cleistothecia.

Fig. 2. Showing conidia and conidiophores. c–Coidia; Co–Conidiophores.



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