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GASTRIC ANATOMY OF THE MOLOSSID BAT, *TADARIDA AEGYPTIACA* (WROUGHTON)

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ABSTRACT

Two sphincters, one at the gastro-oesophageal and the other at the gastro-duodenal junction, are formed by the circular layer of muscles of the muscularis externa in the stomach of *Tadarida aegyptiaca*. The Brunner's glands contain only neutral mucins except for a group of acini which is located on the side of the greater curvature of the stomach, and which contains only acidic mucins. The cardiac glands are unbranched and contain profuse secretion. The fundic mucosa contains pepsinogen cells, partietal cells, interstitial mucous cells and surface mucous cells. There is no pepsinogen cell in the transition zone.

INTRODUCTION

BATS can be recognised on the basis of their diet into several kinds, such as, frugivorous, insectivorous, nectarivorous, carnivorous, piscivorous, sanguivorous and omnivorous kinds. Since the various parts of the digestive tract, and particularly the stomach of mammals, are highly adaptive and undergo modification to suit the dietary habit it is expected that these animals, with such varied, but highly specific, dietary habits, must exhibit a wide variety of modifications in the structure and histochemistry of the stomach. There is very little information on the details of the structure and histochemistry of the stomach of bats[1–8]. The present paper embodies observations on the gastric anatomy of *Tadarida aegyptiaca* belonging to Molossidae, which is considered as one of the most advanced families of Microchiroptera[9].

MATERIAL AND METHODS

Adult specimens of *Tadarida aegyptiaca* (Wroughton) were collected from crevices in the walls and roofs of old buildings in Khandwa, Madhya Pradesh. The stomach and the duodenum of the specimens were fixed in 10% neutral formalin, calcium acetate formol or Rossman's fixative. The tissues were sectioned at 6 to 8 μ after following the usual procedure of dehydration through graded ethanol, clearing in xylol and embedding in paraffin.

For histological examination the sections were stained by Ehrlich's haematoxylin and eosin and Cason's[10] modification of Mallory Heidenhain Azan procedure : one step method. The techniques given by Pearse[11], Gabe[12] and Lillie[13] were employed for the identification of different types of mucins. The classification of mucins given by Spicer *et al.*[14] has been followed in the present report.

RESULTS

Anatomy and histology of the stomach

Figure 1 illustrates the anatomy of the stomach of *Tadarida aegyptiaca*. The narrow oesophagus leads into a slightly wider cardiac region leading to the tubular stomach. The fundic caecum is well developed. The stomach is widest in the tubular region and becomes progressively narrower towards the pyloric sphincter (Fig. 2). The oesophageal and pyloric sphincters are formed by the circular layer of muscles of the muscularis externa. The oesophageal sphincter is considerably thicker along the greater curvature than along the lesser curvature (Fig. 3). The pyloric sphincter is 50–100 μ thick and projects into the duodenal lumen to a distance of 350 μ (Fig. 2) along the lesser curvature.

FIG. 1. Semischematic drawing of the vertical section of the stomach of *Tadarida aegyptiaca*. B.gl., Brunner's glands; c, cardiac region; duo, duodenum; f.c, fundic caecum; oes, oesophagus; py, pylorus; py.sph, pyloric sphincter; t.st, tubular stomach; tr.z, transition zone.

The acini of the Brunner's glands occur on the duodenal side of the pyloric sphincter and extend to a distance of about two mm along the lesser curvature

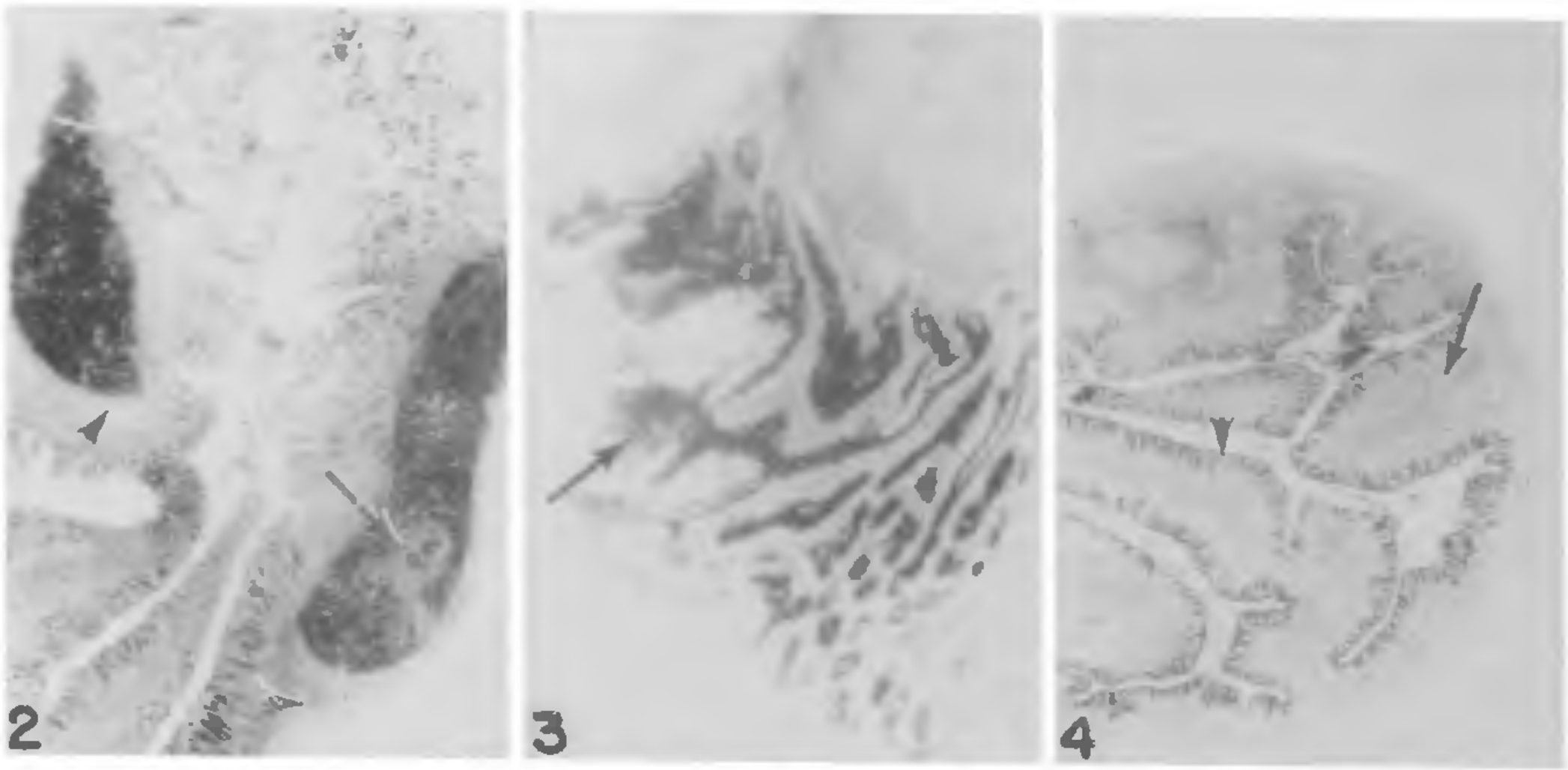
and about one mm along the greater curvature (Fig. 2).

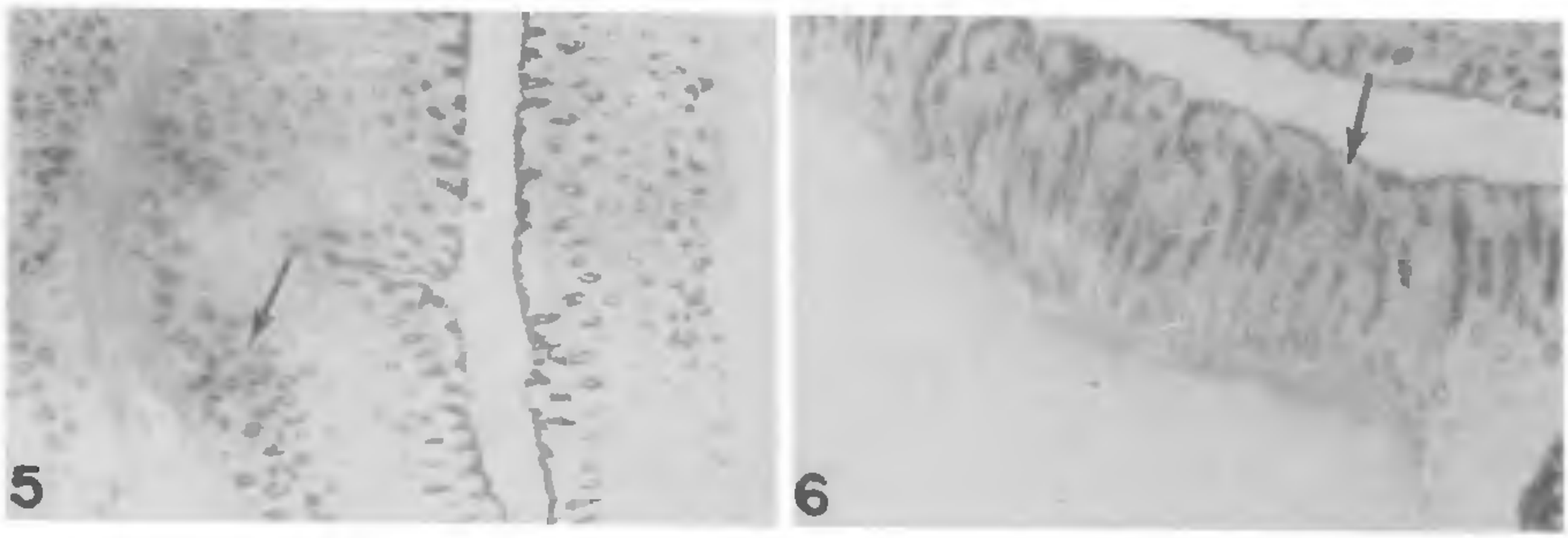
The various cell types of the gastric mucosa are pepsinogen cells, parietal cells, interstitial mucous cells (neck mucous cells of other authors) and surface mucous cells. The interstitial mucous cells are distinguishable into proximal and distal types in those regions of the stomach where they stain differently. All the regions of the stomach may not contain all these types of cells—one or more cell types being absent from certain regions of the stomach.

There is no ruga in the cardiac vestibule, and the cardiac glands are unbranched (Fig. 3). The cardiac glands are made up almost entirely of mucus secreting cells with a few isolated parietal cells. The cytoplasm of the mucus secreting cells contains copious amounts of secretion. Interstitial mucous cells and pepsinogen cells are not present in this region.

The fundic mucosa contains pepsinogen cells in the basalmost part and surface mucous cells (Fig. 4) distally. The middle segment of the gland is occupied by parietal cells and interstitial mucous cells.

The mucosa of the transition zone (Fig. 5) contains numerous proximal interstitial mucous cells interspersed among the parietal cells, but no pepsinogen cell. The surface mucous cells occur distally in this





FIGS. 2–6. Fig. 2. Gastro-duodenal junction; note the presence of two kinds of acini of Brunner's glands. Arrow points towards the CI-positive acini. The rest of the acini are PAS-positive. Arrowhead points towards the sphincter valves. (CI–PAS). × 44. Fig. 3. Gastro-oesophageal junction to show the cardiac glands. Note that they contain profuse secretion (arrow) and are composed of mucus producing cells only (CI–PAS). × 140. Fig. 4. Part of fundic muscosa. Note the darkly stained surface mucous cells (arrowhead). Arrow points towards the thick submucosa core of the rugae (CI–PAS). × 44. Fig. 5. Part of the section through the transition zone. Note the interstitial mucous cells (arrow) (CI–PAS). × 44. Fig. 6. Part of the pyloric mucosa. Arrow points towards the profuse secretion in the surface mucous cells (CI–PAS). × 56.

region. The pyloric mucosa has very deep foveolae and the glands are composed almost entirely of the surface mucous (Fig. 6) cells. A few interstitial mucous cells (which cannot be distinguished into proximal and distal types) and isolated parietal cells, however, occur in the basal 20 to 30 μ segment of the glands.

Cytology of the gastric glands and mucin histochemistry

The pepsinogen cells are polygonal or ellipsoidal in shape with centrally located nuclei. The interstitial mucous cells vary in their shape, being irregular towards the base of the glands. The surface mucous cells are tall columnar and may have intact or ruptured distal ends. They have basally located nuclei.

Table I gives the results of the histochemical tests employed. The pepsinogen cells and parietal cells do not stain specifically with any of the histochemical tests employed here except for giving a weak PAS positive reaction which is resistant to prior treatment with salivary amylase. It is evident from the table that the mucous cells can be distinguished into proximal and distal types only in the fundic region of the stomach and the transitional zone.

The table also indicates that with AB (pH 1·0)—PAS sequential staining the interstitial mucous cells and surface mucous cells stain as with only PAS staining. AF also does not stain these cells. These staining reactions indicate the absence of sulphated mucins in these cells. With AB (pH 2·5)—PAS and CI-PAS sequential staining procedures the following results were obtained. The proximal interstitial mucous cells of the fundic region and the transitional zone take a pink colour and the distal interstitial mucous cells take a blue-purple colour. These reactions indicate the presence of neutral mucins in the proximal interstitial mucous cells and both neutral and acidic mucins with a predominance of neutral mucins in the distal interstitial mucous cells. The surface mucous cells also take a blue-purple colour in all the regions of the stomach. These cells, however, show a predominance of acidic mucins in the cardiac and fundic regions of the stomach and a predominance of neutral mucins over acidic mucins in the transition zone and the pyloric region. The acidic mucins are those with sialo-groups.

While the cells of most of the acini of the Brunner's glands contain neutral mucins, the cells in a few acini with large central lumina contain only acidic (sialo-) mucins.

Discussion

Studies on the distribution and identification of different kinds of mucins in the gastric mucosa have been made only on *Rhinopoma kinneari*, *Taphozous longimanus*[7] and *Miniopterus schreibersii*[8] among bats.

Table I

Distribution of mucins in the interstitial mucous cells and surface mucous cells of the gastric mucosa of Tadarida aegyptiaca

Technique	Cardiac region		Fundic region			Transition Zone			Pylorus	
	Int	s	p	d	s	p	d	s	Int.	s
PAS	4R	4R	4R	4R	4R	4R	4R	4R	4R	4R
Sal.-PAS	4R	4R	4R	4R	4R	4R	4R	4R	4R	4R
CI-PAS	4R	4BR	4R	4RB	4BR	4R	4RB	4RB	4R	4RB
AB (pH 1·0)-PAS	4R	4BR	4R	4RB	4BR	4R	4RB	4RB	4R	4RB
AB (pH 2·5)-PAS	4R	4BR	4R	4RB	4BR	4R	4RB	4RB	4R	4RB
AF	..	..	..	..	..	..	..	..	..	..
Methylation 37° C-AB (pH 2·5)	..	±B	..	±B	±B	..	±B	±B	..	±B
Demethylation 37° C-AB (pH 2·5)	..	3B	..	2B	3B	..	2B	2B	..	2B
Methylation 60° C-AB (pH 2·5)	..	..	..	..	..	..	..	..	..	..
Demethylation 60° C-AB (pH 2·5)	..	3B	..	2B	3B	..	2B	2B	..	2B
Hyaluronidase-AB (pH 2·5)	..	3B	..	2B	3B	..	2B	2B	..	2B

Abbreviations used : p—proximal interstitial mucous cells; d—distal interstitial mucous cells; s—surface mucous cells; int.—interstitial mucous cells.

TABLE II

Distribution of mucins in the different regions of the stomach of Rhinopoma kinneari, Taphozous longimanus *and* Tadarida aegyptiaca

Species	*Rhinopoma kinneari*			*Taphozous longimanus*			*Tadarida aegyptiaca*		
Cardiac region	(cardiac reg. + part of cranial half of fundic caecum)								
	p	d	s	p	d	s	int.	s	s
	acidic (sulphated)		neutral + acidic (sialo-)	acidic (?)		neutral + acidic (sialo-)	neutral		acidic (sialo-)
	rest of fundic caecum)						p	d	s
Fundic region	*	*	neutral + acidic (sialo-)	neutral		neutral + acidic (sialo-)	neutral	acidic (sialo)	
Transition zone	neutral	neutral + acidic (sialo—)		acidic (?)		neutral + acidic (sialo-)	neutral	neutral + acidic (sialo-)	
	int.	s		int.	s		int.	s.	
Pylorus	neutral	neutral + acidic (sialo-)		neutral + acidic (sialo-)		neutral	neutral	neutral + acidic (sialo-)	

Abbreviations used : p—proximal interstitial mucous cells; d—distal interstitial mucous cells; s—surface mucous cells; int.—interstitial mucous cells.

The fundic caecum of *Tadarida aegyptiaca* resembles that of *Rhinopoma kinneari* in not being distinctly saparated from the tubular region of the stomach. The parietal cells exhibit uniform staining reactions in all the species of Chiroptera studied so far[1–8]. The pepsinogen cells of *Rhinopoma kinneari* do not stain specifically with any of the staining procedures employed here but those of *Taphozous longimanus*[7] gave a positive reaction with aldehyde fuchsin and stained specifically with the acid fuchsin component of the Cason's modification of the Malory Heidenhain Azan procedure : one step method. The pepsinogen cells of *Miniopterus schreibersii*[8] too stained with aldehyde fuchsin. It is noteworthy that there should be so much variation in the type of secretion in the mucus secreting cells of the mucosa of the different regions of the stomach of *Rhinopoma kinneari*, *Taphozous longimanus* and *Miniopterus schreibersii* and *Tadarida aegyptiaca*.

The surface mucous cells contain both neutral and acidic (sialo-) mucins only in the caridac region and in the apex of the fundic caecum of *Miniopterus schreibersii*[8]. The surface mucous cells in the rest of the regions of the stomach and the interstitial mucous cells in all the regions of the stomach of this species contain only neutral mucins.

From Table II, which gives the type of mucins secreted by the different regions of the stomach of *Rhinopoma kinneari*, *Taphozous longimanus* and *Tadarida aegyptiaca*, it is evident that the surface mucous cells contain mostly acidic (sialo-) mucins in all the regions of the stomach of the three species, except the pyloric region of the stomach of *Taphozous longimanus* where the mucus secreting cells contain only neutral mucins. The type of secretion in the proximal interstitial mucous cells, however, varies considerably in the different regions of the stomach.

Although it is not possible to draw a sharp line of demarkation sepearating the proximal and the distal interstitial mucous cells on the basis of their shape, since there is a gradual transition of these cells from an irregular or polygonal shape at the base of the gland to the fusiform shape at the distal region of the gland, these can be distinguished on the basis of the nature of mucins secreted by them as determined by their staining reactions. The proximal interstitial mucous cells contain only neutral mucins while the distal interstitial mucous cells contain both acidic and neutral mucins. The surface mucous cells also contain both types of mucins, but these cells can be distinguished from the distal interstitial mucous cells because, while acid mucins predominate in the surface mucous cells, neutral mucins predominate in the distal interstitial mucous cells.

The Brunner's glands of *Tadarida aegyptiaca* are unique in the possession of two distinct kinds of acini : while most of the acini have small central lumina and their cells contain only neutral mucins a a few acini located on the side of the greater curvature of the stomach contain only acidic mucins. Such a situation has not been so far described in any other bat.

The above findings indicate that there are marked differences in the histochemistry of not only the different regions of the stomach of a given species, but in the histochemistry of the stomach of different species of bats. Detailed studies on the dietic habits and the relationship between the nature of the diet and the histophysiology of the gastro-intestinal tract of several species of bats are in progress.

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SEMINAR ON "AREAS OF NATIONAL PRIORITIES IN R & D IN THE 1980s"

This seminar is being organised by the Society of R & D Managers of India, Hyderabad, at Hyderabad, to debate on the following: (*a*) Is our industrial growth primarily based on foreign technology ? To what extent have the indigenous R & D helped in the industrial growth of the country ? (*b*) What priority are we giving to develop alternative fuel cycle for atomic energy ? (*c*) Why is space research not being applied for rural education ? (*d*) Have we set the priorities right ? Which sector would require more allocation for research from the following :

1. Safe drinking water; 2. Energy ; 3. Metallurgy ; 4. Electronics ; 5. Dryland Agriculture ; 6. Pharmaceuticals ?

A list of areas of research which should be considered top priority for the 1980s may be considered.

For details please contact : Indradev, Convener and Hon. Gen. Secretary, Society of R & D Managers of India, ASCI, Hyderabad 500 475.

NEUROSCIENCE SOCIETY OF INDIA

The Third Annual Meeting of the Neuroscience Society of India will be held at University of Hyderabad, Hyderabad, during December 10-12, 1980. At this time it has also been proposed that a symposium on 'Nutrition and Brain Function' be conducted.

For details please contact : Prof. K. Subba Rao, School of Life Sciences, University of Hyderabad, Hyderabad 500 134.