

in the white pulp cells only, whereas the red pulp cells were virtually devoid of the enzyme activities. During wound healing phase, there was an increase in the activities of both the phosphatases in the cells of white pulp. Alkaline phosphatase activity declined below the normal level when blastema was formed (Table I). However, at this stage the activity of acid phosphatase remained at a higher level. Nevertheless, during the next phase of tail regeneration, i.e., differentiation, alkaline phosphatase reactivity in the spleen reached its preautotomy level, whereas that of acid phosphatase gradually decreased reaching its preautotomy level when the regenerate reached its full grown state.

DISCUSSION

Activities of both the hydrolytic enzymes were discernible in the cells of white pulp only. An increase in the activity of both these phosphatases in the white pulp during wound healing implies an augmentation of lymphocytopoietic function of the spleen⁷. Alkaline phosphatase which is considered to be an inducible enzyme is known to accumulate in tissues or organs prior to the onset of their functions³. The process of wound healing would undoubtedly demand increased turnover of lymphocytes which would result in enhancement of cellular proliferation in the white pulp of the spleen that in turn would be reflected in the increased alkaline and acid phosphatase activities. Phosphatases have been implicated in cellular proliferation^{3, 9} and also in phagocytosis¹⁰. Hence, an increase in reactivities of these two enzymes in the present context could be considered to be aiding the lytic activities occurring at the wound site during early period of regeneration and later the cellular proliferation.

The decline in reactivity of alkaline phosphatase to a subnormal level during blastema phase could be

due to the completion of wound healing and reduced involvement of lymphocytes in the ensuing regenerative process. However, an increase in acid phosphatase activity during the same period indicates lytic activities being continued to clear up the cellular debris from the regenerate and the tail stump which are being brought to the spleen.

During the differentiation phase, alkaline phosphatase reached its preautotomy level and remained so thereafter; this points to the normalization of the spleen function. At this stage the histological features of the spleen are also comparable to those observed in the lizards with intact original tail².

1. Snodgrass, M. J. and Snook, Th., *Anat. Rec.*, 1971, 170, 243.
2. Shah, R. V., Kothari, J. S. and Hiradhar, P. K., *J. Anim. Morphol. Physiol.*, 1977, 24 (2) (in press).
3. Moog, F., In *Biochemistry of Animal Development*, ed. R. Weber, Academic Press, New York, 1965.
4. McWhinnie, J. W. and Sanders, J. W., *Develop. Biol.*, 1966, 14, 169.
5. Sweeny, L. R. and Shapiro, B. L. *Anat. Rec.*, 1971, 170, 235.
6. Burstone, M. S., *Enzyme Histochemistry and Its Application in Study of Neoplasms*. Academic Press, New York, 1962.
7. Asnani, M. V., Pilo, B. and Shah, R. V., *J. Anim. Morphol. Physiol.*, 1971, 16, 188.
8. Olsen, R. L. and Nordquist, R. E., *J. Invest. Derm.*, 1966, 46, 431.
9. Shah, R. V. and Menon, G. K., *J. Anim. Morphol. Physiol.*, 1974, 21, 8.
10. Fry, A. E., Leius, V. K., Bacher, B. E. and Kalienbach, J. C., *Gen. Comp. Endocrinol.*, 1973, 21, 16.

PEYER'S PATCHES IN SOME INDIAN BATS

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ABSTRACT

The Peyer's patches in twelve Indian species of bats having different feeding habits were studied. In general, the Peyer's patches are more in number in the frugivorous species than in the insectivorous ones. The Peyer's patches are absent in *Rhinopoma kiuneari* and *Megaderma lyra lyra* which, however, have a well developed caecum. It is suggested that the degree of development of the Peyer's patches is dependant on the bacterial content of the diet since the Peyer's patches are aggregations of lymph nodules.

THE ileum of mammals is characterised by the presence of patches of lymphoid tissue—the Peyer's patches. It is well known that the lymphoid tissue plays an important role as a defence mechanism

against bacterial infection, and its occurrence at several points along the alimentary canal is evidently meant to ensure the elimination of all unwanted bacteria from the gut. Hence, the Peyer's patches are a part

TABLE I
Peyer's patches in twelve species of bats with varying food habits

Family	Species	Number of specimens examined	Feeding habits	Number of Peyer's patches
Pteropidae	<i>Cynopterus sphinx gangeticus</i>	4	frugivorous	9*
"	<i>Rousettus leschenaulti</i>	4	"	7
"	<i>Pteropus giganteus giganteus</i>	4	"	27
Rhinopomatidae	<i>Rhinopoma kinneari</i>	5	insectivorous	nil
Emballonuridae	<i>Taphozoux longimanus</i>	4	"	4
Megadermatidae	<i>Megaderma lyra lyra</i>	4	carnivorous	nil
Hipposideridae	<i>Hipposideros speoris</i>	4	insectivorous	4
Rhinolophidae	<i>Rhinolophus rouxi</i>	3	"	3
Vespertilionidae	<i>Pipisterillus mimus mimus</i>	4	"	3
"	<i>Scotophilus heathi</i>	4	"	7 to 10
"	<i>Miniopterus schreibersii</i>	3	"	3
Molossidae	<i>Tadarida aegyptiaca</i>	4	"	4

* The terminal part of the rectum of this species has two rows of lymph nodules.

of the immune mechanism associated with the digestive system.

To-date there is no information on the Peyer's patches in Indian bats. Forman⁴ gave an account of the number and distribution of Peyer's patches in several species of New World bats. He mentioned that generally the frugivorous, nectarivorous, sanguivorous (blood feeders) and omnivorous bats have a greater abundance of lymphoid tissue than the insectivorous and piscivorous species. He mentioned that the higher abundance of lymphoid tissue in the intestinal tract of herbivorous bats was probably related to the higher intake of bacteria by plant feeders than the species which consume other kinds of diet.

The present report embodies the distribution and description of Peyer's patches in twelve species of Indian bats. The Peyer's patches were counted by the method of Hellman⁶ with some modifications. The entire intestine was slit along the mesentery and kept in tap water for one to three hours until the muscles lost their tonus. The intestine was then stretched to its fullest capacity, cleaned with a camel hair brush, wound spirally round a glass cylinder and immersed in 40% acetic acid for an hour. The Peyer's patches appear as whitish, opaque, characteristically nodulated areas. The difficulty encountered in locating the end of the small intestine and the beginning of the large intestine, as mentioned by Schultz⁷, can easily be overcome by this method since the last Peyer's patch, which is usually the largest, marks the end of the ileum. The intestines were preserved in Kaiserling's fluid (Gabe 1975). Only adult specimens were examined for the present study. In the case of *Rhinopoma kinneari* and *Megaderma lyra lyra* the

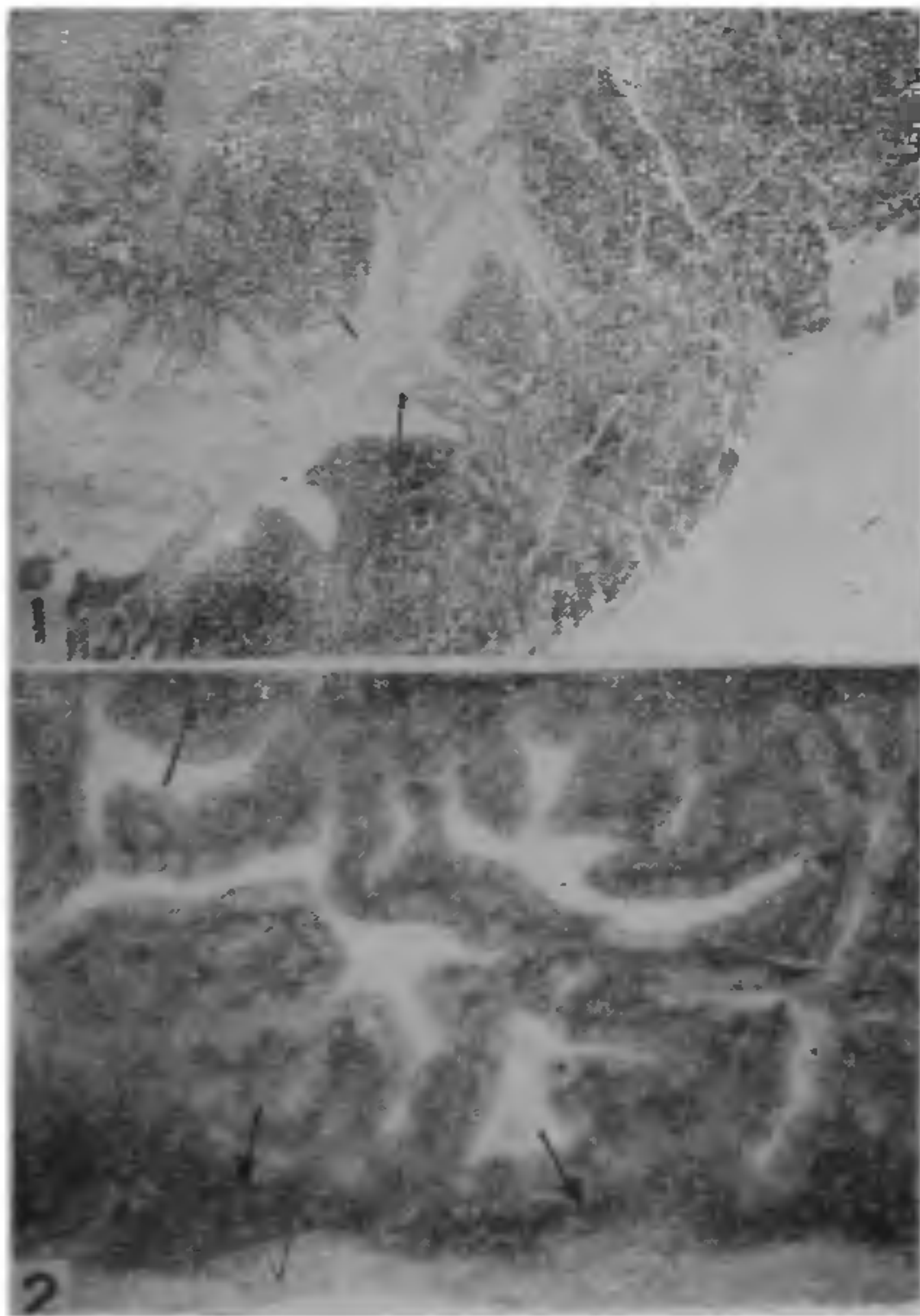
entire caecum was removed and fixed. The tissues were processed as per usual procedure and the sections were stained with haematoxylin and eosin.

Table I gives the counts of the Peyer's patches in the twelve species of bats examined.

The table reveals that the number of Peyer's patches is more in the frugivorous *Cynopterus*, *Rousettus* and *Pteropus* than in the insectivorous or carnivorous species. The case of *Scotophilus heathi* appears to be exceptional in several ways since it possesses a variable number of Peyer's patches. Forman⁴ reported the occurrence of a variable number of Peyer's patches in a few microphiropteran species. He mentioned, however, that since the number of each species examined was very small "conclusions drawn must be considered tentative". In addition to the Peyer's patches a few isolated lymph nodules also occur scattered through the length of the ileum in *Cynopterus sphinx gangeticus* and *Pteropus giganteus giganteus* the latter species having also the largest count of twentyseven Peyer's patches reported for any species of bats so far. The Peyer's patches in the distal half of the ileum of this bat are rod-shaped, each being 1-3 cms long and consisting of 2-4 rows of lymph nodules, while the Peyer's patches in the proximal half of the ileum of this species as well as in all other bats examined here (except *Cynopterus*) are spindle shaped with tapering ends. The Peyer's patches of *Cynopterus* unlike those of all other bats examined here are circular in shape. Further, in all the specimens the seventh Peyer's patch counting from the duodenal end is semi-lunar in shape. Besides, the terminal part of the rectum although lacking a distinct Peyer's patch has two rows of lymph nodules.

Forman⁴ mentioned that he did not observe patches in the "large intestine" of the thirtyfive species of bats he examined.

It is noteworthy that not only the position of the Peyer's patches is constant in all the specimens of a species studied here (except *Scotophilus heathi*) but the size of a given Peyer's patch is constant for all the specimens of a species. Also, it is peculiar that the carnivorous *Megaderma lyra lyra* has no Peyer's patch and that most of the lymphoid tissue of the intestine, except for a few lymphoid patches interspersed between the Brunner's glands at the gastroduodenal junction (Bhide¹), is consolidated as the caecum (Fig. 1) which lies at the ileo-colonic junction. *Rhinopoma kinneari* too is peculiar in having no Peyer's patch in the ileum and in the occurrence of a continuous layer of lymphoid tissue (Fig. 2) beneath the mucosa in the caecum.



FIGS. 1-2. Fig. 1. Part of the section through the ileo-colonic junction of *Megaderma lyra lyra*. Note that the caecum is composed of aggregations of lymphoid tissue (arrow). (HE), $\times 64$. Fig. 2. Part of the section through the caecum of *Rhinopoma kinneari*. Note the continuous layer of lymphoid tissue (arrow) at the base. (HE), $\times 146$.

From the foregoing it is evident that the ileum of herbivorous species have a generally better developed lymphoid tissue in the form of Peyer's patches than that of insectivorous species. The total absence of

Peyer's patches from the ileum, but the occurrence of a caecum containing abundant lymphoid tissue in *Rhinopoma kinneari* and *Megaderma lyra lyra*, is also significant. This is suggestive of the possibility that the food of these species may have very low content of pathogenic bacteria. The fact that *Megaderma* is an exclusively predaceous carnivore appears to support this suggestion. Similarly, the food of *Rhinopoma kinneari* may be assumed to be of low bacterial content since it feeds on large fleshy insects. The occurrence of one large mass of lymphoid tissue in these two species at the ileo-colonic junction may be sufficient to meet the defence demands of these animals and ensure bactericidal action at one place only. Schultz⁷ first reported the occurrence of a caecum in two families of bats namely the Rhinopomatidae and the Megadermatidae. However, he did not describe the histology of the caecum in his studies. Peyer's patches have been considered to be the mammalian equivalent of the avian Bursa of Fabricius (Fichtelius³). Eloy *et al.* (1975) have shown that at least one thymus dependant function is present in this gut-associated lymphoid tissue.

The occurrence of a variable number of Peyer's patches in *Scotophilus heathi* cannot be explained unless the dietary habits of the animal are studied in detail. Forman⁴ reported the occurrence of a variable number of Peyer's patches in a few microchiropteran species. He mentioned, however, that since the number of specimens of each species examined was very small "conclusions drawn must be considered tentative". It is also noteworthy that the number of Peyer's patches in *Scotophilus heathi* is much more than in the other Microchiroptera studied here.

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1. Bhide, S. A., *Curr. Sci.*, 1978, 47, 571.
2. Brossat, A., *J. Bombay Nat. Hist. Soc.*, 1962 *c.*, 59, 707.
3. Fichtelius, K. E., *Exp. Cell. Res.*, 1967, 46(1), 231.
4. Forman, G. L., *Trans. Ill. Acad. Sci.*, 1974, 67 (2), 152.
5. Gabe, M., *Histological Techniques*, Masson, Springer Verlag, 1976, p. 1106.
6. Hellman, T., *Ztschr. f. d. ges. Anat. Abt. HZtschr. f. Konstitutionslehre.*, 1921, 8, 191.
7. Schultz, W., *Zeit. Wissenschaft. Zool.*, 1965, 171, 241.