

FIGS. 1-2. Fig. 1. Section of healthy stomach of *C. gachua* showing PAS positive mucoid materials (M) in the apical border of epithelial cells. Al, Blue and PAS  $\times 50$ . Fig. 2. Section of infected stomach of *C. gachua* showing lesser amount of PAS positive mucoid materials (M) in the epithelial cells. Note the presence of capsules containing *G. goppo* in the submucosa. Al, Blue and PAS  $\times 50$ .

mucoid materials (Fig. 2) but large amounts are present in the lumen, stomach wall between the fluke and host tissue and around the body of *G. goppo*. They are PAS positive and do not stain with alcian blue and lose their PAS reaction after prior acetylation and regain it after saponification. They may be neutral polysaccharides secreted by the host stomach to lessen the effects of toxins secreted by the fluke and to reduce the irritation caused after the entrance of the parasite.

This is perhaps the first report of high secretion of neutral polysaccharide by gastric epithelium in infected fish. Bullock<sup>3</sup> has reported acid mucopolysaccharide between the parasite and the intestinal wall in salmonoid fishes. Bucke<sup>2</sup> has also reported large number of goblet cells and acid mucopolysaccharide in the intestine of *Esox lucius* infected by cestodes.

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#### SYSTEMS MODELS FOR PARASITE PATHWAYS IN ICHTHYOPARASITOLOGY OF THE HIMALAYAN RIVERINE ECOSYSTEM

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LITERATURE does not record parasitological investigations on hillstream fish in the Himalayan riverine ecosystem. Malhotra and co-workers<sup>1-4</sup> have attempted some studies on various aspects of parasitocoenoses in fish (*viz.*, species-composition, effect of temperature and host age, feeding habits, and physiological state on parasite distribution) and their statistical correlations were worked out in different sex and weight classes in the host-parasite system.

The present study marks a systems approach (Ratcliffe *et al.*<sup>5</sup>) to identify the changes in the rate of flow of parasites through a host-parasite system and the specific points where the various influencing factors act. The statistical data gathered from a parasitological survey of 2224 hillstream fish of 12 genera and 22 species in Garhwal Himalayas (See Malhotra<sup>1</sup>) have been utilized to suggest a basic universal model of a fish-cestode parasite system depicting parasite pathways in the verte-

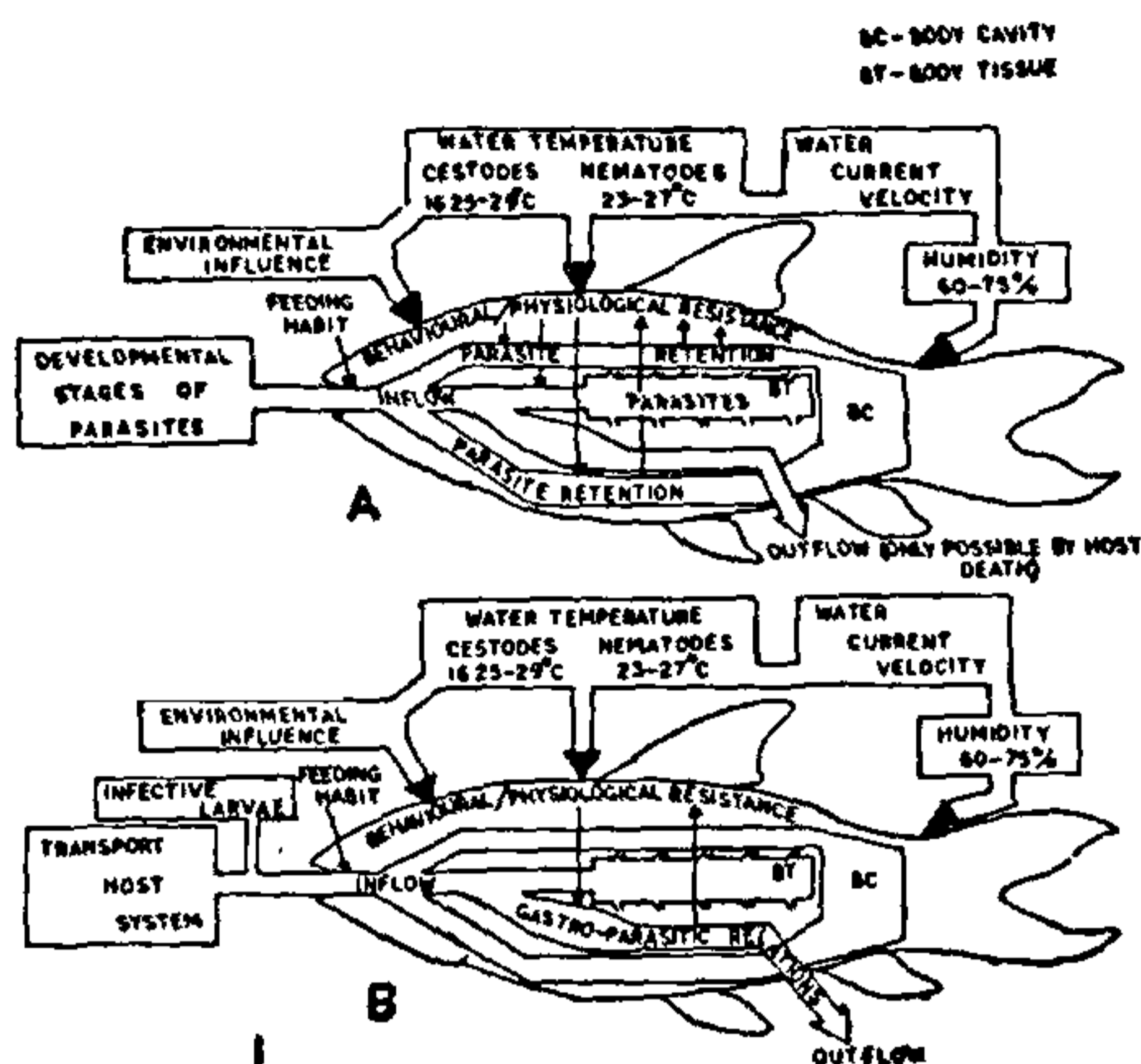


FIG. 1. Parasite pathways in fish hosts in the Himalayan riverine ecosystem in A—an intermediate or transport host system; B—a definitive host-parasite system.

brate host's body with an input and output which is capable of further detailed elaboration. As is evident from Fig. 1, the factors controlling 'inflow' may be, firstly, the availability of infective larvae and secondly, the feeding habits of fish. On the other hand, 'outflow' is influenced by the failure of the parasites to establish themselves, by the behavioural/physiological resistance of fish and by natural mortality at the termination of the parasite's life span. The overall changes in infection patterns thus seem to be under the influence of the unpredictable behaviour of the biotic and abiotic factors of the environment where a slight variation can alter the extent of parasite abundance and species distribution in each host-parasite system.

Nearly all the parasites reported from the hill-stream fishes in the Himalayan riverine ecosystem can be referred to one or the other system, i.e., the 'intermediate host system' serves as a model for *Schistocephalus solidus* (Mueller<sup>6</sup>) while most of the remaining species (*Bothriocephalus scorpii* (Mueller<sup>6</sup>), *B. teleostei* n.sp. (Malhotra<sup>1</sup>), *Comphronema* spp., *Polyonchobothrium armatii* n.sp. (Malhotra<sup>1</sup>), *Ptychobothrium nayarensis* n.sp. (Malhotra<sup>1</sup>), *Senga* spp. (Malhotra<sup>1</sup>), and *Sterliadochona* spp.) can be described by the 'definitive host system'. However, a few species, viz., *Capooria barilii* n.g., n.sp. (Malhotra<sup>1</sup>), *Guptaia garhwalensis* n.g., n.sp. (Malhotra<sup>1</sup>), *Mackiewiczia satpuliensis* n.g., n.sp. (Malhotra<sup>1</sup>) and *Tortocephalus songi* (Malhotra and Capoor<sup>7</sup>) cannot be presently referred to either model until more information about their life history is available.

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### HAEMATOENZYMOLOGY OF HETEROPNEUSTES UNDER CHEMICOAZO STRESS OF BISMARK BROWN

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AMINOAZODYES including Bismark brown (a permitted aminoazo dye) in the form of residual wastes from textile printing and dyeing industries often render critical chemicoazo stress in fresh water fish which suffer a huge mortification.

The fish haematology under various chemical stresses has been worked out<sup>1-3</sup>. Recently, Goel and Garg<sup>4-5</sup> have worked out some haematological and enzymological changes in the liver and kidney of *Channa* induced by azodye exposure. The present paper deals with the haematological and seroenzymological changes in *Heteropneustes fossilis* induced by chronic exposure of a basic azodye, the Bismark brown (2,4'-diamino, 3-aminoazobenzene; DAAB).

#### Material and Methods

Forty live fish (*Heteropneustes fossilis*, 30 to 59 g) were treated with a sublethal concentration of 0.01% dye bath (DAAB) (LC<sub>50</sub> being 0.015% for 96 hr at 20 ± 4°C) after acclimatizing to laboratory conditions for 7 days. Forty fish of control group were kept in tap water at the same temperature. The photooxidation of the dye added was checked by seal-covering the fish aquaria with black paper.

The fish of both experimental and control groups were sacrificed after 15 days and blood from cut caudal vein was collected in a vial having anticoagulant EDTA. The red cell and white cell count per cmm and absolute blood parameters were determined by standard methods<sup>6</sup>.