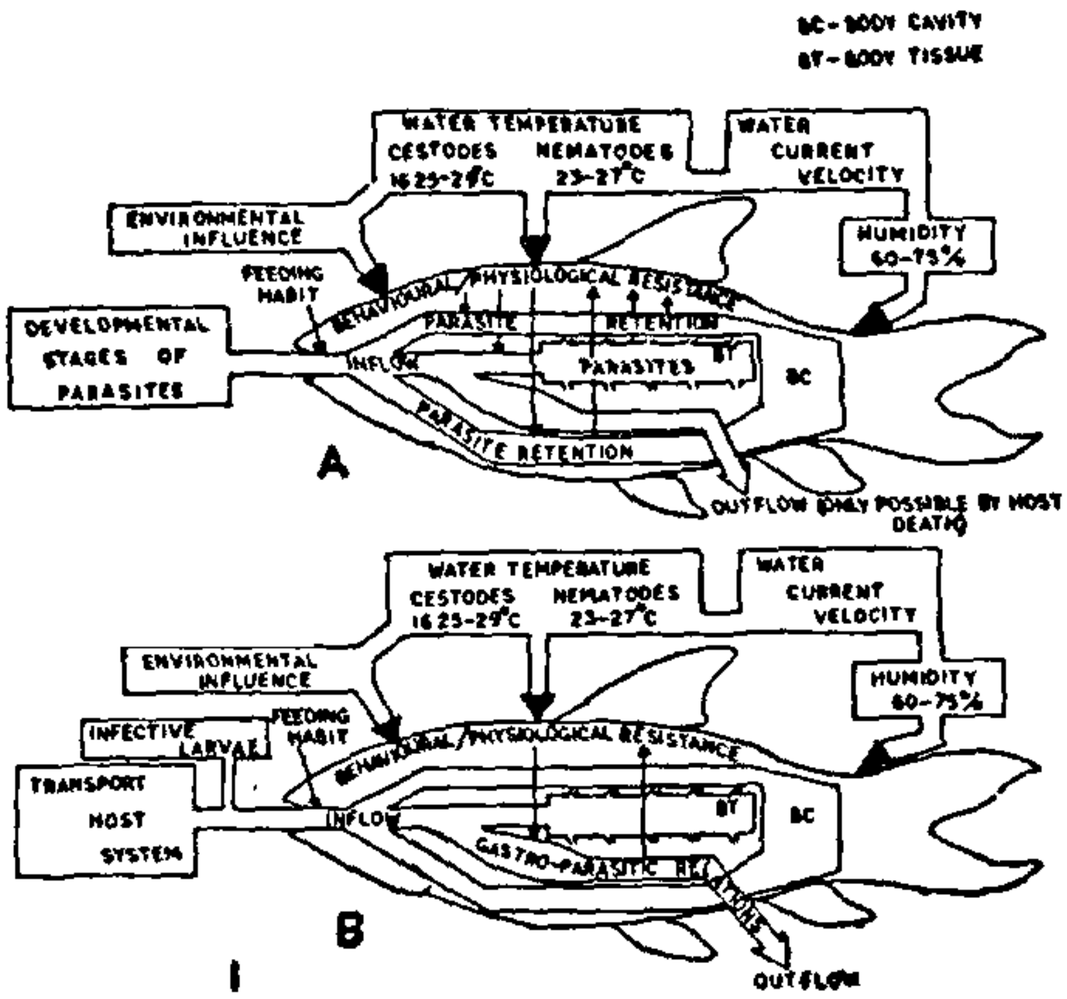

FIG. 1. Parasite pathways in fish hosts in the Himalayan riverine ecosystem in A—an intermediate or transport host system; B—a definitive host-parasite system.

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[6]) while most of the remaining species (*Bothriocephalus scorpii* (Mueller[6]), *B. teleostei* n.sp. (Malhotra[1]), *Comephronema* spp., *Polyonchobothrium armatii* n.sp. (Malhotra[1]), *Ptychobothrium nayarensis* n.sp. (Malhotra[1]), *Senga* spp. (Malhotra[1]), and *Sterliadochona* spp.) can be described by the 'definitive host system'. However, a few species, *viz.*, *Capooria barilii* n.g., n.sp. (Malhotra[1]), *Guptaia garhwalensis* n.g., n.sp. (Malhotra[1]), *Mackiewiczia satpuliensis* n.g., n.sp. (Malhotra[1]) and *Tortocephalus songi* (Malhotra and Capoor[7]) 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 dying 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[1–3]. Recently, Goel and Garg[4–5] 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_{60} 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[6].

The enzymes, AlPase, AcPase, RNAse, GOT and GPT were assayed following the methods of Oser[7] in Hawk's physiological chemistry. Amylase and cholinesterase were estimated according to the methods given by Bergmeyer[8].

Results

Data given in Table I reveal that the dye exposure to *Heteropneustes* results in :

(1) an acute anemia associated with decrease of RBC count and Hb%,
(2) an increase of total leucocytes; RBC: WBC ratio decreased,
(3) an increase in PCV and MCV and a decrease in MCHC and MCH,
(4) an increase of serum enzymes including phosphatase, amylase, cholinesterase, GOT and GPT. All the values were statistically significant.

Discussion

The decrease in red cell count and haemoglobin indicated occurrence of acute anemia during dye exposure. Anemias have also been reported to occur in response to dyes (Chandra and Singh[9] and Goel and Garg[4]), pesticides (Goel *et al.*[10]) and alloxan (Agrawal *et al.*[11]). The increase in MCV and PCV values and white cell count are in agreement with the results of Shammi and Qayyum[12] and Goel and Garg[4].

The increased value of Icteric index of plasma of experimental fish indicated a possible increased level of bile pigments in plasma which correlated with hepatodysfunction during dye intoxication[4,5].

TABLE I

Haematoenzymology of blood of Heteropneustes fossilis *under stress of* 2,4-*diamino* 3-*aminoazobenzene*

	Control	Experimental
RBC × 10^6/cmm	3·55 ±0·002	2·87 ±0·02[a]
WBC × 10^3/cmm	35·10 ±0·02	38·20 ±0·21[a]
Hb/dl	14·20 ±0·03	9·20 ±0·21[a]
PCV/dl	43·70 ±0·02	83·33 ±0·00[b]
MCV/μm^3	123·09 ±0·60	290·40 ±2·54[b]
MCHC/dl	32·49 ±0·03	11·00 ±0·006[b]
MCH/Pg	40·00 ±0·08	32·05 ±0·05[b]
Icteric index	15·60 ±0·10	30·00 ±0·00[b]
Alkaline phosphatase*	0·160±0·002	0·205±0·009[a]
Acid phosphatase*	0·175±0·0008	0·230±0·00[a]
Ribonuclease*	0·184±0·005	0·246±0·00[a]
Amylase unit/ml	3·20 ±0·00	7·60 ±0·04[b]
GOT unit/ml	0·074±0·001	0·337±0·001[a]
GPT unit/ml	0·086±0·001	0·178±0·003[a]
Cholinesterase unit/ml	70·00 ±0·00	126·60 ±0·80[b]

All values are mean ± S.E. (10 estimations).
* Activity expressed in mgP/ml serum.
(*a*) $P < 0·01$; (*b*) $P < 0·05$,

Enzyme analysis revealed a marked increase in phosphatases (alkaline and acid phosphatase) and transaminases (GOT and GPT) activity in experimental fish. Increased serum transaminases (GOT and GPT) activity has also been shown by CCl_4 poisoning by Prise-Davies and Wilkinson[13] and Molander *et al.*[14] The increase of phosphatases activity in liver and kidney of *Channa* during chronic exposure of 2,3,4-triaminoazobenzene has also been reported by Goel and Garg[5].

During the present study the serum cholinesterase gave more than 40% increase in its activity and these results are supported by similar findings of Schneiderbauer and Rettenbacher[15].

Blood serum enzymes level index reflects to the physiological status of the organs under chemical stresses. The changed pattern of the serum enzymology, during the present work, indicated the distorted pattern of enzyme system resulted from the cellular injuries in the organs under chemicoazo stress of dye.

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