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# Organal Damage Caused by Aldicarb to a Freshwater Teleost *Barbus conchonius* Hamilton

S. Kumar and S. C. Pant

Department of Zoology, D.S.B. Campus, Kumaun University, Naini Tal-263002, India

The present use of pesticides for personal and commercial farm benefits can be alarmingly deleterious to such non-target organisms as fish. Among carbamate pesticides, aldicarb (Temik) is a systemic poison, registered for use as insecticide as well as nematicide (Ware 1978). There are reports about the application of aldicarb being remarkably harmful for the life of beneficial soil fauna (Edwards and Lofty 1971) and birds (Stickel 1974). Aldicarb dissolves freely in water (solubility: 6000 ppm) and therefore is likely to get into water bodies in great quantities, especially by rain-drain in the areas of its use.

An earlier study evaluated the toxicity of this pesticide to fish (Pant and Kumar 1981). The 96-hr TLm values of aldicarb for the teleost Barbus conchonius were found to be 2.42± 0.01 mg/L and 0.459± 0.001 mg/L in hard and soft water media, respectively. Pickering and Gilliam (1982) have also reported aldicarb as lethal to larval-juveniles of the fathead minnow in concentration as low as 156 µg/L within 30 days post-hatch. However, the literature does not contain any information on the histopathological impact of aldicarb on fish. The present work was an attempt to fill this void and this paper reports the pathological derangements suffered by some of the vital organs viz., the gills, liver and kidney, of Barbus conchonius exposed to a subtoxic concentration of aldicarb in hard water. Such information is a prerequisite to investigate the biochemical action of this new carbamate pesticide in fish.

## MATERIALS AND METHODS

The bioassay was carried out in static aqueous medium having a hardness of 318.57 mg/L as $CaCO_3$, measured according to APHA (1975) and a pH of 7.41. The pesticide aldicarb (Temik, 99% active ingredient) was dissolved at a concentration of 0.8066 mg/L which is 1/3 of its 96-hr TLm value for B. conchonius in hard water as estimated earlier (Pant and Kumar 1981). Prior to their use, live B. conchonius collected from the lake Naini Tal were acclimated to laboratory conditions for a week in similar water and the fish were fed with churned bread cake during this period.

However, no food was supplied during the course of the experiment. The test and control fish, 25 in each set, measured 4.8± 0.45 cm in length. The gills, liver and kidney were removed from 6 fish each time after 2, 7 and 15 days of exposure to aldicarb. The histological fixation was carried out in Bouin's fluid for liver and kidney, and in Lillie's fluid for gills. 6 µm thick sections of the tissues were stained with aldehyde fuchsin (AF) or hematoxylin-eosin (H & E) for microscopic examination. The statistical analysis was done according to Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

As soon as the fish were introduced into the aldicarb solution, they became slightly excited and swam erratically, becoming normal only 2 hours later. After about a week's exposure, there was a consistent increase in the rate of opercular movement till the end of bioassay period but there was no mortality.

The morphological and histological examination of the gills of B. conchonius revealed an immediate oversecretion of mucus in response to aldicarb treatment. By the 7th day, most of the branchial mucus cells had migrated from the deeper layers to the marginal layer of mucus membrane and appeared to be exuding their contents by readily emerging from the epithelium (Fig. 2). As compared to their number in the control fish , there was a significant loss of 24.82%, 46.14% and 23.79% of mucus cells after 2, 7 and 15 days of treatment respectively ($p < 0.01$). After 2 days' exposure, the gill architecture exhibited intense swelling at the tips of several secondary lamellae and the accumulation of blood therein (Fig. 4). Further exposure caused the progression of swelling towards lamellar bases and thrombosis in the accumulated blood so that the secondary lamellae had been turned into club shaped structures after 7 days (Fig. 5). Besides these changes, the epithelium of the secondary lamellae became more and more indistinct, though not showing sloughing or fragmentation at any place (Figs. 4 & 5). There was a total atrophy and disappearance of pillar cells in fully affected lamellae (Fig. 5). By the end of 15 days, the picture of gills remained more or less the same except that a few filaments which had escaped the effects of aldicarb until 7 days, were also affected.

Aldicarb produced only milder alterations in the histology of liver in B. conchonius. After 2 days of treatment, the liver capillaries were swollen and congested at several places, forming rounded to oval areas inbetween hepatic cells. By the end of the experiment, continued inflow of blood in the organ had caused so much pronounced and widespread vasodilation that the hepatocytes appeared to have been split into strands (Fig. 7) in most of the treated fish. However, throughout the course of bioassay, the majority of the hepatocytes retained their normal structure except for the cytoplasm which turned out to be more eosinophilic than that of the control liver.

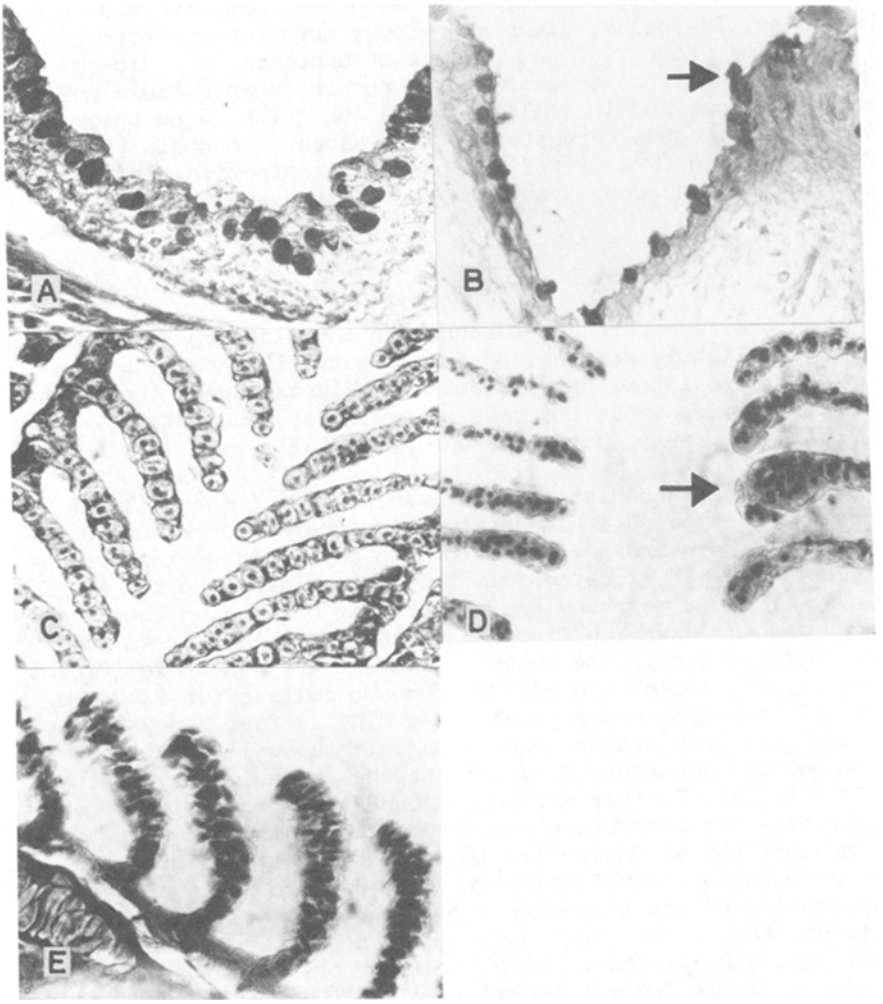


Figure 1. Photomicrographs showing the pathologic effects of aldicarb (0.8066 mg/L) on the gills of Barbus conchonius. Period of treatment noted in days.

A. Branchial mucus membrane with mucus cells in control fish, 15 days. AF, X300.

B. Branchial mucus membrane showing emerging mucus cells (arrow), 7 days. AF, X300.

C. Gill of control fish, 15 days. H&E, X370.

D. Swelling at the tips of secondary lamellae starting (arrow), 2 days. H&E, X370.

E. Swelling and thrombosis in the entire secondary lamellae, 7 days. H&E, X370.

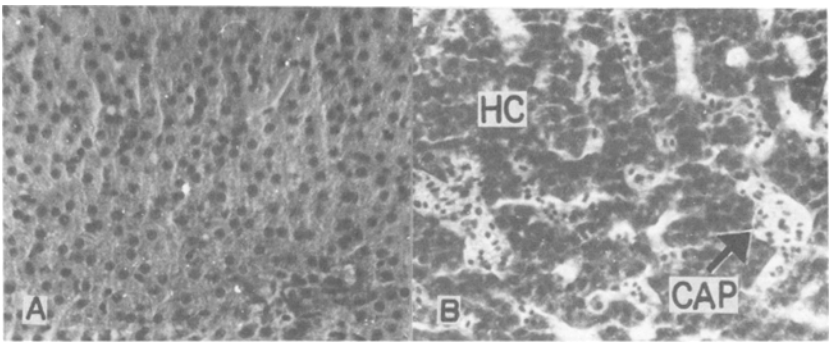


Figure 2. Liver pathology of aldicarb in Barbus conchonius.
A. Liver of control fish, 15 days. H&E, X350.
B. Dilation in the hepatic capillaries (CAP); hepatocytes (HC), 15 days. H&E, X350.

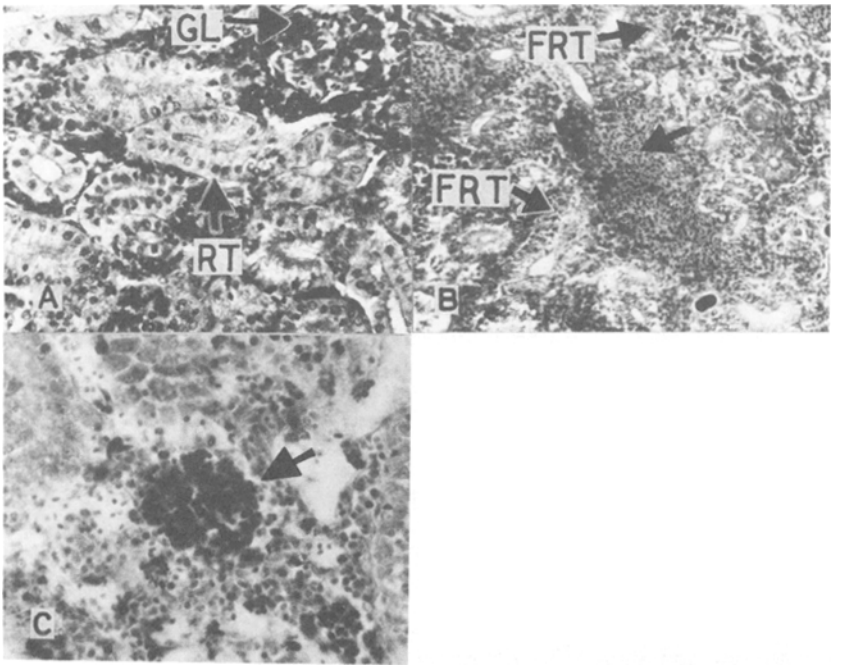


Figure 3. Kidney pathology of aldicarb in Barbus conchonius.
A. Kidney of control fish. Glomerulus (GL), renal tubule (RT), 15 days. H&E, X450.
B. Kidney showing the replacement of lymphoidal tissue by blood (arrow) and fragmentation with necrosis of renal tubules (FRT), 7 days. H&E, X400.
C. Kidney with degenerating lymphoidal tissue and accumulation of black particles (arrow), 15 days. H&E, X450.

The organ affected most deleteriously by aldicarb was the kidney. After 2 days, the kidney suffered internal hemorrhage and congestion as was evident from ruptured capillaries and huge masses of blood cells packing the intertubular spaces. The examination of kidney at the end of 7 days showed that this initial damage had been followed by extensive degeneration of lymphoidal tissue, which was gradually being replaced by blood. Several of the renal tubules seemed to have fully fragmented out and undergone necrosis at this stage (Fig. 9). After the full exposure period (15 days), it was interesting to mark large aggregations of black-staining particles of unknown nature within the lymphoidal tissue which was undergoing dissolution (Fig. 10).

Histopathological studies are useful to evaluate the pollution potential of pesticides since trace levels of pesticides which do not bring about animal mortality over a given period, are capable of producing considerable organal damage. The concentration of aldicarb bioassayed in present studies was not fatal to fish over the entire experimental period of 15 days, yet it was capable of causing remarkable histopathological changes in the gills, liver and kidney of B. conchonius.

One of the common reactions of fish in a toxic environment is the profuse release of mucus from general body surface and the gills in an attempt to evade the toxic action. In Cyprinus carpio, the treatment of a toxic concentration of carbaryl, a carbamate pesticide, resulted into oversecretion of mucus from gills and slight precipitation of it on the gill lamellae (Toor and Kaur 1974). Such a development in fish is known to lead to a stressful condition, the so called coagulation film anoxia. The test specimens of B. conchonius showed an almost similar response as was evident by not only an oversecretion of mucus from gills but also by a migration and significant reduction in the number of mucus cells from the gill mucus membrane. Since the presently tested subtoxic concentration as well as the acutely toxic concentrations i.e. 3-6 mg/L aldicarb tested in other studies (Pant 1982) did not precipitate the secreted mucus over the gills of B. conchonius, this new pesticide does not seem to cause an immediate anoxic stress to fishes as carbaryl does. However, other modifications in gills such as clubbing of secondary lamellae and thrombosis of blood circulating through them must have impaired gaseous exchange leading to respiratory stress in test animals. An increased rate of opercular movements during the later phase of experiment does support the development of such a stress.

An intense vasodilation observed in the liver of aldicarb-treated B. conchonius points out towards an increased hepatic circulation of the pesticide. Since the hepatocytes remained uninjured during the entire period of bioassay, there seems to have been either very little uptake of aldicarb by the liver or there was a very rapid transformation of accumulated pesticide into innocuous metabolites. In comparison to the gills and liver, a much greater damage inflicted to the kidney of the test fish by aldicarb in the present experiment, especially the hemorrhage

and disintegration of renal tubules, may give this pesticide mainly the status of a nephral poison for fish in subtoxic concentration.

Not much is known about the histopathologic effects of carbamate pesticides on fish. In the studies of Lakota et al. (1978), on the histopathologic effects of the subtoxic concentration of propoxur, severe changes in the gills of Cyprinus carpio were observed. However, propoxur could not induce any noticeable pathologic changes in the liver or kidney of the same specimens. On a relative basis aldicarb appears to be capable of producing a wider spectrum of significant histopathologic impairments in fish with even sublethal concentrations and should be categorized as an important pollutant of the aquatic environment.

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