Bull. Environ. Contam. Toxicol. (1985) 35:228–233

Bulletin of Environmental Contamination and Toxicology

Renal Pathology in Fish (*Puntius conchonius* Ham.) Following Exposure to Acutely Lethal and Sublethal Concentrations of Monocrotophos

S. Kumar and S. C. Pant

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

Monocrotophos (Nuvacron), a systemic organophosphate insecticide, is used in controlling a variety of insect pests besides its use as a synergist with some carbamate fungicides. It is generally applied by aerial spraying so that it becomes easier for this pesticide to contaminate the water bodies of nearby areas by drifting. It is considered to be less lethal to fish than various other insecticides (Thomas and Murthy 1976). Monocrotophos does not undergo rapid degradation in freshwater (Eichelberger and Lichtenberg 1971) and may, therefore, accumulate in rivers and ponds in harmful concentrations. However, histopathological derangements in fish on account of monocrotophos poisoning have not been investigated.

The present paper reports the pathological changes in the kidney as a result of exposing the teleost *Puntius conchonius* to acutely lethal and sublethal concentrations of monocrotophos.

MATERIALS AND METHODS

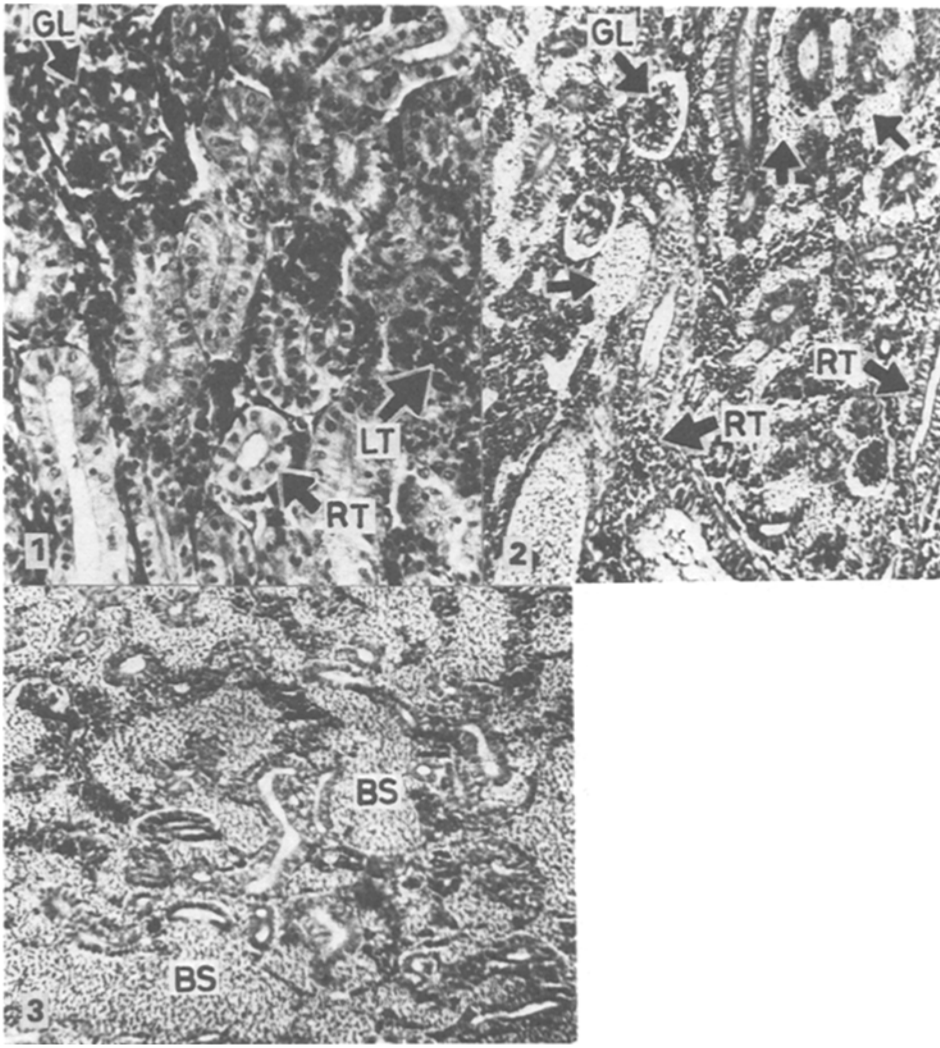
The renal pathology of monocrotophos (commercial formulation with 40% active ingredient) was studied by the static bioassay technique using tapwater as the dilution medium, having a hardness of 380 mg/l as $CaCO_3$ and a pH of 7.5. The hardness was measured according to APHA (1975). Prior to conducting the bioassays for histopathology, a toxicity bioassay was run in similar water in order to estimate the 96-hr TLm value of monocrotophos for *P. conchonius* and the same was found to be 160 $\pm$ 1.0 µg/l. The said pesticide was dissolved in concentrations of 168 µg/l and 53 µg/l for acute and sublethal bioassays, respectively; the sublethal solution was, however, changed every third day. In all, 100 healthy *P. conchonius* of both sexes, 5 $\pm$ 0.4 cm in length, were acclimatized to laboratory environment for 7 days before their use in the bioassays for renal pathology, and during this period they were fed churned bread cake. They were then divided into 3 groups of 40, 25 and 35 fish each, constituting the control, acute and sublethal bioassay sets. The renal pathology was examined in 6 treated specimens each time after 24 and 48 hr in acutely poisoned and after 2, 7, 15 and 30 days in sublethally poisoned fish. An equal number of control fish were examined at similar intervals for histological comparisons. The kidneys were removed from pithed fish, fixed in Bouin's fluid and then processed for microtome-slicing at 6 µm. Sections were stained with hematoxylin-eosin (H&E) and mounted in D.P.X.

RESULTS AND DISCUSSION

The release of fish into monocrotophos solutions immediately resulted into very fast and erratic swimming which, however, calmed down to normal movements within 2-3 hr. In acutely lethal concentration, the initial excitement was also accompanied by occasional jumping, and the fish thus falling out of the containers on glass-base were replaced into the solution quickly. 20% of the fish subjected to acute poisoning had died by the end of 48 hr. Though no mortality took place in the other two groups over the entire experimental period, yet the fish treated sublethally had become slightly morbid beyond 20 days.

The histology of kidney in control fish remained undeviated throughout, showing the normal disposition of renal tubules, glomeruli and interspersed lymphoidal tissue as in untreated specimens (Fig.1). Externally, the kidneys of acutely as well as sublethally treated fish were found to be swollen and enlarged in comparison to their normal size. In acute concentration, some significant changes were noticed in the kidneys of P. conchonius. Within 24 hr, the glomeruli of the majority of Malpighian corpuscles had undergone a marked contraction so that a prominent gap was seen between them and the capsular walls. A widespread vasodilation, as evident by the presence of distinct masses of blood in between the renal tubules and within the lymphoidal tissue, was clearly observed. In addition to these changes, there was severe vacuolation and disintegration in the cells of the renal tubules leading to necrosis at some places (Fig.2). Within the next 24 hr, the changes were drastic and were manifested mainly as extensive degeneration of lymphoidal tissue and nephric tubules and their replacement by blood, thus forming massive sinuses within the kidney (Fig.3).

In sublethal bioassay, as early as 2 days post-exposure, vasodilation and tubular atrophy by way of hydro-

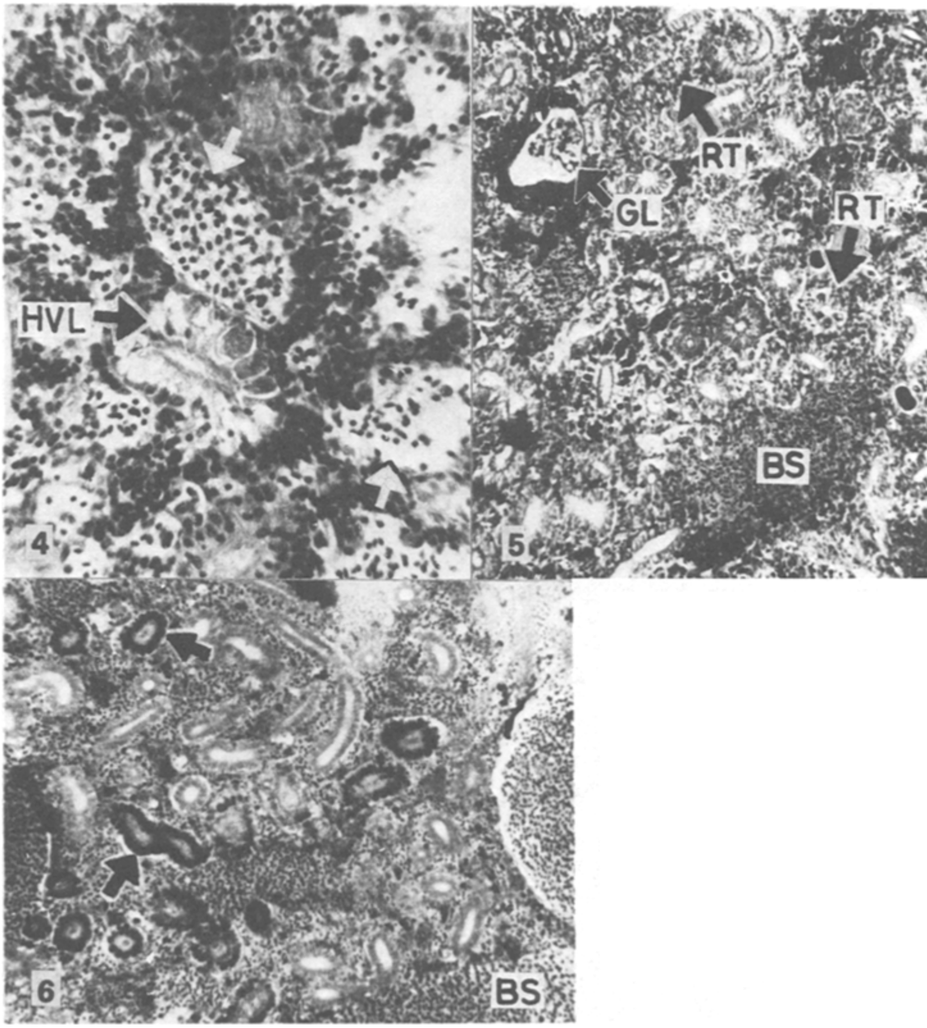


Acute renal pathology of monocrotophos (168 µg/l) in *P. conchonius*. H&E.

Fig.1. Kidney of untreated fish. Glomerulus (GL), renal tubule (RT), lymphoidal tissue (LT). X 450.

Fig.2. After 24 hr, showing contracted glomeruli, vasodilation (arrows) and tubular damage. X 250.

Fig.3. After 48 hr, showing the formation of massive blood sinuses (BS). X 250.



Sublethal renal pathology of monocrotophos (53 µg/l) in <u>P. conchonius.</u> H&E.

Fig.4. After 2 days, showing vasodilation (arrows) and hydropic vacuolation (HVL) in renal tubules. X 450.

Fig.5. After 7 days, showing contracted glomerulus, formation of blood sinuses and necrotic changes in renal tubules. X 250.

Fig.6. After 30 days, showing nuclear pyknosis in some renal tubules (arrows) and blood sinuses. X 250.

pic vacuolation in the cells had become quite evident (Fig.4). Further exposure until 7 days resulted into well marked contraction of the glomeruli, dissolution of lymphoidal tissue and its replacement by blood -forming sinuses, and fragmentation and necrosis in so many renal tubules, leading to the formation of cellular debris here and there (Fig.5). After the full sublethal exposure (30 days), all the intertubular spaces had been occupied by free blood. The kidneys of such specimens showed only the occasional presence of lymphoidal tissue. The accumulation of so much of blood seems to have resulted from internal haemorrhage caused by the rupture of swollen capillaries. It was uniquely observed at this stage that the nuclei of some of the renal tubules had become deeply pyknotic (Fig.6).

The renal pathologies induced by organophosphate insecticides in fish are least worked out. Csepai (1978) has reported hydropic degeneration of renal tubules in carps chronically exposed to insecticide formothion (Anthio). On the basis of the present study, monocrotophos appears to be a stronger nephral poison than formothion for fish as, besides hydropic degeneration of tubules, it also caused glomerular contraction, vasodilation and dissolution of lymphoidal tissue to form blood-sinuses.

The mode of toxic action of monocrotophos in fish is also not well known. In Heteropneustes fossilis, chronic administration of this pesticide by injection has been found to increase the activity of alkaline phosphatase of the kidney (Thomas and Murthy 1976). The histopathologic alterations in the kidney of P. conchonius reveal that monocrotophos is capable of inducing renal dysfunctions of high order and the same might have been partly responsible for death in fish during acute poisoning. Methoxychlor and aldrin are much more lethal than monocrotophos to P. conchonius (Pant 1982). It is of interest to note that the renal pathologies registered by monocrotophos were more severe than those caused by methoxychlor and aldrin by sublethal poisoning in the same fish. It may, therefore, be concluded that monocrotophos is a potential pollutant of aquatic environment and its presence in sublethal concentration may also be hazardous to the life of fish. A high mammalian toxicity of the said pesticide is reported (Ware 1978).

Acknowledgement

The award of a research fellowship by U.G.C., New Delhi to one of the authors (S.C.P.) is thankfully acknowledged.

REFERENCES

American Public Health Association (APHA) (1975) Standard methods for the examination of water and waste water, 14th Ed., Washington DC

Csepai F (1978) Histologically detectable dystrophies in the carp's kidneys exposed to chronic effect of some pesticides. Magy Allatosv Lapja (Hung) 33: 55

Eichelberger JW, Lichtenberg JJ (1971) Persistence of pesticides in river water. Env Sci Technol 5: 541-544

Pant SC (1982) Toxic and histopathologic impact of some pesticides, heavy metallic salts and pH on a teleost, Puntius conchonius Ham., Ph.D. Thesis, Kumaun University, India

Thomas PC, Murthy TL (1976) Studies on the impact of a few organic pesticides on certain fish enzymes. Ind J Anim Sci 46: 619-624

Ware GW (1978) The pesticide book. WH Freeman and Company, USA

Received September 24, 1984; accepted October 23, 1984