ECONOMIC DEVELOPMENT OF INDIA AND ITS EFFECT ON DEGRADATION OF FISH FAUNA

P. B. ROKADE, S. E. GHUMATKAR, P.V. JABDE

Abstract: Economic advancement in our country increased the water and air pollution in India. A detail study of the impact of Industrial influence on fish fauna has been done. A detailed survey has made and data has been collected on the pattern of urbanization since 1901 to 2011. Along with urbanization study of economic growth has been studied. Also metropolitan cities and million plus cities have been surveyed and data is been collected. Urbanization increased the inflow of people from rural areas in search of jobs which in turn increased population and slum areas. The domestic waste from the slum and metropolitan cities are increasing the pollution at higher rate. A survey on the slum population in metropolitan cities has been done since 1981. The present research work has been focused on the metropolitan cities and their waste water management and their area of disposal.

Urbanization ultimately increases the industrialization and use of fertilizers and pesticides in the agriculture and untreated effluents from industries. These pesticides and untreated waste from the industries find their way direct into the potable water bodies which directly harm the fauna present in it. Fishes were exposed to these untreated waste, pesticides and domestic waste to see the effects on the fecundity and parturition.

Guppy fishes were selected for the present study as they are hardy and can survive in harsh environment. Fishes were brought to laboratory and acclimatized and then pollutants from different industries were added. After 96 hrs the fishes were sacrificed to see the impact of Industrial pollution on reproductive organs of the fish. Testes were found to be completely damaged and the development stages were arrested. Ovum became atretic, lost their shape, cytoplasm was liquefied, nuclear membrane damaged etc. Pollution harmed the fecundity of fish which harmed the population growth and increased its mortality taking the fish species towards the doorstep of extinction.

Keywords: Urbanization, Industrialization, *Poeciliareticulata, Industrial pollution, ovary, testis.*

Introduction: Relation of human being and the environment is symbiotic and the relation should be maintained at any cost [1]. But the luxurious never ending needs of human being have brought pollution to their doorstep. Economic advancement of a country counts for its urbanization and industrial development. Considering India, there has been a very rapid increase in the Industrial zone of India. But, this industrialization along with luxury has brought air and water pollution with it as other rewards of industrial development.

In these days, each single country is tryingto overtake the other in process of economic development. For this purpose, every possible stepsare been taken. Natural resources are being depleted to fulfill necessities of human being & over consumed for luxurious needs which are increasing with economic progress of human being.

Economy consists of three sectors i.e. agriculture, industrial & service sectors. Importance & role of these three sectors are according to the nature of economy but all three are inter-dependable. According to the development economists, 'economic development results sectoral transaction from agriculture to industrial & to service sector, transaction of population dependency from agri to industry & from rural to urban area.' India is now in the third stage of demographic transaction & in the first stage of sectoral transformation & economic development. It results growth of industrial sector & urbanization in India [2].

Several industrial zones like Maharashtra Industrial Development Corporation (MIDC) the state of Maharashtra, &newly established& spread all over in India is Special Economic Zone (SEZ) [2,3,4]. These all promote increasing industrialization & urbanization in India[5]and this process is proved to be the genesis of degradation of environment. Land, water, air & forest pollution is spreading in the country at a higher rate and affecting the biodiversity. Because of the higher percentum of water pollution, quality& fecundity of fishes is decreasing. It is hazardous affair for the biodiversity of world living in the water & health of human being consuming fish & others [5,6]. Moreover the waste water which comprises hundreds of chemicals, of which 20% are harmful and carcinogenic. Considering leather tanning industry there are several chemicals emitted in it including Hcl and most carcinogenic is Chromium VI [1].

Such harmful chemicals and heavy metals are directly poured into the potable water bodies without treating the water. These chemicals enter the water and in turn enter the food chain and affect human lives also [1].

Material and Methods: A detailed data of urbanization, industrialization has been taken in account for the last 10-15 years to know the changes in the urbanization and its effect on life forms. As per urbanization is concerned a detailed data of patterns and trends of urbanization in India from 1901 to 2011 has been presented.

Along with data of industrialization and urbanization data on Economic growth of India from 1991-1992 to 2008-2009 was also collected with its growth rate of Agriculture and Industry sector.

In present study effect of urbanization and industrialization has been studied as it is necessary to know how much chemicals our country uses so that the harm of these chemicals can be correlated. In this view data was collected of Consumption of chemical fertilizers in India from 1951-1952 to 2011-2012.

More population, more the urbanization and industrialization which ultimately increase the demand of luxurious need which in turn increases the pollution load. A detailed population study has been done from 1901 to 2011 to show the increase load of luxurious need of people and its effect on fauna of the state. More of the populations of India thrive in slums for which the data has been collected from slum areas from 1981 to 2001.

Most of the waste of the industries in the form of industrial effluent is discharged in the water bodies. Along with industrial waste domestic waste water also plays a vital role in the pollution of water which effect on the survival of the fauna. A detailed data have been given on the metropolitan cities their industrial and domestic waste and their disposal sites.

Fishes were brought to the laboratory and acclimatized for 15 days. Two batches were prepared of 10 fishes in two different aquariums. One was treated as control and other as experimental. In the experimental batch different industrial effluents were added. In first experiment effluent from tanning industry was added, and in other one from paper and pulp industries.

After 96 hours fishes from the experimental and control were sacrificed for their ovary and testis. Blocks were made in paraffin wax and slides were made of 7µ thickness. Slides were stained in Hematoxylin and Eosin.

Slides of control and experimental were observed and photographed for comparative study of the tissues and the harm done by the chemicals to the organs at cellular level.

Results: The average growth rate of NNP(Net National income) was 6.41 percent during 1991-92 to 2008-09 which had less than 5 percent growth rate before 1991 (Table No. 1). It means new economic policy succeeded to achieve high growth ratepositive (Table No. 1)[7].

Consumption of Chemical Fertilizers in India is increasing with the advanced technology in agriculture which affects the aquatic system as these fertilizers find their way to the aquatic system. Total consumption of chemical fertilizers was 70 thousand tones in 1951-52 (Table No. 2). It increased up to 27567 thousand tones in the year 2011-12. It increased almost 400times compare to 1951-52. Consumption per hector of cropped area also increased from 0.5 kg. to 76.8 kg in the same period (Table No. 2) [8].

Urbanization refers to general increase in population and the amount of industrialization of a settlement [9]. Urban population & number of towns in India have increased almost fifteen times from 25.9 to 377.1 million during 1901 to 2011 (Table No. 3). Total population increased from 238 million to 1210.2 million during the same period. It increased almost five times in India. It indicates the growth of urbanization is more than growth of population (Table No. 3) [10]. This increase in population increases the rise in luxury needs and which in turn increases load of pollution. There was only one city Kolkata with million plus city in 1901 in India. Mumbai added in million plus city in 1911 & number remain constant till 1941 (Table No. 4). Million plus cities increased to five in 1951 & there after increased up to 23 in 1991(Table No. 4). 35 cities were million plus in 2001 & became 53 in the year 2011 [11].

This increase in population settles in cities and as the living in metropolitan city is high, this people settle around the city forming large slums. Highest percent of slum population live in Greater Mumbai & it is increasing continuously. 30.8 people of Mumbai live in slum area in 1991 & in the year 2011 the up on to 48.9 percent. Second number goes to Kolkatta with 32.6 percent slum population. Delhi & Chennai comes after with 18.9 percent & 17.7 percent respectively in 2001 (Table No. 5) [2].

Waste water is generated from domestic sources as well as industries. Waste water generates water pollution & effect on biodiversity of water livingWaste water directly disposed in river or damps. It has polluted water on high level (Table No. 6) [12].

This domestic waste water from the slum and metropolitan cities and the industrial waste flows directly in water affecting the aquatic fauna. Now this urbanization and its results like industrial waste, domestic waste and effluents are discharged in to the water body directly without any prior treatment. The chemicals which are disposed on land seep into the table water and pollute it. All these chemicals or pollutants directly or indirectly find their way into the potable waters and ultimately in the food chain [1].

The heavy metals, carcinogens accumulate in the fish tissues and in turn accumulate in human beings. The

metals accumulating in fishes has very adverse effects on their hormones and reproductive capacity.

Poeciliareticulata, Guppy fishes were exposed to these industrial wastes and domestic wastes for 96 hours and a comparative study has been done.

Heavy metals generally produces abnormalities in the fish tissues [13].Ovary of the fish treated with tannery effluent showed regressive changes such as degeneration of the ovarian wall(**Plate I**) [27]. Yolk of the matured ova showed Liquification(**Plate II**). Also hypertrophy of granulosa cells was observed which invaded the follicles [14].when he exposed O. medakato mercury containing effluent.In some cases almost entire yolk found to be degenerated and reached to the stage of atresia (**Plate III**). Premeiotic stages and immature ova were also found damaged, sometimes complete destruction (Plate). The germinal epithelium found affected to the extent of its total destruction (**PlateIV**).Similar results were recorded earlier [15] in fish Garramullyaon exposure to different industrial effluents.The mature stages found completely destroyed while earlierstages showed extensive atrophic condition (**PlateIV**) and similar results were put forward by [15] On this line, many workers have expressed their views that, even at lower concentration of any pollutant it produces alterations in reproductive behavior and induces destruction in the developing oocytes [16].Abnormalities were also noted in ovarian recurrence inguppy after 96 hrs treatment of effluent andsimilar results were noted [17] in *Channapunctatus* when exposed to mercuric compound. Cytoplasmic Liquification took place in growing oocytes onexposure of P. Reticulata to different concentrations of tannery effluent and similar observations were also made [18]when exposed Salmoclarkitoeldrin where atresia of oocytes apparently found significant.(**Plate V)** shows the developing oocyte from control fish in which nuclear membrane, nucleus and nucleolus can be clearly seen, but when compared to effluent exposed fish in Plate the nuclear membrane and nucleus is completely degenerated and plus the nucleolus.

Most of the heavy metals, pesticides and pollutants are known for their affinity towards biological tissues where they get accumulated. Once if the metal is absorbed in the biological system, the metal ions cause damage to the cells and tissues. A cross section of the testis showed several nests of spermiogenic germ cell and masses of spermatids and manifested moderate spermatogenic activities. Spermatogenesis and spermiogenesis was arrested, as a result of which the spermatogonia were about 85% in the lobules of the experimental fish and 15% in the control fish. In control only 15% of spermatogonia were present because the cells were dividing normally and there was no arrest in spermatogenesis [19] (Figure 1 b).

Spermatogenesis and spermiogenesis was arrested due to the blockage in release of Pituitary gonadotropin. Testicular abnormalities like disorganization of lobules (**Plate VI**) and inhibition of spermatogenesis and cell necrosis are observed. Such abnormalities are found in the maturing and mature testis not in the immature testis. Similar results were recorded earlier inCod[20]. Effect of industrial effluent may bring complete sterility [13] and disorganization of lobules and germinal epithelium was also observed[21]). Due to the impact of chromium present in the industrial effluent there was necrosis of the cells present in the lobules of every stage. Due to the destruction and necrosis of the cells of testis the number of sperms, spermatids, spermatocytes were decreased and were observed less in number, similar results were observed in a Guppy fish treated with Methallibure. Few numbers of sperms and other stages of spermatogenesis were observed in experimental fish while the control fish showed all stages of spermatogenesis in every lobule, similar results were observed in guppy [22]. Degeneration of the spermatocytes (**PlateVII**), spermatids (**Plate VIII**)and the atrophy of interstitial and cell necrosis (**Plate IX**) of seminiferous tubules, epithelial cells have been noticed on pesticide treatment in Barbus stigma [23], similar results are obtained in Poeciliareticulata when it was exposed to different concentrations of industrial effluents. Similar results were observed in guppy where atrophy of interstitial cells took place when exposed to Methallibure [22]. Due to degeneration of interstitial cells, production of testosterone hormone may be decreased with and hence affect the spermatogenesis. These results are confirmed with the results recorded in Garramulya subjected to pesticides [24]. Due to necrosis of spermatocytes. Endocrine regulation of testis reveal that, the leydig cells are markedly injured and showed cytoplasmic vacuolization and shrinking of the cells after exposure to industrial effluent against P. reticulata and similar results were observed which are in concurrence to the above findings [25]. Chromium is the heavy metal present almost in all the tanning and leather industry. Heavy metals produce abnormalities in fish tissues [13]. Cadmium can cause necrosis to the spermatogonia cells and spermatids and similar results were obtained in guppy [26].

The cellular division is arrested by the effluents which creates infertility in the males. As the oocytes are degenerated and there is increase in atretic oocytes the fecundity and reproductive capacity of the females decreases which in turn decreases the population of the fishes an ultimately death of fishes.

This continuous exposure of fishes to the effluents becomes fatal to the fishes as a result the species may become extinct.

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Table No. 1.Economic Growth in IndiaAt 2004-05 prices						
Years	**NNP at F.C (Rs. Crores)**		**Per capita NNP (In Rs.)**		**Growth Rate of Agri. sector**	**Growth Rate of Industry. sector**
1991-92	1211877	(0.8)	14157	(-1.2)	-1.4	-0.1
1992-93	1276845	(5.4)	14643	(3.4)	6.0	3.6
1993-94	1354116	(6.1)	15181	(3.7)	3.1	6.1
1994-95	1440972	(6.4)	15835	(4.3)	5.2	9.1
1995-96	1547480	(7.4)	16675	(5.3)	0.0	12.0
1996-97	1375759	(8.3)	17714	(6.2)	8.9	7.2
1997-98	1745160	(4.1)	18103	(2.2)	-1.3	3.3
1998-99	1861252	(6.7)	18934	(4.6)	5.9	4.3
1999-2000	2001250	(7.5)	19993	(5.6)	2.8	6.2
2000-01	2074858	(3.7)	20362	(1.8)	0.3	6.5
2001-02	2190737	(5.6)	21065	(3.5)	5.5	2.7
2002-03	2278363	(4.0)	21575	(2.4)	-4.9	7.1
2003-04	2466093	(8.2)	23005	(6.6)	8.2	7.9
2004-05	2629198	(6.6)	24143	(4.9)	1.1	10.0
2005-06	2877284	(9.4)	26015	(7.8)	4.6	10.7
2006-07	3149149	(9.4)	28067	(7.9)	4.6	12.7
2007-08	3451829	(9.6)	30332	(8.1)	5.5	10.3
2008-09	3664388	(6.2)	31754	(4.7)	0.4	4.7
2009-10	3966408	(8.2)	33901	(6.2)	1.5	9.5
2010-11	4310195	(8.7)	36342	(7.2)	7.5	9.5
2011-12	4572075	(6.1)	38037	(4.7)	3.1	3.8

Note- Figure in () indicates percentage growth.

Source:*Economic.Survey of India.*Central Statistics Office

Table No. 2.Consumption of Chemical Fertilizers in India		
Year	Consumption (1000 tones)	Consumption Per hectare of Cropped area (kg.)
1951-52	70	0.5
197071	2260	13.1
1990-91	12550	76.8
2000-01	16700	90.1
2010-11	28122	144.1
2011-12	27567	141.3

Source- Economic survey- 2012-13, Agricultural statistic at a glance.

Table No. 3. Pattern & Trend of Urbanization in India (1901-2011)						
Sr.No	Census Year	Number of Towns	Urban Population In Million	Percent Urban Population	Annual Exponential Growth Rate	Rate of Urbanization
1	1901	1916	25.9	10.8	-	-
2	1911	1908	25.9	10.3	0.0	-0.46
3	1921	2048	28.1	11.2	0.8	0.87
4	1931	2220	33.5	12.0	1.7	0.71
5	1941	2422	44.2	13.8	2.8	1.50
6	1951	3060	62.4	17.3	3.5	2.54
7	1961	2700	18.9	18.0	2.3	0.40
8	1971	3126	109.1	19.9	3.2	1.06
9	1981	4029	159.5	23.3	3.8	1.72
10	1991	4689	217.6	25.7	3.1	1.02
11	2001	5161	284.5	27.8	2.7	0.82
12	2011	NA	377.1	31.2	-	-

Source- Register General of India, Various Census of India.

Table No. 4.Million Plus Cities in India:			
Census Year	Number of Cities Million Plus	Population In Million	Average Percent Increase
1901	01	1.51	-
1951	05	11.75	26.43
1991	23	70.67	56.75
2001	35	107.88	52.8
2011	53	166.5	54.34

Source-Census of India 1901 to 2011.

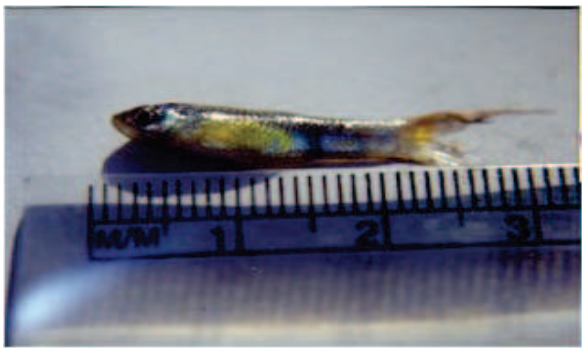
(Figure in percentage to total population of city)

Table No. 5.Slum Population in Metropolitan Cites in India				
Sr.No.	Metropolitan City	1981	1991	2001
1	Greater Mumbai	30.8	43.2	48.9
2	Kolkata	30.3	36.3	32.6
3	Delhi M.C.	18.0	22.5	18.9
4	Chennai	13.8	15.3	17.7

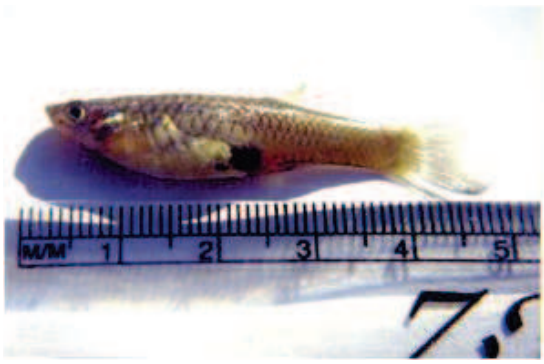
Table No. 6.Metropolitan Cities & Waste Water Management, 1997-98							
Metropolitan City	Volume of Waste Water Generated (Mld)			Waste Water Collected			Mode of Disposal
	Domestic	Industrial	Total	Volume (Mld)	Percent	Capacity (Mld)	
Mumbai	2228.1	227.9	2456.0	2210.0	90.0	109.0	Sea
Kolkata	1383.8	48.4	1432.0	1074.9	75.1	-	Hugli River, Fish Farm
Delhi	1270.0	-	1270.0	1016.0	80.0	981.0	Agri, Yamuna River
Chennai	276.0	-	276.0	257.0	93.1	257.0	Agriculture, Sea

Source-Central of Urban Pollution Series: cups/42/1997-98, CPCB 1997.

Percentage of effluent added to water and the rate of survival and mortality.				
No. of fishes	Effluent in ml	Fishes survived	Mortality of fishes	Mortality %
10	07	10	NIL	NIL
10	10	08	02	20
10	15	07	03	30
10	20	06	04	10
10	25	05	05	50

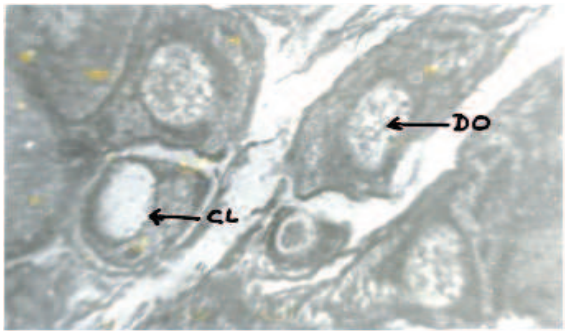


Male guppy fish



Female guppy fish

Plate No. I



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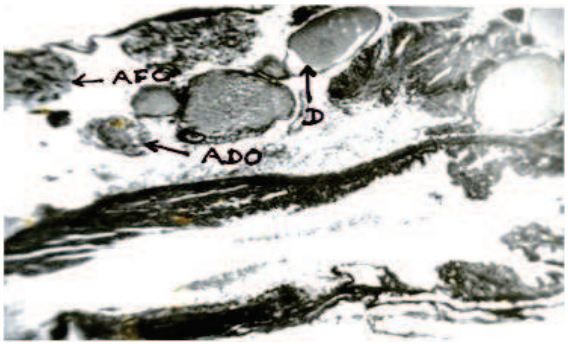

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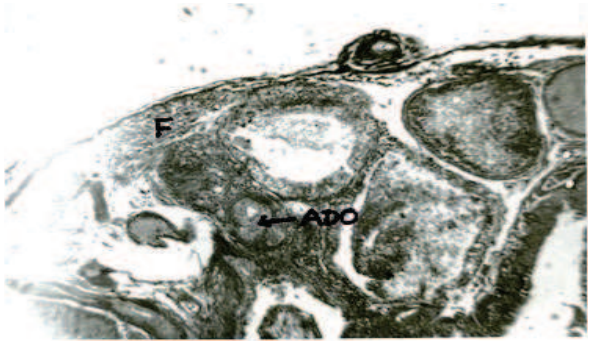

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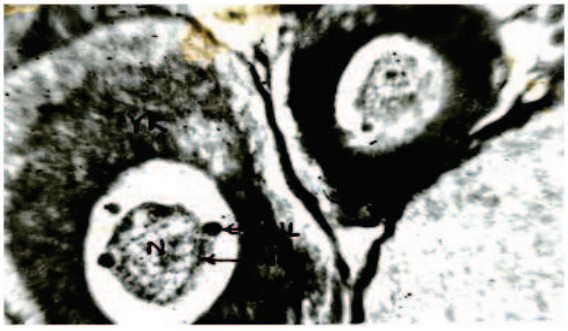
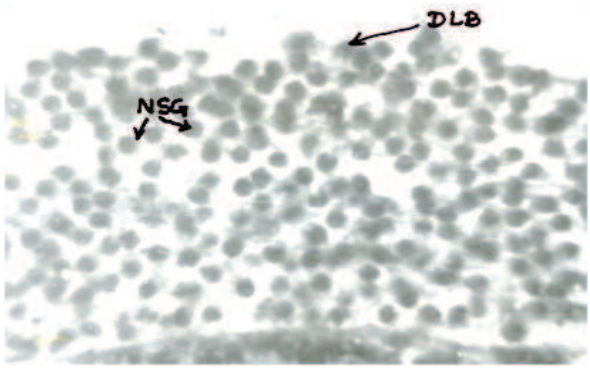


Plate VPlate VI



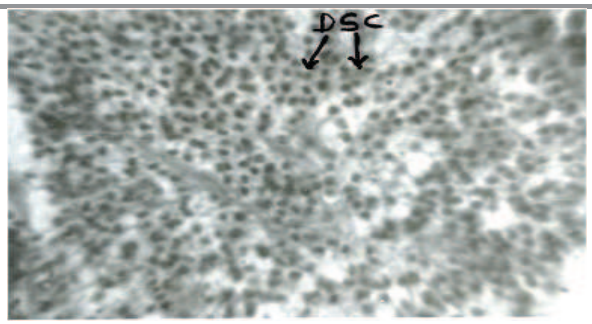
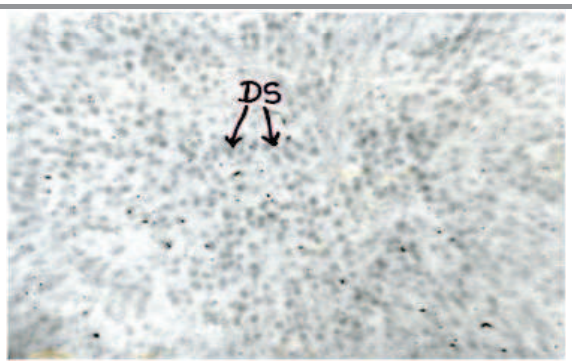


Plate VII



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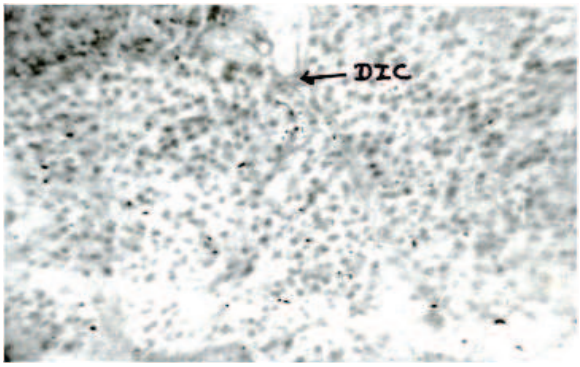

Plate IX

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