from the ovisacs of treated females of *Acartia tonsa*, in which the setae on the appendages were twisted and bent. In the present studies abnormal development was observed in the clasper-like structure of the 1st antennule in males, which helps in holding the female during copulation. However, it was not possible to check this by direct observations of spermatophores. From 1 ppm to 0.25 ppm there was a slight increase in GRA from 64.47 to 70.58%. This is because at 1 ppm there was 50% mortality, which was not scored while estimating growth regulatory activity. From 0.25 to 0.031 ppm GRA decreased in a dose-dependant manner (table 1) and an ID_{50} value of 0.141 ppm calculated by probit analysis. At concentrations below 0.031 ppm, no morphological abnormalities could be observed, and hence they were not considered when calculating the ID_{50}. However, at lower concentrations from 0.015 ppm to 0.00097 ppm fertility was impaired, since all the treated ovigerous females laid non-viable eggs, whereas there was hatching of eggs laid by the control females.

Since Dimilin$^{(R)}$ showed morphogenetic activity even at lower concentrations against *M. thermocyclopoides*, it may be considered for use in potable waters for anticyclops programme. However, it may be noted that at present it has not been cleared for use in potable waters by World Health Organization. Dimilin$^{(R)}$ should not be used in such waters where fishes breed and feed on cyclops since the present study has shown that even minute quantities may disrupt the life cycle of cyclops. It is also not suitable for integrated control programmes where cyclops act as an intermediate host for the fungus *Coelomomyces* sp. which is pathogenic for mosquito larvae.

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Table 1 *The effect of Dimilin on morphogenic activity of Mesocyclops thermocyclopoides*

Concentration (ppm)	% GRA	Statistical values
1	64.47	ID_{50} = 0.141 ppm
0.5	69.45	Variance = 0 0158
0.25	70.58	S. E. = 0.1257
0.125	45.56	χ^2 = 9.312
		χ^2 = 0.05, d.f.4 = 9.488
0.062	46.66	Fiducial limits =
		0.249–0 080 ppm
0.031	33.33	

The total number of copepodite stages used in all the cases was 60, and each concentration was replicated thrice.

Scoring of the resulting stages after treatment

Score	Category
3	Prolongation in the last copepodite stages.
2	Attachment of exuvium to the resulting stage.
1	Abnormal ovigerous females
0	Normal cyclops

$$\% \text{ GRA } \frac{(a \times 3) + (b \times 2) + (c \times 1)}{n \times 3} \times 100$$

a b, c: Number of the abnormal forms in each category; *n:* total number of copepodite stages exposed; 3: maximum score.

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AN EXTREME LINKAGE BETWEEN INVERSIONS IN *DROSOPHILA ANANASSAE*

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CHROMOSOME inversions were detected for the first time through the suppression of crossing over in inversion heterozygotes in *Drosophila melanogaster*[1]. They provide a mechanism for maintaining heterotic systems through the suppression of crossing over[2]. Linked inversions were first reported to occur in non-random association (or linkage disequilibrium) in natural populations of *Drosophila robusta*[3]. Since then a number of cases of linkage disequilibrium between inversions in various species of *Drosophila* have been reported[4–10]. Levitan[4] postulated that non-random association of linked inversions is maintained due to two main factors either alone or in combination: (i) suppression of crossing over between inversions, and (ii) natural selection acting against certain recombinant arrangements. However, the results obtained from various species of *Drosophila* have shown that natural selection involving epistatic interaction between widely separated loci plays an important role in maintaining linkage disequilibrium between inversions[4–10]. *Drosophila ananassae*, a

cosmopolitan and domestic species, is of common occurrence in India. Although more than 50 paracentric inversions are known in this species, only 3 paracentric inversions namely subterminal (or alpha) in 2L, terminal (or delta) in 3L and basal (or eta) in 3R have become cosmopolitan in distribution[11]. Linkage disequilibrium between delta and eta inversions in the third chromosome of *D. ananassae* has been observed in several laboratory stocks[12–16]. Recombination studies between the two heterozygous inversions show that they strongly suppress crossing over between them[17,18]. Further, the rate of crossing-over is influenced by background karyotype and background genotype[18]. The present communication reports an extreme linkage between delta and eta inversions of the third chromosome in a mutant stock of *D. ananassae*.

The mutant stock, the material for the present investigation, was obtained from Prof. C. W. Hinton, Wooster, USA in January 1987. This is a triple recessive stock and the markers of the *X*-chromosome are ct (cut wings), sc (scute bristles) and rb (ruby eyes). It has been maintained for several generations under laboratory conditions. Cytological analysis of the stock revealed that it is polymorphic in 2L, 3L and 3R due to alpha, delta and eta inversions. To study the intrachromosomal associations in this mutant stock, a large number of larvae taken randomly from culture bottles were squashed by the usual acetocarmine method and 3L and 3R karyotypes were identified under microscope.

Due to the presence of delta inversion in 3L, three karyotypes, ST/ST, ST/DE, and DE/DE are distinguishable. Similarly three karyotypes, ST/ST, ST/ET, and ET/ET are ascertained in 3R due to eta inversion. Thus 9 combinations (associations) are detectable between 3L and 3R karyotypes. There are two arrangements, ST and DE in 3L and two arrangements, ST and ET in 3R. Thus 4 combinations between 3L and 3R gene arrangements are expected.

From chromosomal analysis of the ct, sc, rb, stock, the data on the associations between 3L and 3R karyotypes were obtained. For each combination class, the expected number can be calculated from the marginal totals of an RXC contingency table assuming random combination of karyotypes. Any significant deviation from randomness would indicate non-random association of 3L and 3R karyotypes. The observed and expected numbers of different combinations between 3L and 3R karyotypes are given in table 1. Curiously, only four combinations were observed and the remaining five were absent. Further, all the larvae except one were either doubly homozygous or doubly heterozygous. Only one individual was homozygous in 3L and heterozygous in 3R (DE/DE.ST/ET). Thus 3L and 3R karyotypes are associated non-randomly as the deviation from expectation is highly significant ($P < 0.001$).

Table 1 *Observed and expected numbers of different combinations between 3L and 3R karyotypes*

			3L ST/ST	3L ST/DE	3L DE/DE	Total
3R	ST/ST	Obs.	8.0	0.0	0.0	8
		Exp.	0.28	4.32	3.40	
	ST/ET	Obs.	0.0	123.0	1.0	124
		Exp.	4.35	66.89	52.75	
	ET/ET	Obs.	0.0	0.0	96.0	96
		Exp.	3.37	51.79	40.84	
	Total		8.0	123.0	97.0	228

$\chi^2 = 452.42$; d.f. = 4; $P < 0.001$.

From the data of 3L and 3R karyotypes, the number of different combinations between gene arrangements in the third chromosome was estimated. Since most of the repulsion types of combinations were absent, the double heterozygotes were considered to be of the coupling type. Table 2 incorporates the observed and expected numbers of different combinations between 3L and 3R gene arrangements. Interestingly, all the chromosomes except one were in coupling combinations (ST–ST; DE–ET). Out of 456 chromosomes (228 larvae) examined, only one was in repulsion phase of linkage relationship (DE–ST). Thus 3L and 3R gene arrangements are associated non-randomly. The deviation from randomness is highly significant ($P < 0.001$).

Table 2 *Observed and expected numbers of different combinations between 3L and 3R gene arrangements*

			3L ST	3L DE	Total
3R	ST	Obs.	139.0	1.0	140
		Exp.	42.68	97.32	
	ET	Obs.	0.0	316.0	316
		Exp.	96.32	219.68	
		Total	139.0	317.0	456

$\chi^2 = 451.25$; d.f. = 1; $P < 0.001$.

The results of chromosomal analysis show that the two inversions of the third chromosome are tightly linked as only one recombinant chromosome out of the 456 chromosomes analysed was observed. An extreme linkage between inversions observed during the present study can be suggested to the suppression of crossing over. This is based on the results of crossing-over studies by the present authors[15] who found that delta and eta inversions when heterozygous strongly suppress crossing over between them.

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NEUROANATOMY OF FURCOCERCOUS, *CERCARIA MILLERI*

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THE neuroanatomy of certain adult trematode species[1-2] as well as their larvae[3-7] has been studied by several workers. Recently, neuroanatomy of certain trematode cercariae (Monostome, Amphistome, Echinostome and Xiphidio) and rediae has also been described[8]. However, studies on neuroanatomy of Furcocercous are scanty. The present study describes the neuroanatomy of furcocercous cercaria by histochemical localization of acetylcholinesterase.

The snail species, *Vivipera bengalensis* (L.) were collected from the freshwater habitats of Dungarpur and Udaipur districts. The rearing of snails and the method for collection of their trematode larvae are described elsewhere[9,10]. The Furcocercous cercariae, *Cercaria milleri* recovered[11] from the *V. bengalensis* were repeatedly washed in physiological saline and immediately fixed in chilled, 10% neutral formalin. After suitable fixation periods (6 min) the cercariae were processed for localization of acetylcholinesterase[1]. Simultaneously, control whole mounts were also prepared[1].

Cholinesterase activity was most pronounced in the entire nervous system (figure 1). The use of 10^{-4} M eserine inhibited the cholinesterase activity in the whole of the nervous system. The nervous system in the main cercarial body (figure 2) composed of two cerebral ganglia connected with each other by a transverse commissure to form a cerebral complex, lies immediately posterior to oral sucker, 3 pairs of anterior and 3 pairs of posterior longitudinal nerve trunks originate from the lateral sides of each ganglia. Three pairs of nerve trunks could be differentiated according to their position, lateral, ventral and dorsal in the anterior and posterior, respectively. The anterior dorsal, ventral and lateral nerves and their numerous fine branches encircle and innervate the oral sucker and pharynx regions. The posterior dorsal nerve trunks are the largest, stout and prominent as compared to posterior ventral and lateral nerve cords. These, on their way towards the ventral sucker innervate the gut, genital rudiments, excretory bladder and also give fine branches to the tegument. Each posterior lateral nerve cord unites with its fellow, dorsal and lateral nerves by transverse connectives to form 10–15 transverse commissures in ring form immediately after commencement of the posterior