

PHYSIO-PATHOLOGICAL EFFECT OF PARASITIC INFECTION IN CHANNA PUNCTATUS [A HAEMATOLOGICAL REVIEW]

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ABSTRACT

Different qualitative combination of the parasites and total parasitic load in relation to individual infection, alterations in peripheral blood of *Channa punctatus* brought about by infection of the fish by many kinds of helminthic parasites have been analysed. The outcomes showed that in individual infection nematode was the utmost severe and monogeneans the least. Nematode acanthocephalan combination was the most grievous of the different categories of combined infection. The grievous effects were not most marked by entire several kinds of parasites in simultaneous infection. Physio pathological effect however appeared to be directly proportional to entire parasitic burden. The outcome as well exhibited that individual infection by each kind of parasite, physio-pathological effect based on the type of parasite although in combined infection both the types of parasites and its numerical presence showed the limit of physio pathological alterations .By the routine blood test it is crystal clear that the outcome of the factual findings on the graveness of parasitisation of the fishes.

INTRODUCTION

In piscine physiopathology metazoan parasites play a significant role saleszko,1970, Duijn, 1973 Ribelin and Migaki,1975, Roberts,1976,Kinne 1980,Rohde,1982,Kabata 1985, and Ferguson,1985. Attlunteand different fauna of metazoan parasites present in fishes. It is an established matter though fishes contain varieties of infections by various types of parasites Reports of metazoan parasities have been intimated accordingly 7 species in *Diodon hystris*, 10 species in *Chirocentrus dorab*,12 species in *Saurida tumbil* and *Trichuurs savala* (Radha Krishnan,1979) Investigations carried out by many scientists on copepod parasites (Natarajan 1975, Einszporn, orecka,1970 and Einszporn oreckas 1979)

on isopod parasites (Romestand and Triles,1977 and Nair and Nair,1983) on helminth parasites,(Radha Krishnan et al,1983,1984a,and 1984b) exhibit that influence of the type of infections are marked as significant alterations in the physio- pathological set up of the host fishes. To determine the manner and limit of physio-pathological alterations induced by either of type of parasitic infection although investigations has been the outcome of multiple infections of the host by different type of parasites forming a difficult work. Depending on their number and species for infected fish and the site of infection the usual manner is to follow some types of parasites being innocuous to remove the problem (George and Radhakrishnan, 1989)

In the matter the prime circumstance that furnish particular condition in the process is merely parasite will have its influence on the hosts Residing in or on the fish every parasites exerts some deleterious effect on the host. The effect might be moderate without the appearance of no external symptoms but the parasite is harmful to the host(Bauer,1958).

Although from the view point of Bauer 1958, it is crystal clear that physio-pathological studies relating to metazoan parasitic infection, the total parasites infecting fish might not be taken into account. In considering the total possible qualitative and quantitative permutation combinations of different parasites this is due to influences beyond practical and theoretical compromise (George and Radhakrishnan1989).

With a view to finding out the health status of the individual the peripheral blood is a very common physiological system of the vertebrates and in man and domestic animal namely the 'blood test' of diagnostic value of the analysis of peripheral blood. Haematological Investigations are of the same diagnostic values also in fishes (Blaxhall,1972 Bylund 1972,calabrese et al 1975 Mulcahy,1975 and Hickey,1976) On the peripheral blood of *Channa punctatus* during the existing investigation considering the fact a preliminary attempt has been done to assess the hypothesis earlier mentioned by evaluating the influence of metazoan parasitic infections.

In relation to different combinations of the parasites on the fish and in relation to their numerical affluency in the existing investigation, haematological parameters like TEC, TLC,TPC,Hb content, PCV% and erythrocyte leucocyte ratio of the blood of *Channa punctatus* were analysed.

Order ophiocephaliformes-phy- socratic orbitosphenoid absent. Scales are cycloid, caudal fin rays 12. Air bladder very long, posteriorly bifid and extends up to the caudal region. It consists of only one family Ophiocephalidae Channidae and a single

genus channa 5 Branchio stegals are present and Pseudobranchiae are not present on the dorsum head depressed with plate like scales and the body elongate as well subcylindrical. The characteristics of the fishes channa is the presence of 4 gills,5 branchiostegals and the not presence of pseudobranchiae ,and Suprabranchial organ not present.

The wide gill openings and the membrane of the both the sides beneath the isthmus connected and laterally placed eyes. Abruptly curved or almost interrupted lateral line is present. The genus channa (Gronovius1763) consists of 5 species viz. Channa gachua,channa marulius channa punctatus,Channa stewartii and channa striatus. Almost all the species are found in fresh waters of India.(Gopal ji srivastava fishes of U.P and Bihar 3rd edn 1988)

MATERIAL AND METHOD :

From the respective habitats of the fishes as well from local suppliers and the fish markets of Arrah and around only Speciallyhealthy fishes were selected for the investigation and they kept in the laboratory in appropriate tanks. The total length having 38 cm to 153 cm the fishes were anaesthetised by anaesthetic ether.The blood was acquired by cardiac puncture. Each fish was cut open and examined for parasites after procurement of the blood sample. The exact number of the particular type of parasite and the location were recorded. The total number of 100 fishes were analysed out of them 55 were non infected and the rest 45 naturally infected. By employing the standard and the accepted methods haematological analyses were performed.(Blaxhall and Daisley,1973) The immaturity and the maturity of the conditions of the fishes were also considered.

RESULTS

i Prevalence of infection

By the helminthic parasites an effort was made to investigate the nature of infection. The observations are exhibited in Tables A, I and II. Merely six fish(5.7%) were totally free from parasitic infection as is clear from observations. prevalence of the combined infection by the parasites was the maximum(29%) in the case of immature fishes, closely followed by the combined infections of digenean and nematodes (27%) and then by the digeneans alone (17%). 26% were infected by Digenean alone (D alone) 22.6% had combined infections by digeneans and nematodes parasites ,simultaneously,were as 20.5% harboured the entire three parasites.

Irrespective of the maturity conditions as the fishes are considered 24.5% had combined injections by the helminthic parasites and also by Digenean nematode

combination and 20.5% harboured digenean parasites alone (D-alone) . The observations as well exhibit that infection by the Acanthocephalans parasites alone (A-alone) was not common of the 100 fish studied. Only two was infected by the parasites, From the observations, further, it might be concluded the prevalence of the particular infection by the total helminthic parasites was maximum in the mature fishes, while combined infection had an excellent percentage of incidence in the immature fishes. Simultaneously Monogeneans were also found in both the stages.

ii. Haematological parameters:-

On the entire fish studied haematological analyses were carried out. In the infected fishes they were classified depending on the combinations of the helminthic parasites obtained into the undernoted eight categories.

1. Fishes infected by Monogeneans alone- 'M' alones,
2. Fishes infected by Nematodes alone- 'N' alones.
3. Fishes infected by Digeneans alone 'D' alone.
4. Fishes infected by Acanthocephalans alone 'A' alones
5. Fishes with simultaneou infections by Digeneans and Nematodes 'D+N'
6. Fishes with simultaneous infection by Digeneans and Acanthocephalans 'D+A.
7. Fishes with simultaneous infection by Nematodes and Acanthocephalans' N+A. And.
8. Fishes with simultaneous infection by Digeneans, nematodes and Acanthocephalans- 'D+N+A'

The harbouring upto 11helminthic parasites were classified as “moderately infected” and those with more than 11helminthic parasites as “heavily infected” per infected fish depending on the number of parasites in the 'D+N+A' category two groups were delinated.

(A) Heamatological changes in relation to different combination of helminthic parasites.

(i) Total erythrocyte count (TEC= $X10^6/MM^3$)

The mean TEC Values were 2.5 in the infected, 1.5 in Monogenean alone, 2.15 in 'D' alone and 'A' alone, 2.00 in 'A' alone 1.95 in 'D+N and D+N+A ,2.16 in D+Aand 2.03in 'N+A', while compared with the non infected fish, TEC value were low in the entire groups of infected fishes. But the lowest value of 1.95 were recorded (TABLE3) 'D+N and D+N+A groups.

The outcomes of the 't' test (TABLE 4) exhibit that the difference between the TEC values of non infected and 'D+N' ($P<0.01$) Non infected and N+A ($P<0.05$) and non

infected and 'D+N+A'(P<0.05) are significant statically, Hence the outcomes exhibit that infection simultaneously by 'D+N,N+A and 'D+N+A+ in TEC indicated significant fall.

(ii) Total leucocyte count (TLC= $X10^4/MM^3$)

In the non- infected fishes the mean TLC values were seven, 8.73 in D- alone, in N alone and A alone 9.60 in D+N,8.69 in D+A,12.58 in N+A and 9.78 in D+N+A(TABLE 3)In every circumstances of infection TLC recorded higher values compared with the TLC of Non infected fishes. The maximum value 12.58 was studied in combined infection by nematodes and acanthocephalans and the maximum 8.69 in D+A combination. Between the non infected and the infected fishes the difference in TLC values was only significant statistically between the non infected and N+A combined infection (P<0.01) (Table 4)

(iii) Total platelet count (TPC= $X10^4/MM^3$)

In the non- infected fishes the TPC value was 19. To each other the values for N-alone, A- alone and N+A were almost alike while higher than that of none infected. The minimum (16.83) was recorded in D+N+A (Table 3) . In the circumstance of different kinds of infection although Non of the studied TPC value from that of the non infected fish was not similar significantly (Table 4)

(iv) Haemoglobin content (Hb=g%)

In the non infected fishes Hb content was as maximum as 13.9. The Hb contents in the fish with not similar kind of infection noted were 13.07 in D alone ,13.04 in N alone, 12.1 in A alone, 12.57 in D+N,12.83 IN D+A,12.67 in N+A, and 12.76 in D+N+A. For the A alone group the minimum value was recorded (Table 3). In the four categories of combined infections it is as well significant to recorded that the Hb value were almost different Hb contest in the D alone and N alone kinds were somewhat maximum than in the group with combined infection and slightly alike to each other (13.07 and 13.04 respectively)

Between the non infected and the dissimilar kinds of infected fishes (Except D alone type) the outcomes of 't' test exhibit that the dissimilarities in Hb values were significant statistically. At 1%(P<0.01) level of significance non-infected verses D+N type, N+A type and D+N+A type noted dissimilarities and at 5% level (P<0.05) non infected verses N alone and D+A combination also noted dissimilarities (Table 4)

(v). Haematocrit (Ht=%)

In the non infected ,35.54 in D alone, 36.26 in N alone ,32.01 in A alone 33.44 in D+N,33.42 in D+A 33.15 in N+A and 33.29 in D+N+A, While the mean Ht values were 37.27. The Ht values in the entire kinds of infection were lower than Ht that in the lowest value was recorded in the fish with A alone natural infection (32.1) Table 3. Ht values of the four kinds as with Hb content of combined natural infections were almost comparative 33.44, 33.42, 33.15 and 33.29. While in the condition of Hb content that Ht values were higher in the D alone and A alone types. than in the kinds with combined infection while mutually competitive=33.54 and 36.26. Although Ht of N alone kind was higher than that of D alone type. At 5% level the outcomes of 't' test exhibit that dissimilarities in Ht between the non infected and D+N,D+A and N+A were significant and at 1% level that between the non infected and D+N+A Table 4

(vi). Erythrocyte Sedimentation rate (ESR mm/hr)

For the non infected fish the mean ESR value was 2.15. The values noted in the dissimilar infection types are 1.34 in D alone 1.58 in N alone 3.5 in A alone ,1.56 in D+N+A . Except A alone the entire values being lower than that of the non infected fishes Table 3.

In ESR the investigated dissimilarities between the non infected and dissimilar kinds of naturally infected fishes were not significant statistically except that between the non infected and D alone combinations. While at 1% level ($P < 0.01$) the dissimilarity was significant. Table 4.

(vii). Erythrocyte /Leucocyte ratio, (R.B.C/W.B.C ratio) .

The R.B.C /W.B.C ratio in the non infected fishes was as high 38.73 for the naturally infected fish of dissimilar kinds the mean value noted were 30.58 in D alone ,23.33 in N alone 21.5 in A alone 22.06 in D+N, 29.43 in D+N 16.87 in N+A and 22.88 in D+N+A. The lowest value of 16.87 the fishes infected with N+A kind the entire different combinations the ratios were too higher that noted although almost lower than that of the non infected fishes (Table 3)

Outcomes of the 't' test (Table 4) show that dissimilarities in RBC/WBC ratio were significant statistically ($P < 0.01$) between the non infected fishes and D+N kind, N+A kind, D+N+A kinds.

B. Haematological changes in Relation to total parasitic load.

The fishes based on parasitic burden were categorized into following two groups- Moderately infected up to Parasites per fish and heavily infected (up to more than 11 parasites per fish). On these two groups the outcomes of the haematological analyses are exhibited in table 5.

With parasite burden TEC noted an inverse relationship TEC was 2.12 in the moderately infected fish while 1.78 as against 2.5 noted for the non- infected fishes, for the non infected fish TLC was 7.5 Moderate infection caused a sudden rise in TLC up to 10.1 Appreciable TPC was not influenced by infection in the primary stages (moderate infection) as it was almost competitive to that of the non infected 49.5 moderately infected 19.19, A very low value of 14.46, although in heavily infected fishes TPC noted as with TEC with parasitic burden an inverse relation of Hb content noted. The non infected fishes had a Hb content of 13.9 g% which fall to 12.99 in moderately infected fishes and to 12.32 in the heavily infected fishes. In the non infected fishes Ht was 37.27% considerably both in the moderately and heavily infected fishes Ht noted low values 33.13% and 33.46% respectively from 2.2 in the non infected fishes ESR fall to 1.74 in the moderately infected fishes. ESR rise to 2.19 in the heavily infected fishes normally RBC/WBC ratio was high (38.73) the ratio was in the moderately infected fishes was fall to 25.75 while in the heavily infected fishes to 20.09.

It is ultimately from the outcomes of 't' test (Table 6) is clear that the dissimilarities in Hb and Ht values between the non infected and the moderately infected fishes were greatly significant ($P < 0.01$) Dissimilarities between the non infected and moderately infected fishes none of the parameters showed significant statistically.

Between the both the groups comparing the values in non infected and heavily infected fishes it is clear that TEC, Hb and RBC/WBC ratio dissimilar and significant ($P < 0.01$) As well it is remarkable that the 't' value in the case of Ht (uninfected vs heavily infected) was high very close to that at 5% level of significant, also the outcomes exhibit that between moderately infected and heavily infected fishes, TEC ($P < 0.05$) TPC ($P < 0.05$) and Hb ($P < 0.01$) were dissimilar significantly.

Between the both the groups of the fishes although comparison of the outcomes of D alone, D+N and D+N+A types of infection in immature and mature fishes exhibited that the several haematological parameters significantly did not dissimilar (Table

7) and presence of monogeneans on the gills of the fishes also show deleterious effect. For convenient the entire observation and studies are summarised in Table A Tables 1,2,3,4,5,6 and 7.

DISCUSSION :

From the two dissimilar aspects the project has been analysed as

- (i) The influence of the particular infection by the helminthic parasites and of their dissimilar combination and (ii). The influence of entire helminthic parasitic burden on the fishes.

It would very clear from the outcomes obtained in table-3 and 4 the particular infection on the fishes by the Digeneans and nematodes had not too influence significantly ESR alone was influenced in D alone infection. In Hb content there has been a significant fall ($P < 0.05$) in N alone infection with A alone infection since merely two fish was found while in this state suggestive inferences are hard to reach. Compared with having D alone and N alone infections although the haematological parameters of the fish, show that at least three parameters- Hb, Ht, and ESR were influenced by A alone infection, remarkably the first two lower than and certainly the third one higher than that of the non infected fishes.

It is too much clear comparing the aforesaid outcomes regarding deleterious influence of the particulars infection by the helminthic parasites that on the fishes their influence were differ. D alone infection seems to be least deleterious. In this aspect it is relevant that mature digeneans are comparatively less harmful than the larvae (Williams 1967) . As proved by the low TEC and Hb, in N alone infection the tendency was clearly towards anaemia. The larvae and the matures the both nematodes are said to be serious pathogens (Ribelin and Mijaki, 1975) and Radhakrishnan and Nair, 1982) contrary to normal principle that “ despite their rather fearsome proboscis with its rows of hooks, acanthocephalans have not generally been observed as serious pathogens of fish” (Robert, 1978). In *Channa punctatus* helminthic parasites seems to be normal on serious pathological alterations it is to be mentioned here like leucocytosis , hypermia and hyperplasia of connective tissue in *Coregonus lavareatus* infected by *Echinorhynchus salmonis* (Ribelin and Migaki, 1975)

By the helminthic parasites(D+N,D+A, and N+A combination considering combined infection N+A combination had much dangerous influence than the others, compared with the non infected fishes here, five haematological parameters exhibited significant variations such as fall in TEC($P<0.05$), Hb ($P<0.01$)Ht($P<0.05$) and RBC/WBC ratio ($P<0.01$) and rise in TLC ($p<0.01$) TEC($P<0.01$)Hb ($P<0.01$)Ht($P<0.05$)and RBC/WBC ratio ($P<0.01$) were changed significantly in D+N combination. On the other hand D+A combination influenced merely Hb ($P<0.05$) and Ht ($P<0.05$) significantly. By the helminthic parasites from these outcomes it is obvious that the influence of combined infection was very harmful than that of particular infections. It might be seen that the D+N combination was more deleterious than D+A combination hence proving the normal view that acanthocephalans are less harmful than nematodes. Hence the obvious higher harmful influence on one fish by acanthocephalans alone would be taken as an exception than a rule. The harmful influence in the N+A type of infection were more obvious than D+N and D+A combinations in both the two. It proves the initial inference that of the helminthic parasites of channa punctatus the digenean is the least deleterious.

By the helminthic parasites (D+N+A) Combination while simultaneous infection is considered the deleterious influences were obviously normal than in the N+A type of infection. It is just reverse to the exception that simultaneously since the entire parameters are present, their combined influence might be more than in the next possible helminthic combination. By the helminthic parasites in fishes with simultaneous infection the number of nematodes was less than in the D+N and N+A kinds. It might be the cause for the noticed low harmful influence of D+N+A type of infection.

Although this is obvious that the deleterious influences are based on the type helminthic parasite found, the noticed quantitative dissimilarities in several parameters in relation to the dissimilar kinds of infections are evidently the outcome of the dissimilarities in the number of helminthic parasites found. The helminthic parasitic numerical permutation combinations might be very high while it is not possible to assess the entire such combinations to investigate the influence of the all. Although if such an effect persists, the physio pathological alterations in relation to all parasite burden might be hoped to assess the limit of the effect. From

the outcomes hence observed in table 5 and 6 , this is noticed that the harmful influences were to adequate in seriously infected fishes. Such as TEC TPC and Hb were lower in the seriously infected fishes than in the moderately infected one while Ht moderately higher than in the lightly infected fishes, considerably was lower than in the non infected fishes. Also TLC was seen higher than in the non infected fishes while moderately lower than in the lightly infected fishes. Between the non-infected and the moderately infected fishes in several heamatological parameters the noticed parameters were significant statistically merely for Hb and Ht ($P < 0.01$), while a comparison between non-infected and seriously infected fishes exhibits that remarkable alterations found in TEC, Hb and RBC/WBC ratio. This is as well observable that the 't' value in relation to TLC, TPC and Ht in the non infected and seriously infected comparison were considerably higher than those found in the non infected and moderately infected one, showing that these parameters as well in the seriously infected fishes tended to alter significantly.

During the existing project merely limited number of fishes might be investigated. To a certain extent it has handicapped statistical comparison of the outcomes, Although, the obtained data Certainley assess the phenomenon that every helminthic parasite infecting a fish attributes its share to the physio pathological alterations in the fish.

The specific alterations in the make up of the peripheral blood of channa punctatus due to helminthic parasitic infections have been (a) fall in TEC ,Hb content, Ht and R.B.C/W.B.C ratio and (b) rise in TLC. The complete influence has been a tendency towards anaemia(lowered) TEC, Hb and Ht) Simultaneously these findings are in conformity with those intimated on helminthic infestations of dissimilar fishes (Radha krishnan et al, 1983, 1984a, 1984b and Radhakrishnan and Nair 1982)

Besides , the above the other scientists consulted are woo(1990), woo and li(1990)zarrowetal (1964) munshi and dube (1973) ojha and munshi (1975) Hakim (1977) Raja rishi (1989) Mishra(1992) Kumar (2000) Pandey (2005) capkinetal (2006) Dutta and Dalal (2008) Yakeenetal (2011) Kumari(2011) kumar etal(2012) kumaretal (2009) Ariyoshi etal (1990) Bhaskar and Rao(1989), Cameron (1970)

Farghalyetal(1973),Joshi(1989) Jozuka and Adhachi (1979)and singh(2011)and also many others.

Simultaneously kumar along with Mishra 1992 to till the date has done extensive and elaborate works on species of Channa on the various aspects but particularly with Channa punctatus.

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Table A List of Helminth parasites present in channa punctatus.

S. N O	Group	Genera	Species	Host	Site of Infaction	References
1.	Monogencans	Gyrodactylus	<i>G.raipurensis</i>	Channa Punctatus	On the gill & skin	Vankatanarsaiah (1979)
		Gyrodactylus	<i>G.gussevi</i>	DO		Mizzele and Kritsky(1967)
			<i>G.Mizellei</i>	DO		Medougal (1969)
			<i>G.hyderabadensis</i>	DO		Kearn (1986)
2.	Digeneans		G.dasus	<i>C.P</i>		
			G.Indica	DO	Digestive Tract	Gupta (1957)
		Genarchopsis	G.orocandata	DO	DO	Srivastava (1993)
			G. piscieda	Do	DO	
			O.hyderbodi	Do	DO	
			O.philippai	Do	Alimentar y canal	Dayal (1938)
		Orientocreadium	Aindica	DO	Gastro Intestinal tract	Gupta (1957)
			B.Punctatum	DO		Srivastava (1936)
		Asymphylopora	A.handiai	DO		Dayal & Gupta (1954)
		Brahamputrotrema	c. complanatum	DO	Digestive tract	Pandey (1937)
				DO		S.Firdaus (1984)
		Allocreadium			DO	
3	Cestodes	Clinostopmu m	P.Indica			
			S.Vishakhapan	DO	DO	

4..	Nematodes		amensis	DO		
		Polyoncha-	S.Jagannathae	DO	DO	Nama.h.s.(1979)
		trium			DO)
		Senga	s.roori	DO	DO	Ramadevi et
						al.(1973)
5.	Acanthocephalans		P. Allhabadi	DO	DO	
			P.Pandei	DO	DO	
				DO	DO	

		Pallisentis	P. ophioc Phali		DO	Agrawal (1958) RAI (1967) S.Firdaus (1984)
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Table- 1

Channa punctatus prevalence and intensity of infection by helminthic parasites.				
	Monogenean	Digenean	Nematode	Acanthocephalan
No. Of fish examined	100	100	100	100
No. Of fish infected	26 (15.1%)	71 (77.9%)	59(64.5%)	39(42.3%)
No. Of parasite infected fish	2	6	4	3
Maximum no. Of parasites in an infected fish	3	16	13	5

Table: 2

Channa punctatus- prevalence of different types of infection by helminthic parasites. Number in parentheses denote percentage D-Digenean, N- Nematode, A- Acanthocephlan,SL-Standard Length.

Group	No. Of fish		No. Of fish infected in different types of infection.						
	Examined	Non infected	D-alone	N-alone	A alone	D+N	D+A	N+A	D+N+A
Immature(SL<82)	55	3(4.1)	9(16.1)	4(6.1)	-	14(26.1)	8(14.1)	4(6.1)	15(28.1)
Mature(SL<83)	45	4(7.6)	11(25.1)	5(10.1)	2(2.6)	10(22.6)	2(2.6)	5(10.1)	9(20.1)
Total	100	7(5.7)	20(20.1)	9(7.9)	2(1.2)	24(24.5)	10(8.10)	9(7.9)	24(24.5)

Table 3

Channa punctatus- Haematological parameters(means \pm S.E) of Non infected and infected fish only one fish was found in this group D-Digenean, N-Nematode, A-Acanthocephalan.

Haematological parameters	Non-infected	Infected						
		D-alone	N-alone	A alone	D+N	D+A	N+A	D+N+A
Total erythrocyte count TEC ($\times 10^6/\text{MM}^3$)	2.41 \pm 0.12	2.15 \pm 0.09	2.0 \pm 0.15	2.15	1.95 \pm 0.08	2.16 \pm 0.08	2.03 \pm 0.06	1.95 \pm 0.09
Total leucocyte count TLC ($\times 10^4/\text{MM}^3$)	7.01 \pm 0.97	8.73 \pm 0.79	10.01 \pm 1.49	10.01	9.60 \pm 0.68	8.69 \pm 0.99	12.58 \pm 1.06	9.78 \pm 0.84
Total platelet count TPC ($\times 10^4/\text{MM}^3$)	19.01 \pm 1.53	17.62 \pm 1.16	20.87 \pm 1.83	22.01	17.92 \pm 1.07	18.88 \pm 3.13	21.01 \pm 1.22	16.83 \pm 1.19
Haemoglobin content Hbg%	13.81 \pm 0.07	13.07 \pm 0.22	13.04 \pm 0.27	12.01	12.57 \pm 0.12	12.83 \pm 0.26	12.67 \pm 0.21	2.76 \pm 0.15
Haematocrit- (Ht%)	37.27 \pm 1.26	35.54 \pm 0.99	36.26 \pm 1.57	32.01	33.44 \pm 0.52	33.42 \pm 0.78	33.15 \pm 0.36	33.29 \pm 0.59
Erythrocyte sedimentation rate-ESR (mm/h)	2.11 \pm 0.31	1.34 \pm 0.11	1.58 \pm 0.27	3.01	1.56 \pm 0.12	1.51 \pm 0.16	2.08 \pm 0.17	1.96 \pm 0.14
Erythrocyte – leucocyte ratio RBC/WBC ratio	38.73 \pm 6.60	30.58 \pm 2.83	23.33 \pm 4.15	21.41	22.06 \pm 1.37	29.43 \pm 3.53	16.17 \pm 1.58	22.90 \pm 2.12

Table 4

Channa punctatus- Results of student's 't' test comparing the haematological parameters between Non infected and infected by helminthic parasites D-Digenean, N-Nematode,A-Acanthocephalan							
			*P<0.05	*P<0.01			
	TEC	TLC	TPC	Hb	Ht	ESR	RBC/WBC RATIO
Non infected vs D alone	1.5678	1.1641	0.6799	1.8756	0.949	3.1588	1.3334
Non infected vs N alone	1.9459	1.5213	0.7859	2.3961	0.546	1.3379	1.9989
Noninfected vs D+N	2.9953	1.7874	0.5599	54919	3.143	2.1339	3.8979
Non infected vs D+A	1.8999	1.1313	0.0389	2.9629	2.665	1.9258	1.3599
Non infected vs N+A	3.1847	3.5243	0.9584	4.3322	3.427	0.1946	3.5135
Non infected vs D+N+A	2.4899	1.5893	0.9231	3.5719	2.956	0.5599	2.9189

Table: 5

Channa punctatus- Haematological parameters in relation to parasitic burden			
Haematological parameters	Non infected	Moderately infected	Seriously infected
TEC (X10⁶/MM³)	2.51 ± 0.12	2.12 ± 0.12	1.78 ± 0.11
TLC (X10⁴/MM³)	7.01 ± 0.99	10.10 ± 1.44	9.28 ± 0.81
TPC(X10⁴/MM³)	19.01 ± 1.53	19.19 ± 1.27	14.46 ± 1.74
Hb(g%)	13.81 ± 0.07	12.99 ± 0.14	12.32 ± 0.18
Ht %	37.27 ± 1.26	33.13 ± 0.51	33.46 ± 1.04
ESR(mm/h)	2.11 ± 0.31	1.74 ± 0.18	2.19 ± 0.18
R.B.C./W.B.C Ratio	38.73 ± 6.60	25.75 ± 3.79	20.09 ± 1.45

Table: 6

Channa punctatus - Results of students 'T' test Comparing the haematological parameters in relation to parasitic burden.							
*P<0.05, **P<0.01							
	TEC	TLC	TPC	Hb	Ht	ESR	RBC/WBC Ratio
Noninfected VS Highly infected	1.5668	1.4138	0.0999	3.9397	3.5599	1.1773	1.7999
Noninfected VS Heavily infected	3.5943	1.6628	1.6484	5.6634	2.1493	0.3459	3.6599
Lightly infected vs heavily infected	2.2858	0.5869	2.2169	3.1178	0.3872	1.8734	1.4574

Table: 7

Channa punctatus - Results of students 'T' test comparing the haematological Parameters between immature and mature fish in relation to three types of onfection by helminthic parasites.							
	TEC	TLC	TPC	Hb	Ht	ESR	RBC/WBC Ratio
Immature D alone VS mature D alone	0.9979	0.4134	0.2044	0.8416	1.1226	0.4778	1.8496
Immature D+N VS mature D+N	0.9539	0.9529	2.1475	0.9379	0.8282	0.8769	0.0819
Immature D+N+A VS matureD+N+A	0.1174	0.5271	0.4583	0.4133	0.4193	0.9934	0.6857