VARIABILTY IN PARASITES' COMMUNITY STRUCTURE AND COMPOSITION IN CAT FISH WITH RESPECT TO LEVEL OF POLLUTION IN MWANZA GULF, LAKE VICTORIA, TANZANIA.

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ABSTRACT

This study investigated the composition and structure of the parasite communities in Cat fish with respect to levels of water pollution in Lake Victoria. A total of 1071 Clarias gariepinus with mean TL range of 19 to 27 cm were analyzed from three localities in Mwanza Gulf (Kirumba, 298 fish infected with 15 parasite species), Nyegezi (376 fish, with 15 parasites species) and Malimbe (397 fish, with 16 parasites species). Trematodes and nematodes dominated the population with six (35.3%) and five (29.4%) species, respectively. Mean species richness and heteroxenous/monoxenous ratio showed significant changes (Fr = 8.000; p = 0.0046), being high at Malimbe and declining towards Kirumba Bay. Contracaecum species dominated the gut parasites with higher load per infected fish at Kirumba Bay than the other two sites. The observed composition and structural changes among the sites studied are linked to an increase in untreated waste water discharge as a result of higher population density in the Kirumba Bay watershed as opposed to the other localities.

Key words: *Clarias gariepinus*, parasites, level of pollution, Lake Victoria.

INTRODUCTION

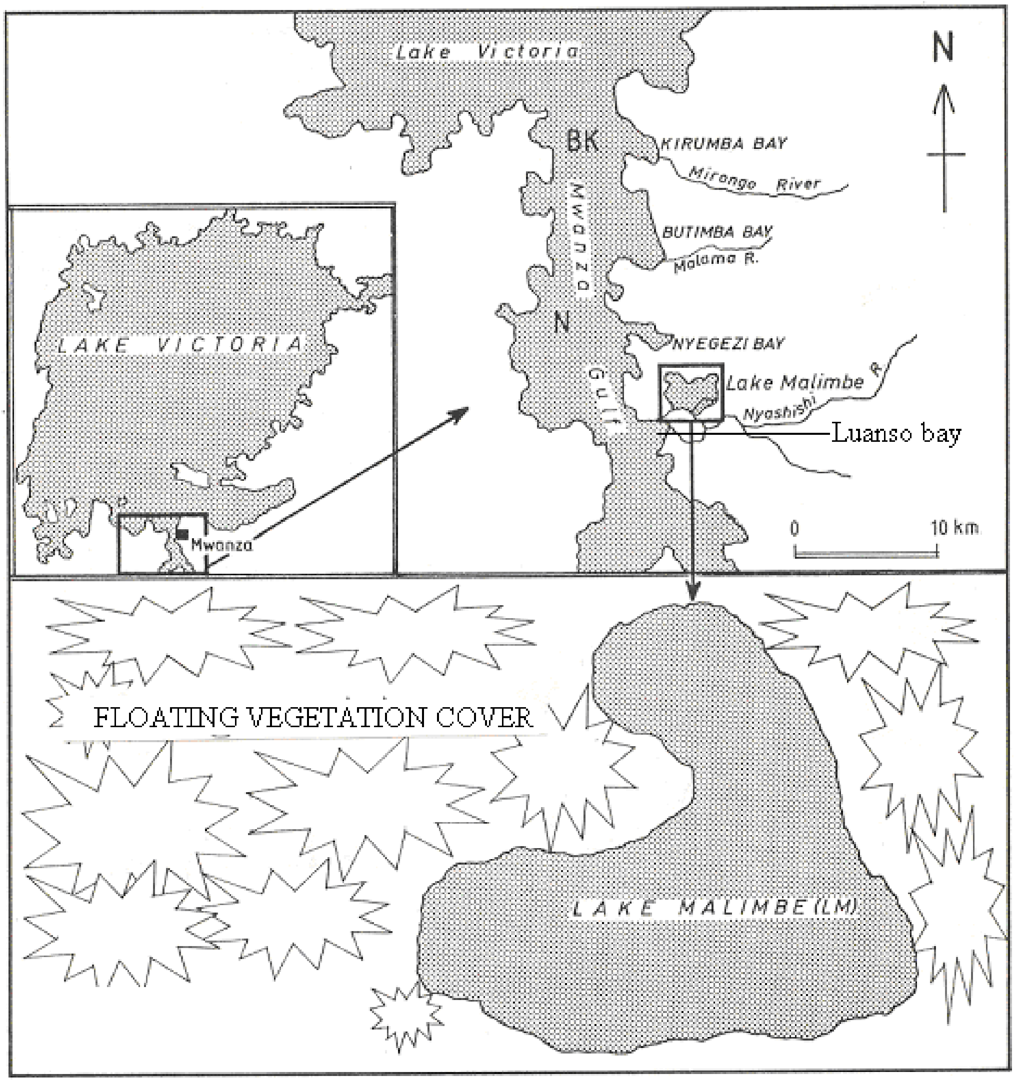
Reliable technologies for detection of pollutants and policies and regulatory framework for managing the aquatic environment are in place; however, most of these techniques are expensive and time consuming. The use of parasites of fish and macroinvertebrates is considered one of the cheapest and reliable ways of tracking environmental perturbation in the aquatic system (Orzell and Platt 2008).

Fish parasites with complex life histories are used as bioindicators for monitoring environmental perturbations in aquatic ecosystems. Specific species of parasites or even the parasite community as whole are utilized as indicators for pollution. Changes in the prevalence and intensity of infection in certain parasite taxa and the composition of parasite communities are used to assess pollution impact to aquatic environment (Nachev and Sures 2009). In addition to indices of population structure and diversity, the ratio between heteroxenous and monoxenous parasite species has been introduced as a parameter for estimation of changes in the state of the environment (Dzikowski *et al*. 2003). Few studies, if any, have used parasites communities as an indicator for ecosystem stress in the East African fresh and marine water bodies. Most studies have used the lengthy and expensive environment assessment and monitoring techniques (Orzell and Platt 2008).

This study compares the composition and structure of the parasites communities infecting *Clarias gariepinus* from three distantly located sites in Mwanza Gulf (Mirongo, Nyegezi and Lake Malimbe), Lake Victoria. *Clarias gariepinus* was chosen as a proxy to study the impact of pollution in the three locations due to its catholic behaviour; the fish is an omnivorous feeder and occupy nearly every habitat in the water (Kennedy 1997). These characteristics render the fish prone to infection by a variety of parasite fauna. The aim was to establish the parasites' population structure in the three locations. The three sites differ in the pattern and intensity of land use in their immediate watershed (agricultural, industrial and residential).

MATERIALS AND METHODS

Study sites



Key: Floating vegetation cover (Macrophytes).

Figure 1: Map of Mwanza Gulf showing sampling sites; Kirumba Bay (BK), Nyegezi Bay (N) and Lake Malimbe (LM).

Sampling was carried out at three sites along the Mwanza Gulf (Fig. 1) namely, Kirumba (BK), Nyegezi (N) and Lake Malimbe (LM). The two sites, Kirumba and Nyegezi Bays are part of the main lake and Malimbe is a satellite lake adjacent to the main lake. Nyegezi is located at 2^o35`S, $32^o$55`E. The eastern part of which is muddy and covered by abundant vegetation. It is relatively shallow in some parts with a maximum depth of nearly 9 m. A single seasonal stream empties into the eastern part of the bay and is utilized as a source of water for irrigation purposes. The western shore is mainly sandy and rocky. Kirumba is located at the entrance to the Mwanza gulf, most part of which is sandy and rocky and along the shores are ports for anchoring ships and boats and human habitats. The Mirongo River which carries industrial and domestic waste water enters the lake via this bay. Lake Malimbe (2^o34.471`S, $32^o$53.867`E), is a satellite lake with a surface area of about 10 km^2, located about 10 km from Mwanza town, adjoins Lake Victoria on the eastern part of the Mwanza Gulf.. Floating macrophytes such as *Papyrus* and *Phragmites* cover most of the lake, except for an area of about 0.5 km^2 with a maximum water depth of 2.5 m. The satellite lake has a muddy bottom and is disconnected from the main lake most of the year especially during dry season. Access to the satellite lake is difficult in the rainy season (March – May), however connection with the main lake is re-established in this period.

Sample Collection and Analysis

Sampling was carried out from September 2007 to September 2008 covering both the dry and rainy seasons. Twenty to fifty fish depending on the availability were examined monthly at each locality. Fish were caught by longlines and baited hook and line. Dead fish were transported in an ice-cooled box and live fish in buckets filled with water from the lake to the laboratory. Parasites were identified and quantified according to the protocol described in Moravec *et al.* (1991a, b).

Parasite diversity (H) and evenness of the distribution of parasite species (E) were derived from the Shannon Wiener index. Differences between index values of the three sampling localities were compared using Kruskal-Wallis test. Differences in prevalence and representation of major parasites taxa were testes with _^{2} tests. Total number of parasite species per locality and mean number of parasite species per fish were calculated as measures of parasite species richness in the population. A population of parasites was regarded as rich or poor based on the number of species of parasites present (Bush *et al.* 2001). All statistical procedures were carried out with INSTAT statistical software with the significance level set at _ < 0.05.

RESULTS

Seventeen parasite species were recorded from the examined 1071 *C. gariepinus*. A total of 1045 (97.6%) *C. gariepinus* were infected with one or more species of parasites totalling 544,386 specimens with a mean intensity of 520.09. Trematodes and nematodes were the predominant groups comprising six (35.3%) and five (29.4%) species, respectively. Cestodes were represented by three species (17.6%), while monogeneans, crustaceans and hirudineans were represented by one species each. Ten species were found in the gut and the rest were isolated from the skin, gills and buccal cavity.

The mean fish total length ranged between 19 cm to 27 cm and the condition factor values of the fish samples did not differ significantly in the three localities, though it was slightly higher at Kirumba Bay (Table 1). In general, the number of parasite species in the three localities of the gulf was relatively similar, however, when fish parasite communities were compared, the prevalence of infection with heteroxenous digeneans was considered not quite significant in the three localities (Fr = 5.200; p = 0.0934). The prevalence of monoxenous monogenea was very low, whereas *Dolops ranarum* was largely recovered from Lake Malimbe (Fig. 2). Representation of major parasite taxa with respect to the whole parasite communities is as shown in Table 2.

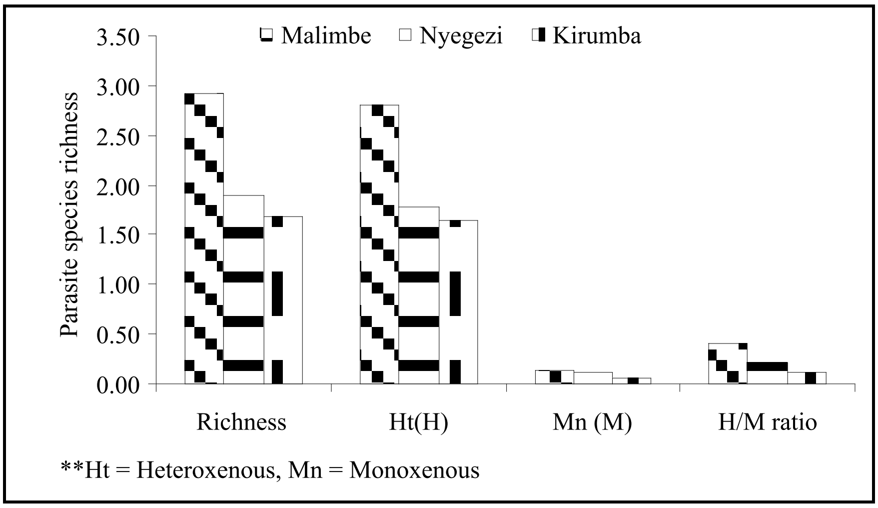


Figure 2: Mean parasite species richness per site in the Mwanza Gulf.

Table 1. Parameters of *Clarias gariepinus* collected from the Mwanza Gulf, Lake Victoria

	Malimbe	Nyegezi	Kirumba
No of parasite species	16(13)*	15(13)*	15 (12)*
Period sampled	2007-2008	2007-2008	2007-2008
No of fish sampled	397	376	298
Mean fish length (cm)	27.2	19.9	21.7
Mean fish weight (gm)	322.5	130.7	238
Condition factor ($K=100*W/L^3$)	1.001± 0.23	1.02± 0.23	1.4± 1.81

* Number of heteroxenous parasites in parenthesis

Table 2. Percentage representation of major parasite taxa infecting *C. gariepinus* in Mwanza Gulf

	Malimbe	Nyegezi	Kirumba
Digenea	43.75	46.7	40
Nematoda	25	26.7	26.7
Cestoda	12.5	13.3	13.3
Crustacean	6.25	0	6.7
Monogenea	12.5	13.3	13.3

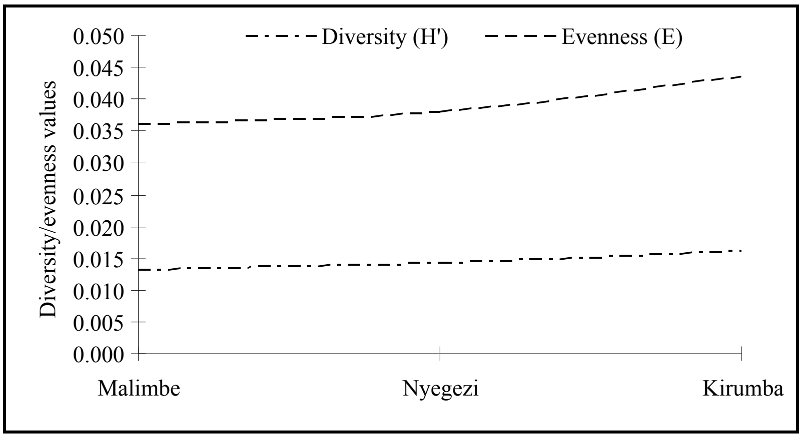


Figure 3: Mean Shannon-Weiner diversity and evenness values per individual fish

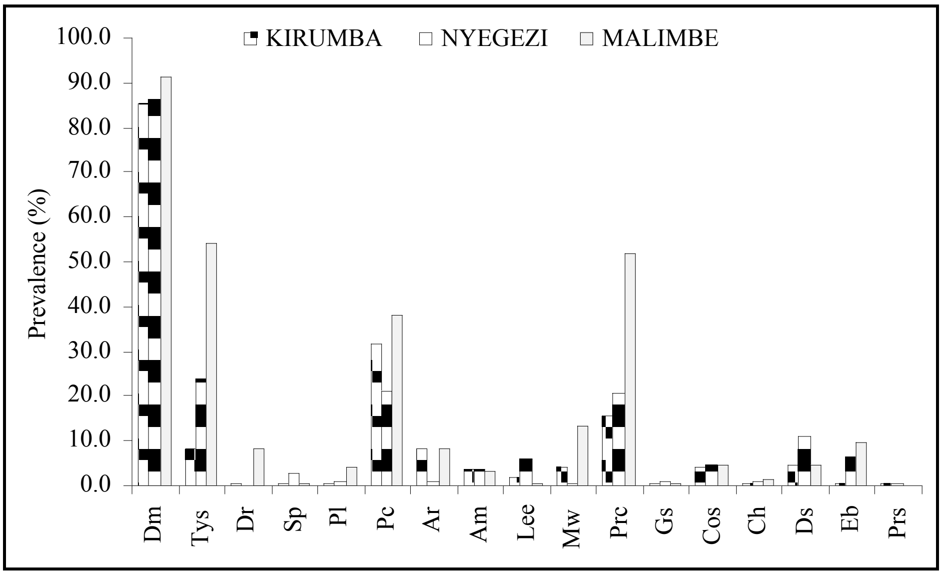


Figure 4: Comparison of prevalence of parasitic infection in Mwanza Gulf.
Dm, *Diplostomum mashonense*, **Tys**, *Tylodephys* sp., **Dr**, *Dolops ranarum*, **Sp**, *Spinitectus peteri*, **Pl**, *Paracamallanus laevionchus*, **Pc**, *Polyonchobothrium clarias*, **Ar**, *Astiotrema reniferum*, **Am**, *Allocredium mazoensis*, **Lee**, Leeches, **Mw**, *Monobothroides woodlandi*, **Prc**, *Paracamallanus cyathopharynx*, **Gs**, *Gyrodyctyrus* sp., **Cos**, *Contracaecum* sp., **Ch**, *Clinostomum heterostomum*, **Ds**, *Dactyrogyrus* sp., **Eb**, *Eumasenia bangweulensis*, **Prs**, ….

The mean values of parasite species richness showed significant changes from Lake Malimbe towards Kirumba Bay for both general parasite population structure and the heteroxenous parasite taxa (Fr = 8.000; p = 0.0046). The heteroxenous/monoxenous ratio showed the same trend, being high at Malimbe and lowest at Kirumba Bay (p <

0.05) (Fig. 3). There was no significant difference in mean Shannon-Weiner diversity and evenness values (p = 0.1000) for individual fish in the three localities sampled along the gulf (Fig. 4). Prevalence of infection in these parasite populations was dominated by four parasite species namely; *Diplostomum mashonense*, *Tylodephys* sp., *Polyonchobothrium clarias* and *Paracamallanus cyathopharynx* in that order. Malimbe had more infection of the four parasites (Fr = 6.500; p = 0.0417) compared to the other two sites (Fig. 5). When gut parasites were considered separately, *Contracaecum* species had a higher parasite load per infected fish in the three localities, more so at Kirumba Bay than in the other two localities. *Monobothroides woodlandi*, *Allocredium mazoensis* and *Astiotrema reniferum* showed a significant load per infected fish in that order (Fig. 6).

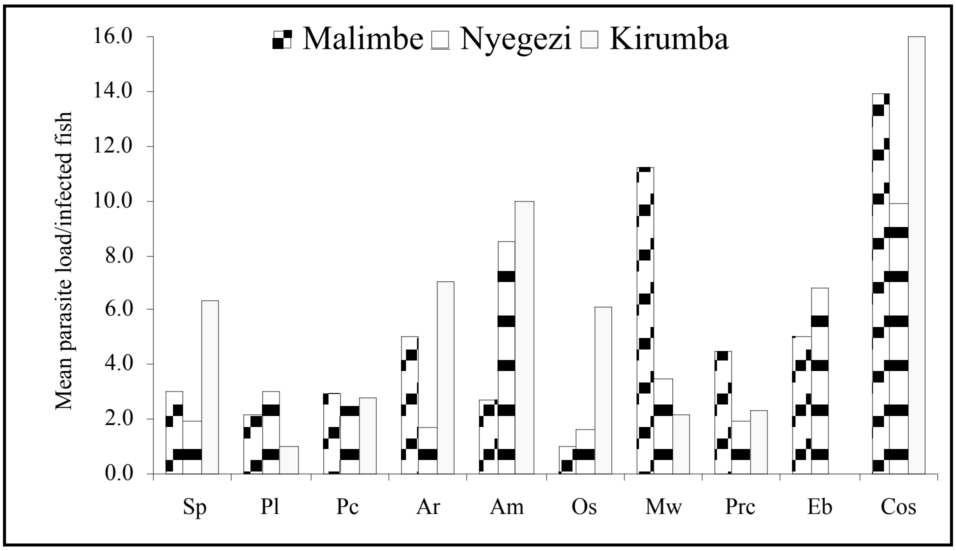


Figure 5: Mean parasite load (gut)/fish in Mwanza Gulf.
Sp, *Spinitectus peteri*, **Pl**, *Paracamallanus laevionchus*, **Pc**, *Polyonchobothrium clarias*, **Ar**, *Astiotrema reniferum*, **Am**, *Allocredium mazoensis*, **Mw**, *Monobothroides woodlandi*, **Prc**, *Paracamallanus cyathopharynx*, **Cos**, *Contracaecum* sp., **Eb**, *Eumasenia bangweulensis*, **Os**, *Orientocredium* sp.

DISCUSSION

Ecological disturbances in Lake Victoria dates back to the 1950s and 1960s when Nile perch (*Lates niloticus*) was introduced in the lake (Witte *et al*. 1992). Recently, studies have provided evidence of increased eutrophication, decreased dissolved oxygen and water transparency in most part of the lake (Witte *et al.* 2000). In addition, of more than 110 haplochromine species originally found in Lake Victoria, only 20 species are available today (Katunzi *et al.*, 2003; Kishe *et al.* 2008). There are multiple sources of environmental threats in the ecology of Lake Victoria including the world problem of global warming and pollution from households, agricultural, industrial and mining activities taking place within the lake basin (Wanink *et al.* 2001).

Despite the qualitative differences in sampling localities characteristics the findings of this study found slight statistical difference in the parasite species richness from the three sampled sites. Fifteen parasites species were found in Lake

Malimbe, fourteen species from Nyegezi and at Kirumba fourteen parasites species were isolated. The digeneans and nematodes were the most predominant species of parasites recorded from *C. gariepinus* in these sites. These groups of parasites are regarded as indicators of ecological disturbances as they pass through a number of intermediate hosts in the course of their life histories (Esch *et al.* 1990). The basic assumption is that in a disturbed environment heteroxenous parasites are less likely to complete their life cycles than monoxenous parasites, either due to direct adverse effects on their free living stages, or as an indirect consequence of the elimination of their intermediate hosts (Paperna 1997).

The Kirumba Bay, a polluted site with waste oil from marine vessels and municipal waste water discharged into the lake via Mirongo River showed only a relative decline in heteroxenous parasite taxa and mean parasite species richness when compared to the other two sites. The trend however, did not indicate a corresponding rise in monoxenous taxa as suggested by Dzikowski *et al.* (2003). The highest heteroxenous/monoxenous ratio and mean parasite species richness per locality were recorded at Lake Malimbe followed by Nyegezi Bay. Nyegezi is closer to the entrance to the Mwanza gulf and hence most likely affected by pollutants from Kirumba Bay (Abelson *et al.* 1999). Although there are potential agricultural activities around Lake Malimbe, the direct influence of agrochemical spills and seepage into the lake is possibly marred by the heavy wetlands surrounding the small satellite lake (Jørgensen, 2000). But as to why the variability in parasite structural pattern in the three sampled sites along the gulf was not statistically significant despite the differences in locality characteristics could not immediately be ascertained. But as noted by Kennedy, (1997), there is insufficient knowledge on parasite life histories, on the effect of different types of pollutants on each stage of their life cycle and on the effects on their intermediate hosts.

The lack of significant variability in parasite structural patterns between the three sites, might suggests that the intermediate hosts to the heteroxenous parasites observed are resistant to pollutants currently being discharged in the Mwanza Gulf (Ogoyi et al. in press), particularly those along Kirumba bay. Certain aquatic macroinvertebrates (zooplankton and zoobenthos) have different degrees of resistance to pollutants (Terrell and Perfetti 1991). Nematodes due to their hard cuticle may as well resist pollutants to a certain extent and thus their free living stages are more likely to survive in polluted environment (Turcekova *et al*., 2002; Barus *et al.* 2007). Moreover, most nematodes utilise zooplanktons such as copepods in certain stages of their life histories, and as suggested by Dzikowski *et al*. (2003), eutrophication promotes an increase in zooplankton and zoobenthos which, save as parasite intermediate hosts. The findings of this study indicate that nematodes (*Contracaecum* sp.) predominated gut parasites infecting *C. gariepinus* at Kirumba Bay.

Prevalence of parasites such as metacercariae of trematodes showed some variation between sites possibly due to fluctuations in the population of their intermediate hosts, being high at L. Malimbe because of the sparse wetlands and declining towards Kirumba as the supportive vegetation cover decreased following convention of shoreline wetlands into other human uses. Also *C. gariepinus* is known to traverse long distances into the wetlands where they may be trapped in the pools of water at the onset of the dry season and predated by piscivorous birds or fishermen with subsequent removal of parasites from the pool. This could also account for the low number of parasites observed at L. Malimbe, as L. Malimbe has sizable wetland commonly utilized for agricultural activities with pools of water in the dry season. Unlike in L. Malimbe, *C. gariepinus* in

Kirumba Bay could use the Mirongo River as an additional source of infection.

Although the population structural patterns for the parasites infecting *C. gariepinus* in the Mwanza Gulf did not show significant variability, the trend indicated that mean species richness per site, prevalence of major parasite taxa and heteroxenous/monoxenous ratio were declining towards Kirumba Bay. As noted by Dzikowski *et al*. (2003) extreme conditions may have conflicting impacts on diverse taxa of parasites and as such overall parasite structural parameters may fail to track transition taking place in the community. Likewise no change in diversity and evenness indices were noted despite slight changes in mean species richness per sites.

CONCLUSION

The study therefore, concludes that the observed parasites composition and structural changes among the sites studied are linked to a rise in human activities with subsequent increase in pollution levels and measures need be taken to avert further environmental deterioration in the lake.

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