

EVIDENCE THAT PARASITES AFFECT CYPRINID FISH POPULATIONS

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Introduction

- Concerns have been raised that coarse fish stocks in England and Wales have declined to a serious extent over the past three decades. Numerous studies have investigated biotic and abiotic factors in these declines. None have considered the role of disease in regulating juvenile coarse fish populations.
- Only a small number of studies have unequivocally demonstrated a link between parasites and population regulation, including nematodes in reindeer and grouse populations.
- Nunn *et al* (2002) (*Freshwater Biology* 48: 579-588) used regression models to demonstrate that the main factor driving cyprinid fry populations was temperature and flow rate.
- Disease status of samples collected at the same sites and at the same time as Nunn *et al* (2002) have been included in new models to determine the effect of disease status on host population dynamics.

Materials and Methods

- Over 5000 freshwater juvenile (0+) cyprinids were collected over a 10-year period every September between 1993 and 2002 from 17 rivers in Yorkshire and Humberside and examined histologically for the presence of parasites and diseases (see Figure 1).
- Thirteen fish species were examined in total. Data presented here relates to roach (*Rutilus rutilus*) and chub (*Leuciscus cephalus*).
- Levels of infection, as well as pathological changes associated with parasites were noted. Parasite data were analysed by a number of methods and regression models were developed to include the effect of disease status, mean annual river temperature, flow rate, position of the north wall of the Gulf Stream (NWGS) and other biotic and abiotic factors on total fish length, relative abundance of hosts and year class strength (YCS).

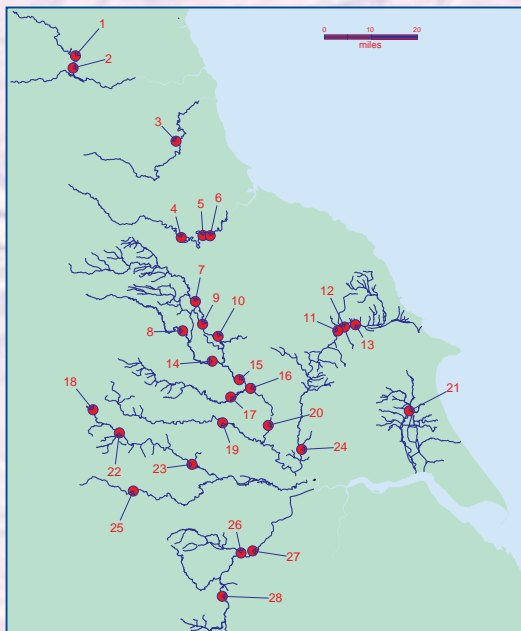


Figure 1:

Table 1: Linear and multiple regression models for impact of disease on length, relative abundance and year class strength of roach in selected sites in Yorkshire. Where I = models including environmental data

Site	Model type	Regression model	P	R ²	n
Beningbrough1	Linear	Length (mm) = 32.1 - 0.899 Coccidia	0.009	66.5%	5
Boston Spa	Linear	Length (mm) = 35.6 - 1.33 <i>Hofereilus</i> sp.	0.142	45.4%	6
Thornton Bridge	Linear	Length (mm) = 34.6 - 0.238 <i>Myxobolus cycloides</i>	0.134	33.3%	8
Ouse	Linear	YCS = 103 - 4.10 <i>Trichodina</i> spp.	0.003	99.3%	4
Ouse ¹	Multiple	YCS = 127 - 4.64 <i>Trichodina</i> spp. - 0.0307 degree days	0.011	100%	4
Wharfe	Linear	YCS = 51.0 + 22.4 <i>Bucephalus polymorphus</i>	0.004	80.2%	5
Beningbrough	Linear	Relative Abundance = 39.3 + 8.75 <i>Hofereilus</i> sp.	0.038	80.8%	5
Beningbrough	Multiple	Relative Abundance = 57.8 + 6.94 <i>Hofereilus</i> sp. - 3.86 Coccidia	0.028	97.2%	53
Boston Spa	Linear	Relative Abundance = 12.9 + 9.32 <i>Bucephalus polymorphus</i>	0.011	83.2%	6
Thornton Bridge	Multiple	Relative Abundance = 9.86 + 0.368 <i>Bucephalus polymorphus</i> + 10.7 RLO	0.027	76.5%	8

Table 2: Linear and multiple regression models for impact of disease on length, relative abundance and year class strength of chub in selected sites in Yorkshire. Where I = models including environmental data

Site	Model type	Regression model	P	R ²	n
Beningbrough	Linear	Length (mm) = 36.2 - 0.147 <i>Myxobolus</i> spp. in muscle	0.063	62.1%	6
Beningbrough ¹	Linear	Length (mm) = 33.2 - 2.33 abundance of <i>Myxobolus</i> spp. in muscle	0.029	94.2%	4
Beningbrough	Multiple	Length (mm) = 8.02 + 1.10 <i>Phyllostomum</i> sp. + 0.199 <i>Bucephalus polymorphus</i>	0.014	94.2%	6
Beningbrough ¹	Multiple	Length (mm) = 34.9 + 0.0771 muscle <i>Myxobolus</i> spp. - 1.38 abundance of muscle <i>Myxobolus</i> spp.	0.002	100%	4
Boston Spa	Linear	Length (mm) = 23.8 + 1.45 <i>Bucephalus polymorphus</i>	0.032	72.5%	6
Boston Spa ¹	Multiple	Length (mm) = 28.1 + 1.00 <i>Bucephalus polymorphus</i> - 0.268 abundance of muscle <i>Myxobolus</i> spp.	0.029	97.1%	5
Thornton Bridge ¹	Multiple	Length (mm) = 23.4 + 0.926 NWGS Jan + 0.766 <i>Myxobolus buckei</i>	0.049	86.5%	6
Ouse	Linear	YCS = 217 - 2.18 <i>Rickettsia</i> -like organisms (RLOs)	0.006	88.0%	6
Ouse ¹	Multiple	YCS = 256 + 26.2 RLO - 1.00 <i>Myxobolus</i> spp. in muscle + 13.7 <i>M. macrocapsularis</i> - 2.53 <i>Bucephalus polymorphus</i>	0.001	100%	6
Wharfe	Linear	YCS = 31.0 + 17.3 <i>Bucephalus polymorphus</i>	0.001	98.3%	5
Beningbrough	Linear	Relative Abundance = 58.7 - 5.09 <i>Phyllostomum</i> sp.	0.005	95.0%	5
Beningbrough	Multiple	Relative Abundance = 64.6 - 0.0876 <i>Myxobolus</i> spp. in muscle - 5.52 <i>Phyllostomum</i> sp.5	0.036	96.4%	5
Beningbrough ¹	Multiple	Relative Abundance = 58.1 - 0.0371 <i>Myxobolus</i> spp. in muscle - 18.0 NWGS July4	0.069	99.5%	5
Boston Spa	Linear	Relative Abundance = 17.3 + 0.775 <i>Myxobolus buckei</i>	0.055	75.7%	5
Boston Spa ¹	Multiple	Relative Abundance = 28.5 - 6.15 <i>Myxobolus</i> spp. in muscle abundance + 10.1 <i>pentrichous</i> ciliates	0.03	97.0%	6
Thornton Bridge	Linear	Relative Abundance = 22.2 + 4.02 <i>Myxobolus macrocapsularis</i>	0.075	58.8%	6

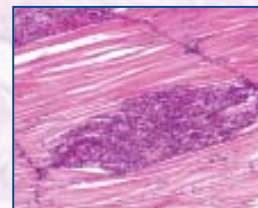


Figure 2:



Figure 3:

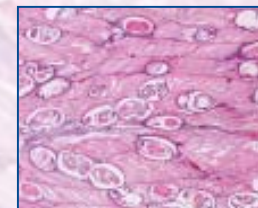


Figure 4:

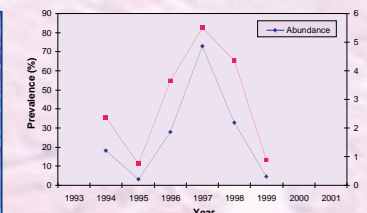


Figure 5:

Results

- A total of 40 parasite species have been identified, many of which are relatively innocuous. These included *Trichodina* sp., ciliate infections, monogeneans, myxozoans such as *Myxobolus* (Figure 2 – *M. pseudodispar*), *Sphaerospora* and *Myxidium* and the digeneans *Bucephalus polymorphus* (Figures 3 and 4) and *Diplostomum phoxini*.
- Parasite prevalence and abundance were strongly correlated over the course of the study (Figure 5) and, at least for myxozoans, followed a similar pattern for each disease.
- Both linear and multiple regression models demonstrated that length, relative abundance of hosts and YCS of roach (Table 1) and chub (Table 2) were correlated with disease status.
- Variance to mean ratios of muscle *Myxobolus* spp. were strongly linked to YCS. In sites and years of poor YCS, variance to mean ratios were high and conversely, in sites and sites with high YCS, mean to variance ratios were low

Conclusions

- This study has, for the first time demonstrated a link between disease and changes at population level in freshwater coarse fish in the UK. Previous studies have shown that the position of the NWGS, water temperature and flow rate are also important drivers for population success.
- Parasites and diseases have limited influence on length of roach. However, the presence of *Trichodina* spp. and *Bucephalus polymorphus* were most strongly correlated to YCS and relative abundance.
- Chub populations, whilst also influenced by *B. polymorphus* are also regulated by the presence of *Myxobolus* spp. in the musculature. Length, relative abundance and YCS were all strongly correlated with parasites in chub populations. It was apparent during the histopathological assessment that chub contained more species of parasites, had higher burdens of infection and demonstrated greater pathological changes when compared with roach.
- It is clear that parasites of cyprinid fry ultimately regulate host populations. However, for each river system and indeed for each host species, the determining factors differ. Synergistic effects between parasite loads, host factors and environmental influences determine the host survivability. There is a need to extend the study to determine the links between the different factors involved, and the influence on both parasite and host "success". It is anticipated that the data obtained and the models developed will assist in the production of more robust predictive population models for freshwater fisheries management and may ultimately be applied to marine fisheries management.

Acknowledgements

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