Estuarine, Coastal and Shelf Science 132 (2013) 87–93

Contents lists available at SciVerse ScienceDirect

Estuarine, Coastal and Shelf Science

journal homepage: www.elsevier.com/locate/ecss

Factors influencing trematode parasite burdens in mussels (*Mytilus* spp) from the north Atlantic ocean across to the north Pacific

J.G. Wilson.[a,*], K.V. Galaktionov[b], A.A. Sukhotin[b], K. Skirnisson[c], K.E. Nikolaev[b], M.I. Ivanov[d], J.O. Bustnes[e], D.H. Saville[f], K.V. Regel[g]

[a] *Zoology Dept., TCD, Dublin 2, Ireland*
[b] *White Sea Biological Station, Zoological Institute, St. Petersburg, Russia*
[c] *University of Iceland, Keldur, Iceland*
[d] *Hydrobiology and Ichthyology Dept., St. Petersburg State University, Russia*
[e] *Norwegian Institute for Nature Research, Tromsø, Norway*
[f] *School of Environmental Sciences, University of Ulster, Newtownabbey, N. Ireland BT37 0QB, UK*
[g] *Laboratory of Parasitology, Institute of the Biological Problems of the North, Magadan, Russia*

ARTICLE INFO

Article history:
Received 8 September 2011
Available online 11 November 2011

Keywords:
mussels
birds
trematodes
Atlantic
Arctic

ABSTRACT

The level and incidence of infection of blue mussels (*Mytilus* spp) by the trematode parasites *Himasthla*, *Renicola* and *Gymnophallus* were studied at 22 sites from north Atlantic waters (Ireland, Iceland, Norway) and across the Arctic Ocean to the Sea of Ohktosk in the north Pacific. Only at one site (Pechora Sea) were no parasites at all recorded. Infestation levels ranged up to 100% of individuals sampled.

Data were analysed with the PRIMER-E package BEST routine. The analysis indicated a considerable influence of geographic location, with closely-connected sites also grouped together on the basis of their parasite communities. The BEST routine suggested that the major influence on infestation was bird (final host) numbers, but that exposure was also a strong factor. The implications of these findings in relation to human exploitation of mussels, to bird conservation, and to the provision of ecosystem goods and services in general is discussed.

1. Introduction

Parasitism is now widely recognized as a factor that influences the composition, structure and function of natural animal communities (Combes, 1996; Thomas et al., 1999; Poulin, 1999). Even when the impact of the parasite is not the death of the host, parasites can decrease the growth, survival or reproductive output of their hosts or can modify their behaviour (Poulin, 2007). Thus they have a direct impact on the provision of natural goods and services.

During the last decade it has become apparent that coastal ecosystems represent a useful model for the investigation of interactions between hosts and parasites (Mouritsen and Poulin, 2002). The rich and abundant fauna of marine organisms in intertidal and upper subtidal zones attracts huge numbers of marine and coastal birds that feed on these animals. The proximity of all these organisms promotes transmission of complex parasite life cycles involving coastal invertebrates, fishes and birds as intermediate and final hosts. In addition, the balance between all components (including parasites) of coastal ecosystems can be affected by anthropogenic influence and climate changes (Lafferty and Kuris, 1999; Bustnes et al., 2000).

This work focuses on mussels of genus *Mytilus* which are ubiquitous bivalve molluscs along the seacoasts of the entire Palaearctic (*Mytilus edulis*/*Mytilus galloprovincialis* on the Atlantic seaboard and *Mytilus trossulus* on the Pacific). Their widespread distribution has led to their use in many pollution status monitoring programs - e.g. the "mussel watch" first proposed by Goldberg et al. (1978) for contaminant loads, and more recently through scope-for-growth (SFG) measurements of system impairment (ICES, 2007). The mussel plays a key role in coastal ecosystems and, in addition to the resource value in fisheries and culture, constitutes a very important food source for marine and coastal birds (waders, gulls, diving ducks), especially common eider (*Somateria mollissima*). While the principal value of the birds lies in conservation, there is still some exploitation of stocks by hunters and by collectors of eiderdown. The birds also act as final hosts for a range of trematode parasites of which *Renicola*, *Himasthla* and

* Corresponding author.
E-mail address: jwilson@tcd.ie (J.G. Wilson.).

0272-7714/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ecss.2011.10.005

Gymnophallus are probably the most common (for review see: Laucker, 1985; Galaktionov, 1996) although it is worth noting that the taxonomy of the parasites is by no means fully worked out (see e.g. Galaktionov and Skirnisson, 2002). A single bird species, or indeed a single individual may host a range of trematode parasites (Skirnisson and Jonsson, 1996), and the reverse is also true, with trematode species like *Renicola* being found across a wide variety of bird hosts, including alien avifauna in zoos, which the parasite could certainly never have encountered before (Stunkard, 1964). Galaktionov and Skirnisson (2002) considered that the parasite distribution was governed by the local occurrence and abundance of final bird hosts, but they did suggest also a link between the climatic conditions and the parasite community.

Belopolskaya (1952), Galaktionov (1996) and, more recently, Barbosa and Palacios (2009) have all suggested that the parasite burden (including trematodes) of birds was related to their feeding habits, with generalized feeders (e.g. gulls) having more parasites. However, the latter failed to detect any geographical pattern in any of the endoparasite distribution, considering it rather to reflect the intensity of investigation, but they did note that some few studies had reported negative findings.

Thieltges and Reise (2007) reported spatial heterogeneity in the distribution of trematode parasite infections in the bivalve *Cerastoderma edule* over the total sample as well as within and among 15 sites over 50 km in the mudflats of the Wadden sea. Their analyses indicated that the density of the first intermediate upstream hosts (*Hydrobia ulvae* and *Littorina littorea*) was the strongest predictor for infection intensity, but, of the other factors considered only the size (positive correlation) and density (negative correlation) of the host were important. However, different patterns have been shown for different types of host. Theiltges et al. (2009a,b) demonstrated a difference between parasites with crustacean hosts compared to bivalve hosts, with geographical scale also a factor, in that, for the latter, environmental factors may be more important at larger (>100 km) scales.

Sinderman (1990) and Mouritsen and Poulin (2002) considered that the trematodes were the most common metazoan parasites of intertidal invertebrates and it has been shown that, especially under conditions of stress, that growth of the blue mussel (*Mytilus edulis*) was lower in parasitized individuals (Thieltges, 2006). Thus the multicomponent "mussel/parasite/bird" system represents an important aspect of the biology of coastal communities and plays a crucial role in coastal environments throughout the Palaearctic. This study has been carried out at sites spread over a wide geographical scale (Irish Sea, North Atlantic, Norwegian Sea, Barents Sea, White Sea, Sea of Okhotsk), each with its specific environmental factors, bird population composition and parasite fauna. The extensive geographical range of the study will provide information to delineate the complex interactions within the mussel/parasite/bird system.

2. Materials and methods

The geographical spread of the locations sampled is shown in Fig. 1, with some locations representing a number of different intertidal mussel populations sampled. These populations are set out in Table 1, along with the number of mussels analysed over the course of the study.

For each mussel population, the following parameters were noted:

- Presence of bird predators of mussels;
- Other molluscan secondary hosts;
- Habitat;
- Mussel population characteristics.

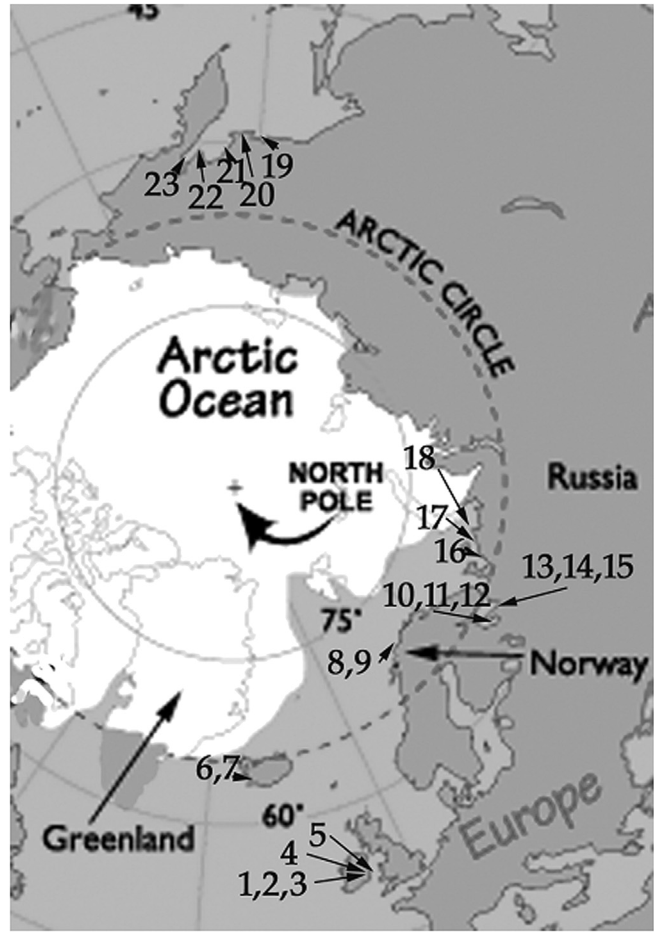

Fig. 1. Geographical distribution of sites (numbered) sampled: see Table 1 for names and locations. White shading indicates area with winter ice cover.

Table 1
Geographical location (Fig. 1) and mussel populations sampled, showing coordinates and number of mussels analysed.

Geographical location	Site No.	Mussel population	Lat (°N)	Long (°E)	No. analysed
Ireland	1	Kilbarrack, Dublin	53.38	−6.61	113
	2	Tolka, Dublin	53.36	−6.20	32
	3	Blackrock, Dublin	53.3	−6.17	74
	4	Rogerstown	53.51	−6.13	33
	5	Greenisland, Belfast	54.70	−5.85	66
Iceland	6	Hvalfjµrdur	64.37	21.6	54
	7	Grafarvogur	64.14	21.8	31
Norway	8	Ringvassµy	69.67	19.26	95
	9	Hungeren	69.68	19.06	81
White sea: Kandalaksha Bay	10	Levin Navolok	66.3	33.46	164
	11	Kruglaja inlet	66.34	33.64	174
	12	Kemluda	66.42	33.81	175
White Sea: Onega Bay	13	Kondostrov, Korga	64.23	36.55	141
	14	Bol'shoy Zhuzhmuy Island, Luda	64.65	34.60	137
	15	Maly Zhuzhmuy Island	64.63	35.64	143
Barents Sea	16	Yarnishnaja inlet	69.09	36.05	138
	17	Cape Kanin	68.54	43.47	156
Pechora Sea	18	Dolgy Island North-west, Korga	69.29	58.85	109
Sea of Okhotsk	19	Nagaeva Bay, Marchekan	59.54	150.78	121
	20	Cape N'uklia	59.54	151.13	325
	21	Ola Lagoon	59.56	151.35	219
	22	Vnutrennia Bay	59.53	154.38	104
	23	Tajgonos peninsula (Impoveem bay)	61.29	159.93	74