Parasites as potential biological tags for capelin (*Mallotus villosus*) in the St. Lawrence estuary and gulf

J. Richard Arthur and Elaine Albert

Fisheries Science Branch
Department of Fisheries and Oceans
Maurice Lamontagne Institute
P.O. Box 1000
Mont-Joli (Québec)
G5H 3Z4

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PARASITES AS POTENTIAL BIOLOGICAL TAGS FOR CAPELIN (*Mallotus villosus*) IN THE ST. LAWRENCE ESTUARY AND GULF

J. Richard Arthur and Elaine Albert

Fisheries Science Branch
Department of Fisheries and Oceans
Maurice Lamontagne Institute
P.O. Box 1000
Mont-Joli, Québec
G5H 3Z4

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ABSTRACT

Arthur, J.R., and E. Albert. 1996. Parasites as potential biological tags for capelin (*Mallotus villosus*) in the St. Lawrence estuary and gulf. Can. Tech. Rep. Fish. Aquat. Sci. 2112:IV+9p.

Parasitological data were analysed in an attempt to separate collections of male capelin (*Mallotus villosus*) caught on the spawning grounds at five localities in the estuary of the St. Lawrence River and the Gulf of St. Lawrence, Canada, in 1994. Only three of the 21 parasite taxa infecting Gulf capelin were considered potentially useful as stock discriminators: the protistan *Microsporidium* sp. and the larval nematodes *Anisakis simplex* and Contracaecinea gen. sp. The results of nonparametric discriminant analyses showed a very low percentage of correct classification, with only 24% (30/125) of the fish being assigned to their true category. No pattern of misclassification was observed to support the regrouping of collections by eastern and western origin. Parasitological data thus provide no evidence to support the concept of separate stocks of capelin in the St. Lawrence estuary and gulf.

RÉSUMÉ

Arthur, J.R., and E. Albert. 1996. Parasites as potential biological tags for capelin (*Mallotus villosus*) in the St. Lawrence estuary and gulf. Can. Tech. Rep. Fish. Aquat. Sci. 2112:IV+9p.

L'analyse des données sur les parasites de capelans mâles échantillonnés à cinq sites de frai dans l'estuaire et le golfe du Saint-Laurent en 1994, a été réalisée afin de tenter de séparer les stocks. Seulement trois des 21 taxons de parasites infectant ces capelans ont été considérés potentiellement utiles comme marqueurs biologiques. Il s'agit du protiste *Microsporidium* sp. et des nématodes larvaires *Anisakis simplex* et Contracaecinea gen. sp. Les résultats d'analyses discriminantes non paramétriques ont démontré un pourcentage très faible de classification correcte. Seulement 24% (30/125) des poissons ont été assignés à leur catégorie d'origine. Les poissons mal classifiés ne semblent suivre aucun patron de classification pouvant appuyer un regroupement des collections provenant de la partie est et ouest du golfe. Aucune évidence de la présence de stocks séparés de capelans dans l'estuaire et le golfe du Saint-Laurent ne peut donc être tirée de ces données.

INTRODUCTION

The capelin (*Mallotus villosus*) is a small cold-water pelagic fish of the family Osmeridae (smelts) having circumpolar distribution and occurring in the northern parts of the North Atlantic and North Pacific oceans (Scott and Scott 1988). With the decline of a number of traditional fisheries in the Gulf of St. Lawrence, the commercial importance of the capelin has increased (Anon. 1994). A roe fishery in the northern Gulf (NAFO Divisions 4RS) for the Japanese market and a smaller fishery in the southern Gulf (Division 4T) for animal consumption accounted for a total catch of more than 10,000 t in 1993 (Anon. 1994).

For fishery management purposes, capelin in the estuary of the St. Lawrence River and Gulf of St. Lawrence are managed as three separate stocks (NAFO divisions 4R, 4S, and 4T). However, the stock structure in this region remains unclear. Based on differences in time of spawning, Parent and Brunel (1976) defined four spawning regions in the lower estuary and Gulf of St. Lawrence. Results of morphometric and meristic analyses have been ambiguous. Sharp et al. (1978) found no evidence for discrete stocks using meristic characters, but reported a strong separation between capelin from six Gulf localities using morphometric data. However, Lambert and Bernier (1989), in a similar study using the same morphometric characters, were unable to discriminate among collections of Gulf capelin. Most recently, Roby et al. (1991) found that while analysis of conventional morphometric data gave inconclusive results, analyses of enzyme electrophoretic patterns and truss morphometric data suggested that collections of fish from the Gulf could be separated into two major groups, one corresponding to the eastern region and the other to the western region, with high gene flow between them.

Although parasites have often provided information useful to fisheries management on the stock structure and migrations of marine fishes (see Lester 1990, Moser 1991, Williams et al. 1992), their analysis has not been widely applied to capelin. Kennedy (1979) attempted to use the cestode *Eubothrium parvum* Nybelin, 1922 to separate stocks of capelin in the Barents Sea, while Pálsson (1986) investigated the use of helminths as possible discriminators for stocks occurring in the northwest Atlantic Ocean. In the present study, we determine whether analysis of parasitological data provides evidence for separate stocks of capelin in the Gulf of St. Lawrence.

MATERIALS AND METHODS

A total of 125 male capelin were collected by trap-net, dip-net, or purse seine on the spawning grounds from May to July 1994 at five localities within the estuary of the St. Lawrence River and the Gulf of St. Lawrence (Figure 1). Fish were individually bagged and deep frozen immediately after capture for later laboratory examination. Host data are summarised in Table 1.

Complete examinations for protistan and metazoan parasites were performed using standard parasitological methods as described in Arthur et al. (1995). The techniques used were effective for the recovery of all parasites except external protistans, which are typically destroyed by freezing, and

hematozoans. A full listing of all 21 parasite taxa identified during this study, as well as their prevalences and intensities of infection by locality, is given by Arthur et al. (1995), who also provide a discussion of the taxonomic problems encountered in their identification.

STATISTICAL ANALYSES

Parasites for use as possible biological tags for capelin stock identification were chosen using the criteria given in Arthur and Albert (1993). These are: (1) that infections be of relative long duration (years rather than months), (2) that no parasite reproduction occur on or in the host, and (3) that the parasite be relatively abundant in at least one of the collections examined. Only seven of the 21 parasites encountered in capelin (Arthur et al. 1995) meet criteria (1) and (2): these include one cestode plerocercoid (Pseudophyllidea gen. sp.) and six larval nematodes [*Anisakis simplex* (Rudolphi, 1809); Contracaecinea gen. sp.; *Hysterothylacium aduncum* (Rudolphi, 1802); *Pseudoterranova decipiens* (Krabbe, 1878); Spirurida gen. sp.; and Nematoda gen. sp.]. Of these, only *A. simplex* and Contracaecinea gen. sp. were abundant enough in at least one of the five collections to be included in analyses. A third species, the protistan *Microsporidium* sp., was also included due to its relatively high prevalence in capelin and the probable long duration of infections. However, this species must be used with caution, as the actual duration of infections and other aspects of its life cycle, including the possibility that one sporoplasm (the infective agent) may produce more than one xenoma ("cyst"), are unknown (see Lom and Dyková 1992).

Summary statistics for the three parasite taxa chosen as potential biological tags are given in Table 2 for all collections. Data given include prevalence (% infected) and intensity of infection (number of parasites per infected fish), expressed as the mean $\pm$ the standard deviation followed by the range, as recommended by Margolis et al. (1982).

Nonparametric discriminant analysis (SAS version 6; SAS Institute, Inc. 1989) using the normal kernel density estimation with an R value of 1.0 was applied to investigate the usefulness of parasites in separating host collections (Arthur and Albert 1993). Cross validation was used to estimate the accuracy of classification rules. Results are presented as a matrix showing the numbers and percentages of fish correctly and incorrectly classified for the five areas sampled.

RESULTS

Results of nonparametric discriminant analysis are given in Table 3. The overall percentage of correct classification obtained was only 24.0% (30 of 125 fish correctly classified), while the percentage of correct classification for individual collections ranged from a high of only 72.0% (Sainte-Thérèse-de-Gaspé) to a low of 0.0% (Havre-Saint-Pierre and Sept-Îles). Examination of misclassifications revealed no pattern of misassignment of collections, indicating that subsequent regrouping of collections by eastern (Havre-Saint-Pierre, Blanc-Sablon, and Sainte-Thérèse-de-Gaspé) and western (Isle-Verte and Sept-Îles) origin, as was suggested by the analysis of Roby et al. (1991), or by other geographic subdivisions, was not possible.

DISCUSSION

The results of this limited study do not provide evidence for the presence of separate stocks of capelin in the St. Lawrence estuary and gulf. This finding may be due to several aspects of this fish's biology. Capelin are relatively short-lived, individuals of over four years of age being uncommon in the Gulf of St. Lawrence (Lambert and Bernier 1989). This short life span undoubtedly limits the numbers of long-lived (age-accumulated) parasites found in capelin. Capelin also have a rather narrow diet. In the Gulf of St. Lawrence, they feed mainly on planktonic crustaceans, with calanoid copepods and euphausiids being particularly important food items (Able et al. 1976). This feeding selectivity results in infection by a limited number of heteroxenous parasites (Arthur et al. 1995). Finally, capelin are pelagic and probably migrate extensively within the Gulf for feeding and reproduction (Bailey et al. 1977). Such migrations would tend to obscure any localised differences in transmission rates.

Pálsson (1986) suggested that capelin from the Gulf of St. Lawrence could be separated from those occurring to the north, northeast, and east of Newfoundland based on the absence of the intestinal digenean *Lecithaster gibbosus* (Rudolphi, 1802) and the possession of a greater abundance of larvae of *Hysterothylacium aduncum* than of larvae of *Contracaecum* sp. Our collections are not strictly comparable to his, due both to temporal and spatial differences: Pálsson's (1986) collections from the Gulf of St. Lawrence were taken in 1980 from the west coast of Newfoundland and from the Baie des Chaleurs, Gaspé Peninsula. However, it is noteworthy that *L. gibbosus*, a common parasite of many species of fishes in the Gulf, was found in low prevalence in three of the five collections of capelin examined by us (Arthur et al. 1995). In addition, in contrast to Pálsson's findings, larval Contracaecinea were much more common and abundant in all of our collections than were larval *H. aduncum* (Table 1 of Arthur et al. 1995). While infection rates for larval *H. aduncum* were somewhat higher in Pálsson's study than in ours (prevalence of 15-21%, mean intensity of 1.2-1.3 vs. prevalence of 0.0-8.0%, mean intensity of 1.0), those for larval Contracaecinea were much lower (prevalence of 7-15%, mean intensity of 1.0-1.3 vs. prevalence of 60-92%; mean intensity of 1.3-2.7). The latter difference probably reflects a general increase in abundance of larval Contracaecinea in Gulf fishes, as noted for Atlantic cod (*Gadus morhua*) and American plaice (*Hippoglossoides platessoides)* by Boily and Marcogliese (1995). These authors consider this increase to be due to increases in the populations of grey seals (*Halichoerus grypus*) and harp seals (*Phoca groenlandica*) in the Gulf of St. Lawrence.

Some adult helminths of capelin's digestive tract, such as *Brachyphallus crenatus* (Rudolphi, 1802) and *Lecithaster gibbosus,* infect capelin with greatly varying abundance (Pálsson 1986, Arthur et al. 1995). Although these parasites are too short-lived to be useful for stock discrimination studies, they may prove valuable for investigating other aspects of capelin biology, such as determining the movements of capelin within the Gulf of St. Lawrence and the patterns of recruitment of juveniles to adult populations.

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Table 1. Data summary for collections of capelin.

Locality	Date	n	Total length[a] (mm)	Weight[a] (g)
Isle-Verte	13-05-94 and 01-06-94	25	155.5 ± 5.3 (146-163)	20.6 ± 2.2 (16.2-24.3)
Sept-Îles	03-06-94 and 08-06-94	25	154.5 ± 4.6 (145-161)	21.1 ± 2.1 (16.9-24.8)
Havre-Saint-Pierre	08-06-94 and 14-06-94	25	155.5 ± 4.5 (147-164)	20.8 ± 1.9 (16.7-24.7)
Blanc-Sablon	30-06-94 and 05-07-94	25	157.0 ± 6.1 (144-168)	23.5 ± 3.1 (17.3-29.2)
Sainte-Thérèse-de-Gaspé	16-06-94	25	149.7 ± 4.3 (141-158)	19.6 ± 2.0 (16.2-24.3)

[a] Total length and weight are given as mean ± SD followed by the range in parentheses.

Table 2. Summary of tag parasites of capelin (*Mallotus villosus*) in the St. Lawrence estuary and gulf.

Locality		*Microsporidium* sp.		*Anisakis simplex* larva		Contracaecinea gen. sp. larva	
	n	P (%)[a]	Intensity[b]	P (%)	Intensity	P (%)	Intensity
Isle-Verte	25	16.0	1.8±1.5 (1-4)	28.0	1.0±0.0 (1)	80.0	2.6±1.3 (1-6)
Sept-Îles	25	36.0	1.7±1.1 (1-4)	12.0	1.7±1.2 (1-3)	72.0	2.7±1.7 (1-7)
Havre-Saint-Pierre	25	16.0	1.0±0.0 (1)	24.0	1.0±0.4 (1-2)	72.0	2.0±1.0 (1-5)
Blanc-Sablon	25	16.0	1.8±0.5 (1-2)	12.0	1.0±0.0 (1)	92.0	2.3±1.7 (1-8)
Sainte-Thérèse-de-Gaspé	25	24.0	1.2±0.4 (1-2)	12.0	1.3±0.6 (1-2)	60.0	1.3±0.6 (1-3)

[a]P(%) = prevalence (percent infected).
[b]Intensities are given as the mean ± SD followed by the range in parentheses.

Table 3. Results of nonparametric discriminant function analysis for the separation of capelin from five localities in the St. Lawrence estuary and gulf using parasite data. Overall correct classification = 24.0% (30/125).

TRUE CATEGORY	ASSIGNED CATEGORY				
	BSA[a]	STG	HSP	IVE	SIL
BSA	11[b] 44.0%	12 48.0%	1 4.0%	0	1 4.0%
STG	4 16.0%	18 72.0%	1 4.0%	2 8.0%	0
HSP	9 39.0%	11 44.0%	0	5 20.0%	0
IVE	13 52.0%	9 36.0%	2 8.0%	1 4.0%	0
SIL	11 44.0%	13 52.0%	1 4.0%	0	0

[a]BSA = Blanc-Sablon, STG = Sainte-Thérèse-de-Gaspé, HSP = Havre-Saint-Pierre, IVE = Isle-Verte, SIL = Sept-Îles.
[b]Indicates number of fish classified to category followed by percentage.

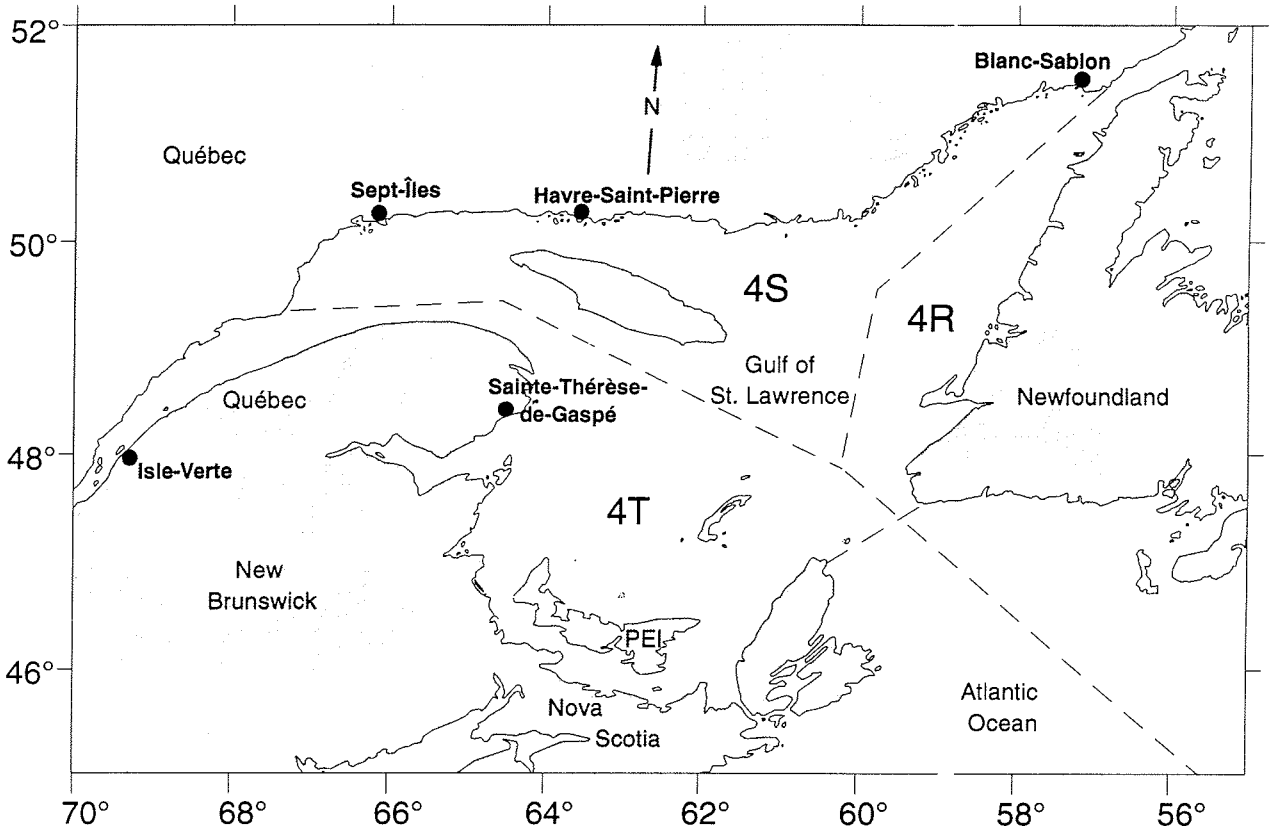

Figure 1. Map of the St. Lawrence estuary and gulf showing collection localities.