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Ecological and Geographical Description of Parasite Fauna of Acadian Redfish *Sebastes fasciatus* Storer

by

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ABSTRACT

By results from parasitological studies on Acadian redfish *Sebastes fasciatus* Storer from different areas along the coast of Canada the ecological and geographical description of this fish parasite fauna is given. Comparative analysis has indicated a significant geographical variability in composition of parasite fauna of Acadian redfish by habitat areas. An existence of seven isolated poorly-intermingling groupings of *S. fasciatus* in the investigated area of its distribution is hypothesized. Thus, the most original is the parasite fauna of redfish from the Gulf of St. Lawrence and to a less extent that on the Flemish Cap Bank. In our opinion, Div. 3N and 3O are inhabited by a single grouping of *S. fasciatus*, poorly- intermingling with the neighbouring ones. There are some grounds to suggest that Div. 2J, 3K and 3L are also inhabited by *S. fasciatus* groupings of marked extent isolation. On the contrary, a significant similarity noted in the parasite fauna of redfish on the Nova Scotia Shelf and St.-Pierre Bank may indicate the integrity of the *S. fasciatus* grouping in these areas and does not exclude a possible penetration of its specimens into the Gulf of St. Lawrence.

INTRODUCTION

Judging by results from the investigations and data analysis undertaken by PINRO, one can suggest that the major object of redfish fishery carried out on the Atlantic Shelf and on the North America slope is Acadian redfish (*Sebastes fasciatus*).

S.fasciatus, as a subspecies of *S. marinus s.* l., typical of the Atlantic coast of the North America, was noted by Taning (1949), Trout (1961), Kotthaus (1961) and later defined by V. V. Barsukov and G. P. Zakharov (Barsukov, 1972; Barsukov and Zakharov, 1972) as a specific species *Sebastes fasciatus* Storer. In this connection, the first data on this species parasites appeared only in the 80s of the 20th century. Thus, some Canadian researchers (Bourgeois, Ni 1983) presented results of studying an incidence of 12 species of metazoan parasites found in *S. fasciatus* from specific areas of the continental slope along the coast of Canada. Information about helminths (13 species) of *S. fasciatus* from the Nova Scotia Shelf area we can find in J. S. Scott (1988). R. A. Khan and co-authors (1986) indicate two species of *Myxosporea* found in redfish off the continental shelf of the Northwest Atlantic. Some other authors (Moran *et al*., 1996) investigated the parasite fauna (21 species) of *S. fasciatus* from the Gulf of St. Lawrence.

As far as parasites are indicators of ecological peculiarities of their host, the results from analysis of the *S. fasciatus* parasite fauna allows to suggest a spatial structure of this species over the investigated part of its area of distribution. A positive experience of applying the data on parasitology was accumulated in recent decades when studying intraspecific structure of redfish from *Sebastes* genus. Such data and other natural markers were used for isolating

local groupings of redfish in the Northwest Atlantic (Sindermann, 1961; Yanulov, 1960; Kabata, 1963) and intraspecific differentiation of *Sebastes mentella* over most area of its distribution (Bakay, 1988, 1989, 1999, 2000, 2001).

MATERIAL AND METHODS

Data on parasites found in 110 specimens of *S. fasciatus* from bottom trawl catches, taken in different Divisions (Div. 3KLMNO and 2J) (Fig. 1) on the continental slope along the Canadian coast and collected by the authors in May-June 1990 (Table 1), were used as material for the paper presented. Complete parasitological dissection and examination of parasites from different systematic groups were done applying the methods developed by Dogel (1933) and supplemented by his followers (Bykhovskaya-Pavlovskaya, 1985; Donets and Shulman, 1973). Besides the data collected, results from studies on the parasite fauna of *S. fasciatus* gained by other researchers (Bourgeois and Ni, 1983; Khan *et al*., 1986; Scott, 1988; Moran *et al*., 1996) were used. Statistic processing of parasitological data was concluded in determination of the incidence of infestation and prevalence rate. The incidence of infestation is a ratio (a proportion) of the number of fish infested by the parasite to the total amount of fish examined, expressed in per cent. The prevalence rate is the mean number of parasites of this species per 1 fish examined.

Geographical variability in the parasite fauna of *S. fasciatus* was analyzed based on the set theory using the technique suggested by Andreev and Reshetnikov (1977, 1978). Individual specificity ($W_{(Ri\ Rj)}$) of the parasite fauna of redfish in a specific area was judged by inclusions of degree, calculated by the formula:

$$W_{(Ri\ Rj)} = \frac{m(Ri \cap Rj)}{M(Rj)} \times 100\%$$

where: $m(Ri \cap Rj)$ is the number of total species in R_i and R_j areas compared;
$m(R_j)$ is the number of species in R_j area, for which the inclusion degree of the species from R_j area is calculated.

When determining pair- and grouping similarity ($L_{0(Ri\ Rj)}$) of *S. fasciatus* parasite fauna, a degree of similarity was established in the areas studied using the weighted pair-grouping method based on the coefficient of Sørensen-Checkanovsky:

$$L_0\ (Ri\ Rj) = \frac{2m\ (Ri \cap Rj)}{m(Ri) + m(Rj)} \times 100\%,$$

where: $m(Ri \cap Rj)$ is the number of total species in Ri and Rj areas compared;
$m(Ri)$ is the number of species in Ri area;
$m(Rj)$ is the number of species in Rj area.

To illustrate the inclusion- and similarity degrees of the parasite fauna of *S. fasciatus* by area, oriented and non-oriented graphs were respectively plotted, as well as a dendrogram of similarity degree of parasite fauna in redfish from six Divisions.

Distinctions in the incidence of infestation by parasites in all the areas surveyed were checked by statistic significance (P) using chi-square test and Fisher's Exact test.

Sebastes fasciatus was identified according to "Identification of Redfishes (*Sebastes*, Scorpaenidae) in the North Atlantic" (Barsukov *et al*., 1992). The basic diagnostic features were the following: angle of slope of the 3rd and 5th preopercular spines, the number of soft rays in anal fin and degree of isolation of parietal and nuchal ridges.

RESULTS AND DISCUSSION

As a result of the investigations, 16 species of parasites referring to 5 taxonomic groups (orders) were found. Four species, i.e. *Myxidium incurvatum, M.obliquelineolatum, Leptotheca adeli* and *Pseudalataspora*, were noted in the order of *Myxosporea;* the two later are described as the new for science (Bakay and Grudnev, 1998). Of helminths, two species of *Cestoda* (*Bothriocephalus scorpii, Scolex pleuronectis* pl.), four species of *Trematoda* (*Derogenes varicus, Lecithophyllum bothriophoron, Podocotyle reflexa, Anomalotrema koiae*) and three species of *Nematoda (Anisakis simplex l., Contracaecum* sp. *L., Hysterothylacium aduncum)* were found. Among the *Crustacea* revealed there were three species of parasites (copepods *Chondracanthus nodosus, Peniculus clavatus, Sphyrion lumpi*).

With allowance for the literature data (Bourgeois and Ni, 1983; Khan *et al*., 1986; Scott, 1988; Moran *et al*., 1996) the parasite fauna of *S. fasciatus* numbers at present 29 species referring to seven taxonomic groups (orders), i.e. *Coccidiomorpha* – 1, *Myxosporea* – 6, *Cestoda* – 3, *Trematoda* – 10, *Nematoda* – 4, *Acanthocephala* – 1, *Crustacea* – 4 (Table 2). The parasite fauna is dominated by the species having a complicated life cycle - 18 (62.1%), of which *Trematoda* – 10 species (55.5%) are predominant. Among the parasites with a simple life cycle (11 species), 6 species (54.5%) of *Myxosporea* were the most frequent.

At the same time, it should be noted that such parasites as *Eimeriida* gen.sp., *Brachyphallus crenatus, Gonocerca sp., Steganoderma formosum, Echinorhynchus gadi* and *Laphystius morhuanus* are not typical of redfish, since they occur only in 0.3-6.0% of fish and as a rule only in one of the areas mentioned. The occurrence of *Myxidium sphaericum* and *Ceratomyxa macrospora*, indicated by R. Khan and co-authors (1986), is in our opinion doubtful since the spores of these parasites were found by us in none of several hundreds of redfish from three species of *Sebastes* genus analyzed in that Atlantic area (Bakay, 1988; Bakay, 1997; Bakay, 2001). In this case, the real number of parasite species, determining a general overview of the parasite fauna of *S. fasciatus* off the Canadian Shelf, does not at present exceed 21. Among them, the parasites having a complicated life cycle (14 species – 66%) predominated as previously, of which a leading role (seven species – 50%) belongs to *Trematoda*. Of seven species of parasites with a simple life cycle are four species (57%) of *Myxosporea* and three (43%) of *Crustacea*.

However, in our opinion, only 12 species constitute the basis of *S. fasciatus* parasite fauna. To them we refer three species of *Myxosporea (Myxidium incurvatum, M.obliquelineolatum, Pseudalataspora sebastei)*, of which two later are specific for redfish from *Sebastes* genus (Bakay, 1997). Among helminths, two species of *Cestoda* (*Bothriocephalus scorpii* and *Scolex pleuronectis* pl.), four species of *Trematoda (Hemiurus levinseni, Derogenes varicus, Lecithophyllum bothriophoron, Podocotyle reflexa)* and two species of *Nematoda (Anisakis simplex l., Contracaecum* sp.*l.)* can be isolated as major parasites. It is typical that all the helminths mentioned are widely spread (frequently as poly-zonal) species occurring in a fairly wide range of hosts and ingested during feeding mainly on pelagic and bottom planktonic crustaceans. However, *Chondracanthus nodosus (Copepoda),* being one of the major parasites of *S. fasciatus,* in contrast to the mentioned helminths, refers to specific parasites of Atlantic redfishes from *Sebastes* genus (Kazachenko, 1986).

Parasites specific for *S. fasciatus* were not found. However, of the number of parasites (21 species), determining a general overview of its parasite fauna, seven species are specific for the whole *Sebastes* genus of the North Atlantic. Among them, six species, i.e. three species of *Myxosporea* (*Myxidium obliquelineolatum, Leptotheca adeli, Pseudalataspora sebastei)* and three species of *Crustacea* (*Chondracanthus nodosus, Peniculus clavatis, Sphyrion lumpi)*, have a simple life cycle (Kazachenko, 1986; Bakay, 1989; Bakay, 1997). The seventh specific parasite is *Anomalotrema koiae* (*Trmatoda*), described by Gibson and Bray (1984) in three species of redfish from *Sebastes* genus of the North Atlantic.

Results from analysis for composition of the *S. fasciatus* parasite fauna indicate that on the whole it is typical of fish plankton-eaters. This is confirmed by availability of the helminths traditional for redfish, i.e. *Bothriocephalus scorpii* and *Scolex pleuronectis* pl. *(Cestoda*), *Hemiurus levinseni, Derogenes varicus, Lecithophyllum bothriophoron* and *Podocotyle reflexa (Trematoda), Anisakis simplex l*. and *Contracaecum* sp.*l.* (*Nematoda)*, as well as rare helminths obtaining by fish when feeding on planktonic invertebrates. In this case, an accumulation of parasites of some species (for example, *Nematoda)* probably occurs, that results in an enhanced intensity of infestation by them.

Among the factors determining a formation of most part of the *S. fasciatus* parasite fauna bulk (eight species of helminths fauna) the leading is ecotrophic one. Along with this, the infestation by parasites with a simple life cycle of development (*Myxosporea, Crustacea)*, is known not to be linked with feeding.

According to a vertical zonal distribution of parasites in fish of the North Atlantic (Zubchenko 1993), the parasite fauna of *S. fasciatus* is mainly represented by two complexes. The first complex includes mesopelagic species. Parasites constituting the parasite fauna base of *S. fasciatus* (*Myxidium incurvatum, M.obliquelineolatum, Pseudalataspora sebastei, Bothriocephalus scorpii, Lecithophyllum bothriophoron, Chondracanthus nodosus)*, as well as rare species describing a general overview of the *S. fasciatus* parasite fauna (*Leptotheca adeli, Peniculus clavatus, Sphyrion lumpi*), also refer to it. This complex of parasites is mainly represented in *S. fasciatus* by the species with a simple life cycle of development. The second complex includes poly-zonal species of parasites having mainly a complicated life cycle and being common for *S. fasciatus* (*Scolex pleuronectis pl., Derogenes varicus, Hemiurus levinseni, Anisakis simplex l.*), as well as those occurring rarely (*Grillotia* sp.*l., Lecithaster gibbosus, Hysterothylacium aduncum, Pseudoterranova decipiens l., Echinorhynchus gadi*). Epicontinental (*Brachyphallus crenatus)* and mesobenthonic (*Myxidium sphaericum, Podocotyle reflexa* and *Anomalotrema koiae*) complexes are represented by single species. No parasites referring to other complexes, i.e. epipelagic, bathybenthonic and bathypelagic species, were found by us and other researchers in *S. fasciatus.*

Analysis of ways of formation of the *S. fasciatus* parasite fauna indicates that it was formed by boreal (boreal-arctic and amphiboreal) species.

By the results of our investigations and available literature data the parasite fauna of *S. fasciatus* was represented for nine areas of the Northwest Atlantic covering a considerable part of distribution area of this species (Table 2). However, none of the areas has showed a presence of all the parasites known, that is undoubtedly accounted for geographical variability in the parasite fauna composition. In each area it consists of most or all of the species constituting the basis of the parasite fauna supplemented with rare spotting of other species of parasites.

To analyze the geographical variability in the redfish parasite fauna, methods of set theory were chosen, which were successfully used by Andreev and Reshetnikov (1977, 1978) during the investigations to classify *Coregonidae* family. Applying the technique of the analysis suggested by the authors mentioned, we have established individual and group specificity of composition of parasite in *S. fasciatus* by habitat areas and determined their pair- and group similarity. Following an appropriate processing of the redfish parasite fauna composition (Table 3), there were obtained data illustrating the inclusion degree of parasite fauna by area (Table 4, Fig. 2), degree of similarity (Table 5, Fig. 3) and dendrogram of similarity in the parasite fauna composition of *S. fasciatus* by habitat area was plotted (Fig .4). The number of areas isolated for analysing the geographical variability was restricted by six, since only maximum and equal number of systematic groups of parasites was examined in them (Table 2). For convenience of graphic depiction in figures, the areas of investigations are designated as follows: 1 – Div. 3K, 2 – Div. 3L, 3 – Div. 3M, 4 – Div. 3), 5 – Div. 3N, 6 – the Gulf of St. Lawrence (Div. 4R-T).

When considering individual specificity of habitat areas of redfish by composition of its parasite fauna relatively each other it should be necessary to note the highest isolation in Subareas 6 and 3. Thus, *Eimeriida gen.*sp., *Brachyphallus crenatus, Gonocerca* sp., *Opecoelidae* gen.sp., *Pseudoterranova decipiens l., Laphystiusmorhuanus* (Moran *et al*., 1996) were found only in Subarea 6 (the Gulf of St. Lawrence) and *Leptotheca adeli, Scolex pleuronectis* pl., *Lecithophyllum bothriophoron,* typical of the parasite fauna of *S. fasciatus* from most areas, were found in Subarea 3 (Flemish Cap Bank) neither by us nor by other researchers (Bourgeois and Ni, 1983). The most "trivial" parasite fauna of *S. fasciatus* was marked in Subarea 1, since 100% of the parasites found there refer to a list of the parasites from Subarea 2 and 92% - to the parasite fauna of *S. fasciatus* from Subareas 4 and 5. The closest have occurred to be Subareas 5 and 4, having a mutual inclusion of parasite fauna compositions by 100-88% (Table 4, Fig. 2).

By similarity of the parasite fauna (L_0) the closest are also Subareas 4 and 5 (similarity degree L_0 = 94%) having, as mentioned above, maximum mutual inclusion of the parasite fauna compositions. The least similarity between other Subareas possesses the parasite fauna of redfish from the Gulf of St. Lawrence (L_0 = 48-63%) and Flemish Cap Bank (L_0 = 63-83%), having as known the least relationship (by significance of inclusion degree of the parasite fauna) between other Subareas (Table 5, Fig. 3).

By results from the analysis of pair- and group similarity, a dendrogram of similarity in composition of the parasite fauna of *S. fasciatus* was plotted for six Subareas of the Northwest Atlantic (Fig. 4), confirming the highest closeness of compositions of the parasite fauna of redfish from Subareas 4 and 5 (L_0 = 94%), Subareas 1 and 2 (L_0 = 86%) and the highest isolation of the parasite fauna of *S. fasciatus* from Subarea 6 (L_0 = 57,5%) and Subarea 3 (L_0 = 79%).

Thus, the analysis of geographical variability in the *S. fasciatus* parasite fauna has indicated that against the background of relatively poor, outwardly uniform and not fairly original composition there is an internal structure uniting all the areas together which is called by us "a core" of the parasite fauna. Meanwhile, an attempt was undertaken to estimate a degree of similarity or difference in compositions of redfish parasite fauna in different parts of area of distribution by availability (or a lack) of specific species of parasites, that can be used for a subsequent studying of the intraspecific structure of *S. fasciatus*.

Data from literature and our observations show that of three known species of redfish from *Sebastes* genus mainly *S. fasciatus* extrudes larvae in the area of the Grand Newfoundland Bank in April-July. Thus, by the results from PINRO investigations, this season in 1986 did not reveal any females of *S. mentella* with the signs of terminated, commenced or forthcoming extrusion, and 94-100% of females were immature at all (Barsukov *et al*., 1990). These authors also point out that *S. fasciatus* (95-99%) were predominant in redfish catches taken on the southern slopes of the Grand Newfoundland Bank, a proportion of *S. mentella* (44-46%) was increasing in the northern Divisions (3L, 3K) and *S. mentella* were preponderant only on Flemish Cap Bank. This is confirmed by the results from the ichthyoplankton surveys for 1960-1967 (Bainbridge and Cooper, 1971), according to which a proportion of larval *S. fasciatus*, characterising by availability of sub-caudal melanophores (Templeman, 1980), constituted 81-90% of the total amount of larval *Sebastes* in the northern Divisions (3L, 3K, 2J) in May-June. Domination of *Sebastes* larvae with sub-caudal melanophores (90%) here in July indicates a significant predominance of *S. fasciatus* in the area of the Nova Scotia Shelf and in the Gulf of Maine (Bainbridge and Cooper, 1971).

In connection with the mentioned above, mass extrusion of *S. fasciatus* larvae over a vast area from the southern Labrador to the Nova Scotia Shelf and Flemish Cap Bank suggests an existence of several relatively isolated groupings of this species of redfish similar to those in *S. marinus* and *S. mentella* in the Northwest Atlantic (Yanulov, 1960, 1962; Sindermann, 1961, 1983; Bakay, 2001). However, it should be noted that the conclusions have been done by the first two researchers probably before studying the *S. fasciatus* and *S. mentella* separately.

Peculiarities of the current system in this region of the Atlantic contribute to a formation of several poorly intermingling groupings of *S. fasciatus* in the area of distribution. Thus, as is customary, the larvae and pelagic juveniles of *S. fasciatus* are not subject to extent transport by strong currents (as it occurs in *S. mentella* and *S. marinus* in the Northeast Atlantic), but find themselves mainly in quasi-stationary gyres typical of the Atlantic shelf zone of North America (Litvinenko, 1981). Geographical originality of the area and bottom relief are known to serve as favourable factors contributing to isolation of fish groupings. At the coast of Canada they are pronounced in availability of bays and banks (shallows) separated by relatively deep waters.

By results from the analysis of available parasitologic data (Table 2) (besides those used in the mathematical analysis of the geographical variability in parasite fauna) (Table 3) one may suggest that seven groupings of *S. fasciatus* at least, with a different rate of isolation between them, exist in the area investigated. In our opinion, as it was mentioned earlier, the most isolated groupings of *S. fasciatus* inhabit the Gulf of St.Lawrence and Flemish Cap Bank.

The first is characterised by the largest variety of parasite fauna (21 species), of which six species occurred only in that area (Table 2). Moreover, parasites of five species (*Myxidium obliquelineolatum, M.sphaericum, Grillotia* sp. *L., Echinorhynchus gadi, Peniculus clavatus*), occurred in other areas, were not found in Acadian redfish from the Gulf of St.Lawrence. At the same time, the rate of infestation by parasites from nine species common for other areas (*M.incurvatum, Scolex pleuronectis, Derogenes varicus, Lecithaster gibbosus, Lecithophyllum bothriophoron, Podocotyle reflexa, Anisakis simplex l., Hysterothylacium aduncum, Chondracanthus nodosus)* notably differs (statistical significance $P<0.05$). However, availability of helminths, common for different areas, in *S. fasciatus* from the Gulf of St. Lawrence and adjacent areas (St. Pierre Bank, Nova Scotia Shelf, Div. 3K and 2J) indicates that restricted migrations to the Gulf of St. Lawrence are possible between these groupings of redfish. This is confirmed by a lack of *Crustacea* and some helminths in *S. fasciatus* from adjacent waters.

The Flemish Cap Bank is separated from the Grand Newfoundland Bank by the deep Flemish Pass Strait having special hydrographic regime. The redfish larval drift off the Bank, mainly to its center, is conditioned by a cyclonic current acting here (Serebryakov, 1962). These conditions serve as a relative isolating barrier for penetrating the redfish specimens from neighboring groupings of the Grand Newfoundland Bank (Div. 3N, 3O, 3L). This is proved by the following peculiarities of *S.fasciatus* parasite fauna of Flemish Cap Bank: a) a lack of *Leptotheca adeli* and *Myxidium sphaericum (Myxosporea), Scolex pleuronectis* (larvae of *Cestoda* from a mixed group of *Tetraphyllidea*), *Lecithophyllum bothriophoron (Trematoda)* typical of the redfish on the Grand Newfoundland Bank; b) higher rate of infestation (statistical significance P<0, 05) by *Bothriocephalus scorpii (Cestoda), Anisakis simplex l.* and *Contracaecum* sp.*l. (Nematoda*); c) lower occurrence of some species of *Myxosporea* (*Myxidium obliquelineolatum, Pseudalataspora sebastei*), copepods *Chondracanthus nodosus* (P<0.05) and others. As can be seen in Table 2, differences between the parasite fauna of Acadian redfish on the Flemish Cap Bank and that of the redfish from Div. 3NO are less significant compared to the other areas that indicates a possible partial penetration of *S. fasciatus* from the Flemish Cap Bank to the southern slopes of the Grand Newfoundland Bank.

On the contrary, the parasite fauna of Acadian redfish from Div. 3N and 3O is characterized by a significant degree of similarity (statistical significance of differences - P>0.05). Thus, according to available data, of 17 parasite species found in redfish from these Divisions 15 species occurred in both Divisions (Table 2), and a rate of infestation for 15 of them has no reliable differences (P>0.05). In our opinion, the peculiarities mentioned indicate an integrity of *S. fasciatus* grouping inhabiting the southern slopes of the Grand Newfoundland Bank.

Significant isolation of redfish inhabiting the southern slopes of the Grand Newfoundland Bank (Div. 3N and 3O) from redfish in Div.3L is in our opinion conditioned by peculiarities of the hydrographic regime in these divisions and probably small depths on the central Grand Newfoundland Bank. This isolation is confirmed by differences in the parasite fauna which are expressed for *S. fasciatus* from Div. 3NO by much lower infestation by all species of *Myxosporea*, larvae of *Cestoda* from a mixed group of *Tetraphyllidea (Scolex pleuronectis*), trematodes *Derogenes varicus* and *Podocotyle reflexa*. *Bothiocephalus scorpii (Cestoda*), *Echinorhynchus gadi (Acanthocephala*) and *Sphyrion lumpi (Crustacea*) were not found in Div. 3L; no *Lecithaster gibbosus* and *Anomalotrema koiae (Trmatoda*) were found on the southern slopes of the Grand Newfoundland Bank (Table 2).

Isolated groupings of *S. fasciatus* probably also inhabit Div. 2J, 3K and 3L; however, their specimens do not migrate far. Parasitological data that prove this include different rates of infestation (statistical significance P<0.05) by common species parasites (3 species of *Myxosporea*, larvae of *Scolex pleuronectis*, trematodes *Derogenes varicus* and *Podocotyle reflexa*), as well as a lack or availability of other species of trematodes *Hemiurus levinseni, Lecithaster gibbosus, Lecithophyllum bothriophoron, Anomalotrema koiae*, nematodes *Anisakis simplex l.* and two species of *Crustacea (Chondracantus nodosus, Peniculus clavatus*) in one of these Divisions (Table 2).

The Nova Scotia Shelf, including the Gulf of Maine (Div. 4V-X), and St. Pierre Bank (Subdiv. 3Ps) are in our opinion inhabited by a single grouping of *S. fasciatus.* The data available only on helminths of redfish (Table 2) from these divisions (Bourgeois and Ni, 1983; Scott, 1988) are much similar. Thus, of 13 species of parasites, 8 have occurred to be common for these Divisions, and the rates of infestation by six of them were fairly close (statistic significance P>0.05). Notable distinctions (P<0.05) were found for the rate of infestation by two species of parasites only (*Podocotyle reflexa, Anisakis simplex l.).* Besides, prevalence of parasites from five species, occurred in redfish on the Nova Scotia Shelf, but not revealed in redfish on the St. Pierre Bank, made up only 0.6-6.0%, i.e. these differences are statistically unreliable (P>0.05).

A lack of *Crustacea* and larvae of *Scolex pleuronectis* in redfish from this grouping, as well as notable distinctions (statistical significance P<0.05) in the rate of infestation by helminths of common species (*Derogenes varicus, Lecithophyllum bothriophoron, Podocotyle reflexa),* give grounds to suggest its isolation from Acadian redfish grouping inhabiting the southern slopes of the Grand Newfoundland Bank.

CONCLUSIONS

Based on the comparative analysis for significant geographical variability in the parasite fauna composition of *S. fasciatus* inhabiting different habitat areas along the coast of Canada, it was suggested that at least seven isolated, poorly intermingling groupings exist in the area of its distribution. It should be noted that our opinion of the Acadian redfish intraspecific structure much similar to the results obtained by K. P. Yanulov (1962) from isolation of populations and stocks of *Sebastes mentella* Travin inhabiting most of the above-mentioned areas. Probably, such coincidence is mostly accounted for the fact that K. P. Yanulov has studied mixed aggregations of redfish consisting of *S. mentella* and *S. fasciatus* in different proportion depending on a specific area. V. V. Barsukov (1981) also believes that Acadian redfish creates a number of fairly isolated groupings along the Canadian coast, which are in his opinion the populations.

The authors hope that the results presented from the investigations will be useful for a further definition of the status of the isolated groupings and expected boundaries between them.

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Table 1. The sites of *Sebastes fasciatus* sampling for parasitologic examinations in May-June 1990.

Sub-area	Fish examined, spec.	Position		Depth, m
		Long.	Lat.	
3K	20	$49^0$22 N	$51^0$28 W	322
		$49^0$25 N	$50^0$04 W	328
		$50^0$06 N	$52^0$25 W	335
		$51^0$16 N	$51^0$55 W	345
		$50^0$39 N	$53^0$27 W	350
		$50^0$48 N	$53^0$07 W	449
3L	20	$48^0$07 N	$49^0$10 W	257
		$48^0$35 N	$49^0$52 W	290
		$48^0$17 N	$49^0$04 W	432
		$48^0$05 N	$47^0$57 W	500
3M	20	$47^0$22 N	$45^0$50 W	301
		$48^0$00 N	$44^0$49 W	330
		$46^0$54 N	$44^0$06 W	346
		$47^0$57 N	$44^0$38 W	360
		$46^0$31 N	$45^0$49 W	460
3N	20	$42^0$56 N	$49^0$51 W	297
		$42^0$56 N	$50^0$46 W	349
		$43^0$42 N	$49^0$04 W	420
3O	30	$45^0$00 N	$52^0$28 W	100
		$43^0$10 N	$51^0$17 W	290
		$43^0$26 N	$51^0$34 W	410
		$43^0$50 N	$52^0$30 W	480
		$43^0$07 N	$51^0$11 W	510

Table 2. Parasite fauna of *Sebastes fasciatus* from various regions of the Northwest Atlantic

Parasite, sistematic group	Divisions									Statistical significance (P)
	2J[1]	3K[5]	3L[5]	3M[5]	3O[5]	3N[5]	3Ps[1]	4(V-X)[2]	4(R-?)[4]	
COCCIDIOMORPHA										
Eimeriida gen. sp.		-	-	-	-	-			6,0	>0.05
MYXOSPOREA										
Myxidium incurvatum		5,0	20,0	5,0	13,3	5,0			42,0	<0.05
M. obliquelineolatum		5,0	45,0	5,0	13,3	10,0			-	<0.05
M. sphaericum[3]		+	+	-	+	+	+		-	
Ceratomyxa macrospora[3]		+	+	+	+	+	+		32,0	
Leptotheca adeli		10,0	15,0	-	3,3	5,0				>0.05
Pseudalataspora sebastei		35,0	65,0	15,0	20,0	20,0				<0.05
CESTODA										
Bothriocephalus scorpii	-	-	-	45,8[1] 1,1	6,7 0,1	5,0 0,1	1,5 0,015	2,5 0,2	2,0 0,02	<0.05
Grillotia sp. l.	-	-	-	-	-	-	-	5,0 0,2	-	>0.05
Scolex pleuronectis pl.	21,4 0,4	15,0 1,5	54,2[1] 8,8	-	13,3 0,2	10,0 0,1	-	1,9 0,02	22,0 0,3	<0.05
TREMATODA										
Hemiurus levinseni	42,9 0,7	-	-	-	-	-	6,1 0,2	9,5 0,2	10,0 0,2	<0.05

Table 2 (continued)

Parasite, sistematic group	Divisions									Statistical significance (P)
	2J[1]	3K[5]	3L[5]	3M[5]	3O[5]	3N[5]	3Ps[1]	4(V-X)[2]	4(R-?)[4]	
Brachyphallus crenatus	-	-	-	-	-	-	-	-	4,0 0,04	<0.05
Derogenes varicus	64,3 1,2	5,0 0.05	41,7[1] 1,0	10,0 0,1	3,3 0,03	5,0 0.05	15,2 0,2	11,0 0,1	46,0 1,0	<0.05
Gonocerca sp.	-	-	-	-	-	-	-	-	2,0 0,02	>0.05
Lecithaster gibbosus	-	-	8,3[1] 0,2	-	-	-	3,0 0.05	1,9 0.05	12,0 0,3	<0.05
Lecithophyllum bothriophoron	-	-	4,2[1] 0,1	-	25,9[1] 0,5	-	4,5 0,2	1,6 0,016	80,0 3,8	<0.05
Steganoderma formosum	-	-	-	-	-	-	-	0,3 0,03	-	>0.05
Opecoelidae gen. sp.	-	-	-	-	-	-	-	-	14,0 0,1	<0.05
Podocotyle reflexa	64,3 1,2	10,0 0,1	83,3[1] 1,8	16,7[1] 0,3	3,3 0,03	10,0 0,1	34,8 0,8	9,1 0,2	40,0 0,9	<0.05
Anomalotrema koiae	-	20,0 0,3	10,0 0,1	5,0 0.05	-	-	-	6,0 0,2	2,0 0,02	<0.05
NEMATODA *Anisakis simplex* l.	-	25,0 0,5	20,0 0,7	75,0 2,0	66,7 1,4	25,0 1,1	27,3 0,8	4,4 0,2	38,0 0,6	<0.05
Pseudoterranova decipiens l.	-	-	-	-	-	-	-	-	8,0 0,1	<0.05

Table 2 (continued)

Parasite, sistematic group	Divisions									Statistical significance (P)
	2J[1]	3K[5]	3L[5]	3M[5]	3O[5]	3N[5]	3Ps[1]	4(V-X)[2]	4(R-?)[4]	
Contracaecum sp. l.	28,6 0,5	20,0 0,3	20,0 0,4	90,0 5,2	30,0 0,6	45,0 1,3	33,3 0,4	50,3 2,1	58,0 1,2	<0.05
Hysterothylacium aduncum	-	-	-	2,1[1] 0,02	-	-	-	1,3 0,1	30,0 0,4	<0.05
ACANTHOCEPHALA										
Echinorhynchus gadi	-	-	-	-	3,3 0,03	-	-	0,6 0,06	-	>0.05
CRUSTACEA										
Chondracanthus nodosus	7,1 0,1	-	8,3[1] 0,1	2,1[1] 0,02	13,3 0,2	10,0 0,1	-		24,0 0,5	<0.05
Peniculus clavatus	-	-	5,0 0.05	5,0 0.05	5,0 0,1	5,0 0,1	-		-	>0.05
Sphyrion lumpi *	-	-	-	5,0 0.05	3,3 0,03	5,0 0.05	-		2,0 0,02	>0.05
Laphystius morhuanus	-	-	-	-	-	-	-		2,0 0,02	>0.05

Notes: [1] – by the data from Bourgeois C.E. and I-H. Ni, 1983 (axcept of *Protozoa*);
[2] - by the data from Scott J.S, 1988 (only helminths – Nova Scotia Shelf);
[3] - by the data from Khan R.A., Bowering W.R., Bourgeois C.E. *et al*., 1986;
[4] - by the data from Moran J.D.W., Arthur J.R., Burt M.D.B., 1996 (Gulf of St. Lawrence);
[5] – our data; * – with allowance for remaince of *S. lumpi* presence.
over line – prevalence of parasite, %; under line – abundance index;
"+" – the parasite occurs, "-" – the parasite does not occur.

Table 3. Composition of *Sebastes fasciatus* parasite fauna in six areas of the Northwest Atlantic.

Parasite species	Areas					
	1	2	3	4	5	6
COCCIDIOMORPHA						
Eimeriida gen. sp.	-	-	-	-	-	+
MYXOSPOREA						
Myxidium incurvatum	+	+	+	+	+	+
M. obliquelineolatum	+	+	+	+	+	-
M. sphaericum	+	+	-	+	+	-
Ceratomyxa macrospora	+	+	-	+	+	+
Leptotheca adeli	+	+	-	+	+	-
Pseudalataspora sebastei	+	+	+	+	+	-
CESTODA						
Bothriocephalus scorpii	-	-	+	+	+	+
Scolex pleuronectis pl.	+	+	-	+	+	+
TREM ATODA						
Hemiurus levinseni	-	-	-	-	-	+
Brachyphallus crenatus	-	-	-	-	-	+
Derogenes varicus	+	+	+	+	+	+
Gonocerca sp.	-	-	-	-	-	+
Lecithaster gibbosus	-	+	-	-	-	+
Lecithophyllum bothriophoron	-	+	-	+	-	+
Opecoelidae gen. sp.	-	-	-	-	-	+
Podocotyle reflexa	+	+	+	+	+	+
Anomalotrema koiae	+	+	+	-	-	+
NEMATODA						
Anisakis simplex l.	+	+	+	+	+	+
Pseudoterranova decipiens l.	-	-	-	-	-	+
Contracaecum sp. l.	+	+	+	+	+	+
Hysterothylacium aduncum	-	-	+	-	-	+
ACANTHOCEPHALA						
Echinorhynchus gadi	-	-	-	+	-	-
CRUSTACEA						
Chondracanthus nodosus	-	+	+	+	+	+
Peniculus clavatus	-	+	+	+	+	-
Sphyrion lumpi	-	-	+	+	+	+
Laphystius morhuanus	-	-	-	-	-	+
Number of species by areas	12	16	13	17	15	21

Notes: a) here, in the Tables 4-5 and in the figures 2-4 the areas of investigation are designated as follows: **1** – Div. 3K, **2** – Div. 3L, **3** - Div. 3M, **4** – Div. 3O, **5** – Div. 3N, **6** – Gulf of St. Lawrence (Div. 4R-T);

b) "+" – the parasite occurs, "-" – the parasite does not occur.

Table 4. Matrix of inclusion degree (%) of *Sebastes fasciatus* parasite fauna composition from six areas of the Northwest Atlantic

Areas	1	2	3	4	5	6
1		75	64	65	73	38
2	100		79	82	87	52
3	75	69		71	80	52
4	92	88	86		100	52
5	92	81	86	88		48
6	67	69	79	65	67	

Table 5. Matrix of similarity degree (%) of *Sebastes fasciatus* parasite fauna composition from six areas of the Northwest Atlantic.

Areas	1	2	3	4	5
2	86				
3	69	73			
4	76	85	77		
5	81	84	83	94	
6	48	59	63	58	55

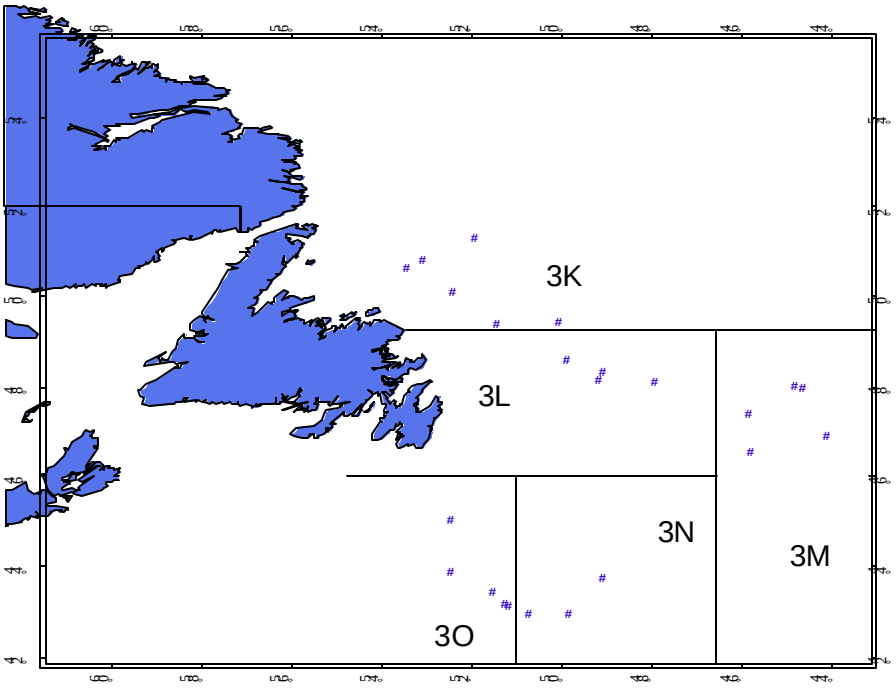

Fig. 1. Redfish sampling sites, May-June 1990.

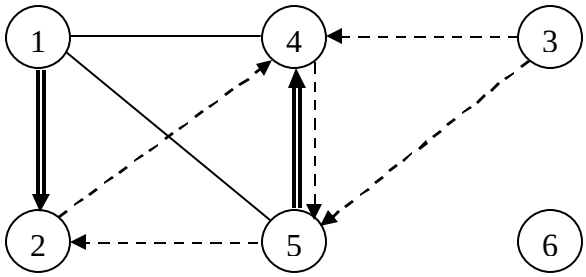

Fig. 2. Oriented graph constructed against the matrix of inclusion degree of *Sebastes fasciatus* parasite fauna composition from six Northwest Atlantic areas (see Table 4) which shows connections at similarity degree t =100 (doubled arrow), t = 92 (single arrow) and t = 86 (dotted arrow).

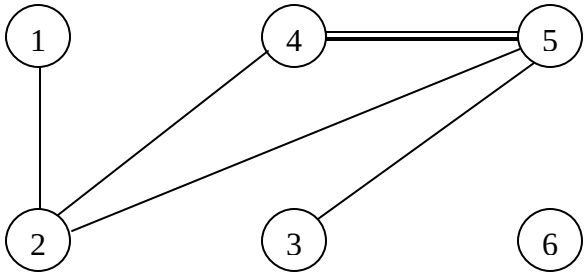

Fig. 3. Non-oriented graph constructed against the matrix of inclusion degree of *Sebastes fasciatus* parasite fauna composition from six Northwest Atlantic areas (see Table 5) which shows connections at similarity degree t = 83 (single line) and t = 94 (double line).

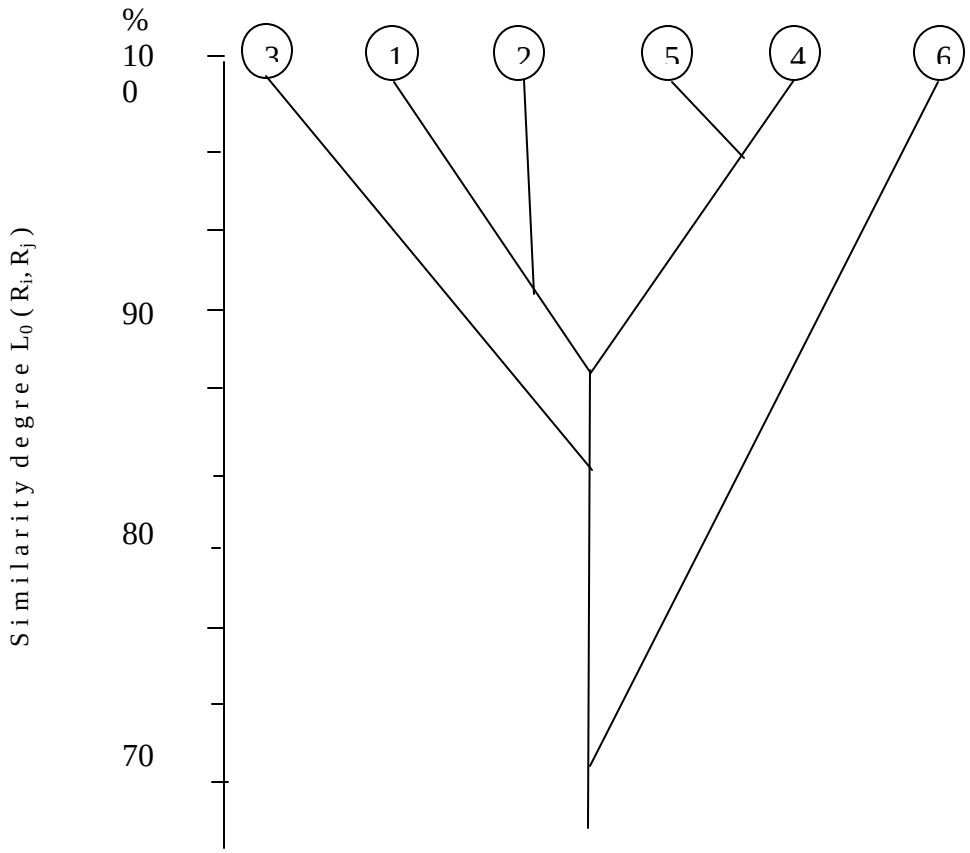

Fig. 4. Dendrogram of similarity degree of *Sebastes fasciatus* parasite fauna composition from six Northwest Atlantic areas.