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Parasitology

PARASITE FAUNA OF
ATHERESTHES STOMIAS (JORDAN ET GILBERT, 1880)
(PLEURONECTIFORMES) FROM THE NORTHEASTERN PACIFIC
OCEAN

PARAZYTOFAUNA
ATHERESTHES STOMIAS (JORDAN ET GILBERT, 1880)
(PLEURONECTIFORMES) Z PÓŁNOCNO-WSCHODNIEGO PACYFIKU

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The material was sampled from the areas of Vancouver Island and Kodiak Island. A total of 38 specimens of *Atheresthes stomias* was examined. The parasite fauna of the fish studied consisted of 18 species assigned to different systematic groups (*Myxidium incurvatum* Thélohan, 1892; *Paramyxoproteus reinhardti* Wierzbicka, 1986; *Ceratomyxa ramosa* Awerinzew, 1907; *Kudoa* sp.; *Entobdella pugetensis* Robinson, 1961; *Neodidolophora pugetensis* (Robinson, 1961); *Bothriocephalus* sp.; *Nybelinia surmenicola* Okada in Dollfus, 1929; *Scolex pleuronectis* O.F. Müller, 1788; *Steganoderma formosum* Stafford, 1904; *Lecithaster gibbosus* (Rudolphi, 1802); *Podocotyle* sp.; *Anisakis simplex* (Rudolphi, 1809); *Pseudoterranova decipiens* (Krabbe, 1878); *Hysterothylacium aduncum* (Rudolphi, 1802); *Echinorhynchus gadi* Zoega in O.F. Müller, 1776; *Corynosoma strumosum* (Rudolphi, 1802); and *C. villosum* Van Cleave, 1953). The muscles were parasitized by nematodes *A. simplex* and *P. decipiens* and myxozoans *Kudoa* sp. The latter parasite caused changes in the texture of muscles. *A. stomias* was found to be a new host for *M. incurvatum*, *P. reinhardti*, *C. ramosa*, *Bothriocephalus* sp. and *Podocotyle* sp.

INTRODUCTION

Very few researchers have conducted parasitic surveys of *Atheresthes stomias* (Jordan et Gilbert, 1880). One of particularly interesting was a publication by Kabata and Whitaker (1984). The authors described parasite fauna of this host from two areas of the

Pacific Ocean off the Canadian coast. They studied 25 fish from the Hecate Strait and the same number from the west coast of Vancouver Island. They covered all systematic groups of parasites from Protozoa to Crustacea inclusive. Slightly earlier data on *A. stomias* were published in the synopsis of the parasites of Canadian fishes by Margolis and Arthur (1979). They listed for this host a myxozoan *Kudoa* sp. and a copepod *PhrEXOcephalus cinnatus* Wilson, 1908. The latter species was studied by Kabata (1967, 1969) and by Kabata and Forrester (1974). Beverley-Burton (1984) listed a monogenean *Entobdella pugetensis* Robinson, 1961 parasitizing the host discussed. Mamaev (1965) described metazoan parasites of *A. stomias* from the Bering Sea.

Parasite fauna of a congener—*A. evermani* Jordan et Starks, 1904 from the waters of north Pacific (Kamčackij Zaliv, Avačinskij Zaliv, and Kronockij Zaliv) was studied by Mamaev et al. (1963). These authors surveyed metazoan parasites based on 40 host specimens studied. Subsequently Mamaev. (1965) studied metazoan parasites of fishes from the Bering Sea. Another contribution was a work by Kovaleva et al. (1983) devoted to protozoans and containing a description of a new genus and new species—*Schulmania quadriolata*, which was found in the urinary bladder of *A. evermani*.

The present work consists of an analysis of the parasite assemblage of *A. stomias* from the northeastern Pacific and it includes all parasite groups.

MATERIAL AND METHODS

A total of 38 specimens of *Atheresthes stomias* caught in the northeastern Pacific was subjected to detailed parasitological necropsy. The majority of the fish (36) came from an area off the Vancouver Island, while the remainder (2)—from the Kodiak Island. The former sample was collected on 29 September 1977, while the latter—in January 1981. The total length of the “Vancouver Isl.” fish ranged from 33.5 to 53.0 cm. Their weight was 260–1510 g. The “Kodiak” fish were 50.5 and 55.0 cm long and their weighed 935 and 1500 g respectively.

The fish were frozen on board the ship and at this stage delivered to the Department of Fish Diseases, Agricultural University of Szczecin. The fish were promptly thawed and studied for their parasites through full, detailed necropsy. The musculature was studied with unaided eye throughout its crumbling. Only the fish from the Kodiak Island were examined microscopically. The parasites recovered representing Monogenea, Cestoda, Digenea and some Acanthocephala (genus *Echinorhynchus*) were fixed in 75-% ethanol following their gentle flattening. The parasites were stained in alum carmine and mounted on microscopic slides. Parasites representing Myxozoa, Nematoda, and some acanthocephalans (genus *Corynosoma*) were identified on non-preserved material. Some of them were

fixed in formalin on physiological solution, immediately after necropsy. The drawings were made using a drawing tube for microscope.

RESULTS

A total of 18 species of parasites was recovered from the studied specimens of *Atheresthes stomias*. The infection intensity for some parasites was very high (Tab. 1).

Table 1

Parasites of *Atheresthes stomias* from two areas of the northeastern Pacific Ocean

Parasite species	Vancouver (n = 36)			Kodiak (n = 2)	
	P	I	A	n	I
<i>Myxidium incurvatum</i>	44.4	+—++	—	2	+
<i>Paramyxoproteus reinhardti</i>	80.5	+—+++	—	0	0
<i>Ceratomyxa ramosa</i>	86.1	+—++	—	2	+—+++
<i>Kudoa</i> sp.	—	—	—	1	++
<i>Entobdella pugetensis</i>	86.1	1–31	6.94	2	1–2
<i>Neodiclidophora pugetensis</i>	50.0	1–7	1.25	2	2–3
<i>Bothriocephalus</i> sp., immature	2.8	1	0.03	0	0
<i>Nybelinia surmenicola</i> , plerocercoid	75.0	1–15	4.44	2	1–40
<i>Scolex pleuronectis</i> , plerocercoid	27.8	1–3	0.36	1	137
<i>Steganoderma formosum</i>	25.0	1–5	0.58	0	0
<i>Lecithaster gibbosus</i>	2.8	3	0.08	0	0
<i>Podocotyle</i> sp.	2.8	1	0.03	0	0
<i>Anisakis simplex</i> , larva	100.0	3–72	18.11	2	29–36
<i>Pseudoterranova decipiens</i> , larva	22.2	1–2	0.28	1	1
<i>Hysterothylacium aduncum</i> , larva and adult	36.1	1–6	0.72	0	0
<i>Echinorhynchus gadi</i>	5.5	1	0.05	1	2
<i>Corynosoma strumosum</i> , juv.	25.0	1–3	0.39	2	1–2
<i>Corynosoma villosum</i> , juv.	22.2	1–9	0.67	2	3–7

P—prevalence [%],

I—intensity,

A—abundance (total number of individuals of particular parasite species in a sample of hosts ÷ total number of individuals of the host species (infected + uninfected) in a sample),

+ —single spores under a coverslip 20×20 mm

++ —0–10 spores in an observation field (magnification 400×),

+++ —more than 10 spores in an observation field.

The phylum Myxozoa was represented by four species. Most prevalent and the most abundant were *Paramyxoproteus reinhardti* Wierzbicka, 1986 inhabiting the urinary bladder and *Ceratomyxa ramosa* Awerinzew, 1907 found in the gall bladder. Quite prevalent

were also *Myxidium incurvatum* Thélohan, 1892. Parasites of the genus *Kudoa* deserved particular attention. Abundant spores of this species were found in the muscles of one of the fish from the Kodiak Island area. The spores were star-shaped with moderately elongated arms. One of the polar capsules was slightly bigger. The spores did not form concentrations that could be visible with unaided eye. The muscles of the infected fish exhibited altered texture. They were soft and loosened.

Both monogenean species—*Entobdella pugetensis* Robinson, 1961 and *Neodiclidophora pugetensis* (Robinson, 1961) were parasites frequently encountered. They were found on the gills of the studied fish.

One of the cestodes—*Nybelinia surmenicola* Okada in Dollfus, 1929 at the stage of plerocercoid turned out to be a common parasite of this host and it was found most often in the stomach wall, rarely in the other organs of the body cavity. Two other species—tetraphyllidean plerocercoids *Scolex pleuronectis* O.F. Müller, 1788 (Fig. 1) and immature specimen of *Bothriocephalus* sp. (Fig. 2) were found in the intestine.

Fig. 1. *Scolex pleuronectis*—plerocercoids

Fig. 2. Juvenile specimen of *Bothriocephalus* sp.

Three adult digeneans were also found in the intestine. Only *Steganoderma formosum* Stafford, 1904 was more prevalent, while *Lecithaster gibbosus* (Rudolphi, 1802) and *Podocotyle* sp. were found in single host specimens.

The most common parasite of the host studied was a nematode *Anisakis simplex* (Rudolphi, 1809). Encysted L₃ larvae occurred in different organs of the body cavity: mostly in the stomach and intestine walls. The muscles of the fish studied yielded a total of 395 nematodes, which constituted 55.1% of the total number of the specimens found. The majority of the *A. simplex* larvae found in the

muscles were located in the abdominal flaps. There were less abundant in the dorsal part of the body.

Two other nematodes—*Pseudoterranova decipiens* (Krabbe, 1878) and *Hysterothylacium aduncum* (Rudolphi, 1802) were found rarely. The stomach and intestine harbored adult specimens of *H. aduncum*, as well as L₃ and L₄ larvae. Only once a single L₃ larva of this species was found in the gonads. Encysted L₃ larvae of *P. decipiens* were found mostly in the dorsal musculature of the body. Only sporadically they were recovered from the gonads.

Only four specimens of acanthocephalans *Echinorhynchus gadi* Zoega in O.F. Müller, 1776 were found in the intestine of the three fish. Relatively frequent in the material studied were encysted juvenile forms of *Corynosoma strumosum* (Rudolphi, 1802) and *C. villosum* Van Cleave, 1953. They were located on various organs in the body cavity of the fish examined.

DISCUSSION

Comparison of the present results with the data provided by Kabata and Whitaker (1984) reveals certain similarities in the composition of metazoan parasite fauna of *Atheresthes stomias*. The following nine species occurred in both works: *Entobdella pugetensis*, *Neodicliphora pugetensis*, *Nybelinia surmenicola*, *Scolex pleuronectis*, *Steganoderma formosum*, *Anisakis* sp., *Pseudoterranova decipiens*, *Hysterothylacium aduncum*, and *Corynosoma villosum*. Crustaceans were found neither in our own studies nor in the data of Kabata and Whitaker (1984) pertaining to the fish from the west coast of the Vancouver Island. The latter authors found one copepod—*Naobranchia occidentalis* Wilson, 1915 in the host specimens from the Hekate Strait. On the other hand the discussed authors did not find in their fish form off the Vancouver Island monogeneans *E. pugetensis* which were very prevalent in our own material. The second monogenean species—*N. pugetensis* was found by Kabata and Whitaker (1984) in the fish form both areas. Systematic position of *N. pugetensis* was studied by Mamaev (1987). Further comparison reveals that a total of four presently recovered species was not reported by Kabata and Whitaker (1984) namely *Bothriocephalus* sp., *Lecithaster gibbosus*, *Podocotyle* sp., *Echinorhynchus gadi*, and *Corynosoma strumosum*. All of the above-mentioned parasites with the exception of *C. strumosum* were rarely recorded in the presently studied material. The single specimen of a digenean *Podocotyle* sp. was morphologically similar to *P. reflexa* (Creplin, 1825). On the other hand the present results did not mention *Derogenes varicus* (O.F. Müller, 1784), *Prosorhynchus* sp., *Stephanostomum* sp., and *Corynosoma wegneri* Heinze, 1934 that were reported by Kabata and Whitaker (1984).

Far more distinct differences were observed in the composition of myxozoan parasites of *A. stomias*. Kabata and Whitaker (1984) found 6 species, while we were able to find only 4, but totally different species. Only two of our findings (*Ceratomyxa ramosa* and *Kudoa* sp.) were congeners of the species found by Kabata and Whitaker (1984). The urinary bladder of the presently studied fish yielded spores of very prevalent *Paramyxoproteus reinhardti*. This species was described for the first time by Wierzbicka (1986) from Greenland halibut *Reinhardtius hippoglossoides* (Walbaum, 1792). Its second record was reported by Arthur and Albert (1994) who decided to place this parasite in the genus *Myxoproteus* Doflein, 1898. On the other hand Lom and Dyková (1992), in their monograph, confirmed the validity of the genus *Paramyxoproteus*. Kabata and Whitaker (1984) studying the urinary bladder of the fish of both areas found different species—*Conispora meridionalis*. This species was described for the first time by Evdokimova (1977) as *Myxoproteus meridionalis* from the urinary bladder of *Merluccius hubbsi* Marini, 1932. The species was later redescribed by Kovaleva and Gaevskaja (1982). Subsequently Lom and Dyková (1992) considered the genus *Conispora* Sankurathri, 1977 as a junior synonym

of the genus *Myxoproteus*. Also the gall bladder yielded in the two cases two different species: Kabata and Whitaker (1984) found there *Zschokkella* sp., while in the present data *Myxidium incurvatum* was relatively prevalent species. Detailed description of the latter parasite, occurring also in the Greenland halibut was published by Wierzbicka (1990).

Kudoa thyrsites (Gilchrist, 1924) was a common parasite of *A. stomias* from both regions according to Kabata and Whitaker (1984). In the present results, the musculature of a single fish from the Kodiak Island area yielded numerous spores assigned to the genus *Kudoa*. Their morphology was different from descriptions of *K. thyrsites* given by Kovaleva et al. (1979), Langdon (1991), and Langdon et al. (1992). The spores in our own material were more similar to *K. histolytica* (Pérard, 1928) redescribed by Kovaleva et al. (1979). Identification up to the species level of these parasites was not possible due to accidental destruction of the material (freezer failure). Presently found spores of *Ceratomyxa* sp. were similar to *C. ramosa* Awerinzew, 1907 and to *C. drepanopsettae* Awerinzew, 1908. Arthur and Albert (1994) suggested that the above-mentioned species were synonyms. Existing descriptions of these species do not provide differences exceeding limits of individual variability. Their separate identity cannot be any longer justified by different host species. In view of the above the present authors see no reasons for considering *C. drepanopsettae* as a valid species and thus recognize the priority of *C. ramosa*.

Species composition of the metazoan parasites of *A. stomias* from the Bering Sea (Mamaev, 1965) was similar to the present findings. The above-mentioned author found a total of 14 parasites, out of which 9 were listed, in the present work (among others: *L. gibbosus*, *E. gadi*, and *C. strumosum*).

RECAPITULATION

1. Parasite fauna of *Atheresthes stomias* for the northeastern Pacific Ocean consisted of 18 species. In this number were 4 myxozoans, 2 monogeneans, 3 cestodes, 3 digeneans, 3 nematodes, and 3 acanthocephalans.
2. The most prevalent and most abundant parasites were *Paramyxoproteus reinhardti*, *Ceratomyxa ramosa*, *Entobdella pugetensis*, *Neodicliphora pugetensis*, *Nybelinia surmenicola*, and *Anisakis simplex*.
3. The muscles were parasitized by two nematodes—*Anisakis simplex* and *Pseudoterranova decipiens*—and one myxozoan *Kudoa* sp. The latter parasite was responsible for changes in the texture of the tissue.
4. *A. stomias* was found to be a new host for the following parasites *Myxidium incurvatum*, *Paramyxoproteus reinhardti*, *Ceratomyxa ramosa*, *Bothriocephalus* sp., and *Podocotyle* sp.

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REFERENCES

- Arthur J.R., E. Albert**, 1994: A survey of the parasites of Greenland halibut (*Reinhardtius hippoglossoides*) caught off Atlantic Canada, with notes on their zoogeography in this fish. *Can. J. Zool.*, **72**, 4: 765–778.
- Beverley-Burton M.**, 1984: Monogenea and Turbellaria. In: Guide to the parasites of fishes of Canada. [L. Margolis, Z. Kabata (eds.)] Part I. *Can. Spec. Publ. Fish. Aquat. Sci.*, **74**: 68–70, 182.
- Evdokimova E.B.**, 1977: Miksosporidii kostistych ryb Patagonskogo šel'fa (Atlantičeskoe poberež'e Argentiny). [Myxosporidians of teleost fishes from the Patagonian shelf (the Atlantic coast of Argentina)]. *Parazitologija*, **11**, 2: 166–178. (In Russian, English summary).
- Kabata Z.**, 1967: Morphology of *PhrEXOcephalus cincinnatus* Wilson, 1908 (Copepoda: Lernaecercidae). *J. Fish. Res. Bd Can.*, **24**, 3: 515–526.
- Kabata Z.**, 1969: *PhrEXOcephalus cincinnatus* Wilson, 1908 (Copepoda: Lernaecercidae): morphology, metamorphosis, and host-parasite relationship. *J. Fish. Res. Bd Can.*, **26**: 921–934.
- Kabata Z., C.R. Forrester**, 1974: *Atheresthes stomias* (Jordan and Gilbert, 1880) (Pisces: Pleuronectiformes) and its eye parasite *PhrEXOcephalus cincinnatus* Wilson, 1908 (Copepoda: Lernaecercidae) in Canadian Pacific waters. *J. Fish. Res. Bd Can.*, **31**, 10: 1589–1595.
- Kabata Z., D.J. Whitaker**, 1984: Results of three investigations of the parasite fauna of several marine fishes of British Columbia. *Can. Tech. Rep. Fish. Aquat. Sci.*, **1303**: 1–19.
- Kovaleva A.A., A.V. Gaevskaja**, 1982: Novye vidy miksosporidij ryb jugo-zapadnoj Atlantiki. [New data on Myxosporidia from the south-western Atlantic fishes]. *Parazitologija*, **16**, 5: 353–359. (In Russian, English summary).
- Kovaleva A.A., S.S. Šul'man, V. N. Jakovlev**, 1979: Miksosporidii roda *Kudoa* (Myxosporidia, Multivalvulea) bassejna Atlantičeskogo okeana. [Microsporidians of the genus *Kudoa* (Myxosporidia, Multivalvulea) from the Atlantic Ocean]. *Trudy Zool. Inst. AN SSSR*, **87**: 42–64. (In Russian).
- Kovaleva A.A., A.V. Zubčenko, V.K. Krasin**, 1983: Obosnovanie novogo semejstva miksosporidij (Protozoa, Myxosporidia) s opisaniem dvuch novych rodov. [Foundation of a new myxosporean family (Protozoa, Myxosporidia) with a description of two new genera]. *Parazitologija*, **17**, 3: 195–202. (In Russian, English summary).
- Langdon J.S.**, 1991: Myoliquefaction post-mortem ('milky flesh') due to *Kudoa thyrsites* (Gilchrist) (Myxosporea: Multivalvulida) in mahi mahi, *Coryphaena hippurus* L. *J. Fish Diseases*, **14**: 45–54.
- Langdon J.S., T. Thorne, W.J. Fletcher**, 1992: Reservoir hosts and new clupeoid host records for the myoliquefactive myxosporean parasite *Kudoa thyrsites* (Gilchrist). *J. Fish Diseases*, **15**: 459–471.
- Lom J., I. Dyková**, 1992: Protozoan parasites of fishes. Elsevier, Amsterdam-London-New York-Tokyo: 177–191.
- Mamaev Ju.L.**, 1965: Gel'minty ryb Beringova morja. V: Paraziticheskie červi domašnich i dikich životnyh [V.A. Leonov, Yu.L. Mamaev, P.G. Oshmarin (eds.)]. [Helminths of fish from the Bering Sea. In: Parasitic worms of domestic and wild animals]. *Raboty Gel'mintol.*, **40**-Let. Nauč. Pedagog. Dejat. Prof. A.A. Soboleva, Izd. AN SSSR, Vladivostok: 168–188. (In Russian).

- Mamaev Ju. L., 1987: O sistematičeskom položenii roda *Neoheterobothrium* Price, 1943 (Monogenea, Diclidophoridae) v svjazi s opisaniem novogo vida *N. syacii* sp.n. [On the systematic position of the genus *Neoheterobothrium* Price, 1943 (Monogenea, Diclidophoridae) in connection with the description of a new species *N. syacii* sp.n.]. *Parazitologija*, **21**, 1: 69–73. (In Russian, English summary).
- Mamaev Ju.L., A.M. Paruchin, O.M. Baeva, 1963: Paraziticheskie červi kambalovykh ryb dal'nevostočnykh morej. V: Paraziticheskie červi životnykh Primor'ja i Tichogo Okeana [P.G. Oshmarin (ed.)]. [Parasitic worms of flatfish of far eastern seas. In: Parasitic worms of animals of the Primore and Pacific Ocean]. Izd. AN SSSR, Moskva: 82–113. (In Russian).
- Margolis L., J.R. Arthur, 1979: Synopsis of the parasites of fishes of Canada. *Bull. Fish. Res. Bd Can.*, 199: 216.
- Wierzbicka J., 1986: *Paramyxoproteus reinhardii* gen.n. et sp.n. (Bivalvulida, Myxospora), a parasite of *Reinhardtius hippoglossoides* Walbaum, 1792. *Acta Protozool.*, **25**, 2: 227–234.
- Wierzbicka J., 1990: Parasitic Protozoa of a Greenland halibut, *Reinhardtius hippoglossoides* (Walbaum, 1792). *Acta Ichth. Piscat.*, **20**, 1: 91–98.

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PARAZYTOFAUNA *ATHERESTHES STOMIAS* (JORDAN ET GILBERT, 1880)
(PLEURONECTIFORMES) Z PÓŁNOCNO-WSCHODNIEGO PACYFIKU

STRESZCZENIE

Materiał pochodził z łowisk w okolicy wysp Vancouver i Kodiak. Łącznie zbadano 38 osobników *Atheresthes stomias*. Fauna pasożytnicza badanych ryb obejmowała 18 gatunków należących do Myxozoa (4 gatunki), Monogenea (2), Cestoda, Digenea, Nematoda i Acanthocephala (po 3 gatunki). Najczęściej i najliczniej stwierdzane były: *Paramyxoproteus reinhardii*, *Ceratomyxa ramosa*, *Entobdella pugetensis*, *Neodichthophora pugetensis*, *Nybelinia surmenicola* i *Anisakis simplex*. W mięśniach znaleziono dwa gatunki nicieni – *A. simplex* i *Pseudoterranova decipiens* oraz myxosporidia z rodzaju *Kudoa*, które wywoływały zmiany konsystencji tkanki. *A. stomias* jest nowym żywicielem pasożytów: *Myxidium incurvatum*, *P. reinhardii*, *C. ramosa*, *Bothriocephalus* sp. i *Podocotyle* sp.

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