Arch. Pol. Fish. (2011) 19: 87-93
DOI 10.2478/v10086-011-0010-y

RESEARCH ARTICLE

Atlantic sturgeon, *Acipenser oxyrinchus* Mitchill, infected by the parasitic leech, *Caspiobdella fadejewi* (Epshtein) (Hirudinea; Piscicolidae), in the Drwęca River

Received – 30 April 2011/Accepted – 25 May 2011. Published online: 30 June 2011;

Aleksander Bielecki, Andrzej Kapusta, Joanna M. Cichocka

Abstract. This study presents the parasitic relationship between the leech, *Caspiobdella fadejewi*, and the juvenile Atlantic sturgeon, *Acipenser oxyrinchus*. The aim was to determine leech invasion intensity and extensity and describe parasite feeding location preferences on the ventral side of the snout and gill cavities. The prevalence of *C. fadejewi* occurrence was 37.3%, at an intensity of one to eight leeches. It was confirmed that the intensity of leech occurrence was positively correlated with sturgeon total length ($r=0.545$, $P<0.05$, $N=15$). The host-searching mechanism is most probably based on positive phototaxis. This is the first record of *C. fadajewi* from *A. oxyrinchus*. The leech was first observed during routine examinations of sturgeon collected in June 2008. The leeches were usually attached to the inside lower portion of opercula near the isthmus.

Keywords: leech; Hirudinea; Piscicolidae; European

A. Bielecki [✉], J.M. Cichocka
Department of Zoology
University of Warmia and Mazury
Oczapowskiego 5, 10-718 Olsztyn, Poland
e-mail: alekb@uwm.edu.pl

A. Kapusta
Department of Ichthyology
Inland Fisheries Institute in Olsztyn, Poland

Introduction

Sturgeons are one of the oldest living groups of vertebrates in the world. Their natural area of occurrence includes the waters of Europe, Asia, and North America. They inhabit inland waters, bays, estuaries and the coastal zones of seas and oceans. Most sturgeon species are migratory living in brackish waters, but spawning in fresh waters. These fish reach substantial sizes, are long lived, and achieve sexual maturity late in life. They are also one of the world's most endangered species. Twenty-five of the 27 species of *Acipenseriformes* are endangered (Pikitch et al. 2005). The Atlantic sturgeon, *Acipenser oxyrinchus* Mitchill, is an anadromous fish that inhabits brackish waters and spawns in rivers. This species became extinct in the Baltic Sea in the twentieth century (Mamcarz 2000, Kolman et al. 2011), but it still occurs along the Atlantic coast of Canada and northern USA (Waldman and Wirgin 1998, Grunwald et al. 2008). Programs to restore the Atlantic sturgeon to the inland waters of Poland have been underway since 2004. Eggs and juvenile stages are obtained through the artificial reproduction of wild sturgeon spawners from the St. John River. Approximately 51 thousand juvenile sturgeon have been released into the Drwęca River since 2006 (Kolman et al. 2011).

With very few exceptions freshwater leech species that parasitize fish (Piscicolidae) belong to the monophyletic family that inhabits the continental waters of the Holarctic (Bielecki 1997, Utevsky and Trontelj 2004, Utevsky 2007, Sket and Trontelj 2008, Bielecki et al. 2011a). The leech species that occur in the Palearctic probably have or have had greater interaction affinity with sturgeons than with other fish species. This group of leeches includes *Limnotrachelobdella okae* (Moore) and *Limnotrachelobdella turkestanica* (Stschegolew) which parasitize Kaluga, *Huso dauricus* (Georgi), as well as *Acipenserobdella volgensis* (Zykoff) that has been noted false shovelnose sturgeon, *Pseudoscaphirhynchus kaufmanni* (Kessler), from the Amu Darya River. The only location of occurrence of this last leech in Poland is in the Grabowa River, and *A. volgensis* has been noted on body surfaces and the gills of ship sturgeon, *Acipenser nudiventris* Lovetsky, and sterlet, *Acipenser ruthenus* L. This leech is likely specific to the *Acipenseridae* (Bauer et al. 2002). *Acipenserobdella pawlowskii* Sket is an endemic species in Lake Ohrid, and certainly parasitizes other fish species. Obviously, these leeches can occur on other fish species, and *A. volgensis* has been confirmed in Poland on the fins and in the gill cavities of sea trout, *Salmo trutta* L. (Bielecki 1997).

Leeches feed on the lymph and blood of fish, and some species, such as *Piscicola geometra* (L.), attach to their hosts for relatively short periods of several hours to a day. Since some leeches quickly detach from their hosts, they have likely been of little interest to parasitologists (Polyanski 1955, Utevsky and Trontelj 2004, Bielecki et al. 2011a). However, some leeches spend their entire life cycles on their hosts only detaching to form cocoons. One such species occurring among Polish fauna is *Caspiobdella fadejewi* Epshtein which parasitizes oral cavities and especially gill cavities. This leech was confirmed in *Acipenseriformes*, among others on *A. ruthenus*.

Lukin (1976) included *C. fadejewi* in a group of endemic Palearctic leeches with limited distribution and in a subgroup of Caspian species. *C. fadejewi* is an external parasite of fish, especially rheophilic cyprinids. Studies conducted to date (Lukin 1976, Bielecki 1997, Jueg et al. 2004) indicate that *C. fadejewi* is euryphagous and is mostly interactively associated with cyprinids and percids. This species was noted on the sturgeon species *A. ruthenus*. The aim of the current study was to analyze the occurrence of the leech species *C. fadejewi* among Atlantic sturgeon caught in the Drwęca River.

Materials and methods

The material for analysis was collected during studies of the ecology of juvenile Atlantic sturgeon in the Drwęca River (length – 207 km, drainage basin surface area – 5697 km^2). The river flows from the Dylewskie Hills near Ostróda though postglacial valleys, deep-cut beds, and lakes Ostrowin and Drwęckie and then flows into the Vistula River near Toruń. Most of the drainage is meadow and forest. The largest tributaries are the Wel, Iławka, and Skarlanka rivers. The mean annual water flow is 30 $m^3\ s^{-1}$. The river has been an ichthyological nature reserve since 1961, and has recently been designated as part of the NATURA 2000 ecological network of protected areas. The occurrence of 35 fish species in the Drwęca River distinguishes it among other rivers of similar size in Poland (Backiel 1964). Many species that are rare in Poland occur in the Drwęca including among others barbel, *Barbus barbus* (L.), river bullhead, *Cottus gobio* L., and common minnow, *Phoxinus phoxinus* (L.). Thanks to migratory fish restoration programs, vimba, *Vimba vimba* (L.), sea trout, *S. trutta*, and salmon, *Salmo salar* L., are also noted in the river. Historically, Atlantic sturgeon spawned in the Drwęca River (Grabda 1968, Mamcarz 2000).

The Atlantic sturgeon were reared at the Department of Sturgeon Fish Breeding in Pieczarki, and prior to release, they were measured (± 1 mm) and weighed (± 1 g). Each released individual was tagged with Carlin tag. On June 3, 2008, 378 sturgeon were released into the Drwęca River near Samborowo (Table 1). The fish were recaptured from June 5 to 13,

Table 1
Characteristics of sturgeon released into the Drwęca River (AOS), recaptured with leeches (AOH), recaptured without leaches (AOC). Data are means ± SD

	N	TL (cm)	Body weight (g)	Condition
AOS	378	42.3±4.08	239.8±74.66	0.308±0.040
AOH	15	42.2±4.41	278.0±91.45	0.311±0.024
AOC	58	41.8±4.30	230.7±79.00	0.303±0.034

2008 using gear deployed nearly across the full width of the river near the village of Pustki approximately 30 km downstream from the stocking site. The segment of the Drwęca River between these two sites was typical of lowland rivers (width – 10-20 m, mean depth – approximately 1.5 m), and it flowed through meadows with partially wooded banks. Most of the bottom along this segment was sandy with several sites of soft sediments. Macrophytes were not numerous, and relatively abundant submerged vegetation developed in the second half of June. Water temperature during this period ranged from 18.1 to 22.7°C, and oxygen content ranged from 6.5 to 8.0 O_2 dm^{-3}. The sturgeon caught were identified by the external Carlin tags, and measured, weighed, and examined for leeches using standard parasitological methods. Seventy-five sturgeon were caught, and leeches were confirmed on 28 individuals. The leeches collected were preserved in 70% ethyl alcohol.

The prevalence and intensity of the leech infection of sturgeon was determined. Spearman's correlation was used to compare the length of the sturgeon with the number of leeches, while Wilcoxon's test was used to compare the condition of the fish before release and after recapture. The Kruskal-Wallis test was used to compare the total length (TL), weight (W), and condition coefficient (K) of sturgeon released into the river (AOS), recaptured with leeches (AOH), and recaptured without leeches (AOC). All analyses were performed using the Statistica 9.0 program (Statsoft Kraków, Poland).

Results

The sturgeon caught did not differ in length, or weight from those that had been released into the Drwęca (Kruskal-Wallis test, $P>0.05$; Table 1). The body sizes and the values of the condition coefficients of sturgeons with leech infection did not differ statistically significantly from sturgeons without leech infection (Kruskal-Wallis test, $P>0.05$). The prevalence of *C. fadejewi* was 37.3%, while intensity ranged from 1 to 8 leeches (mean ± SD respectively 2.5 ± 1.99). The intensity of leech occurrence was positively correlated with sturgeon length (Spearman correlation; $r=0.545$, $P<0.05$, $N=15$). The leeches were noted most frequently on the paired fins or the rostrum (near the barbels and oral cavity) and less frequently on the sides of the body or the caudal or anal fins. Fish that spent from two to ten days in the river had significantly higher condition coefficient values (Wilcoxon's test, $P<0.05$). Most of the leeches were large measuring from 5.5 to 9.7 mm and engorged with fish blood. *C. fadejewi* has ten eye-like spots near the posterior sucker (Figs. 1, 2). A few individuals had spermatophores attached to them (Fig. 3). The collected *C. fadejewi* individuals included three specimens of another species, and these are currently being investigated.

Discussion

To date, few studies have focused on dependencies between fish and leeches. One such study examined just this relationship regarding an invasion of *Piscicola respirans* Troschel on the fins of European grayling, *Thymallus thymallus* (L.) (Bielecki 1997, Bielecki et al. 2011b). Some parasitic leeches can occur in great numbers; one example is *Johanssonia kolaensis* Selensky, which parasitize *Anarhichas* sp. and in extreme cases can destroy their fins (Bielecki

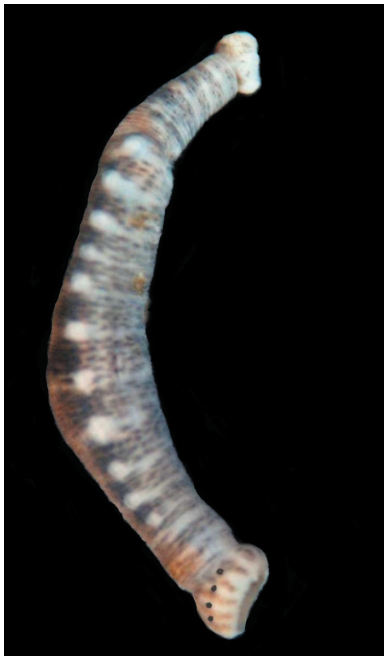

Figure 1. *Caspiobdella fadejewi*: lateral abdominal view, eye-like spots on posterior sucker (photo: A. Bielecki, retouched)

Figure 2. *Caspiobdella fadejewi*: lateral dorsal view, A – two pairs of eyes on anterior sucker, B – eye-like spots on posterior sucker (photo: A. Bielecki, retouched)

et al. 2011b). Moreover, Piscicolidae are a vector for fish hematozoans (Khan and Paul 1995).

In terms of the host and gill cavity microhabitats that *C. fadejewi* parasitizes, it is comparable to *A. volgensis*; however, there is still too little information regarding the life cycle of *A. volgensis* (Bielecki 1997). *C. fadejewi* is most similar to *P. respirans* regarding habitat and strategy for locating its host. Both species mainly inhabit streams and rivers, and are found less frequently in dam reservoirs and lakes (Jabłońska-Barna and Bielecki 2002). Among the species preferring lotic waters, *C. fadejewi* is similar to *P. fasciata* Kollar, *P. pojmanskae* Bielecki, *P. annae* Bielecki, *P. elishebae* Bielecki, *P. niewiadomskae* Bielecki, *P. witkowskii* Bielecki, *P. brylinskae* Bielecki, *Italobdella ciosi* Bielecki, and *Pawlowskiella stenosa* Bielecki, (Bielecki 1993, 1994, 1997, 2001, Bielecki and Cios 1988, Bielecki et al. 2011a, 2011c). They locate the host by its shadow which causes decreased light intensity to be detected by the eye-like spots located near the posterior sucker. *C. fadejewi* also has eye-like spots near its posterior sucker (Bielecki 1997, 1999, Bielecki et al. 2011b). *P. respirans* is, however, a fin parasite that does not seek out the oral cavity of its host (Bielecki et. al. 2011b). Under experimental conditions, it has been confirmed that, in comparison to *P. geometra* and *P. respirans*, *C. fadejewi* detected the smallest decrease in light intensity at 1.5 lux, and it had the lowest threshold for light dosage (Bielecki 1999). *C. fadejewi* perceived decreases in light intensity at 2.5 lux.

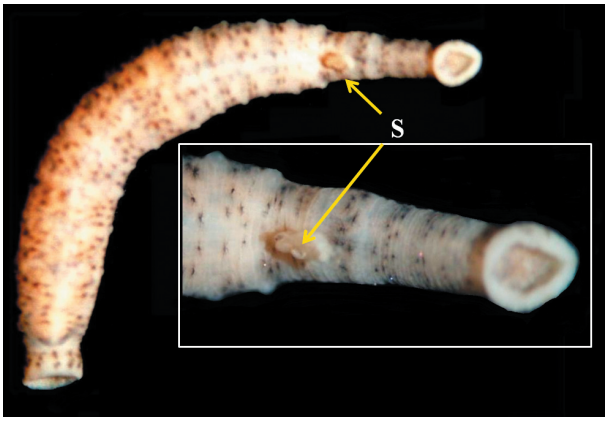

Figure 3. *Caspiobdella fadejewi*: S – spermatophore (photo: A. Bielecki)

The prevalence of *C. fadejewi* occurrence on fish was 37.3%, while intensity ranged from one to eight leeches, which was lower in comparison to the same

parameters noted in the San (<70%) and Biebrza (<50%) rivers (Bielecki 1997). While the recaptured sturgeon infected with *C. fadejewi* did not differ significantly statistically regarding length, weight, or condition, in comparison to the fish released into the Drwęca (without leeches), it should be underscored that the leeches were on the sturgeon for a very short period of two to ten days. The normal leech life cycle lasts from three to four months, and then the consequences of parasitization can be pronounced (Bielecki, Nysa Kłodzka River, unpublished data). Judging from the size of the leeches (maximum length – 9.7 mm, width – 2 mm) and the spermatophores attached to some of them, the leeches were in the middle phase of their cycle and some of them could have been migrating to either the oral or gill cavities.

The literature lacks information regarding the impact leech infection has on fish length, weight, and condition, although recreational fishers have reported that fish infected with many leeches are in poor condition. It was confirmed that the occurrence of leeches was positively correlated with sturgeon total length ($r=0.545$, $P<0.05$). Leeches were located most frequently on paired fins or the rostrum (near the barbels and oral cavity), and were noted less frequently on the sides of the body or the caudal or anal fins. It is interesting that there was also a dependency between increased numbers of leeches and increasing fish length, and similar distribution on hosts (above all on the ventral and pectoral fins) and other species of leech parasites which also had eye-like spots on their posterior suckers (Bielecki 1997). The distribution of *P. respirans* on grayling from the Dunajec River (Bielecki et al. 2011a) and *Cystrobranchus meyeri* Hayunga and Grey on *Catostomus commersoni* Lacépède from North America was similar with the most leeches on the ventral and pectoral fins (Hayunga and Grey 1976). These two intriguing dependencies were recently deciphered: fish leech parasites that have often have eye-like spots near the posterior sucker and on the urosome have a positive phototaxic mechanism for locating hosts (Bielecki et al. 2011b). Leeches thus equipped utilize the host's shadow, which causes decreases in light intensity perceived by the eye-like spots located near the posterior sucker, to locate the host. The condition for this reaction is leech migration to the brightest site, or positive phototaxis, which permits them to perceive the host's shadow (Bielecki 1988, 1997, 1999, Bielecki et al. 2011a, 2011c). To date, leech host location has only been explained by chemotaxis (Friesen 1981, Khan and Emerson 1981). However, this mechanism probably dominates in the stagnant waters of lakes and ponds where it is possible to send and receive chemical signals. In lotic waters, especially those of rivers and brooks, this is impossible, and in such fast-flowing waters the positive phototaxis mechanism dominates, and chemotaxis is a secondary phenomenon. Only after locating the fish, does the leech discover through the chemotaxis mechanism whether the host is appropriate or not. Sawyer (1986) and many other authors studying *P. geometra* have mentioned the importance of mechanical stimuli such as responsiveness to water disturbances among others. These are mentioned since they have yet to be disproved for *P. geometra* which, unlike *C. fadejewi*, *P. respirans*, and other leech species, occurs predominantly in fishponds, lakes and slow-flowing rivers, where detecting water disturbances is more likely than in brooks and fast-flowing rivers.

The cartilaginous Chondryichties fishes played an important role in the evolution of fish leech parasites (Piscicolidae). Utevsky et al. (2007) recently used molecular methods to determine the significance of brackish water leeches of the non-monophyletic sub-family Pontobdellinae in the phylogeny of fish leech parasites. Leeches of this family, such as *Pontobdella muricata* (L.) and *Pontobdella macrothela* Schmarda, mainly parasitize cartilaginous fishes. Based on the biological and phylogenetic position of the giant Antarctic leech, *Megaliobdella szidati* Meyer et Burreson, it is hypothesized that the ancestor of fish leech parasites was a muscular, free-living leech of significant body proportions. The phylogenetic hypothesis suggests it was possible for the leech to move from its ancestral free-living life strategy to periodic parasitization, to

cartilaginous fish parisitization, and then to teleost fish parasitization.

References

Backiel T. 1964 – Fish populations in the Drwęca River system – Roczn. Nauk Rol. 84-B-2: 193-214 (in Polish).

Bauer O.N., Pugachev O.N., Voronin V.N. 2002 – Study of parasites and diseases of sturgeons in Russia: a review – J. Appl. Ichthyol. 18: 420-429.

Bielecki A. 1988 – L'importance de la phototaxie positive pour retrouver des hôtes par *Cystobranchus respir*ans Troschel, 1850 et *Piscicola geometra* (L.) (Hirudinea, Piscicolidae) – Le 2-eme Congres des *Spécialistes* des Sangsues, Ottawa, Canada.

Bielecki A. 1993 – *Italobdella ciosi*, a new leech genus and species from Italy (*Hirudinea*, *Piscicolidae*) – Genus 4: 67-78.

Bielecki A. 1994 – *Piscicola pojmanskae* a new leech species from Poland (*Hirudinea*: *Piscicolidae*) – Genus 5: 423-438.

Bielecki A. 1997 – Fish leeches (Hirudinea: Piscicolidae: Piscicolinae) of Poland in relation to the Palearctic piscicolines – Genus 20: 223-375.

Bielecki A. 1999 – Role of eye-like spots in parasite leeches (Hirudinea: Piscicolidae) in fish-hosts searching – Wiad. Parazyt. 45: 339-345.

Bielecki A. 2001 – *Piscicola brylinskae*, a new leech species from the Netherlands (*Hirudinea*: *Piscicolidae*) – Wiad. Parazyt. 47: 119-126.

Bielecki A., Cios S. 1998 – *Italobdella ciosi* Bielecki, 1993 (Hirudinea, Piscicolidae) in the river Adda, Northern Italy – Boll. Mus. reg. Sci. nat. Torino 15: 249-253.

Bielecki A., Cichocka J.M., Jeleń I., Świątek P., Adamiak-Brud Ż. 2011a – A checklist of leech species from Poland – Wiad. Parazyt. 57: 11-20.

Bielecki A., Cichocka J., Terlecki J., Witkowski A. 2011b – Invasion of the leech *Piscicola respirans* Troschel, 1850 (Hirudinea, Piscicolidae) on fins of European grayling *Thymallus thymallus* (L.) – Biologia 66: 294-298.

Bielecki A., Palińska K., Cichocka J.M., Beenen R., Jeleń I., Adamiak-Brud Ż. 2011c – New information on the geographical distribution of *Piscicola brylinskae* Bielecki, 2001 (Hirudinea: Piscicolidae) in Poland and remarks on its systematic position – Biologia 66: 654-661.

Friesen W.O. 1981 – Physiology of water motion detection in the medicinal leech – J. Exp. Biol. 92: 255-275.

Grabda E. 1968 – Sturgeon – threatened fish – Och. Przyr. 33: 177-191 (in Polish).

Grunwald C., Maceda L., Waldman J., Stabile J., Wirgin I. 2008 – Conservation of Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus*: delineation of stock structure and distinct population – Conser. Genet. 9: 1111-1124.

Hayunga E. G., Grey A. J. 1976 – *Cystobranchus meyeri* sp. n. (Hirudinea: Piscicolidae) from *Catostomus commersoni* Lacépčde in North America – J. Parasitol. 64: 621-627.

Jabłońska-Barna I., Bielecki A. 2002 – Leeches (Hirudinea) in the central part of brackish Lake Gardno – Pol. J. Natur. Sc. 12: 235-242.

Jueg U., Grosser C., Bielecki A. 2004 – Zur Kenntnis der Fischegelfauna (Hirudinea: Piscicolidae) in Deutschland – Lauterbornia 52: 39-73.

Kolman R., Kapusta A., Duda A., Wiszniewski G. 2011 – Review of the current status of the Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus* Mitchill, 1815 in Poland: principles, previous experience, and results – J. Appl. Ichthyol. 27: 186-191.

Khan R.A., Emerson C.J. 1981 – Surface topography of marine leeches as revealed by scanning electron, microscopy – Trans. Am. Microsc. Soc. 100: 51–55.

Khan R.A., Paul A.J. 1995 – Life cycle studies on arctoboreal leeches (Hirudinea) – J. Helminthol. Soc. Wash. 62: 105-110.

Lukin E.I. 1976 – Leeches of fresh and brackish waters. Leech fauna of the USSR – Izdat. Nauka, Leningrad, 484 p. (in Russian).

Mamcarz A. 2000 – Decline of the Atlantic sturgeon *Acipenser sturio* L., 1758 in Poland: An outline of problems and prospects – Bol. Inst. Esp. Oceanogr. 16: 191-202.

Pikitch E.K., Doukakis P., Lauck L., Chakrabarty P., Erickson D.L. 2005 – Status, trends and management of sturgeon and paddlefish fisheries – Fish Fish. 6: 233-265.

Polyanski Y.I. 1955 – Parasitology of fishes of the northern seas of the USSR. Parasites of the fishes of the Barents Sea – Tr. Zool. Inst. Akad. Nauk SSSR 19: 5-170 (in Russian).

Sawyer R.T. 1986 – Leech Biology and Behaviour – Vol. I-III, Clarendon Press, Oxford, 1065 p.

Sket B., Trontelj P. 2008 – Global diversity of leeches (Hirudinea) in freshwater – Hydrobiologia 595: 129-137.

Utevsky S.Y., Trontelj P. 2004 – Phylogenetic relationships of fish leeches (Hirudinea: Piscicolidae) based on mitochondria DNA sequences and morphological data – Zool. Scr. 33: 375-385.

Utevsky S.Y., Utevsky A.Y., Schiaparelli S., Trontelj P. 2007 – Molecular phylogeny of pontobdelline leeches and their place in the descent of fish leeches (Hirudinea, Piscicolidae) – Zool. Scr. 36: 271-280.

Utevsky A. 2007 – Antarctic Piscicolid Leeches – Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Bonn, 80 p.

Waldman J.R., Wirgin I.I. 1998 – Status and restoration options for Atlantic sturgeon in North America – Conserv. Biol. 12: 631-638.

Streszczenie

Zarażenie jesiotra *Acipenser oxyrinchus* Mitchill pasożytniczą pijawką *Caspiobdella fadejewi* (Epstein) (Hirudinea; Piscicolidae) w Drwęcy

Słodkowodne gatunki pijawek pasożytujące na rybach (Piscicolidae) jako monofiletyczna rodzina, z nielicznymi wyjątkami, zamieszkują wody kontynentalne Holarktyki. W pracy scharakteryzowano występowanie pasożytniczej pijawki *Caspiobdella fadejewi* u juwenalnych jesiotrów *Acipenser oxyrinchus* Mitchill. Określono ekstensywność oraz intensywność zarażenia jesiotrów wpuszczonych do Drwęcy. Ekstensywność występowania *C. fadejewi* wynosiła 37,3%, a intensywność od 1 do 8 pijawek. Stwierdzono, że intensywność występowania pijawek była dodatnio skorelowana z długością całkowitą jesiotrów ($r=0{,}545$, $P<0{,}05$, $N=15$). Pijawki najczęściej były zlokalizowane na płetwach parzystych lub rostrum, rzadziej na bokach ciała, płetwach odbytowej lub ogonowej. Prawdopodobnie odszukiwanie żywiciela związane jest z pozytywną fototaksją. Pijawki wykorzystują w odszukiwaniu żywiciela jego cień, który powoduje spadek natężenia światła odbierany przez plamki oczopodobne znajdujące się na przyssawce tylnej.