Odonata as food of fish

Ważki jako pokarm ryb

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Abstract. Presented is data on the occurrence of Odonata in fish stomachs in certain waters in Poland, Finland, Italy and France. In general Odonata are a rare item in fish stomachs (they constitute less than 1% of the organisms eaten). In Poland the main Odonata eaten by salmonids are *Calopteryx*, *P. pennipes* and gomphids, almost exclusively in highland and lowland running waters. In the material from Finland there is a striking lack of Zygoptera. The material from Italy, though small, indicates a similar role of lotic and lentic species.

In general high water favours consumption of Odonata larvae by salmonids in running waters, by increasing their availability to fish (higher catastrophic drift). In the case of perch it seems that the consumption increases during low water level. In the material adults played a negligible role.

Introduction

Odonata, as large invertebrates, attract considerable attention on the part of fish in various parts of the world. A survey of the literature confirms that at times these insects fall prey to fish in no small numbers (e.g. Tillyard 1920, Muttkowski 1925, Momot 1965, Stenson 1979 and Donald and Anderson 1982). However, there is surprisingly little information on and analysis of factors governing the availability of Odonata to fish. Moreover, there are very few synopsis on the role of Odonata to fish in natural conditions (Cios 1992; Corbet 1999). Therefore the purpose of this article is to present my own data on the occurrence of Odonata in fish stomachs and to draw from it some preliminary conclusions.

Material and methods

In the years 1985–2005 about 3 000 fish have been collected in various European countries for fish-food studies. The main species were: grayling (*Thymallus thymallus*) – about 60% of the material, brown trout (*Salmo trutta* m. *fario*) – about 25%, rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), pike (*Esox lucius*), perch (*Perca fluviatlis*) and black bass (*Micropterus salomoides*) – together about 15%. In running waters the salmonids are usually drift feeders. Pike prefer an ambush type of strategy, while perch and bass usually actively seek the food, when swimming slowly (I have observed this on several occasions).

The fish were caught mainly with rod and line (flyfishing and spinning) during leisure trips. Many fish stomachs were collected during angling competitions, especially in the case of Wda (38 fish were caught on 9 September 1988, 35 on 29 October 1994 and 34 on 23–24 October 1993) and Drawa. Some fish were obtained through the courtesy of other anglers (e.g. the material from France was kindly sent by Mr. Pierre Brulin, editor of the journal *Truites, Ombres et*

Saumons). Since the material was not collected in a systematic way (the fish were caught mainly during good angling periods, differing for each species and water) it has limited value for drawing conclusions concerning overall role of Odonata on a yearly basis. Therefore I omitted here statistical analysis. The main value of my material consists of indicating the taxonomic composition of the eaten Odonata, as well as of certain conditions when these insects become available to fish in larger numbers. The data may be also useful for faunistic research on the distribution of Odonata, especially protected species.

Odonata occurred in the material from four countries:

Poland. Rivers: Brda (RW – section from Rytel to Woziwoda), Czarna Hańcza (Frącki), Drawa (DNP – Drawieński National Park; O – downstream of Osieczno), Gwda (P – Płytnica; L – Lędyczek), Jeziorka (P – Przęsławice; G – Głosków), Łyna (Roś), Pasłęka (Pityny), Piława (lower part), Raba (near Pcim), Rawka (near the mouth of stream Białka), Rurzyca (affluent of Gwda), San (Lesko), Sobina (affluent of Wda), Wisła (section Ustroń–Skoczów) and Wkra (Joniec and Borkowo). Still waters: Brda (W – old river leg near Woziwoda) and Rakowe Lake (near Tarnowo, vicinity of Wałcz).

Finland. Rivers: Ii (near Taivalkoski), Merikarvia (near Pori), Muurame (near Jyväskyla), Pudas (near Lieksa), Nellim (Inari Lake drainage area), Tornio (near Tornio). Still water: Lake Pahta (near Inari).

Italy. Rivers: Po (upstream of Torino), Ticino (mainly old river legs and affluents; Be – Bereguardo, Bn – Bernate, Bo – Boffalora, Tu – Turbigo) and Vera.

France. Rivers: Chapeauroux and Uier.

The Odonata in fish stomachs were in various stages of digestion. At times only the remains were found, rendering identification very difficult, or possible only to the level of suborder (in some cases assembling the pieces was like fitting together a jigsaw puzzle). However, I am certain that in many cases identification by a specialist would have been much more precise.

Results and discussion

The Odonata found in fish stomachs are presented in tables 1 and 2. A summary of the specimens from Polish waters is presented below:

Running waters

Calopteryx sp. (*splendens* (Harris) and *virgo* (L.))	365 l + 7 im
Platycnemis pennipes (Pall.)	16
Erythromma najas (Hansemann) + *Coenagrion* sp.	66
Coenagrionidae	2
Zygoptera n. det.	5
Total Zygoptera	454 l + 7 im
Gomphus vulgatissimus (L.)	37
Gomphus sp.	2
Ophiogomphus cecilia (Fourcroy)	18
Gomphidae	1
Sympetrum sp.	1
Libellulidae	1
Anisoptera n. det.	12
Total Anisoptera	72 l

Stillwaters

Coenagrionidae	14
Aeshna grandis (L.)	1

The total number of specimens found in the three other countries is as follows:

Finland

Zygoptera n. det.	1
Onychogomphus forcipatus (L.)	14
Gomphide	3
Somatochlora sp.	1
S. metallica (Vander Linden)	1
Anisoptera n. det.	2

Italy

Calopteryx sp.	4
Ischnura elegans (Vander Linden)	6
Coenagrionidae	1

Ophiogomphus (?) sp.	1
Orthetrum sp.	4
Sympetrum sp.	4
S. sanguineum	1
Anisoptera n. det.	1
France	
Ophiogomphus cecilia (Fourcroy)	1
Anisoptera n. det.	1

In general Odonata constitute a minor item in the diet of the studied fish – less than 1% of the food items by number, but much more in terms of weight and energy derived from them. The overall frequency occurrence is ca. 2%.

In Poland the main Odonata eaten by salmonids are *Calopteryx*, *P. pennipes* and the gomphids. This is in agreement with the taxonomic composition and relative abundance of the species of Odonata in Polish running waters (Buczyński and Tończyk 1997). The Odonata are eaten mainly in highland and lowland rivers, especially with abundant aquatic vegetation (in some of these waters, like Wda o Wel, the frequency occurrence may reach over 50%). In mountain and submontane waters they are a rare item (only 4 recorded specimens from San, Wisła and Raba), probably deriving from lentic parts of these rivers.

Of interest is the large number (66 specimens) of *Erythromma najas* and *Coenagrion*, both of them lentic species, in a trout 36 cm long from the river Rawka (the stomach contents of this fish was delivered to me by an angler, with a brief description of the fishing conditions). Probably these damselflies drifted from some still water, during high water, since in the stomach of this fish I found also, among others, 6 *Lymnaea*, 3 *Physa* and 2 *Notonecta*, also showing preference for lentic stretches. This conclusion is supported by similar observations in other waters (see below). *Erythromma najas* is a common species in lentic parts of Rawka (G. Tończyk – personal information).

The taxonomic composition of Odonata from Finnish waters differs from the Polish ones. In Finland there is a dominance of Anisoptera, especially the gomphids. The lack of *Calopteryx* is striking, though these damselflies are common, at least in the southern part of the country.

In the case of Italy, the scarcity of the material does not permit drawing definite conclusions. However, the presence of *Calopteryx* in trout waters (Po and Vera) is in line with the situation in Poland. The other waters are usually either still or with a slow flow. Therefore the presence of lentic species is not surprising.

In general high water, resulting in catastrophic drift, seems to be a factor strongly enhancing the availability of Zygoptera (especially *Calopteryx*) and Anisoptera larvae to salmonids. I observed this in spring (Jeziorka 18 April, and Merikarvia), as well as in autumn (Wda 29 October). In the case of Wda on this date in one fish I found 23 *Calopteryx* and 1 *O. cecilia*, while in another fish 13 *Calopteryx*, 1 *G. vulgatissimus* and 2 *O. cecilia*. These high numbers may be considered rather remarkable. I may add here that another unusual prey in Wda on this occasion were five crayfish (*Orconectes limosus*), a rare item in grayling stomachs under normal conditions, which became available to fish as a result of high water, reinforcing the conclusion about the role of catastrophic drift.

The results of drift studies support my conclusion. Elliott (1967) caught *Pyrrhosoma nymphula* and *Cordulegaster boltoni* larvae only during a spate. Benson and Pearson (1987) reported many Gomphidae in drift, but during high water.

However, judging from their occurrence in fish stomachs, one may conclude that some larvae, especially *Calopteryx*, may be

a common item of the constant drift. In the literature there are reports of high drift density of larvae in various parts of the world - BENKE et al. (1986) in the case of Odonata, ZISCHKE et al. (1983) – *Enallagma* and *Ischnura*, KEEFER and MAUGHAN (1985) – Coenagrionidae, while PREVOT and PREVOT (1986) – Coenagrionidae, *O. forcipatus* and *C. splendens*. Small numbers of *C. virgo* were reported by WENINGER (1968), while of Cordulegastridae by JOHNSON and JOHNSON (1982).

It seems that – in contrast to salmonids – perch consume more Odonata during low water conditions (Jeziorka and Wkra). This may result from active search by perch of prey along the bottom in areas with no or little flow of water. Even slow movement of the larvae may render them detectable to this vigilant predator.

Adults of Odonata are rare items in fish stomachs, though there are interesting reports from other countries on this issue (CIOS 2005b). I have encountered only three cases of such predation. The first one was reported earlier (CIOS 2005a). The other two, presented here, concern *Calopteryx*. As regards the six adults from a trout in Sobina, unfortunately in 1985, still at an early stage of my research, I wasn't aware of the uniqueness of this case and I didn't record the sex of the insects. The recent case of a *C. splendens* ? in a perch from Rurzyca may point to predation on egg-laying females, possibly below the water surface.

CORBET (1999) presented a few conclusions on the role of Odonata to fish: larger fish eat Odonata, especially trout may gorge themselves with the larvae, larger larvae are selected and predation may greatly reduce the Odonata population. My material indicates that various zoophagous fish prey on Odonata. Trout, grayling, perch and pike all eat the larvae, whenever they are available to the fish. I cannot confirm any particular preference of trout for Odonata. Definitely also other predatory fish (like chub) also prey on them, but satisfactory research is lacking. I would like to draw attention to pike and perch, which on occasion may prey heavily on the larvae in some waters and further data may shed more light on this issue.

In running waters both small and large larvae are eaten and at present it is impossible for me to state, whether fish exhibit any preference (selection) in this respect. There also seems to be no difference in the consumption of the larvae by adult (> 30 cm) salmonids. Perhaps small fish eat less larvae, but I had no possibility to verify this, due to the official size limit of the fish, that an angler has to respect.

Table 1. Odonata found in fish stomachs from Polish waters (larvae, unless otherwise stated).

Name of water	**Sampling date**	**Fish species**	**Odonate**	**Number of specimens**
Brda (RW)	29-30.10.1994	Grayling	*Calopteryx* sp.	15
	27.11.1994	Grayling	*Calopteryx* sp.	34
	18-19.11.1995	Grayling	*Calopteryx* sp.	6
	25.11.1996	Grayling	*Calopteryx* sp.	1
	1-2.06.1996	Grayling	*Calopteryx* sp. *P. pennipes*	4 1
	1-2.06.1996	Brown trout	*Calopteryx* sp.	12

Table 1. Count.

	24.11.1996	Grayling	*Calopteryx* sp. Coenagrionidae	1 1
	14.10.2002	Grayling	*Calopteryx* sp.	1
	24.11.2002	Grayling	*Calopteryx* sp.	4
	30.11.2003	Grayling	*Calopteryx* sp.	1
Brda (W)	11.11.1996	Pike	Coenagrionidae	14
Czarna Hańcza	16-17.04.1988	Brown trout	*Calopteryx* sp.	2
Drawa (DNP)	23.10.1988	Grayling	*Calopteryx* sp. Zygoptera	2 2
	17.10.1992	Grayling	*Calopteryx* sp. *Coenagrionidae*	13 1
	15.10.1995	Grayling	*Calopteryx* sp. Gomphidae	7 1
	13.10.1996	Grayling	*Sympetrum* sp.	1
Drawa (O)	14.10.2001	Grayling	*Calopteryx* sp. Anisoptera	13 1
	13.10.2002	Grayling	*Calopteryx* sp. Anisoptera	8 4
	2.11.2003	Grayling	*Calopteryx* sp.	1
Gwda (L)	12.10.2002	Grayling	*Calopteryx* sp. *G. vulgatissimus*	2 2
Gwda (P)	28-29.08.1993	Grayling	*Calopteryx* sp. Zygoptera	1 1
Jeziorka (P)	16.06.1994	Brown trout	Zygoptera	1
	18.04.2004	Brown trout	*Calopteryx* sp.	9
Jeziorka (G)	26.07.1996	Perch	*Calopteryx* sp.	23
Łyna	28.09.2002	Grayling	*Calopteryx* sp.	2
	8.05.2005	Brown trout	*C. splendens*[1)]	2
Pasłęka	??.04.1992	Brown trout	*Calopteryx* sp.	1
	29.09.2002	Grayling	*Calopteryx* sp. *G. vulgatissimus*	5 1
Piława	10.11.1996	Grayling	*Calopteryx* sp.	2
Raba	27-30.04.2005	Rainbow trout	*O. cecilia*[1)]	2
Rakowe L.	15-20.08.1993	Pike	*Aeshna grandis*	1
Rawka	7.04.1995	Brown trout	*E. najas* + *Coenagrion* sp.	66
Rurzyca	5.07.2005	Perch	*C. splendens*	1?
San	1.06.2002	Grayling	Anisoptera	1
Sobina	29.05.1985	Brown trout	*Calopteryx* sp.	6 im

[1)] Det. Dr. P. Buczyński.

Table 1. Count.

Wda	9.09.1988	Grayling	*Calopteryx* sp. *P. pennipes*	24 4
	23-24.10.1993	Grayling	*Calopteryx* sp. *P. pennipes* *Gomphus* sp.	29 6 2
	29.10.1994	Grayling	*Calopteryx* sp. *P. pennipes* Libellulidae *G. vulgatissimus* *O. cecilia*	146 2 1 12 7
	28.10.1995	Grayling	*Calopteryx* sp. *P. pennipes* *G. vulgatissimus* *O. cecilia*	21 3 20 5
Wel	26.06.1993	Brown trout	*Calopteryx* sp.	2
	21.05.1994	Brown trout	*Calopteryx* sp. Anisoptera	15 1
	9.04.1995	Brown trout	*Calopteryx* sp.	5
	7-9.05.1995	Brown trout	*Calopteryx* sp.	6
	21.05.1995	Brown trout	Anisoptera	2
	23.03.1996	Brown trout	*Calopteryx* sp.	1
Wisła	13-14.05.1995	Brown trout	Zygoptera	1
Wkra	10.08.1996	Perch	*G. vulgatissimus* *O. cecilia* Anisoptera	2 4 3
	9.07.2005	Perch	*C. splendens*[1)]	2

Table 2. Odonata larvae found in fish stomachs from Finnish, Italian and French waters.

Country	**Water**	**Date**	**Fish species**	**Odonata**	**Number of specimens**
Finland	Iijoki	7-12.07.1998	Grayling	*Somatochlora* sp.	1
	Merikarvianjoki	13-14.06.1998	Grayling	*O. forcipatus*	14
	Muurame	15.05.1999	Grayling	Zygoptera	1
	Nellim	20-26.06.2001	Grayling	*S. metallica*	1
	Pahtajärvi	7-9.06.2000	Grayling	Anisoptera	1
	Pudasjoki	11.08.2000	Grayling	Anisoptera	1
	Tornio	10.06.2001	Grayling	Gomphidae	3

[1)] Det. Dr. P. Buczyński.

Table 2. Count.

Italy	Po	18.11.1990	Grayling	*Calopteryx* sp. *I. elegans*	1 6
	Ticino (T)	21.07.1991	Pike	*Sympetrum* sp.	1
	Ticino (Bo)	22.07.1989	Pike	Anisoptera	1
		5.07.1992	Black bass	Coenagrionidae	1
		5.08.1992	Pike	*S. sanguineum*	1
	Ticino (Bn)	21.08.1992	Pike	*Ophiogomphus* sp. (?)	1
	Ticino (Be)	23.05.1992	Pike	*Orthetrum* sp. *Sympetrum* sp.	4 3
	Vera	5 and 22.04.1992	Brown trout	*Calopteryx* sp.	3
France	Chapeauroux	5.06.1994	Brown trout	Anisoptera	1
	Uier	9.06.1994	Grayling	*O. cecilia*	1

Further research should provide more data on the role of Odonata in still waters. This would supplement the rich existing experimental research on fish predation on the larvae, hitherto dealing only with lentic species.

I would like to thank dr. Paweł Buczyński for his assistance in determining the recently found specimens. Cooperation with him should significantly improve the results of my future research. New data from Finland, currently collected, will be presented at a later date.

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Streszczenie

Przedstawiono ważki stwierdzone przez autora w żołądkach ryb (lipieni, pstrągów potokowych, tęczowych i źródlanych, okoni, szczupaków i basów wielkogębowych), złowionych na wędkę w Polsce, Włoszech, Finlandii i Francji w latach 1985–2005. Z zasady ważki są rzadko zjadane przez ryby (stanowią mniej niż 1% organizmów stwierdzonych w żołądkach ryb), choć w niektórych ciekach nizinnych i wyżynnych ich rola może być znaczna.

W Polsce głównymi gatunkami zjadanymi przez ryby łososiowate są *Calopteryx* ssp., *P. pennipes* i Gomphidae, prawie wyłącznie w rzekach nizinnych i wyżynnych. W materiale z Finlandii zwraca uwagę brak Zygoptera. Materiał z Włoch, choć nieliczny, wskazuje na zbliżoną rolę gatunków siedlisk lotycznych i lenitycznych.

Generalnie wysoka woda sprzyja zwiększonej dostępności larw dla ryb łososiowatych, zarówno wiosną, jak i latem. W przypadku okonia wydaje się, że konsumpcja ważek wzrasta podczas niskiego stanu wody. Imagines rzadko są zjadane przez ryby (autor stwierdził jedynie trzy takie przypadki).

Key Words. Odonata, dragonflies, fish, predation.