

Redescription of *Proteocephalus neglectus* La Rue, 1911 (Cestoda: Proteocephalidae), a trout parasite, including designation of its lectotype

V. HANZELOVÁ and T. SCHOLZ

Institute of Helminthology, Slovak Academy of Sciences, Hlinkova 3, 040 01 Košice, Czechoslovakia;

Institute of Parasitology, Czechoslovak Academy of Sciences, Branišovská 31, 370 05 České Budějovice, Czechoslovakia

Key words: Cestoda, *Proteocephalus*, taxonomy, *Salmo trutta* m. *fario*, *Oncorhynchus mykiss*

Abstract. The tapeworm *Proteocephalus neglectus* La Rue, 1911 (Cestoda: Proteocephalidae), a common trout parasite in Europe, is redescribed on the basis of type specimens, comparative material from two different hosts (*Salmo trutta* m. *fario* and *Oncorhynchus mykiss*) and several geographical regions as well as on the literary data. The lectotype of this species is designated and the problem of the validity of *Proteocephalus* species parasitizing salmonid fish is briefly discussed.

The tapeworms of the genus *Proteocephalus* Weinland, 1858, are common and widely distributed parasites of freshwater fish, including salmonids. One of the commonest species, *Proteocephalus neglectus*, parasitizing mainly trout, was originally described by La Rue (1911) on the basis of specimens found in brown trout (*Salmo trutta* m. *fario* L.) from Switzerland. *P. neglectus* currently occurs in many European countries, mainly in those where rainbow trout (*Oncorhynchus mykiss* (Walbaum)) is reared in cage cultures: Russia, Germany, Denmark, Czechoslovakia, Great Britain, Yugoslavia, Italy (Freze 1965, Priemer 1980, From and Hørlyck 1981, Moravec 1982, Chubb et al. 1987, Ghittino 1987, Scholz 1989). In addition to that there are several records of *P. neglectus* in Asia (Freze 1965, Dubinina 1987, Scholz and Ergens 1990).

The identification of proteocephalids and their mutual differentiation have been based mostly on slight differences in their morphology. However, current studies indicate that morphological criteria used are much more variable in individual taxa than it was previously thought to exist (Ieshko and Anikieva 1980, Anikieva et al. 1983, Anikieva 1991, Hanzelová and Špakulová 1992). These data, therefore, raised problem of the validity of individual *Proteocephalus* species, including those parasitizing salmonid fish. The clarification of the currently rather confused situation in the taxonomy of this tapeworm group requires, among others, a thorough biometrical and morphometrical evaluation of individual taxa.

Consequently, the redescription of one of these species, *P. neglectus*, is given in the present paper; its lectotype is also designated and described herein.

MATERIALS AND METHODS

The following material was evaluated in the present study:

- 1) *P. neglectus* syntypes: two pieces of the strobila without scolices from "Forelle – *Trutta fario*" (= *Salmo trutta* m. *fario*) found in Switzerland and designated by F. Zschokke as "*Taenia longicollis* Rud.". Both mounts originating from Prof. H. B. Ward's collection (types No.09.10, Files No. M 756, C 456–7,8) are deposited in U.S. National Museum, USDA, Agricultural Research Service, Beltsville, Maryland, USA (Cat.No. 49 850);
- 2) four specimens from *Salmo fario* (= *Salmo trutta* m. *fario*), Môtiers near Neuchâtel, Switzerland; 28. 5. 1985; deposited in Muséum d'Histoire Naturelle, Geneva (Cat.No. 985/574, C 16/82–88).
- 3) two specimens from *Salmo trutta* m. *fario*, the Kamenice river, North Bohemia, Czechoslovakia; XI. 1978 and VII. 1979 (see Moravec 1982);
- 4) several tens of specimens from *Oncorhynchus mykiss*, Jesenice water reservoir, West Bohemia, Czechoslovakia VI. 1974, VI. 1987 (see Scholz 1989);
- 5) 30 tapeworms from *O. mykiss*, Dobšiná water reservoir, East Slovakia, Czechoslovakia; IX. 1988, IX. 1989, III. 1991 (see Hanzelová and Špakulová 1992);
- 6) 13 tapeworms from *O. mykiss*, Těšenov fish farm, South Moravia, Czechoslovakia; 4. 11. 1991.
- 7) tapeworms from *O. mykiss*, erroneously identified as *P. percae* (Müller, 1780), a fish farm near Viborg, Denmark; X. 1980 (see From and Hørlyck 1981).

Morphological characteristics measured are the same as were described by Hanzelová and Špakulová (1992). Three additional indices were used: LMS/WMS (the ratio of mature segment length to width), LGS/WGS (the ratio of gravid segment length to width) and DPCS/LCS (the ratio of the distal part of cirrus sac length to its total length). Distal part means the length of cirrus sac from the genital atrium to the external margin of vitelline follicles. All measurements are in μm unless otherwise stated.

RESULTS

The measurements of *P. neglectus* lectotype, the reference specimens studied as well as literary data are given in Table 1. The evaluation of the syntypes revealed that permanent mount labelled File No. C 456–7 undoubtedly served to La Rue for the description of *P. neglectus* (compare Fig. 81; La Rue (1914)). We designated this slide as lectotype (Figs. 1 B, C). The other mount, designated as paralectotype (File No. C 456–8), represents only a fragment of the strobila in a very poor condition (Fig. 1 A). The examination of the lectotype showed several discrepancies between La Rue's description (La Rue 1911, 1914) and our observations (see Table 1).

The biometrical variability of *P. neglectus* from the different hosts and regions is considerable in many morphological characteristics. The present data also indicate that measurements of *P. neglectus* overlap ranges given for this species in identification keys (La Rue 1911, 1914, Freze 1965, Dubinina 1987). Taking into consideration this fact, the species *P. neglectus* is redescribed. (The data summarized in Table 1 provided a basis for the redescription; the measurements of the lectotype in parentheses).

Table 1. Biometrical characteristics of *Proteocephalus neglectus* La Rue, 1911

Host	<i>Salmo trutta</i> m. <i>fario</i>				<i>Oncorhynchus mykiss</i>				
Geographical region	Lectotype	La Rue 1914	Môtiers	Kamenice	Jesenice	Dobšiná	Těšenov	Viborg	Freze 1965
	Switzerland				Czechoslovakia				
Length of body (mm)	0.84	1.53	1.41	32	80	1.60	1.25	55	250 (40)
Maximum width of body (mm)	—	—	210–279	216	200–370	159–411	201–372	1.2	20
Width of scolex	—	—	73–86	60–86	74–106	59–128	81–146	237	180–260
Diameter of sucker	—	—	0.26–0.41	30	0.29–0.40	0.22–0.48	0.27–0.51	76–94	57–83
DS/WGS	—	—	47–52	—	46–87	32–73	38–86	0.33–0.40	—
Diameter of apical organ	—	—	0.60–0.64	—	0.58–0.90	0.33–0.75	0.34–0.72	41	57–85
DAO/DS	—	—	211–264	—	200–390	135–372	148–433	0.44–0.54	—
Width of neck	—	—	0.44–0.74	0.14–0.23	0.14–0.92	0.30–1.49	0.47–1.25	154	182–323
Length of mature segment (mm)	—	—	0.92–1.16	0.72–0.82	0.39–1.35	0.35–1.41	0.44–0.92	0.21–0.32	0.20–0.40
Width of mature segment (mm)	—	—	0.44–0.68	—	—	0.46–2.37	0.66–1.97	0.53–0.69	0.60–0.90
LMS/WMS	0.48–0.57	0.50–0.75	0.68–0.98	0.28–1.04	0.32–1.58	0.22–1.60	0.62–1.10	0.30–0.57	—
Length of gravid segment (mm)	0.81–0.84	0.93–1.53	0.81–1.41	0.81–1.13	0.74–1.58	0.52–1.38	0.56–0.92	0.28–0.88	0.90
LGS/WGS	0.59–0.64	—	0.51–1.06	—	—	0.23–2.43	0.88–1.41	0.31–1.16	0.90
Length of testes	53–77	42–64	40–124	30	46–124	52–116	44–106	36–77	70–91
Width of testes	78 and 88	—	—	18–24	41–106	—	—	54–72	39–65
Number of testes	178–243	75 and 76	41–72	42–60	64–95	29–91	44–99	63–77	222–303
Length of cirrus sac	77–84	185–390	193–301	240–330	185–377	148–372	167–314	195–336	50–71
Width of cirrus sac	58–81	up to 80	36–80	—	46–92	56–130	64–126	50–66	—
Distal part of cirrus sac	2.31–2.89	—	2.28–4.00	—	—	—	32–95	—	—
LCS/WCS	0.33–0.44	—	0.15–0.39	—	2.50–4.80	2.08–3.80	2.09–3.34	3.10–5.50	—
DPCS/LCS	0.22–0.30	0.25–0.33	0.18–0.31	0.33	0.20–0.38	0.23–0.52	0.19–0.35	—	—
Width of ovary	577–606	—	708–902	544–585	320–1210	262–928	363–686	0.32–0.42	0.33
Length of ovarian lobe	273–290	—	268–432	—	—	93–424	162–353	320–456	200–300
Width of ovarian lobe	76–96	—	130–207	54–82	—	93–424	162–353	109–192	—
Isthmus of ovary	26	—	13–65	—	50–140	72–327	90–227	63–90	78–130
Diameter of vaginal sphincter	39–45	16	33–43	—	50–60	13–104	12–44	17–30	30–40
Number of uterine branches (total)	8–12	—	11–16	11–14	10–14	18–68	24–46	30–41	40–60
— on each side	4–6	7–9	—	—	—	8–14	9–22	11–16	—
Diameter of internal envelope	—	42–47	—	36–39	33–39	—	7–11	31–37	5–9
Diameter of oncosphere	24–28	26–26.5	—	21–24	23–26	21–35	—	18–21	42–47
									25–30

Proteocephalus neglectus La Rue, 1911

Fig. 1; Table 1

Body length up to 250 mm, maximum width 2 mm (0.84 mm). Scolex semi-spherical or spherical, 159–411 wide. Four suckers, measuring 57–146 in diameter, situated laterally or anterolaterally. DS/WS 0.22–0.51. Apical organ well developed, 30–87 in diameter. DAO/DS 0.33–0.90. Neck slightly developed or indistinct, 135–433 wide. Body with evident segmentation. Size of mature segments $0.14\text{--}1.49 \times 0.35\text{--}1.41$ mm, LMS/WMS 0.30–2.37, that of gravid segments

$0.22\text{--}1.60 \times 0.31\text{--}1.58$ mm ($0.48\text{--}0.57 \times 0.81\text{--}0.84$ mm). LGS/WGS 0.23–2.43 ($0.59\text{--}0.64$). Testes nearly spherical, 30–124 (53–77) in diameter, lying in one or two (one) layers in medular parenchyma. Testis number 29–99 (78 and 88), mostly about 60. Cirrus sac elongated, rather variable in shape: with narrower distal part or tapering in proximal part, measuring $148\text{--}390 \times 46\text{--}130$ ($178\text{--}243 \times 77\text{--}84$). Cirrus sac composed of two unequal part, overlapping one another (Fig. 1 B). Indices: LCS/WCS 2.08–5.50 (2.31–2.89), DPCS/LCS 0.15–0.44 (0.33–0.44), LCS/WMS 0.18–0.52 (0.22–0.30). (Cirrus somewhat protruded, bluntly ended). Position of cirrus sac alternating irregularly. Ovary bilobed, its total length 200–1210 (577–606); size of ovarian lobes $93\text{--}432 \times 50\text{--}327$ ($273\text{--}290 \times 76\text{--}96$). Width of ovarian isthmus 12–104 (26). Vitelline follicles forming two laterally situated longitudinal bands. Vagina without visible *pars copulatrix vaginae* and coils, avoiding or crossing cirrus sac in its course, opening anterior to cirrus sac opening. In distal part, vagina provided with well developed oval sphincter 18–68 (39–45) in diameter. Uterus forming 8–22 (8–12) lateral branches altogether, 4–11 (4–6) on each side. Eggs of typical appearance, with external transparent envelope; diameter of oncosphere 18–35 (24–28).

DISCUSSION

Proteocephalus neglectus was erected and briefly described by La Rue in 1911. In this paper, it was differentiated only from *P. longicollis* Linstow on the basis of unspecified differences in genital organs. Three years later, the same author (La Rue 1914) gave much more detailed description supplemented by two line drawings of *P. neglectus* and specified type host ("*Forelle-Trutta fario*"). He also speculated about probable type locality (Geneva or Luzern lakes in Switzerland) and designated type specimens (No. 09.10).

The evaluation of *P. neglectus* syntypes revealed differences between the original description (La Rue 1911, 1914) and present data in the following morphological characteristics: 1) number of testes (78 and 88 in lectotype whilst 75 and 76 in La Rue's description); 2) number of uterine branches (4–6 and 7–9 on each side, respectively); 3) diameter of vaginal sphincter (39–45 μm and only 16 μm , respectively); 4) course of the distal part of vagina (it completely avoids cirrus sac in the lectotype whilst La Rue (1914) stated: "Normally in its course the vagina is slightly bowed posteriad across the middle or in the inner end of the cirrus-pouch") (see Table 1, Figs. 1B, C).

In addition to the above-mentioned discrepancies, statements of La Rue (1914) "When the cirrus is partly protruded the cirrus-pouch is constricted near its inner end (Fig. 81). It is also reduced in length, measuring in various states of contraction $0.185\text{--}0.190\text{--}0.220\text{--}0.265$ mm by a maximum breadth of about 0.080 mm. In a single proglotid the cirrus pouch was in normal condition. This is delineated (Fig. 82). This cirrus-pouch measures 0.390 mm long" seem to be

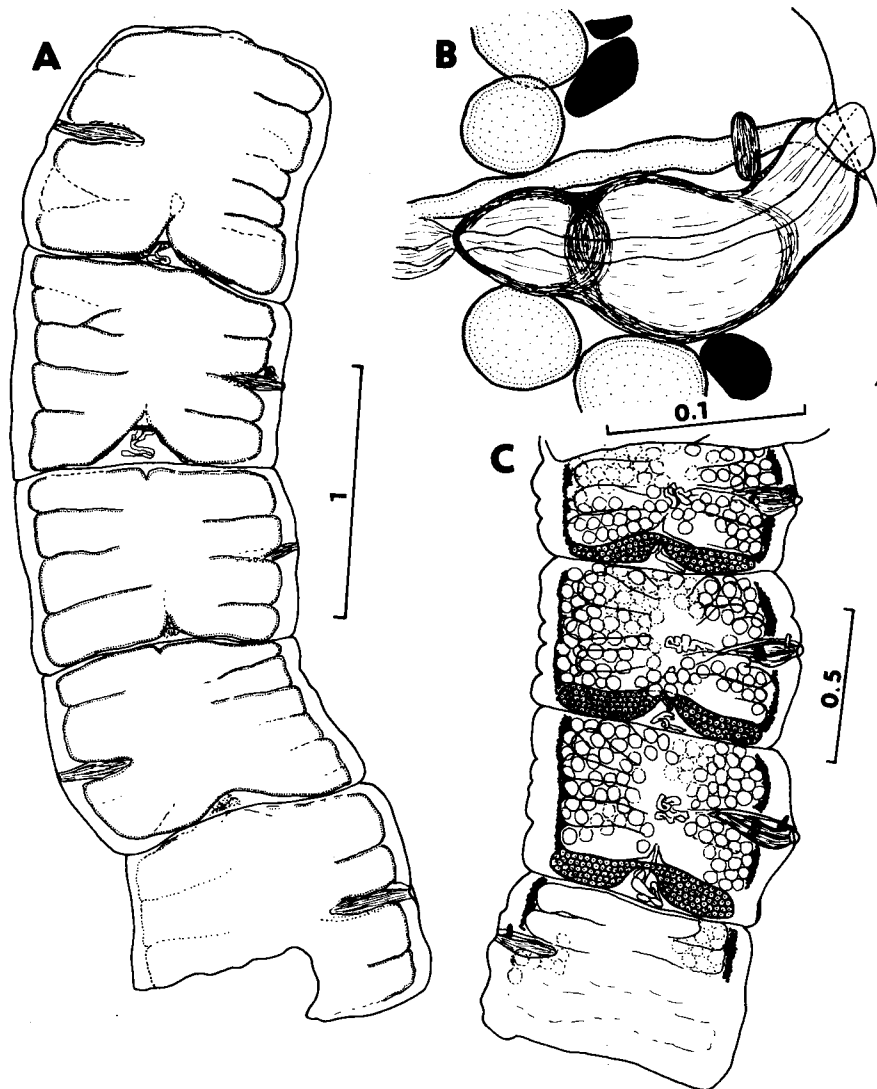


Fig. 1. *Proteocephalus neglectus* La Rue, 1911 – lectotype (B, C), paralectotype (A). A, C – fragments of strobila with gravid segments; B – cirrus sac. Two anterior segments rolled back without any visible internal structures are omitted in the lectotype (C). Scale bar in millimetres (mm).

doubtful or even erroneous. In our opinion, cirrus sacs in the lectotype are without any contractions or deformations and they correspond in their shape and size to those described by many authors who studied the morphology of *P. neglectus* (Freze 1965, Dubinina 1987, Scholz 1989, Hanzelová and Špakulová 1992). Besides that, the length of 0.390 mm seems to be rather large for *P. neglectus* cirrus sac.

The present morphological study of *P. neglectus* based on the examination of the types and reference specimens coming from different fish hosts and geographical regions also revealed considerable biometrical and morphological variability of *P. neglectus*. The study, together with literary data, also enabled to supplement the species diagnosis of this tapeworm. It is clear from this diagnosis that mutual differentiation of *P. neglectus* and some other *Proteocephalus* species parasitizing salmonid and coregonid fish seems to be rather difficult, if at all possible.

In his monographs, Freze (1965) listed as much as 14 *Proteocephalus* species found in salmonid and coregonid fish. They are as follows: *P. arcticus* Cooper, 1921, *P. parallacticus* McLulich, 1943, *P. primaverus* Neiland, 1952, *P. pusillus* Ward, 1910, *P. salmonidicola* Alexander, 1951, *P. salmonis-umblae* (Zschokke, 1884), and *P. tumidocollis* Wagner, 1953 from salmonids (fish genera *Salmo*, *Oncorhynchus* and *Salvelinus*), and *P. coregoni* Wardle, 1932, *P. exiguus* La Rue, 1911, *P. fallax* La Rue, 1911, *P. laruei* Faust, 1919, *P. longicollis* (Zeder, 1800), *P. pollanicola* Gresson, 1952, and *P. wickliffi* Hunter et Bangham, 1933 from coregonids. The slight morphological differences between the most of the above species and *P. neglectus* clearly cast doubts on the validity of many these taxa. Their conspecificity appears to be rather probable.

For example, the species *P. tumidocollis*, described by Wagner in 1953 from *Salmo gairdneri* (= *Oncorhynchus mykiss*) in North America and *P. neglectus* are morphologically nearly identical (compare the description made by Wagner (1953) with the present data). However, the synonymization of these two species is not possible without a re-examination of *P. tumidocollis* types and their comparison with *P. neglectus*.

The above-mentioned assumption about the probable conspecificity of many taxa from the genus *Proteocephalus* parasitic in salmonid and coregonid fish is supported by results of comprehensive studies about the morphology of proteocephalids made by other authors (Ieshko and Anikieva 1980, Anikieva et al. 1983, Anikieva 1991, Hanzelová and Špakulová 1992).

Acknowledgements. The authors wish to thank to Dr. J. R. Lichtenfels and Dr. P. A. Pilitt, U.S. National Museum, USDA, Beltsville, USA, for loan of the type specimens of *P. neglectus*, to Dr. J. From, Danish Institute for Fisheries and Marine Research, Skaerbaek, Denmark and to Dr. A. de Chambrier, Département des Invertébrés, Muséum d'Histoire Naturelle de Genève, Switzerland for kind providing *P. neglectus* specimens from *Salmo trutta m. fario* and *Oncorhynchus mykiss*. Our thanks are also due to Ing. J. K. Macko, Institute of Helminthology, Košice and to Dr. F. Moravec, Institute of Parasitology, České Budějovice for valuable advice. The results were obtained from the studies supported by grant SAS No. 160/92 and grant ČSAV No. 62210.

REFERENCES

- ANIKIEVA L. V. 1991: The use of morphological indices of *Proteocephalus pollanicola* (Cestoda: Proteocephalidae) for a more precise definition of the origin of its host, *Coregonus pollan* Thompson. *Parazitologiya* 25: 228–233. (In Russian.)
- ANIKIEVA L. V., MALAKHOVA R. P., IESHKO E. P. 1983: Ecological Analysis of Parasites of Coregonid Fish. Publ. House Nauka, Leningrad, 168 pp. (In Russian.)
- CHUBB J. C., POOL D. W., VELTKAMP C. J. 1987: A key to the species of cestodes (tapeworms) parasitic in British and Irish freshwater fishes. *J. Fish. Biol.* 31: 517–543.
- DUBININA M. N. 1987: Class Cestoda Rudolphi, 1808. In O. N. Bauer (Ed.), Key to the parasites of freshwater fishes. Vol. 3. Publ. House Nauka, Leningrad, pp. 5–76. (In Russian.)
- FREZE V. I. 1965: Proteocephalids – tapeworm helminths of fish, amphibians and reptiles. Essentials of Cestodology, Vol. 5. Publ. House Nauka, Moscow, 539 pp. (In Russian.)
- FROM J., HØRLYCK V. 1981: First recorded occurrence of *Proteocephalus percae* (Müller, 1780) in Danish farmed trout. *Bull. Eur. Ass. Fish Pathol.* 1: 40–41.
- GHITTINO C. 1987: Casi di proteocefalosi in trote iridee d'allevamento. *Riv. It. Piscic. Itiop.* A 22: 21–25.
- HANZELOVÁ V., ŠPAKULOVÁ M. 1992: Biometric variability of *Proteocephalus neglectus* (Cestoda: Proteocephalidae) in two different age groups of the rainbow trout from the Dobšiná dam (East Slovakia). *Folia Parasitol.* 39: 307–316.
- IESHKO E. P., ANIKIEVA L. V. 1980: Polymorphism in *Proteocephalus exiguus* (Cestoidea: Proteocephalidae) – a wide spread parasite of the coregonids. *Parazitologiya* 14: 422–426. (In Russian.)
- LA RUE R. B. 1911: A revision of the cestode family Proteocephalidae. *Zool. Anz.* 38: 473–482.
- LA RUE R. B. 1914: A revision of the cestode family Proteocephalidae. III. *Biol. Monogr.* 1, No. 1–2, pp. 3–351.
- MORAVEC F. 1982: The finding of the cestode *Proteocephalus neglectus* La Rue, 1911 from brown trout from Czechoslovakia. *Folia Parasitol.* 29: 189–190.
- PRIEMER J. 1980: Lebenszyklus von *Proteocephalus neglectus* (Cestoda) aus Regenbogenforellen *Salmo gairdneri*. *Angew. Parasitol.* 21: 125–133.
- SCHOLZ T. 1989: Amphilinida and Cestoda, parasites of fish in Czechoslovakia. *Acta Sci. Nat. Brno* 23, No. 4, 56 pp.
- SCHOLZ T., ERGENS R. 1990: Cestodes of fishes from Mongolia. *Acta Soc. Zool. Bohemoslov.* 54: 287–304.
- WAGNER E. D. 1953: A new species of *Proteocephalus* Weinland, 1858 (Cestoda), with notes on its life history. *Trans. Am. Microsc. Soc.* 72: 364–369.

Received 1 July 1992

Accepted 6 August 1992