Oceanological and Hydrobiological Studies
International Journal of Oceanography and Hydrobiology
Vol. XXXVII, No.4

Institute of Oceanography (61-71) University of Gdańsk
ISSN 1730-413X 2008 eISSN 1897-3191

DOI 10.2478/v10009-008-0013-1
Original research paper

Received: *June 04, 2008*
Accepted: *October 16, 2008*

Infestation of the black cormorants (*Phalacrocorax carbo sinensis* L. 1758) from the colony on the Selment Wielki, with the nematode *Contracaecum rudolphii* Hartwich, 1964 (Nematoda, Anisakidae)

Janina Dziekońska-Rynko[1], Jerzy Rokicki[2]

[1] Department of Zoology, Faculty of Biology
University of Warmia and Mazury
ul. Oczapowskiego 5, 10-957 Olsztyn, Poland
[2]Department of Invertebrate Zoology, University of Gdańsk
al. Piłsudskiego 46, Gdynia, Poland

Key words: *Contracaecum rudolphii*, black cormorant, infestation intensity, infestation prevalence

Abstract

Seasonal changes in the intensity and prevalence of infestation of the black cormorants from the colony on Lake Selment Wielki were investigated. In 2006, the cormorants were procured in April, August, and October, while in 2007, they were collected in August and September. The prevalence of the infestation was very high and reached 100%. The highest intensity (mean values of 102.46 and 82.17 nematodes/bird in 2006 and 2007, respectively) was revealed in the cormorants shot in August. Intensity of infestation of those birds procured in autumn 2006 was more than twice that found in spring and one-fourth of that found in summer of that year. Similarly, in autumn of 2007, the birds' stomachs contained less than half of the number of nematodes recorded in summer of that year.

[1] Corresponding author: *jdr@uwm.edu.pl*

INTRODUCTION

At the turn of the 20th century, the European population of the black cormorant (*Phalacrocorax carbo* L. 1758) consisted of as few as 3500-4500 pairs; about 150 pairs have been recorded in Poland (Przybysz 1997, Stempniewicz et al. 1998). The granting of legal protection to the species in Poland in 1952, the increase in the abundance of cyprinids and percids (the major food items of the cormorants), and the ban on DDT-containing pesticides resulted in a rapid growth of the species' abundance (Hansen 1984, Przybysz et al. 1988, de Nie 1995, Carss 2003).

According to Gmitrzuk (2004), black cormorant's effects on aquatic ecosystems may be analysed from two standpoints: effects on fisheries and the species' role in the functioning of a lacustrine ecosystem. The black cormorant is a typical fish-eater feeding on numerous fish species. As shown by many authors (Martyniak et al. 1997 a, b; Mellin & Krupa 1997) black cormorant's diet is dominated by small cyprinids and percids, which also contribute most to the fish biomass in highly trophic lakes (Prejs 1978). In contrast, species such as pike, whitefish, and vendace occur only sporadically in the black cormorant diet (Wziątek et al. 2005). The black cormorants play an important sanitary role with respect to the fish population: they remove parasite-infected individuals (Barber 2003). The contribution of which to the population increases with progressing eutrophication (Prejs 1978, Dzika 2003). On the other hand, the black cormorant may contribute to parasite dispersal in aquatic environments. Numerous parasites, whose larvae were present in the fish consumed, continue developing and mature in the black cormorant's body. A large part of faeces produced by the cormorants, containing various developmental stages of parasites, ends up in water where the parasites carry on their development. Important for parasite dispersal are also migrations of the black cormorants from their wintering grounds to breeding sites. Establishment of parasites in new ecosystems is favoured by climatic changes, primarily warming of the climate.

The nematode *Contracaecum rudolphii* is a cosmopolitan species, commonly found in ichthyophagous birds (Huizinga 1971, Kuiken et al. 1999, Nottekämper et al. 1999, Torres et al. 2000, Abollo et al. 2001, Torres et al. 2005, Amato et al. 2006). The nematode was first reported in Poland from the crested grebes (*Podiceps cristatus, P. griseigena, P. ruficollis*) in the Lublin Upland and in the little grebe (*Tachybaptus ruficollis*) near Białystok (Bezubik 1956). Korpaczewska and Sulgostowska (1967) found the nematode in the intestines of the crested grebes in Lake Warnołty, whereas Okulewicz (1989) reported the parasite to be present in the oesophagus of the red-throated diver (*Gavia stellata*) near Jelenia Góra. The nematode's presence in the Polish black

cormorant population was first reported by Żuchowska (2000). Studies carried out in the Kąty Rybackie breeding colony and in selected Masurian lakes showed almost 100% of the black cormorant in northern Poland to be infested (Kanarek et al. 2002, Szostakowska & Sulgostowska 2004, Kanarek & Rokicki 2005). Nottenkämper et al. (1999) found the infestation with that nematode to be very high in Bavaria (intensity and prevalence of 96.3 and 100%, respectively) and in the St. Gallen canton of Switzerland (63.3 and 94%, respectively). According to Kuiken et al. (1999), the prevalence of *C. rudolphii* invasion and its intensity in the black cormorant is bird age-dependent: the 1-week-old chicks showed 50% prevalence, while the 2- and 3-week-olds were infested in 71 and 83%, respectively and all the adults (100%) were hosts to the nematode.

Papers on the nematode's ability to complete its life cycle in Poland are very scarce. The laboratory study of Dziekońska-Rynko & Rokicki (2007) showed that in north-western Poland, similarly to North America (Huizinga 1966, Bartlett 1996) and Azerbaijan (Mosgovoy et al. 1968), copepods are the initial hosts, while fish are the second intermediate hosts and the major source of cormorant infestation. While in the cormorant stomach, the larvae moult for the last time and mature. The literature survey revealed a single paper only on the nematode's presence in fish in Poland (Szostakowska & Fagerholm 2007). On the other hand, many years of studies failed to demonstrate the presence of the parasite's larvae in those fish species that contribute most to the black cormorant diet (Dzika 2003, Rolbiecki 2003). The nematode's larvae were, on the other hand, frequently reported from fish in Chile (Torres & Cubillos 1987, Torres et al. 2000), Brazil (Martins et al. 2005), and the Black Sea (Kvach 2005, Pronkina & Belofastova 2005), which suggests that the parasite develops in water that is warmer than the waters of Poland, and that the black cormorants become infested during wintering.

The present study was aimed at investigating the prevalence and intensity of infestation of the black cormorants from the breeding colony on Lake Selment Wielki. In the 1970s, the black cormorants were seldom observed on the lake; the first nesting sites were reported in 1988. Since that time, the colony size has been growing steadily: at present, the colony consists of about 3000 birds (Abramczyk, pers. comm.).

MATERIALS AND METHODS

The study was carried out in 2006 and 2007 in the black cormorant breeding colony on Lake Selment Wielki (Province of Warmia and Masuria, north-eastern Poland). The cormorants were procured by shooting, 3 times in 2006 (on 12 April, just after the birds had arrived to the colony; on 27 August, after they

had completed clutch rearing; and on 4 October). In 2007 it proved impossible to shoot the cormorant prior to their breeding season, so the cormorants were procured on 24 August and 28 September. A total of 61 birds were examined.

For the study, the entire alimentary tract was dissected and divided into the oesophagus, stomach, and intestine. The individual parts were cut along their length and examined for the presence of the nematode *C. rudolphii*. The nematodes found were fixed in 10% formalin and cleared in lactophenol prior to identification. The larval stages were identified following Huizinga (1966) and Baruš et al. (1978).

RESULTS

The data on the infestation prevalence and intensity and the abundance of different developmental stages of the parasite are summarised in Table 1.

In all the black cormorants examined *C. rudolphii* were found only in the glandular stomach. The prevalence of infestation of the total black cormorant population was almost 100%. The highest infestation intensity (mean values of 102.46 and 82.17 individuals in a bird in 2006 and 2007, respectively) was revealed in August. In autumn 2006, infestation intensity was more than a half that found in spring and a quarter of the summer intensity. Similarly, nematodes found in autumn 2007 were more than two times fewer than those encountered in summer of that year. The nematodes found in stomachs of the birds shot in spring, immediately after their arrival to the colony, were dominated by females (65.34%) that measured, on the average 40.8 mm. Stomachs of most birds contained very little food; nematodes, both adult and larval, were anchored in the stomach wall. Nematodes found in stomachs of those birds shot in summer and autumn were dominated by larvae, which accounted for 47.82 and 56.08% of all nematodes isolated from the stomachs in 2006 and 2007 respectively. Stomachs of most black cormorants contained abundant food, whole or slightly digested fish being frequently found. The nematodes were immersed in the stomach content and occasionally they were found in the slightly digested fish. Analysis of the fish remains (scales, tail fins) in the stomach content showed roach, bream, and bleak to be the main food items for the cormorant colony studied. Remains of pike and tench were occasionally found in the stomachs as well.

DISCUSSION

Results obtained in this study showed the intensity and prevalence of infestation in the black cormorant colony on Lake Selment Wielki to be very high and varying seasonally. In this study, the adult and larval nematodes found

in the stomachs of the black cormorant studied were smaller than those found in the cormorant studied by Huizinga (1966). In his study, females measured 46.5 mm on the average, the average length of the females found in this work was 40.8, 35.4, and 38.7 mm in spring, summer, and autumn 2006, respectively. Males found by Huizinga (1966) averaged 43.17 mm in length, this study showing the male nematodes to measure from 20.4 mm (the shortest males) in autumn 2006 to 32.5 mm (the longest males) in summer 2006. According to Baruš et al. (1978) the female and male lengths range within 10.10-77.60 and 12.10-33.90 mm, respectively.

The highest intensity in both years of study was recorded in August, which could have resulted from the very intense feeding activity just before the birds were shot. According to Wziątek et al. (2005), the most intensive feeding of the black cormorants in colonies located in north-eastern Poland occurs in July and August. The very high infestation intensity appears to indicate a mass occurrence of the nematode in fish. The available literature, however, contains but a few papers on larval *C. rudolphii* in the fish inhabiting areas located in the vicinity of the colony under study. It was only Szostakowska & Fagerholm (2007), who examined 10 fish species (*Carassius carassius, Scardinius erythrophthalmus, Abramis brama, Blicca björkna, Tinca tinca, Esox lucius, Lucioperca lucioperca, Acerina cernua, Neogobius melanostomus*), found stage 3 larvae of the nematode in the crucian carp from Lake Selment Wielki and in the Caspian round goby from the Gulf of Gdańsk. In their study, both the prevalence and intensity of infestation were very low: only 3 out of 120 crucian carp examined were found to carry the nematode larvae. Two crucian carp contained 1-2 larvae, the third one hosting 500 larvae. The prevalence and intensity of infestation of the round goby were 2.4% and 1, respectively. The literature survey failed to reveal papers on the larval *C. rudolphii* presence in fish from other areas in Poland. Studies of fish from the Vistula Lagoon and Lake Wulpińskie, potential feeding grounds of the black cormorants from colonies in the immediate vicinity, failed to detect the larval *C. rudolphii,* too (Dzika 2003, Rolbiecki 2003).

The high number of *C. rudolphii* larvae in stomachs of the black cormorants examined may indicate a possibility of the nematode being capable of closing its live cycle in Poland, and that the cormorants become infested not only in their wintering areas, but also during the breeding season. In August 2006 and 2007, the larvae accounted for about 48 and 56% of the total numbers of *C. rudolphii* individuals found, respectively. A similar pattern was observed in autumn, but the total number of *C. rudolphii* found in the stomachs was definitely lower. As shown by a laboratory-based study of Dziekońska-Rynko & Rokicki (2007) the *C. rudolphii* eggs may develop at the water temperature as low as about 16-17°C and that cyclopoids may act as first intermediate hosts. In

summer, when the water temperature in lakes rises to more than 20°C, eggs of the nematode removed from the cormorant's body with faeces, may then fairly rapidly develop to produce larvae. The latter, having left the egg cover, are consumed by copepods, the major diet item of cyprinid fishes. The lack of publications on the larval nematode's presence in the fish results most probably from the small size of the larvae. A month after the experimental infestation of the crucian carp with *C. rudolphii* larvae, the larvae found in the fish body cavity averaged 841.25 μm in length, the mean length increasing to 1242.47 μm after 2 months (Dziekońska-Rynko et al. 2007). According to Moravec (1994), the early 3rd larvae found in the fish are 0.78–0.91 mm long, the older stages measuring 15.0–24 mm.

The distinctly lower infestation intensity in autumn than in summer is difficult to explain. In 2006, the mean infestation intensity in those birds shot in August was 4 times that found in the birds shot in late September, while in 2007 the pattern was repeated except that the August infestation intensity was twice as high as in late September. The only explanation that can be offered is that the change of birds in the colony. Migration routes of those cormorants breeding in north-eastern Poland are very poorly known. According to Mokwa et al. (2005), the black cormorants ringed in Poland were most commonly reported west or south of the breeding colony. The longest distances were covered by the black cormorants migrating to Tunisia, Egypt, Algeria, and Spain. At the same time, Poland is a destination for those birds migrating from the north, mainly from Sweden and Denmark, and from the White, Barents, and Azov Seas. The infestation intensity lower by a high factor could mean that the birds obtained in September had flown in from the north. Waters in northern Europe, much colder than those in Poland, are not hospitable to the development of the *C. rudolphi* eggs and do not permit the nematode to complete its life cycle. This contention may be supported by the lack of reports of the nematode's larvae in the fish of northern Europe, the larvae being present in those fishes caught in warmer areas (Torres & Cubillos 1987, Torres et al. 2000, Kvach 2005, Pronkina & Belofastova 2005).

Seasonal changes in the infestation intensity of the cormorants were described by Huizinga (1971) from Connecticut, USA. He found the highest number of nematodes, dominated by larvae, in stomachs of the cormorants short in August and September. The lowest numbers were typical of November, and most of the nematodes found were females. Seasonality in infestation intensity and prevalence in the Chilean cormorant *Ph. brasilianus* were reported by Torres et al. (2000). They found the highest intensity in spring, 75% of the nematodes being adult. The 3rd stage larvae were present only in autumn and winter, while the 4th stage larvae were found throughout the period of study, but they were at their most abundant (51%) in winter.

The presence of the nematode's larvae in fish from the Selment Wielki and the Gulf of Gdańsk (Szostakowska & Fagerholm 2007) confirms that the parasite is capable of closing its life cycle in Polish waters, and casts doubt on the safety of fish consumption, particularly prior to thermal treatment. As shown by the research carried out in Chile (Torres & Cubillos 1987, Torres et al. 2000), the introduced salmonids turned out to reveal a particularly high intensity and prevalence of infestation with the nematode's larvae. The nematode is a member of the family Anisakidae and, perhaps as is the case with other anisakids (*Anisakis simplex, Pseudoterranova decipiens*), humans may act as paratenic hosts. The problem of accidental human infestation with the nematode as a result of consuming dishes prepared of raw fish containing the parasite, has been widely discussed in the literature (Smith & Wotten 1978, Beldsoe & Oria 2001, Mercado et al. 2001). As shown by the relevant research, anisakids are highly pathogenic with respect to intermediate and definite hosts. Larvae of *A. simplex* damage the stomach of their intermediate and definite hosts (Smith & Wootten 1978, Young & Lowe 1969) and of the experimentally infested mammals. A similar ability to produce lesions in the stomach wall was observed during *C. rudolphii* invasions in cormorants (Huizinga 1971, Amato et al. 2006). This study, too, found the black cormorant stomach to show numerous haemorrhages related to penetration of the mucosa by the larvae that subsequently undergo their last moult. In view of the constantly increasing abundance of the black cormorant in Poland, the parasites, so abundant in their alimentary tract, may pose a threat to other organisms.

REFERENCES

Abollo E., Gestal C., Pascual S., 2001, *Anisakid infection in the European shag Phalacrocorax aristotelis aristotelis*, J. Helminthol., 75: 209-214

Amato J.F.S., Monteiro C.M., Amato S.B., 2006, *Contracaecum rudolphii Hartwich (Nematoda, Anisakidae) from the Neotropical Cormorant, Phalacrocorax brasilianus (Gmelin) (Aves, Phalacrocoracidae) in southern Brazil,* Rev. Bras. Zool., 23: 1284-89

Barber I., 2003, *The role of parasites in fish-bird interactions: a behavioural ecological perspective*. [in:] Interactions between Fish and Birds: Implications for Management, Eds. Cowx I.G., Fishing News Books, Blackwell Science Ltd., Oxford, pp. 221-43

Bartlett C.M., 1996, *Morphogenesis of Contracaecum rudolphii (Nematoda: Ascaridoidea), a parasite of fish-eating birds, in its copepod precursor and fish intermediate hosts*, Parasite, 4: 367-76

Baruš V., Sergeeva T.P., Sonin M.D., Ryzhikov K.M., 1978, *Helminths of Fish-Eating Birds of the Palaearctic region. I Nematoda,* USSR Academy of Sciences, Helminthological Laboratory Czechoslovak Academy of Sciences, Institute of Parasitology. Moscov/Prague

Beldsone G.E., Oria M.P., 2001, *Potential hazards in cold-smoked fish: parasites*, J.Food Sci., 66: 1100-03

Bezubik B., 1956, *Contributon to helminthofauna of waters birds from Poland*, Acta Parasitol. Polon., 4: 58-88

Carss, D.N.,2003, *Reducing the conflict between cormorants and fisheries on a pan-European scale*, Report to the European Commission (REDCAFE final report).

De Nie H., 1995, *Changes in the inland fish populations in Europe in relation to the increase of the cormorant Phalacrocorax carbo sinensis*, Ardea 83: 115-22

Dziekońska-Rynko J., Rokicki J., 2007, *Life cycle of the nematode Contracaecum rudolphii Hartwig, 1964 (sensu lato) from northern Poland under laboratory conditions*, Helminthologia, 44: 95-102

Dziekońska-Rynko J., Gomułka P., Wziątek B., 2007, *Experimental infection of Carassius carassius with Contracaecum rudolphii larvae*, Wiad. Parazytol., 53: 211, (in Polish)

Dzika E., 2003, *Metazoan parasites of roach Rutilus rutilus (L.) in the lakes of Mazury Destrict as a quality indicator of aquatic environment,* Dissertations and monographs.UWM Olsztyn, (in Polish with Engl. summ.)

Gmitrzuk K., 2004, *The Phalacrocorax carbo cormorant's influence on the aquatic and forest ecosystems of Węgierski National Park*, Parki Narodowe i Rezerwaty przyrody, 23: 129-146, (in Polish)

Hansen K., 1984, *The distribution and numbers of the Southeren Cormorant Phalacrocorax carbo sinensis in Europe*, Dansk Orn. Foren. Tidsskr., 78: 29-40

Huizinga H.W., 1971, *Contracaeciasis in pelicanform bird*, J. Wildl. Dis., 7: 198-204

Huizinga H.W., 1966, *Studies on the life cycle and development of Contracaecum spiculigerum (Rudolphi, 1809) (Ascaroidea: Heterocheilidae) from marine piscivorous birds,* J. Elisha Mitchell Sci. Soc., 82:181-95

Kanarek G., Rokicki J., 2005, *The status of the studies on the helminth fauna of the Great Cormorant (Phalacrocorax carbo sinensis) in northern Poland,* Wiad. Parazytol., 51: 165

Kanarek G., Rolbiecki L., Sitko J., Baruš V., Rokicki J., 2002, *The occurrence of Contracaecum rudolphii Hartwig, 1964 in the cormorant (Phalacrocorax carbo sinensis) in northern Poland*, 5. Slovenské a české parazitologické dni, 28-31 maja 2002, Stará Lesná, Slovenská Republika. Program a zbornik abstraktov, 22

Korpaczewska W., Sulgostowska T., 1967, *Contribution to helminthofauna of birds from Mazur waters (Warnołty Lake)*, Wiad. Parazytol. 13: 737-44, (in Polish)

Kuiken T., Leighton F.A., Wobeser G., Wagner B., 1999, *Causes of morbidity and mortality and their effect on reproductive success in double-crested cormorants from Saskatchewan*, Wildl. Dis. Ass. 35: 331-46

Kvach Y., 2005, *A comparative analysis of helminth faunas and infection parameters of ten species of gobid fishes (Actinopterygii: Gobiidae) from the north-western Black Sea*, Acta Ichthyol. Pisc., 35: 103-10

Martins M.L., Onaka E.M., Fenerick Jr., 2005, *Larval Contracaecum sp. (Nematoda: Anisakidae) in Hoplias malabaricus and Hoplerythrinus untaeniatus (Osteichthyes: Erythrinidae) of economic importance in accidental marshlanda of Maranhao*, Brazil. Vet. Parasitol., 127: 51-9

Martyniak A., Mellin M., Stachowiak P., Wittke A., 1997a, *Food composition of cormorants Phalacrocorax carbo sinensis in two colonies in north-east Poland*, Ekol. Pol. 45: 245

Martyniak A., Terlecki J., Boroń S., Hliwa P., Szamańska U., Gabryś B., Romaniewicz A., 1997b, *Diet composition of cormorants Phalacrocorax carbo sinensis from pellets collected at Katy Rybackie colony, northern Poland*, Ric. Biol. Selvaggina, Suppl., 26: 505-510

Martyniak A., Wziatek B., Szymanska U., Hliwa P., Terlecki J., 2003, *Diet composition of Great Cormorants Phalacrocorax carbo sinensis at Katy Rybackie, NE Poland, as assessed by pellets and regurgitated prey*, Vogelwelt, suppl., 124: 217-25

Mellin M., Krupa R., 1997, *Diet of cormorant, based on the analysis of pellets from breeding colonies in NE Poland*, Ric. Biol. Selvaggina, Suppl., 26: 511-15

Mercado R., Torres P., Munoz V., Apt W., 2001, *Human infection by Pseudoterranova decipiens (Nematoda, Anisakidae) in Chile*: *Report of seven casec*, Mem. Ins. Cruz. 96: 653-55

Mokwa T., Bzoma Sz., Gromadzki M., 2005, *Where from and where are the cormorants Phalacrocorax carbo observed in Poland migrating?*, Materiały Ogólnopolskiej Konferencji Ornitologicznej „Ornitologia polska na progu XXI stulecia-dokonania i perspektywy" Olsztyn , 82, (in Polish)

Moravec F., 1994, *Parasitic nematodes of Freshwater Fishes of Europe*. Academia, Praha

Mosgovoy A.A., Shakhmatova W.I., Semenova M.K., 1968, *Life cycle of Contracaecum spiculigerum (Ascaridata: Anisakidae), a parasite of domestic and game birds*, Trudy Gelmintol. Lab. Akad. Nauk. 19: 129-136 (in Russian)

Nottenkämper D., Korbel R., Kösters J., 1999, *The infection of great cormorants (Phalacrocorax carbo sinensis L. 1758) with Contracaecum rudolphii (Nematoda: Ascaridoidea) in the district of Upper Bavaria (Germany) and the canton St. Gallen (Switzerland)*, Tierärztl. Prax. Kleintier, 4: 27

Okulewicz A., 1989, *Intestinal nematodes of Gavia stellata and Gavia arctica (Gaviidae)*, Wiad. Parazytol., 35: 35-42, (in Polish with Engl. summ.)

Prejs A., 1978, *Lakes eutrofisation and the ichtiofauna*, Wiad. Ekol. 24: 201-8, (in Polish with Engl. summ.)

Pronkina N.V., Belofastova I.P., 2005, *New date about nematodes of the Black Sea golden grey mullet Liza aurata (Pisces: Mugilidae)*, Ekol. Morja, 68: 77-82 (in Russian with Engl. summ.)

Przybysz J., 1997, *Cormorants,* Wyd. Lubelskiego Klubu Przyrodników, Świebodzin (in Polish)

Przybysz J., Engels J., Melin M., Mrugasiewicz A., Przybysz A., Przybysz K.,1988, *A quantitative increase of cormorant (Phalacrocorax carbosinensis Shaw et Nodder) populations in Poland,* Prz. Zool., 32: 71-81, (in Polish with Engl. summ.)

Rolbiecki L., 2003, *Diversity of the parasite fauna of cyprinid (Cyprinidae) and percid (Percidae) fishes in the Vistula Lagoon, Poland,* Wiad. Parazytol., 49: 125-64

Smith J. W., Wootten R., 1978, *Anisakis and anisakiasis*. Advan. in Parasitol. 16: 93-163

Stempniewicz L., Goc M., Nitecki C., 1998, *The need to conduct ecological studies on the cormorant Phalacrocorax carbo in Poland,* Notatki Ornitologiczne 39: 33-45 (in Polish with Engl. summ.)

Szostakowska B., Fagerholm, H.P., 2007, *Molecular identification of Two Strains of Third-Stage Larvae of Contracaecum rudolphii Sensu Lato (Nematoda:Anisakidae) From Fish in Poland*, J. Parasitol., 93: 961-64

Szostakowska B., Sulgostowska T., 2004, *Helminthofauna Phalacrocorax carbo sinensis from northern Poland*, Wiad. Parazytol., 50: 119 (in Polish)

Torres P., Ortega J., Schlatter R., 2005, *Nematode parasites of the digestive tract in Neotropic cormorant chicks (Phalacrocorax brasilianus) from the River Cruces Ramsar site in southern Chile*, Parasitol. Res., 97: 103-7

Torres P., Cubillos V., 1987, *Infection with larvae of Contracaecum (Nematoda, Anisakidae) in Salmonids acclimatized in Chile*, J.Vet. Med. B., 34:177-82, (in Spanish with Engl. summ.)

Torres P., Valdiviesa J., Schlatter R., Montefusco A., Revenga J., "et al." 2000, *Infection by Contracaecum rudolphii (Nematoda: Anisakidae) in the Neotropic cormorant Phalacrocorax brasilianus, and fishes from the estuary of the Valdivia river, Chile*, Stud. Neotrop. Fauna & Environm., 35:101-8

Wziątek B., Martyniak A., Hliwa P., Kozłowski J., Krzywosz T., „et al." 2005, *Great cormorant predation on coregonid fishes at sites In Poland,* Advanc. Limnol., 60: 285-97

Young P.C., Lowe D.,1969, *Larval nematodes from fish of the subfamily Anisakinae and gastro-intestinal lesions in mammals*, J. Comp. Path., 79: 301-13

Żuchowska E., 2000, *Contracaecum rudolphii Hartwich, 1964 (Nematoda: Anisakidae) in Great Cormorants in Poland*, Wiad. Parazytol., 46: 411-12 (in Polish)