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DIGENEAN FAUNA OF THE GREAT CORMORANT *PHALACROCORAX CARBO SINENSIS* (BLUMENBACH, 1798) IN THE BRACKISH WATERS OF THE VISTULA LAGOON AND THE GULF OF GDAŃSK (POLAND)

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ABSTRACT. The great cormorant *Phalacrocorax carbo sinensis* (Blumenbach, 1798) is one of the most important birds in the Vistula Lagoon and the Gulf of Gdańsk area. As a typical piscivore, the bird plays a significant part in life cycles of parasites in aquatic ecosystems. Within January 2000-June 2001, a complete helminthological examination was performed on great cormorants collected in the nesting area at Kąty Rybackie on the Vistula Spit (80 specimens) and in the Vistula Lagoon (10 specimens). The infection prevalence, mean intensity, and intensity range were 92.2%, 376.5, and 1-4524, respectively. The presence of 9 digenean species (*Paryphostomum radiatum* (Dujardin, 1845), *Petasiger exaeretus* Dietz, 1909, *P. phalacrocoracis* (Yamaguti, 1939), *Mesorchis pseudoechinatus* (Olsson, 1876), *Metorchis xanthosomus* (Creplin, 1846), *Cryptocotyle concavum* (Creplin, 1825), *Hysteromorpha triloba* (Rudolphi, 1819), *Tylodelphys clavata* (Nordmann, 1832), and *Holostephanus dubinini* Vojtek et Vojtkova, 1968) was recorded, *P. phalacrocoracis* being the most common parasite (prevalence 92.2%, mean intensity 323.8). *Tylodelphys clavata* proved a parasite new for the great cormorant moreover the records of *P. phalacrocoracis*, *H. triloba*, and *H. dubinini* are the first in Poland, while *C. concavum* and *M. pseudoechinatus* were for the first time recorded in the great cormorant in Poland.

Key words: brackish waters, Digenea, great cormorant, *Phalacrocorax carbo sinensis*, Poland.

INTRODUCTION

Of the five subspecies of the cormorant *Phalacrocorax carbo* (Linnaeus, 1758), the great cormorant *Phalacrocorax carbo sinensis* (Blumenbach, 1798) occurs in central Europe, including Poland (Cramp and Simmons 1977, Tomiałojć 1990, Przybysz 1997). Great cormorants are large piscivorous birds growing to the length of 100 cm and attaining the wing span of 160 cm. Great cormorants inhabiting central Europe migrate regularly to overwinter in the Mediterranean, Bay of Biscay, and North Sea areas (Cramp and Simmons 1977, Przybysz 1997). In the 1980s, the *Ph. carbo sinensis* population grew rapidly in abundance throughout Europe, thereby rendering the great cormorant a common species, and even a dominant in numerous avian faunas. Such population growth resulted in a number of adverse effects,

including those incurred by fisheries (fish consumption) and forestry (damage to trees caused by strongly caustic faeces) (Dobrowolski and Dejtrowski 1997, Przybysz 1997, Szramka 2000).

The knowledge of the great cormorant parasitic fauna in Poland is fragmentary only. Some publications dealt with cestodes (Rybicka 1958, Korpaczewska 1963a, b), nematodes (Okulewicz 1989, Okulewicz and Rokicki 1998, Żuchowska 2000), and mallophagans (Złotorzycka 1990). The great cormorant trematode fauna was studied solely by Sulgostowska (1958, 1960a, b, 1963) who examined a few birds only.

This paper deals, for the first time in Poland, with digeneans parasitising the great cormorants feeding in brackish waters of the Vistula Lagoon and the Gulf of Gdańsk.

MATERIALS AND METHODS

Within January 2000-June 2001, a total of 90 great cormorants including 78 juveniles at their first year of life and 12 adult, sexually mature birds were examined. As the gonads were poorly developed in the juveniles, only the adults were sexed. The juveniles were collected during breeding seasons (mid-May until late June) in 2000 (52 birds) and 2001 (26 birds) from the nesting colony at Kąty Rybackie on the Vistula Spit (Fig. 1). They were those individuals unable to fly that fell out of nests. The adults examined had been found dead on the Vistula Spit or in

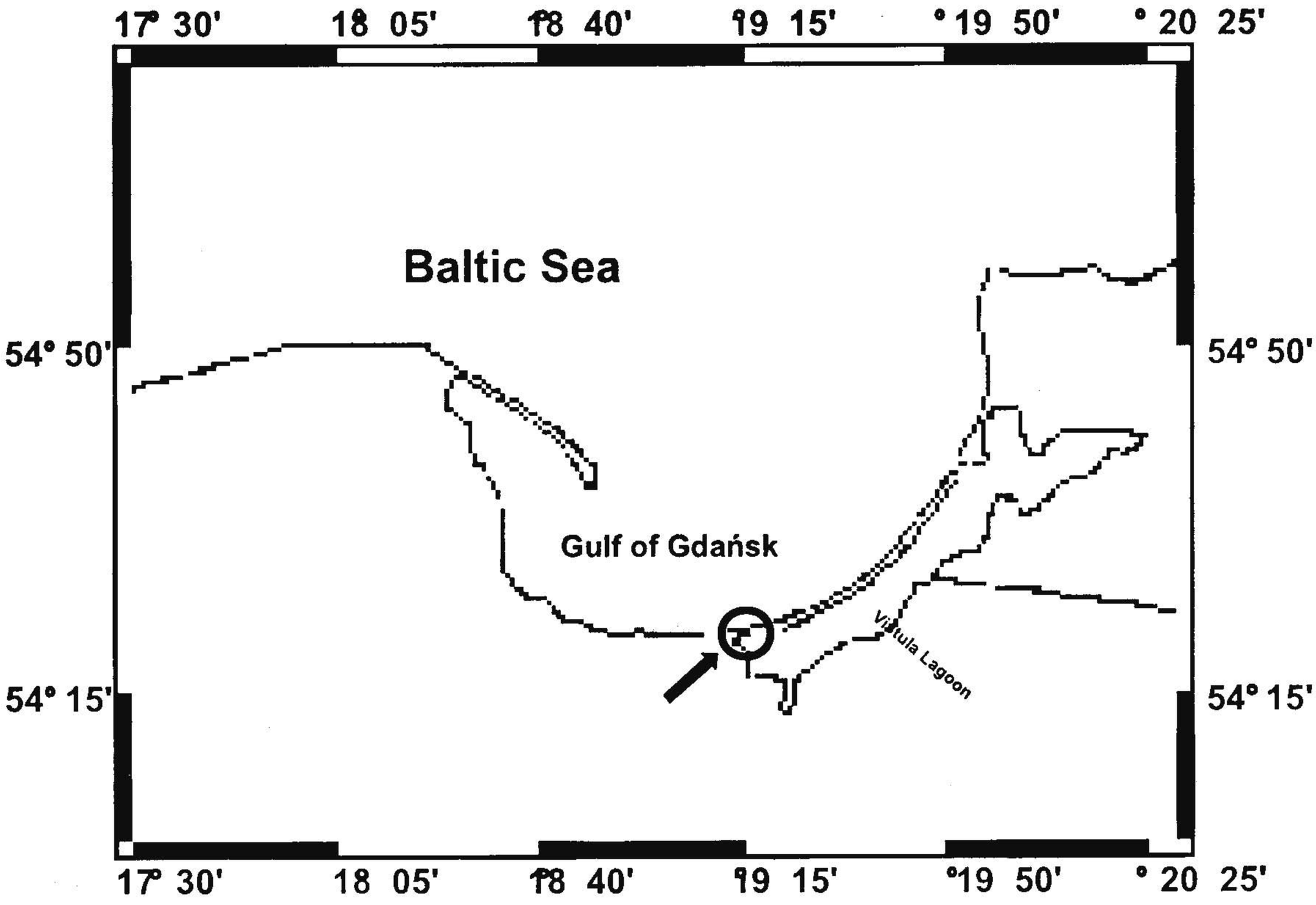

Fig. 1. Study area; thick circle – breading colony at Kąty Rybackie

fishing nets set up in the Vistula Lagoon (1 bird in January 2000, 1 bird in March 2000 and 1 in March 2001, 4 birds in April 2000, and 5 birds in April 2001).

The birds were subjected to a complete helminthological examination, carried out according to the generally adopted protocol (Dubinina 1971). The intestine, stomach, body cavity, mouth cavity, eyelids, liver, gall bladder, kidneys, ovaries, bursa Fabricii (at juveniles), oesophagus, tracheae, bronchia, heart, tarsi, and the subcutaneous tissue were examined. The parasites were removed from the intestine by decantation, the supernatant being additionally filtered through the miller's gauze. The parasites were fixed in 70% ethanol. Some of the parasites were stained in borax carmine, dehydrated in glacial acetic acid, and cleared in benzyl alcohol. Permanent mounts of some parasites were made by embedding them in Canada balsam; the remaining ones were left in the clearing fluid or in alcohol.

RESULTS

The total digenean prevalence in the great cormorant examined was 92.2%, the mean intensity and the intensity range amounting to 376.5 and 1-4524 individuals, respectively. The intestines and gall bladders (the latter containing only *Metorchis xanthosomus*) of 83 birds were found to contain 9 trematode species which were dominated by *Petasiger phalacrocoracis* (92.2%, 323.8; 1-4500) (Table 1).

The year 2000 materials showed the presence of 8 digenean species (*Paryphostomum radiatum*, *Petasiger exaeretus*, *P. phalacrocoracis*, *Metorchis xanthosomus*, *Cryptocotyle concavum*, *Hysteromorpha triloba*, *Tylodelphys clavata*, *Holostephanus dubinini*), the infection affecting 93.1% of the birds and the infection mean intensity amounting to 75.6. In 2001 the survey yielded 7 species (lack of *C. concavum* and *T. clavata,* the presence of *Mesorchis pseudoechinatus* not recorded in 2000), the infection prevalence and mean intensity being 90.6% and 335.6, respectively.

The infection level was different in the various ages categories: the juveniles hosted 8 digenean species that affected 93.6% of the birds with a mean intensity of 406.5, while the adults hosted 7 species affecting 83.3% of the birds with a mean intensity of 157.5 (Table 1).

DISCUSSION

The great cormorant (*Phalacrocorax carbo sinensis*) is one of the most common birds in the area of the Vistula Lagoon and the Gulf of Gdańsk. It nests at the Vistula Spit's base, forming a breeding colony at Kąty Rybackie; the colony is the largest in Poland and one of the largest in Europe. About 6000 breeding pairs are recorded there each year; the number of birds counted at the end of the breeding season may even exceed 25000 (Stempniewicz 1997).

Table 1. The frequency of *Digenea* in cormorants of different age, feeding on the Vistula Lagoon and Gulf of Gdańsk

Age of birds / Parasites	No. of parasites [ind.]			Prevalence [%]			Mean int. [ind]			Range of int. [ind.]		
	Juveniles	Adults	Total	Juveniles	Adults	Total	Juveniles	Adults	Total	Juveniles	Adults	Total
Paryphostomum radiatum	323	326	649	53.8	83.3	54.4	7.7	46.6	12.2	1-39	1-122	1-122
Petasiger exaeretus	4	8	12	3.8	16.6	4.4	1.3	4	2.4	1-2	3-5	1-5
P. phalacrocoracis	26020	852	26872	93.6	83.3	92.2	365.4	85.2	328.8	1-4500	1-452	1-4500
Mesorchis pseudoechinatus	2	0	2	2.6	0	2.2	1	0	1	1	0	1
Metorchis xanthosomus	565	11	576	37.2	33.3	36.6	19.5	2.8	17.4	1-128	1-5	1-128
Cryptocotyle concavum	392	0	92	3.83	3.33	0	30.7	0	30.7	9-68	0	9-68
Hysteromorpha triloba	648	376	1026	53.8	50	53.33	15.4	62.7	21.3	1-149	1-255	1-255
Tylodelphys clavata	0	2	2	0	8.33	1.13	0	2	2	0	32	2
Holostephanus dubinini	2001	7	2008	74.4	16.6	66.63	34.5	3.5	33.8	1-239	2-5	1-239
Total	29673	1579	31252	93.6	83.3	92.2	406.5	157.7	376.5	1-4524	1-522	1-4524

The number of digenean species found in this study (9) is fairly high. For comparison, 9 species were also recorded in Ukraine (Smogorzhevskaya 1976), 12 taxa (11 species and 1 taxon identified to the genus level) being recorded in the former East Germany (Reimer 1969) and 11 taxa being found in Moravia (Czech Republic) (Našincová et al. 1993).

Tylodelphys clavata was recorded for the first time in the great cormorant. As, however, the parasite was represented by two immature individuals, and in view of the digenean's larval stages being very common in the intermediate hosts, i.e., fish in the Gulf of Gdańsk and in the Vistula Lagoon (Rolbiecki at al. 1999, Rolbiecki 2003), it can be presumed that the infection was accidental and that the parasites would perish in the bird without acheiving their maturity. On the other hand, *Petasiger phalacrocoracis*, *Hysteromorpha triloba*, and *Holostephanus dubinini* proved new for the fauna of Poland, while the records of *Cryptocotyle concavum* and *Mesorchis pseudoechinatus* were the first in the great cormorant of Poland. Apart from *Paryphostomum radiatum*, *Petasiger exaeretus*, *P. phalacrocoracis*, and *Holostephanus dubinini*, the parasites specific for the great cormorant, and the grebe-specific *Tylodelphys clavata*, the parasites identified affect a wide spectrum of hosts, including birds belonging to different orders (Yamaguti 1958, Bykhovskaya-Pavlovskaya 1962, Sonin 1985, 1986, Sulgostowska and Czaplińska 1987). Among the parasites found in this study, *Mesorchis pseudoechinatus* and *Cryptocotyle concavum* had been earlier found in the area, the former in the Laridae and the latter in the Laridae and Anatidae (only in the Gulf of Gdańsk) (Markowski 1933, Malczewski 1964, Sulgostowska and Grytner-Zięcina 1974, Grytner-Zięcina and Sulgostowska 1978). In addition, in the Gulf of Gdańsk *Clangula hyemalis* (Anatidae) had been found to host digeneans (not identified to the species level) of the genera *Tylodelphys*, *Paryphostomum*, and *Petasiger* (Sulgostowska and Grytner-Zięcina 1974). Prior to this study, the great cormorant in Poland (Masurian lakes) had been found to host as few as 3 digenean species: *Paryphostomum radiatum*, *Petasiger exaeretus*, and *Metorchis xanthosomus* (Sulgostowska 1958, 1960a, b, 1963). It has to be remembered, however, that *P. exaeretus* is frequently mistaken for *P. phalacrocoracis*, regarded as a common species (Našincová et al. 1993, 1994).

The parasites identified consist of species typical of both marine (*Mesorchis pseudoechinatus*, *Cryptocotyle concavum*) and freshwater (*Paryphostomum radiatum, Petasiger exaeretus, P. phalacrocoracis, Metorchis xanthosomus, Hysteromorpha triloba, Tylodelphys clavata, Holostephanus dubinini*) ecosystems. It is worth emphasising that the infection is of local origin because all the species, except *Tylodelphys clavata*, were recorded in the juvenile cormorants, fed by their parents with fish caught in the vicinity of the colony. It is noteworthy that life cycles of all the digenean species found involve metacercariae (larvae) dwelling in fish; the birds become infected *via* the trophic chain. The absence of larger, typically

freshwater reservoirs in the vicinity of the Kąty Rybackie colony is indicative of the fact that the digeneans find conditions favourable for their development also in the brackish habitats of the Vistula Lagoon and the Gulf of Gdańsk of average salinities amounting to 2.4 and 7.5‰, respectively (Łomniewski 1958, Majewski 1990).

The relationship between the parasites' presence and the birds' age may be an interesting problem. The present study, involving 78 juveniles and as few as 12 adult great cormorants, does not make it possible to detect any unambiguous trend in age-dependent infection effects. However, the infections were heavier in the juveniles, both generally and with respect to most of the parasitic species (Table 1). This finding is in agreement with observations of other authors (Bykhovskaya-Pavlovskaya 1962, Smogorzhevskaya 1976, Sitko 1993) who noted that young birds were frequently more heavily infected than adults. The authors quoted explain this by referring to a higher food consumption by the juveniles fed by the parents who take up less food themselves. Obviously, this explanation applies to the period of nesting only. When that stage is over, the young birds join their parents in getting food on their own. In addition, at the beginning of their independent life the young, less experienced cormorants, are able to catch less fish than the adults.

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