Belg. J. Zool. — Volume 124 (1994) — issue 2 — pages 93-103 — Brussels 1994

*Manuscript received on 15 March 1994*

# FISH SPECIES OF THE LOWER ZEESCHELDE (BELGIUM) : A COMPARISON WITH HISTORICAL CHECKLISTS

by

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## SUMMARY

In the 19th century approximately 40 fish species (excluding freshwater species) were recorded in the lower Zeeschelde between the Dutch/Belgian border and Antwerpen. In comparison with the 19th century and the first half of the 20th century the total number of fish species in the Beneden-Zeeschelde has decreased considerably. The present checklist (1991-1993) of fishes of the lower Zeeschelde (excluding freshwater species) contains only 26 species. The fish community is composed of marine species (13), catadromous species (3), estuarine residents (9) and one anadromous fish species. Besides, 6 freshwater fish species have presently been recorded. The distribution of diadromous fishes, estuarine residents and freshwater fishes is probably greatly affected by low oxygen levels in the lower Zeeschelde, whereas the disappearance of adventitious marine species is probably also the result of anthropogenic effects on a much wider geographic scale. A comparison was made with recent and historical checklists of fishes of the Westerschelde and the Oosterschelde (the Netherlands).

## INTRODUCTION

The tidal area of the Schelde, which is called Westerschelde in the Netherlands and Zeeschelde in Belgium, represents one of the last remaining true estuaries in Europe which is marked by an important salinity gradient (HEIP, 1989) (Fig. 1). Research efforts have recently been undertaken to accumulate information on most compartments of this unique ecosystem (see HAMERLYNCK *et al.*, 1993a for a review) : data have become available for the functional units of the phytoplankton, the zooplankton, the hyperbenthos and the macrobenthos. Apart from DE VEEN *et al.* (1979) reliable quantitative data on the occurrence of fish in the Westerschelde estuary have only more recently been collected by HAMERLYNCK *et al.* (1993b).

However, their study area only covered marine localities (zone A in Fig. 1) and some brackish localities (up to the Belgian/Dutch border) (zone B in Fig. 1). The fish communities in the brackish water area upstream of the border (zone C in Fig. 1) and in the freshwater area have not been investigated during the last decennia. By collecting fish which were imprisoned in the cooling system of the Nuclear Power Station at Doel (Fig. 1) a recent checklist of species occurring in the lower Zeeschelde could be obtained.

The obtained checklist is compared with historical checklists of fishes of the lower Zeeschelde which were published during the last 150 years. The oldest checklist for the brackish area of the Schelde, comprising 38 species (excluding freshwater fish species), was published in 1842 by DE SELYS-LONGCHAMPS ; POLL (1945, 1947) listed 40 species in the area between Antwerpen and the Belgian/Dutch border. Checklists of freshwater fish which were published in the 19th century and in the first part of the 20th century (MAES, 1898 ; ROUSSEAU, 1915) did not contain geographical distributions. The first reliable list of freshwater fish in the lower Zeeschelde is from POLL (1945, 1947). The present checklist is further compared with a checklist of fishes captured in 1989 in the Westerschelde (HAMERLYNCK *et al.*, 1993b) and with a historical checklist for the Oosterschelde (BOTTEMANNE, 1884). Finally, preliminary information is provided on the average densities of the different fish species collected in the water intake of the nuclear power station of Doel.

## MATERIAL AND METHODS

The present checklist for zone C (brackish zone of the lower Zeeschelde) (Fig. 1) was obtained by monitoring the fish which were imprisoned in the cooling circuit of the Nuclear Power Station of Doel between september 1991 and december 1993. The Nuclear Power Station at Doel is situated on the lower Zeeschelde about 5 km east of the Belgian/Dutch border. Cooling water is withdrawn from the Schelde by an intake which is located 2 m above the bottom. Fish larger than about 3 cm are retained by rotating screens and are afterwards discharged. Between 1991 and 1993 $8 \times 10^6$ m$^3$ cooling water was sampled to obtain the present checklist.

The checklists of DE SELYS-LONGCHAMPS (1842) and POLL (1945, 1947) cover the fish species collected from beam trawl catches in the lower Zeeschelde and they therefore disregard species which occur in the Westerschelde only : The first author lists all the species which were observed as far as Antwerpen in the years preceding publication, whereas the samples of the second author were all collected in 1943 or 1944 between the Dutch/Belgian border and Antwerp. Further on in the text, we will refer to the year of publication rather than to the period of collection. Some species were probably overlooked by these authors (the common goby *Pomatoschistus microps* and the painted goby *P. pictus* were probably lumped with the sand goby *P. minutus* by both authors ; three-spined stickleback *Gasterosteus aculeatus* was probably not considered to be an estuarine species by DE SELYS-LONGCHAMPS, 1842) or had not yet been described at that time (for example, the

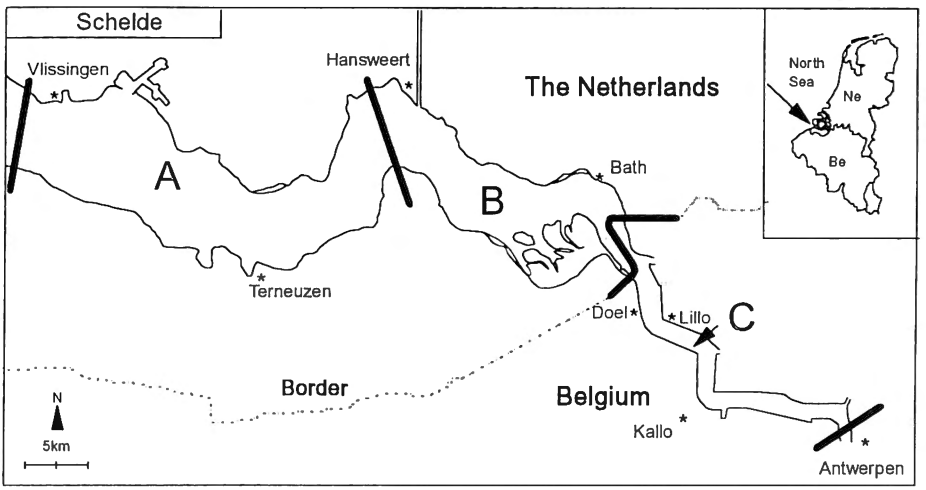


Fig. 1. — Map of the Schelde estuary, with indications of Zones A, B (Westerschelde) and C (lower Zeeschelde). Be = Belgium; Ne = the Netherlands.

smaller pipefish *Syngnathus rostellatus* was only described in 1855, lozano's goby *Pomatoschistus lozanoi* was described as a new species in 1923). These fish were quoted with a question mark in Table 1. For summation of the number of species we distinguish between recorded number of species and estimated number of species.

The common and scientific names of fish species were used according to WHEELER (1992). The species were classified in six ecological types depending on the use they make of estuarine areas (ELLIOTT and TAYLOR, 1989, COSTA and ELLIOTT, 1991, HAMERLYNCK *et al.*, 1993b) : CA stands for catadromous species, AN stands for anadromous species, MJ for juveniles of marine species that make use of the estuary as a nursery ground, MO for adventitious marine species with no estuarine requirements, ER for estuarine resident species, and FW for freshwater species. In contrast to HAMERLYNCK *et al.* (1993b), *Pomatoschistus minutus* and *P. lozanoi* were classified as juveniles of marine species (MJ) and not as seasonally occurring marine species (MS).

## RESULTS AND DISCUSSION

The fish species recorded during the present study are listed in Table 1 and Table 2. The checklist contains 32 species belonging to 6 ecological types : juvenile migrant species (10), catadromous species (3), estuarine residents (9), adventitious marine species (3), freshwater species (6) and anadromous species (1). Two species, the painted goby *Pomatoschistus pictus* and the sand-smelt *Atherina presbyter*, are new records for the area.

The checklists of DE SELYS-LONGCHAMPS (1842) and POLL (1945, 1947) are listed and compared with the present checklist in Table 1. In the 19th century

TABLE 1

List of the fish species (excluding freshwater fish species) of the lower Zeeschelde, according to DE SELYS-LONGCHAMP (1842) (1), POLL (1945, 1947) (2) and the present data (3) (Ecological types are explained in Material and Methods), and approximate yearly mean density at the power station of Doel.

| Species | Type | 1842 (1) | 1945 (2) | 1991-93 (3) | 1991-93 (3) |
|---|---|---|---|---|---|
| **Family Petromyzontidae** | | | | | |
| *Petromyzon marinus* (L.) | AN | x | | | |
| *Lampetra fluviatilis* (L.) | AN | x | x | x | o |
| **Family Scyliorhinidae** | | | | | |
| *Scyliorhinus canicula* (L.) | MO | x | | | |
| **Family Squalidae** | | | | | |
| *Squalus acanthias* (L.) | MO | (x) | | | |
| **Family Squatinidae** | | | | | |
| *Squatina squatina* (L.) | MO | x | (x) | | |
| **Family Rajidae** | | | | | |
| *Raja clavata* (L.) | MO | x | | | |
| *Raja batis* (L.) | MO | x | | | |
| **Family Dasyatidae** | | | | | |
| *Dasyatis pastinaca* (L.) | MO | | (x) | | |
| **Family Acipenseridae** | | | | | |
| *Acipenser sturio* (L.) | AN | x | | | |
| **Family Anguillidae** | | | | | |
| *Anguilla anguilla* (L.) | CA | x | x | x | oo |
| **Family Congridae** | | | | | |
| *Conger conger* (L.) | MO | x | (x) | | |
| **Family Clupeidae** | | | | | |
| *Clupea harengus* (L.) | MJ | x | x | x | ooo |
| *Sprattus sprattus* (L.) | MJ | x | x | x | oooo |
| *Alosa alosa* (L.) | AN | x | | | |
| *Alosa fallax* (Lacépède, 1803) | AN | x | x | | |
| **Family Engraulidae** | | | | | |
| *Engraulis encrasicolus* (L.) | ER | x | x | x | o |
| **Family Osmeridae** | | | | | |
| *Osmerus eperlanus* (L.) | ER | x | x | x | o |
| **Family Salmonidae** | | | | | |
| *Salmo salar* (L.) | AN | x | | | |
| *Salmo trutta* (L.) | AN | | (x) | | |
| *Coregonus lavaretus* (L.) | AN | x | | | |

TABLE 1 (*cont.*)

| Species | Type | 1842 (1) | 1945 (2) | 1991-93 (3) | 1991-93 (3) |
|---|---|---|---|---|---|
| **Family Gadidae** | | | | | |
| *Gadus morrhua* (L.) | MJ | x | x | | |
| *Merlangius merlangus* (L.) | MJ | x | x | (x) | o |
| *Trisopterus luscus* (L.) | MJ | x | x | x | o |
| *Melanogrammus aeglefinus* (L.) | MO | x | | | |
| *Ciliata mustela* (L.) | MJ | | x | | |
| **Family Belonidae** | | | | | |
| *Belone belone* (L.) | MO | x | x | | |
| **Family Atherinidae** | | | | | |
| *Atherina presbyter* (Cuvier, 1829) | ER | | | x | o |
| **Family Gasterosteidae** | | | | | |
| *Gasterosteus aculeatus* (L.) | ER | ? | x | x | oo |
| **Family Syngnathidae** | | | | | |
| *Syngnathus acus* (L.) | ER | x | x | x | o |
| *Syngnathus rostellatus* (Nilsson, 1855) | ER | ? | x | x | ooo |
| **Family Triglidae** | | | | | |
| *Trigla lucerna* (L.) | MO | x | x | (x) | o |
| *Eutrigla gurnardus* (L.) | MO | x | | | |
| **Family Cottidae** | | | | | |
| *Myoxocephalus scorpius* (L.) | ER | x | x | | |
| **Family Agonidae** | | | | | |
| *Agonus cataphractus* (L.) | ER | x | x | | |
| **Family Cyclopteridae** | | | | | |
| *Cyclopterus lumpus* (L.) | MO | | x | | |
| *Liparis liparis* (Linnaeus, 1766) | ER | | x | | |
| **Family Percichthyidae** | | | | | |
| *Dicentrarchus labrax* (L.) | MJ | | x | x | oo |
| **Family Carangidae** | | | | | |
| *Trachurus trachurus* (L.) | MO | | x | x | o |
| **Family Mugilidae** | | | | | |
| *Liza ramada* (Risso, 1826) | CA | | x | x | o |
| **Family Zoarcidae** | | | | | |
| *Zoarces viviparus* (L.) | ER | x | x | x | o |
| **Family Trachinidae** | | | | | |
| *Echiichthys vipera* (Cuvier, 1829) | MO | | x | | |
| *Trachinus draco* (L.) | MO | x | | | |

TABLE 1 (*cont.*)

| Species | Type | 1842 (1) | 1945 (2) | 1991-93 (3) | 1991-93 (3) |
|---|---|---|---|---|---|
| **Family Ammodytidae** | | | | | |
| *Ammodytes tobianus* (L.) | ER | x | x | x | o |
| *Hyperoplus lanceolatus* (Sauvage, 1824) | MO | | x | | |
| **Family Callionymidae** | | | | | |
| *Callionymus lyra* (L.) | MO | x | (x) | | |
| **Family Gobiidae** | | | | | |
| *Pomatoschistus microps* (Kroyer, 1838) | ER | ? | x | x | oooo |
| *Pomatoschistus minutus* (Pallas, 1770) | MJ | x | x | x | oooo |
| *Pomatoschistus lozanoi* (deBuen, 1923) | MJ | ? | ? | x | ooo |
| *Pomatoschistus pictus* (Malm, 1865) | MO | | | (x) | o |
| *Aphia minuta* (Risso, 1810) | MO | | x | | |
| **Family Bothidae** | | | | | |
| *Arnoglossus laterna* (Walbaum, 1792) | MO | | x | | |
| *Scophthalmus maximus* (L.) | MO | x | | | |
| *Scophthalmus rhombus* (L.) | MO | x | x | | |
| **Family Pleuronectidae** | | | | | |
| *Pleuronectes platessa* (L.) | MJ | x | x | x | o |
| *Pleuronectes flesus* (L.) | CA | x | x | x | o |
| *Limanda limanda* (L.) | MJ | | | (x) | o |
| **Family Soleidae** | | | | | |
| *Solea solea* (L.) | MJ | x | x | x | oo |
| **Recorded number of species** | | 38 | 40 | 26 | |
| **Estimated number of species** | | (42) | (41) | | |

x present
(x) only 1 record
? probably present but overlooked or not known at the time
o $< 0.1/1000\ m^3$
oo $> 0.1/1000\ m^3 < 1/1000\ m^3$
ooo $> 1/1000\ m^3 < 10/1000\ m^3$
oooo $> 10/1000\ m^3$

approximately 40 marine, anadromous, catadromous or brackish water species inhabited the brackish water between the Dutch/Belgian border and Antwerpen. De Selys-Longchamps (1842) listed 38 species, but the three-spined stickleback *Gasterosteus aculeatus*, Nilsson's pipefish *Syngnathus rostellatus*, the common goby *Pomatoschistus microps* and Lozano's goby *P. lozanoi* were probably overlooked or

TABLE 2

List of the freshwater fish species of the Lower Zeeschelde according to POLL (1945, 1947) (1) and according to the present data (2)

| | 1945 | 1993 |
|---|---|---|
| Species | (1) | (2) |
| **Family Esocidae** | | |
| *Esox lucius* (L.) | x | |
| **Family Cyprinidae** | | |
| *Cyprinus carpio* (L.) | x | x |
| *Abramis brama* (L.) | x | x |
| *Abramis bjoerkna* (L.) | x | |
| *Rutilus rutilus* (L.) | x | x |
| *Rutilus erythrophtalmus* (L.) | x | |
| **Family Cobitidae** | | |
| *Misgurnus fossilis* (L.) | x | |
| **Family Percidae** | | |
| *Perca fluviatilis* (L.) | x | x |
| *Stizostedion lucioperca* (L.) | x | x |
| **Family Centrarchidae** | | |
| *Lepomis gibbosus* (L.) | x | |
| **Family Gasterosteidae** | | |
| *Pungitius pungitius* (L.) | x | x |
| **Number of species** | 11 | 6 |

were not known at that time. POLL (1945, 1947) listed 40 species (*P. lozanoi* was probably overlooked), with one striking absence : the sturgeon *Acipenser sturio* had all but disappeared from the Schelde estuary by then, probably due to both overfishing (REDEKE, 1941) and habitat destruction.

There is a marked historical decrease in total number of fish species recorded in the brackish water in the last decennia (Fig. 2). In comparison to the checklists of DE SELYS-LONGCHAMPS (1842) and POLL (1945) more than 15 species have disappeared from the lower Zeeschelde in 1994.

The fish community in the lower Zeeschelde is dominated by a small number of fish species. Sixteen species were found in densities lower than 0.1/1000 $m^3$ (Table 1).

Most apparent is the absence of some typical estuarine resident species, such as the bull-rout *Myoxocephalus scorpius*, the hook-nose *Agonus cataphractus* and the sea-snail *Liparis liparis*. These species were recorded by HAMERLYNCK *et al.* (1993b)

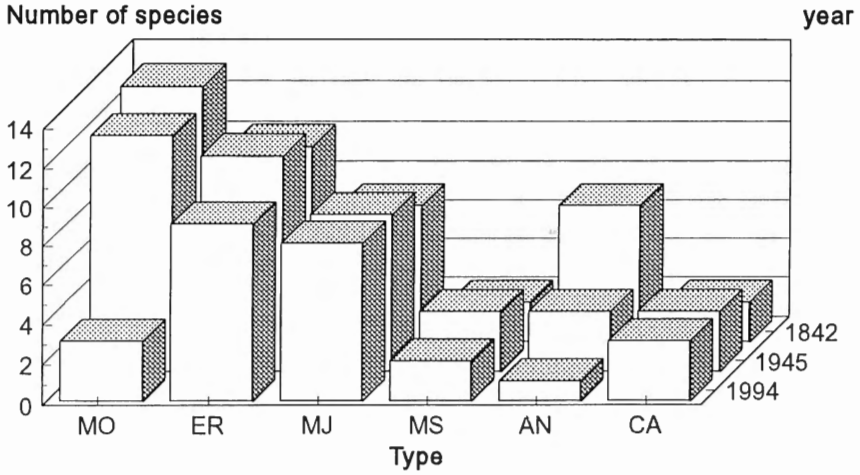


Fig. 2. — Number of fish species belonging to the different ecological types in 1842 (DE SELYS-LONGCHAMPS), 1945 and 1947 (POLL) and 1994 (the present data). For the abbreviations of the ecological types see Material and Methods.

both in the marine and the brackish zone of the Westerschelde. Possibly, they do not penetrate to the lower Zeeschelde due to reduced oxygen levels in this area.

Some marine species which occasionally occurred in the Zeeschelde in the 19th century, such as the monkfish *Squatina squatina* and the brill *Scophthalmus rhombus*, have not been recorded in this study. However, the local disappearance of these species may be a result of the overall decrease in abundance of these species in the North Sea, due to overfishing.

Furthermore, the almost complete absence of anadromous fishes is noteworthy, such as the sea lamprey *Petromyzon marinus,* the allis shad *Alosa alosa*, the twaite shad *Alosa fallax,* the sturgeon *Acipenser sturio*, the schelly *Coregonus lavaretus* and the salmon *Salmo salar*. These fish species were recorded by DE SELYS-LONGCHAMPS (1842), but all (except twaite shad) had already disappeared in the middle of this century (POLL, 1945). At present, all these species seem to be absent, probably due to anthropogenic effects (*e.g.* migration barriers in the middle and upper courses of the river). Though the three latter species may have been abundant before the 18th century (VAN NEER and ERVYNCK, 1993) they were rare in the 19th century in the Oosterschelde which at that time was still connected with the Westerschelde (BOTTEMANNE, 1884). The lamprey *Lampetra fluviatilis*, which presently is a protected species in Belgium, is the only anadromous species which has persisted in the lower Zeeschelde till now (Table 1).

Finally, the number of freshwater fish species was reduced to 6. Among these, the carp *Cyprinus carpio*, the roach *Rutilus rutilus* and the bream *Abramis brama* were rarely found in the present study. The other three species, the perch *Perca fluviatilis*, the pikeperch *Stizostedion lucioperca* and the nine-spined stickleback *Pungitius pungitius*, represented less than 0.7 % of the total number of fish found

between 1991 and 1993 (VAN DAMME, unpubl.). Notwithstanding the low water quality in the lower Zeeschelde, it is noteworthy that some freshwater fish species are still present in this area. However, it is not clear whether they can survive in summer when oxygen concentrations regularly fall below 2 mg/l (VAN DAMME, unpubl.). Exchange of fish individuals between the Schelde and adjacent channels, docks or affluents might help to sustain the freshwater fish populations. BRUYLANTS *et al.* (1989) recorded a number of catadromous and freshwater fish species in small rills which are connected with the Schelde by docks and sluices. Some of these species, such as the eel *Anguilla anguilla*, the stone loach *Noemacheilus barbatulus*, the bullhead *Cottus gobio*, the roach *Rutilus rutilus*, the silver bream *Abramis bjoerkna*, ten-spined stickleback *Pungitius pungitius* and perch *Perca fluviatilis* may occasionally venture in the Schelde and may then be caught by the water intake of the Power Station. Other possible sources of freshwater fish are the Albert canal which is connected with the Schelde by a sluice and which contains a rather rich fish fauna (VERREYCKEN, unpublished), and a channel at Bath, which connects the Zoommeer (a freshwater lake) with the Westerschelde.

The fish fauna in more upstream parts of the Schelde (upper Zeeschelde) has not been studied in the past years. Most authors assume that fish are absent in this area due to low oxygen levels and pollution stress (DE VEEN *et al.*, 1979; HAMERLYNCK *et al.*, 1993b). Though temperature and salinity normally play the dominant role in structuring estuarine fish communities (COSTA and ELLIOTT, 1991) community structure in the upper regions of strongly polluted estuaries such as the Schelde is also strongly affected by reduced oxygen levels. In the more upstream part of the Schelde estuary nowadays all hyperbenthic life has disappeared because of hypoxia (MEES *et al.*, 1993). Furthermore, macrobenthic communities have a low diversity and a low density upstream of Doel (YSEBAERT *et al.*, 1993). The absence of the hyperbenthic and macrobenthic compartments, normally containing the main food items for fish populations in the tidal area, further reduces the chance that stable populations of fish might be formed in this zone.

We should be aware that the completeness of a checklist is dependent on the collection efficiency and intensity. It is beyond all doubt that there are differences in catch efficiency among the different authors cited : DE SELYS-LONGCHAMPS (1842) and POLL (1945, 1947) collected fish qualitatively from an unspecified number of beam trawl catches of commercial fish trawlers, whereas *e.g.* HAMERLYNCK *et al.* (1993b) used a research vessel equipped with a 3m beam trawl, which is thought to have a lower catch efficiency than a commercial beam trawl. For extensive discussions on the catch efficiency of beam trawls we refer to KUIPERS *et al.* (1992). The efficiency of the method of collection of imprisoned 0+ juvenile and adult fish in cooling systems has been discussed by VAN DENSEN and HADDERING (1982). Typically pelagic fish, such as twaite shad, allis shad, sprat and herring may be caught inefficiently with this method.

## ACKNOWLEDGEMENTS

C. Belpaire has assisted in the determination of some small freshwater species. The authors would like to thank J. Maes, S. Maebe, I. van Roosbroeck and P. Parren for sampling assistance in harsh conditions. Electrabel is acknowledged for giving permission to sample fish from the cooling system of the Nuclear Power Station at Doel.

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