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Spawning Migration and Population Condition of Twaite Shad (*Alosa fallax*, Lacépède 1803) in Lithuania

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Basic biological information on a twaite shad population (*Alosa fallax*, Lacépède 1803) is presented based on a 2-year study involving 273 adult and 18 juvenile specimens. The fish were caught in the Curonian Lagoon and the coastal zone of the Baltic Sea. At the end of July, 2004, the intensive and record late spawning of twaite shad was observed. At the end of May, 2005, the beginning of spawning migration of this fish was noted. Twaite shad was one of the key fish species caught with 38-50 mm mesh size nets at the material sampling location. The fish catch per unit of effort (CPUE) in different mesh size gill nets fluctuated from 2.7 to 32 individuals. In the spawning shoal male individuals were predominant. The standard body length of twaite shad females varied from 322 to 430 mm. The standard body length of males varied from 280 to 390 mm. Twaite shad ranged from 2+ to 9+ years, but the majority were from 4+ to 7+ years old. Females exhibited higher condition factor (CF) and gonadosomatic index (GSI) values than males. Young fish were caught at 7 stations out of 17, although their abundance was not high. Besides the twaite shad, there were juveniles of 18 more fish species caught in the coastal zone.

Key words: *twaite shad, spawning, Curonian Lagoon, Baltic Sea, Lithuania.*

1. Introduction

Twaite shad (*Alosa fallax*, Lacépède 1803), occurs along most of the west coast of Europe, from southern Norway to the eastern Mediterranean Sea, and in the lower reaches of large accessible rivers along these coasts. There are several non-migratory populations of this fish in a few European lakes. With an exception of these isolated populations, the normal habitat of this species is the sea, and the lower reaches of large unpolluted rivers where there is an easy access to spawning grounds (Maitland & Tristan, 2000). In general, populations of twaite shad have declined across Europe (Aprahamian & Aprahamian, 1990; Bervoets et al., 1990; Groot, 1990; Maitland & Lyle, 1990; Thiel & Winkler, 2004). Because of this decline, the twaite shad is now given legal protection. It is listed in Annexes II and V of the EU Habitats and Species Directive, Appendix III of the Bern Convention, and has been included in the Red Data Books of some countries (Balevičius, 1992; Whilde, 1993; Fricke et al., 1995; Plikšs & Aleksejevs, 1998; Hlopnikov et al., 1998, Bram & Piet, 2003).

Anadromous twaite shad is one of the four species of the Clupeidae family dwelling in Lithuania (Virbickas, 2000). The main concentration sites of the twaite shad spawning shoals were found at the mouth of the Atmata River and in the shallows of the Ežia (Švagždys, 1999). In the first half of the 20th century, twaite shad was one of the most abundant migratory fish in the Curonian Lagoon. In the middle of the 20th century the resources of twaite shad started decreasing. Therefore, as an endangered species, it was included in category I of the Red Data Book of Lithuania (Balevičius, 1992). Even artificial reproduction of the species was proposed (Gaigalas et al., 1992).

After a longer interval twaite shad occurred in experimental catches of 1994. In 1996 and later their migration in the Curonian Lagoon was extremely abundant (Repečka, 2003B). At that time twaite shad was more and more often caught in the Curonian Lagoon and also in the coastal zone of the Baltic Sea (Zolubas, 2000; Repečka, 2003B).

In 2003 twaite shad was removed from category I to V (restored), and in 2005 it was removed from the Lithuanian Red Data Book.

Twaite shad is the basis of this study. The main objective of this research is to study the biology of adult twaite shad that has immigrated to the Curonian Lagoon. Moreover, in order to study possible spawning, sampling has been also carried out for juvenile shad in the Baltic Sea coastal zone.

2. Material and methods

The research into the twaite shad spawning shoal in the Curonian Lagoon was carried out at the end of July, 2004 and in May, 2005. A 30-metre-long beach seine with a sack was employed to study fish juveniles in the Baltic Sea in August, 2005. The examination material of adult fish was collected near the Vente Cape, a coastal area in the eastern part of the Curonian Lagoon (55°21'N, 21°12'E). Adult fish were caught with gill nets (38, 45, 50 and 70 mm mesh bars) set at 1.0–1.5 m. Juveniles of twaite shad were caught in the coastal zone of the Baltic Sea in 17 stations from Nida to Butinge (Fig. 1). All sampling stations were located at 1–1.5 m depth.

Each twaite shad was weighed (body weight in g = W, ±1.0 g) and measured (total and standard length and l_{Smitt} in mm = TL, ST, l_{Smitt} ±1 mm).

Each fish was dissected for determination of gonadosomatic index (GSI). GSI (for mature fish only) was calculated according to Eiras (1981), using the formula: GSI = gonad weight x 100/total body weight.

Fish condition factor (CF) was determined using the formula (Ngonidzashe & Fernando, 2000): $CF = W\ 100 / L^b$; where W is the wet weight of fish in grams; L is the standard length in cm; b is the exponent derived from the length–weight relationship.

Length–weight relationship was estimated using the model (Ricker, 1975):

$W = a\ L^b$. Parameters a and b were calculated by the least-squares on natural logarithm transformed data. The comparison of the estimated gradients for males and females was carried out via covariance analysis (ANCOVA).

The age of fish collected in 2004 and 2005 was determined for each 273 fish for both sexes. The age structure was determined from scales. A sample of scales was removed from each fish individual and subsequently mounted and read for its age.

CPUE index was calculated as the number and biomass of each caught fish per one 30 m long gill net per one day. On the whole, 273 adults (144 in 2004 and 129 in 2005) and 28 juveniles of twaite shad were examined.

Frequency of occurrence for each fish species (V, %), caught in the coastal zone of the Baltic Sea was calculated according to Joganzen & Faizova (1978): V = a/A 100; where a - the number of collected samples, when the species was caught; A – the total number of all samples collected during the research period. According to the ecological classification and frequency of occurrence, fish species are divided into four classes: occasional: V < 15%, rare: 15-40%, common: 40-70%, and frequent: > 70%.

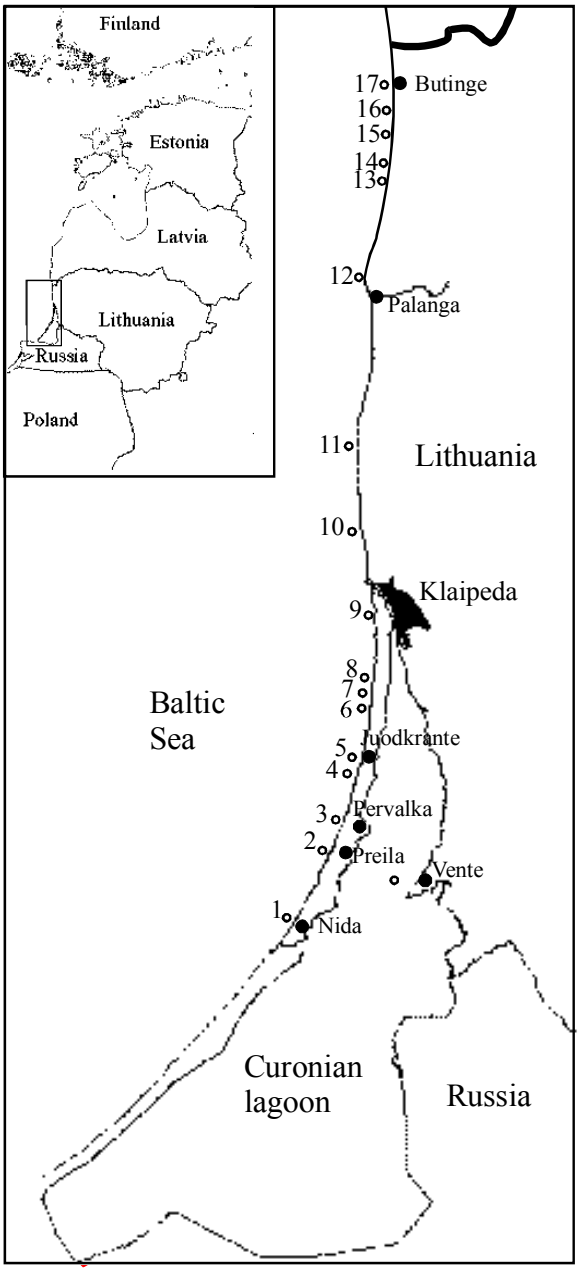

Fig. 1. Material sampling location in 2004 and 2005

3. Results

In spring and summer of 2004, the water temperature in the Curonian Lagoon was very low. As a result, the duration of spawning migration and spawning of twaite shad lengthened that year. As a rule, spawning used to finish by the middle of July, whereas in the Curonian Lagoon solitary spawning individuals can be still caught at the beginning of August (Maniukas, 1959). However, in 2004 intensive spawning of twaite shad was observed at the end of

July near the Vente Cape, at a distance of 300-400 m from the shore. The spawning was a noisy affair, with much splashing and chasing near the surface. Such intensive and record late spawning of that fish was observed for the first time. Twaite shad was one of the key fish species caught with 38-50 mm mesh size nets at the material sampling location (up to 74% according to abundance and up to 73% according to biomass; Fig. 2). In July, 2005, at the same time, there were only several spent individuals of the twaite shad catch.

During spawning twaite shad was one of the most abundantly netted fishes. CPUE in different mesh size gill nets fluctuated from 7.5 to 32 individuals (mean 17.9 individuals). Twaite shad biomass-based CPUE ranged from <3.5 in 70 mm mesh size gill nets to over 12 kg in 38 mm mesh size gill nets (mean 8.9 kg) (Fig. 3).

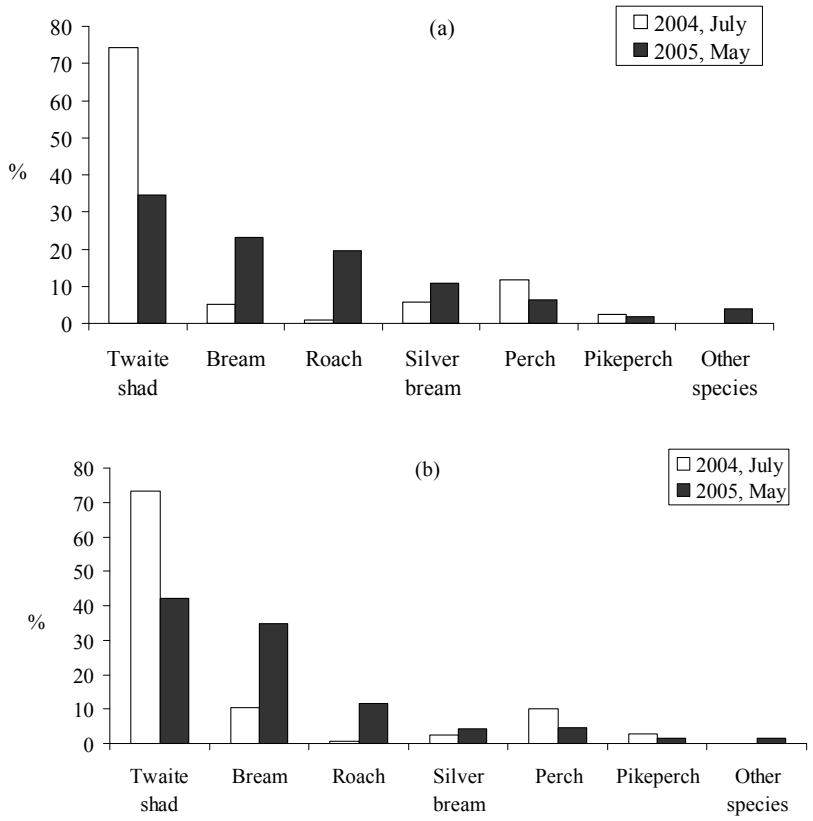

Fig. 2. Composition of fish species abundance (a) and biomass (b) (in per cent) in July, 2004 and May, 2005

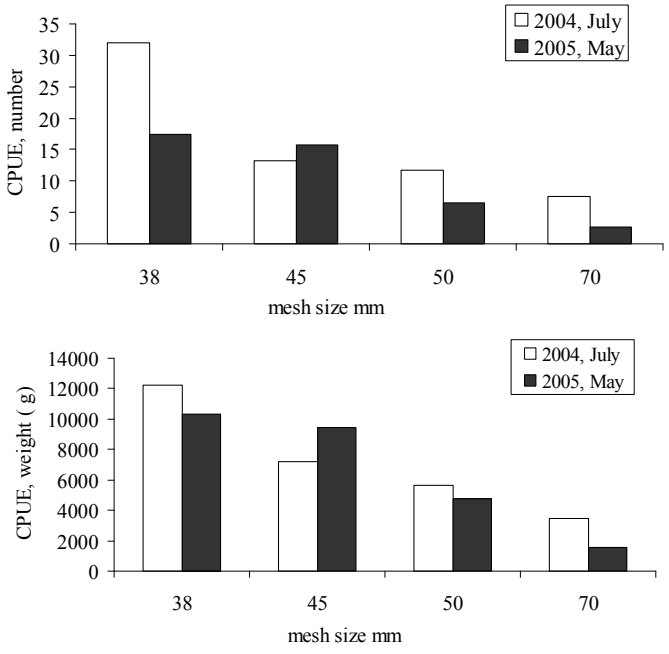

Fig. 3. CPUE in different mesh size nets

In the spawning shoal males were predominant. Overall, males outnumbered females by about 5:1. These results are closely in agreement with those reported by Repečka (2003B) for the spawning population of the twaite shad in the Curonian Lagoon in 1998-2000. The main exception to this was found at Solway Firth, Scotland, where mature females were 4-fold more common than males (Maitland & Lyle, 2005). These ratios may have been affected by gear selectivity (Gaigalas, 2001).

None of each twaite shad was immature, both mature and spent fish of both sexes were found. The standard body length of twaite shad females varied from 322 to 410 mm (mean 369±4.3 mm), the most common body length ranging from 360 to 390 mm (up to 54% of the caught females). The body length of males varied from 285 to 381 mm (mean 333±8.7 mm), males with the body length range 290-310 mm prevailing (they made 60% of the caught males).

The weight of each twaite shad ranged from 280 to 880 g. The mean weight of males was 412±10.2 g and that of females 676±35.1 g (Table 1).

Table 1. Biological characteristics of twaite shad in July, 2004 and May, 2005

Biological features	Females		Males		Total	
	lim	mean±s.e.	lim	mean±s.e.	lim	mean±s.e.
Total body length (TL), mm	392-479* 402-500	445±5.4 454±6.9	341-447 350-458	394±8.2 407±3.1	341-479 350-500	403±3.5 419±3.2
Body length l_{Smitt}, mm	334-421 342-443	377±5.1 387±6.2	296-390 300-400	345±8.6 357±2.8	296-421 300-443	351±3.0 364±2.9
Standard body length (SL), mm	322-400 332-430	365±4.3 374±6.1	285-381 280-390	333±8.7 344±2.8	285-400 280-430	339±3.0 351±2.8
Body weight (W), g	410-880 485-1116	676±35.1 753±39.3	280-620 355-810	412±10.2 576±14.6	280-880 355-1116	458±13.4 620±16.0
GSI	1.6-11.5 6.2-20.9	7.0±0.67 12.6±0.67	0.5-10.9 5.1-11.2	3.1±0.23 8.0±0.12	0.5-11.5 5.1-20.9	3.8±0.25 9.1±0.26
CF	0.9-1.8 1.1-1.9	1.41±0.01 1.67±0.02	0.8-1.4 1.2-1.9	1.12±0.10 1.55±0.01	0.8-1.8 1.1-1.9	1.17±0.01 1.58±0.01
Age group, years	4+ - 8+ 4+ - 9+		2+ - 7+ 3+ - 8+		2+ - 8+ 3+ - 9+	
Number	25 32		119 97		144 129	

** - in numerator - data collected in July, 2004, in denominator - data collected in May, 2005*

The length/weight relationships of twaite shad are shown in Figure 4. These were all mature fish. In 2004 the longest and the heaviest male twaite shad was 381 mm (SL) and 620 g, whereas the longest and the heaviest female was 400 mm and 880 g.

The age of twaite shad ranged from 2+ to 9+ years, but the majority (64.2%) were from 4+ to 5+ years old (Fig. 5).

In 2005, twaite shad spawners began migrating from the Baltic Sea to their spawning grounds in May. The number of examined each twaite shad was 129.

The other fish species which were spawning or were close to (bream, roach) were also abundant in that period, but, like in 2004, twaite shad was a predominant species in catches (42% of the whole number and 34.6% of the whole biomass of the caught fish). However, CPUE was smaller than in 2004 and fluctuated between 2.7 (70 mm mesh size gillnet) and 17.5 individuals (38 mm mesh size gillnet) (mean 10.6 individuals).

In that year males were predominant. The sex ratio was about 3:1. None of twaite shad were spent.

The fish caught in May 2005 were on average about 1 cm longer in comparison with those caught in July 2004. The standard length of the caught females in the spawning shoal varied from 332 to 430 mm (mean 379±6.1 mm), fish with the body length of 350- 400 mm being predominant. The standard length of males in the spawning shoal varied from 280 to 390 mm (mean 344±2.8 mm), 320-360 mm long fish predominating (Table 1).

In 2005 the weight of females ranged from 485 to 1116 g (mean 753±39.3 g), and that of males varied from 355 to 810 g (mean 567±14.6 g), the mean weight of males being 63% of that of the females. The longest and the heaviest male twaite shad was 390 mm (SL) and 620 g, whereas the longest and heaviest female was 430 mm and 1116 g.

Twaite shad ranged from 3+ to 9+ years old, but the majority (68.0%) were from 5+ to 7+ years old (Fig. 4).

CF and GSI were not similar for both sexes. Females exhibited higher CF values than males. GSI of males was usually lower than that of females. Almost all the fish caught before the end of May, 2005 had large gonads with high GSI. At the end of the spawning period in July, 2004 GSI of males and females was lower than that at the beginning of spawning migration in May, 2005 (mean GSI of females was 1.8-fold lower and that of males –2.6-fold lower (Table 1).

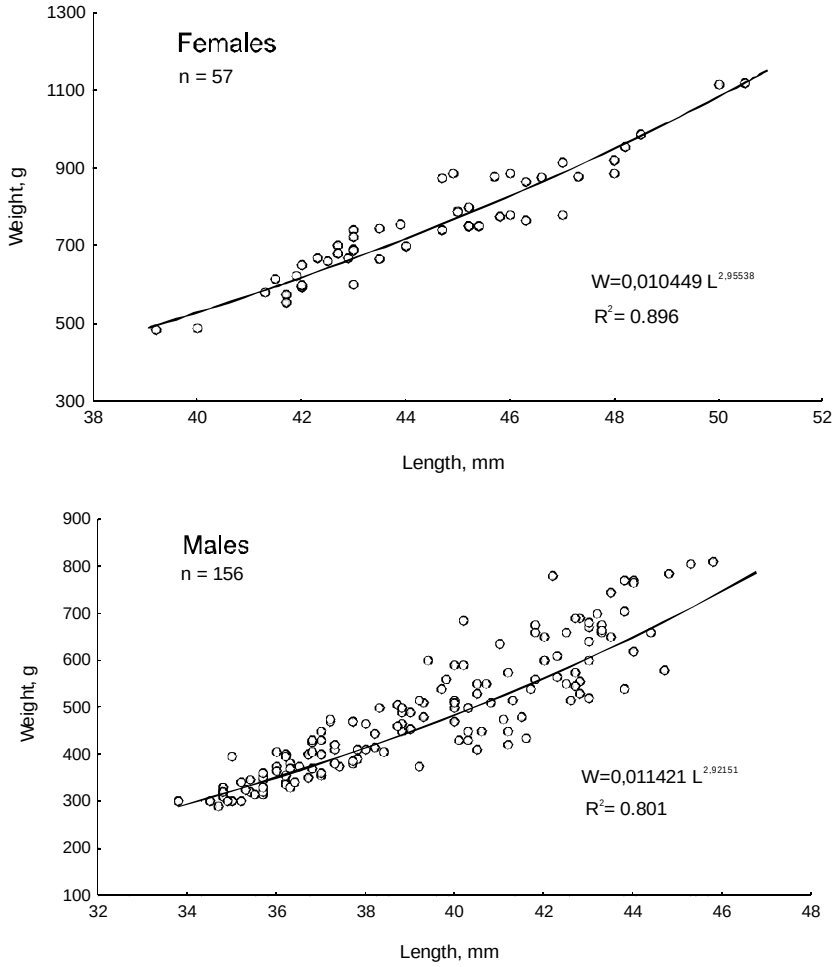

Fig. 4. Length/weight relationship of twaite shad caught in the Curonian Lagoon in 2004 and 2005

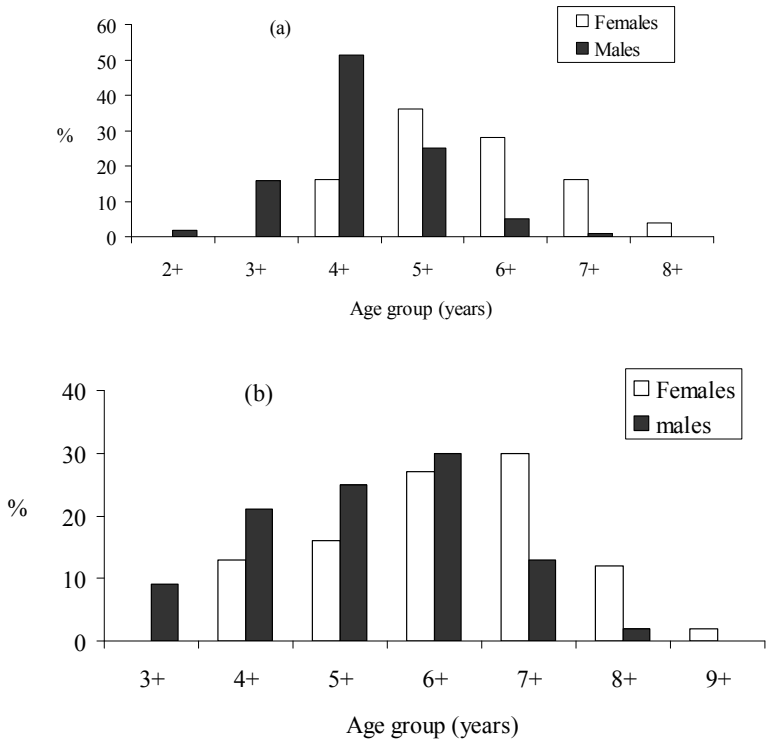

Fig. 5. Age structure of twaite shad (in per cent) in July, 2004 (a) and May, 2005 (b)

The largest testis recorded from a twaite shad was 76 g from a male of 453 mm (TL) and 805 g taken on 22 May, 2005. The heaviest ovary was 229 g from a female of 500 mm and 1116 g taken on 23 May, 2005. These are less than the maximum weights reported in the literature (Eiras, 1981; Maitland & Lyle, 2005), but well within the range of the fish known to be close to spawning.

Young twaite shads belonging to the 0-year group have been present in samples from the Baltic Sea coastal zone during the late summer of 2005. The caught juveniles of that fish proved that spawning was successful: young fish were caught at 7 stations out of 17, although their abundance was not high. Most often there were from 1 to 5 fish caught at one station (according to abundance 0.08-2.4% and according to biomass 0.19-3.65%). Only at the station near Butinge (Station No 4) there were 17 juveniles of twaite shad caught (they made up to 16% of the caught fish and up to 23% of the biomass) (Table 2).

Table 2. Biological characteristics of twaite shad juveniles caught in the coastal zone of the Baltic Sea in August, 2005

Station Number	Total length		Weight		Number, %	Weight, W%	No.
	lim	mean	lim	mean			
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	7.8	-	2.7	0.08	0.80	1
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-
10	-	8.2	-	3	0.19	1.53	1
11	-	-	-	-	-	-	-
12	-	7.1	-	2.7	0.04	0.40	1
13	-	7.2	-	1.6	0.12	0.19	1
14	5.7-7.8	6.7	0.9-8.9	1,8	2.40	3.65	5
15	7.5-7.7	7.6	1.4-1.5	1.45	0.55	0.60	2
16	-	-	-	-	-	-	-
17	7.5-10.0	8.8	3.1-8.1	5.3	16.83	23,47	17
Total	5.7-10	8.1	0.9-8.9	4.0	0.40	2.03	28

Nearly all juveniles of twaite shad (96.6%) were caught in the Klaipeda-Butinge coastal zone, where conditions for breeding of many fishes and recuperation of juveniles are more favourable than near the Curonian Spit (Repečka et al., 1996).

In addition to twaite shad, there were juveniles of 18 more fish species caught in the coastal zone. Only two species can be ascribed to a group of frequent species (V > 70%). Five fish are attributed to common species (V 40-70%), the same number of fish is ascribed to occasional species (V < 15%). A comparatively great number of fish (seven fish species) was ascribed to the group of rare (V 15-40%) fish. Flounder and turbot occurred most frequently in the coastal zone of the Baltic Sea. The common fish species included sprat, smelt, roach, perch, sandeel, while Baltic herring, asp, vimba, bleak, pikeperch and three-spined stickleback were attributed to the rare ones. Twaite shad belongs to this group also. Occasional species included silver bream, bitterling, garfish and sand-goby

4. Discussion

In the first half of the 20th century twaite shad were the most abundant and one of the most important fish of the family Clupeidae in the North and the Baltic Seas as well as the Curonian Lagoon. Its commercial catches were big: fishermen of Lithuania alone used to catch about 200-300 tons of twaite shad per year. In 1948 there were still 57.5 tons of twaite shad caught but later a sharp decrease in their catches was observed. Catches of twaite shad were last registered in statistics in 1957 (Repečka, 2003B).

During the last thirty years only single twaite shad accidentally got into fishermen's eeltraps (Svagždys, 1999).

Twaite shad had almost disappeared from some earlier sites and was included in the Lithuanian Red Data Book (Balevičius, 1992). Similar changes in the abundance of twaite shad in the second half of the 20th century was recorded in the other areas. At the beginning of the 20th century, twaite shad occurred in high densities in the Elbe and the Rhine rivers and was of great commercial importance. In the following decades the species suffered from overfishing, stowing of rivers and loss of spawning habitat. In the Rhine system, twaite shad disappeared around 1966 following the closure of the Haringvliet (Vorberg et al. 2005). Maitland and Lyle (1990) reported that shad had occurred extensively around the Scottish coast in the past but were now increasingly uncommon. Groot (2002) has pointed to the fact that the decline in shad populations coincided with the decline of allis shad, Atlantic salmon and other commercially valued species.

Decline in twaite shad was probably caused by several factors, not only overfishing. River regulation work has destroyed several spawning habitats, and pollution and silting up may also have played a role in the stock depletion. Closing off of the river, thereby changing the freshwater tidal system in the estuary into a river with a one-way flow, has likely been the fatal blow for the population (Groot, 2002).

For scientific research purposes solitary twaite shad individuals were still caught in Lithuania during experimental fishing until 1981-1982. After a longer interval twaite shad occurred in experimental catches of 1994. In 1996 and later their migration in the Curonian Lagoon was extremely abundant. In that year the catches of twaite shad in the Curonian Lagoon were also recorded in commercial statistics (13 kg in 1996) (Repečka, 2003B). Later commercial catches of twaite shad fluctuated from 24 to 440 kg.

However, since this species is under full legal protection, fishermen do not register landings, so there is a lack of reliable information on the actual twaite shad abundance in Lithuanian waters (Maksimov, 2004).

Lately, twaite shad has noticeably increased in abundance as a result of river and lagoon pollution abatement (several water treatment plants were built, the amount of industrial and agricultural pollutants decreased). Now nitrogen and phosphorus levels in the rivers and the Curonian Lagoon are 2–3 times lower in comparison with the period 15–20 years ago (Repečka, 2003A).

The deepening of the port of Klaipeda has also had a positive effect on anadromous fish species. As a result, anadromous fish species started migrating to the Curonian Lagoon and the Nemunas River basin more intensively (Repečka, 2005).

Over the last several years their abundance increased so much, that in May-June 1998-2002 twaite shad became one of the key fish species caught with 38-50 mm mesh size nets on migratory routes in the Curonian Lagoon and aquatories of spawning grounds (Repečka, 2003B). Our data confirm that.

Mature adult twaite shads enter the estuaries of many European rivers from April onwards and migrate some distance upstream, though the exact distance is variable. Twaite shad may spawn in, or just above, the tidal reaches of rivers, but many stocks spawn in freshwater well upstream of this. In the River Wye, some fish travel over 190 km to reach their spawning grounds at Builth Wells. Unlike salmonids, however, shads do not enter narrow streams even when these are accessible (Maitland & Tristan, 2000).

Recently, spawning of twaite shad has been most often observed in the aquatories of the Cape of Vente and the Ežia shoal. Although Maniukas (1989) and Gaigalas et al. (1992) state that twaite shad swim to spawn in the Nemunas river above 400 km, the 1996-2002 studies failed in gathering such information. Recently, in the lower part of the Nemunas River only several individuals of twaite shad have been caught (Kesminas, Repečka, 2005). Most probably, the population of twaite shad that has spawned in the Nemunas River has not restored itself yet. Data provided by Švagždys (1999) and Repečka (2003B) confirm that.

Size and age structures of twaite shad individuals caught in different years differed. If compared 1998-2002 (Repečka, 2003B) data with the data of 1951-1966 (Maniukas, 1989), it is obvious that in 1998-2002 smaller and younger fish predominated in the spawning shoal of twaite shad immigrants in the Curonian Lagoon (Fig. 6).

A great part of the 2001 experimental catches (over 38%) consisted of fish of the age group 2+, which were distinctly dominant after a year (aged 3+) in spring and summer of 2002. Fish of the older age groups were much less common. It is thought that as a result of sabrefish (*Pelecus cultratus* (L.)) fishing during the summer months in previous years a great amount of older twaite shad between 5 and 8 years of age were caught. Therefore the 2001-2002 populations were dominated by not big 32-36 cm long 3+ years of age fish (Repečka, 2003B).

According to the data of our research the length structure of the caught twaite shad was similar to that of the fish examined in 1951-1966, the mean of the body length being shorter by 1 cm.

In recent years, twaite shad have been more and more often caught in the coastal zone of the Baltic Sea with 25-30 mm mesh size gill nets and with a beach seine (Repečka, 2003B; Zolubas, 2000). Our data confirm that. In earlier years the occurrence of twaite shad and their juveniles in the coastal zone was extremely rare. According to Zolubas (2000) the occurrence frequency of twaite shad juveniles in beach seines catches was V < 15% in 1995-1997, V 15-40 in 1998 – 15-40% and V 40-70% in 1999. According to gill net catches, the adult twaite shad was an occasional fish species in the Baltic Sea coastal zone until 1998, in 1999 it was ascribed to rare species and in 2000 to the common ones. According to trawling catches in the open sea, the twaite shad is attributed to occasional fishes.

In the 21th century twaite shad has become most abundant in some other regions. The results obtained in the Meldorf Bight clearly indicate that twaite shad regularly occur in the Wadden Sea. Juveniles especially are caught in high densities. Exceptionally high numbers of individuals of 6-9 cm length were caught in 2003. Adults of 30-40 cm frequently appear in the catches of the commercial stow net fishery in the Elbe (Vorberg et al. 2005).

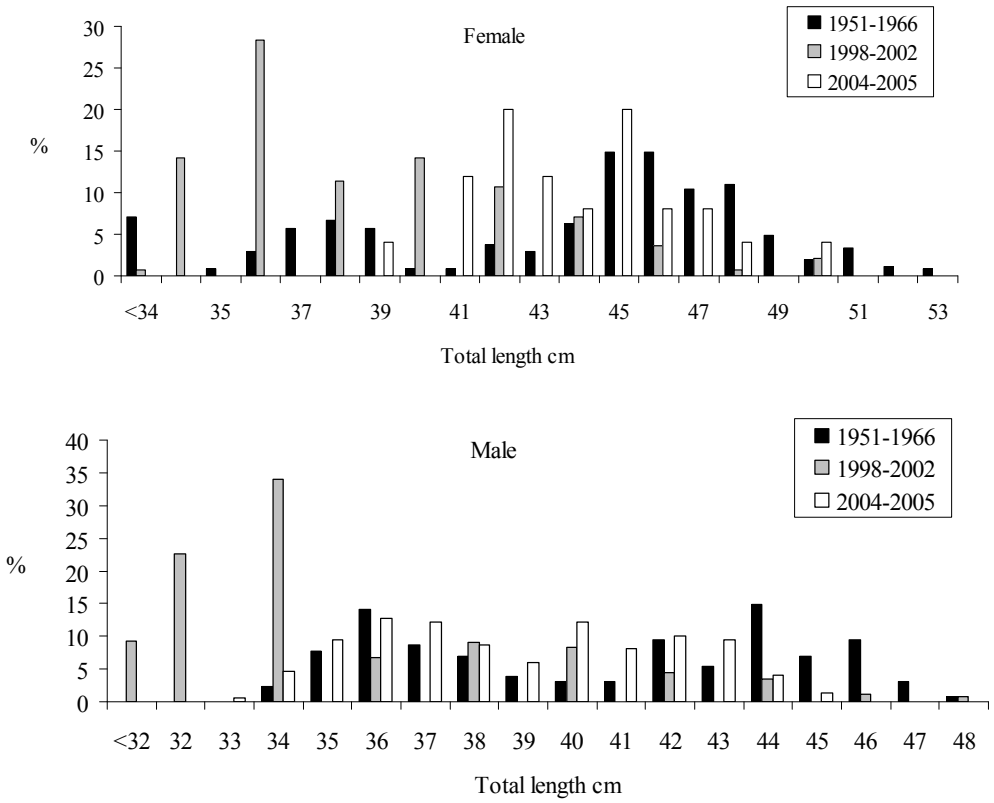

Fig. 6. Length frequency distribution of twaite shad caught in the Curonian Lagoon in 1951-1966 (Maniukas, 1989), 1998-2002 (Repečka, 2003 B) and 2004-2005 (our data)

5. Conclusion

The primary conclusion is that relatively little is known about the detailed ecological and habitat requirements of twaite shad. Much more research is needed on the biology and ecology of this species. In recent years in the basin of the Baltic Sea the stocks of twaite shad have been restored only in the basin of the Curonian Lagoon, hence protection of the reproduction of twaite shad, whose spawning grounds are preserved by the EU Habitat Directive, is the task of utmost significance. The catches of adult twaite shad in the Curonian Lagoon and their juveniles in the Baltic Sea are constantly plentiful for several years, wherefore the twaite shad was removed from the Lithuanian Red Data Book in 2005. It is most probable that the fishery catch statistics in Lithuania will be more reliable in the future and in 2006 we will have real catches. Fishing intensity of twaite shad will not increase in the future because special protection measures are applied to this fish.

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References

Aprahamian, M. W. & C. D. Aprahamian, 1990. Status of the Genus *Alosa* in the British Isles: past and present. Journal of Fish Biology 37A: 257–258.

Balevičius, A. (ed.), 1992. Red data book of Lithuania. Ministry of Environment, Vilnius (in Lithuanian).

Bervoets L. J. C. & Verheyen R. F., 1990. The value of lowland rivers for the conservation of rare fish in Flanders. Journal of Fish Biology 37A: 223–224.

Bram G. W. A. & Piet H. N., 2003. Fish zonations and guilds as the basis for assessment of ecological integrity of large rivers. Hydrobiologia 500: 157–178.

Eiras, J. C., 1981. Sur une population d'Alosa alosa L., poisson migrateur amphibiotique, thalassotrophe, bloque´ e en eau douce au Portugal. Cybium 5: 69–73.

Fricke, R.; Berghahn, R. & Neudecker T., 1995. Rote Liste der Rundmäuler und Meeresfische des deutschen Wattenmeer- und Nordseebereichs (mit Anhängen: nicht gefährdete Arten). Schr.-R.f.Landschaftspfl. u. Natursch., H. 44: 101-113.

Gaigalas K., 2001. The fish of Curonian lagoon basin. Klaipėda.

Gaigalas K., Gerulaitis A., Kesminas V., Mlerienė E., Repečka R., Valušienė V., Žiliukas V. & Žiliukienė V., 1992. Rare fish of Lithuania. Vilnius: 18-24 (in Lithuanian).

Groot S. J. D., 2002. A review of the past and present status of anadromous fish species in the Netherlands: is restocking the Rhine feasible? Hydrobiologia 478: 205–218.

Groot, S. J. D., 1990. The former Allis and Twaite Shad fisheries of the lower Rhine, the Netherlands. Journal of Applied Ichthyology 6: 252–256.

Joganzen V. G. & Faizova L. V., 1978. On the determination of indices of occurrence, abundance and

biomass and their interrelations in some hydrobionts. Elements of aquatic ecosystems, Moscow: 215-225.

Kesminas V. & Repečka R., 2005. Human impact on fish assemblages in the Nemunas River, Lithuania. Large Rivers Vol. 15, No. 1-4. Arch. Hydrobiol. Suppl. 155/1-4: 275-287.

Khlopnikov M. M., Keida M. E., Karasiova E. M., Tylik K. V. & Shibaev S. V., 1998. Assessment of the current state of ichthyofauna diversity in major basins of Kaliningrad region. Fisheries biological researches by ATLANTNIRO in the Baltic Sea during 1996-1997: 129-152 (in Russian).

Maitland P. S. & Tristan W. H., 2000. Ecology of the Allis and Twaite Shad. Conserving Natura 2000, Rivers Ecology Series No. 3: 1-28.

Maitland, P. S. & Lyle A. A., 1990. Practical conservation of British fishes: current action on six declining species. Journal of Fish Biology 37A: 255–256.

Maitland, P. S. & Lyle A. A., 2005. Ecology of Allis Shad *Alosa alosa* and Twaite Shad *Alosa fallax* in the Solway Firth, Scotland. Hydrobiologia 534: 205–221.

Maksimov J., 2004. The "revival" of the twaite shad (*Alosa fallax,* Lacépède 1803) population in the Curonian lagoon. Bulletin of the Sea Fisheries Institute. 1(161): 61-62.

Maniukas J. L. 1959. The ichthyofauna, state of resources and commercial fishing in the Curonian Lagoon. Vilnius: 297-298 (in Russian).

Maniukas J. L., 1989. Biology of the Atlantic twaite shad (*Alosa fallax fallax*) in the Curonian Lagoon. Journal of ichthyology 29 (5): 866-868 (in Russian).

Ngonidzashe A. G. M. & Fernando C. H., 2000. Growth, mortality and reproduction of Sargochromis codringtonii in Lake Kariba, Zimbabwe. Hydrobiologia 438: 237–244.

Plikšs M. & Aleksejevs E., 1998. Latvijas daba. Zivis. Gandrs.

Repečka R., 2003A. Ecology and changes in abundance of twaite shad and vimba in Lithuanian waters. ICES CM 2003/R:05: 11.

Repečka R., 2003B. Changes in biological indices and abundance of salmon, sea trout, smelt, vimba and twaite shad in the coastal zone of the Baltic Sea and the Curonian Lagoon at the beginning of spawning migration. Acta Zoologica Lituanica 13(2): 195-216.

Repečka R., 2005. Dynamics of the fish community structure in the Lithuanian coastal zone of the Baltic Sea on the Basis of the monitoring programme. Acta Zoologica Lituanica. 15(2): 161-164.

Repečka R., Žiliukas V. & Stankus S., 1996. The abundance of the fish larve and fry in the coastal zone of the Baltic Sea and Kursiu Lagoon. Fishery and Aquaculture in Lithuania II, Vilnius: 95–108.

Ricker W. E., 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Board Can., 191.

Švagždys A., 1999. Characteristic of the spawning shoal of twaite shad (*Alosa Fallax Fallax*) immigrants in the Kuršių Lagoon. Acta Zoologija Lituanica 9(1): 174-177.

Thiel R. & Winkler H., 2004. Status of the anadromous twaite shad (*Alosa fallax* Lacepède, 1803) in German and adjacent waters of the Baltic Sea. ICES CM 2004/S:08: 236-237.

Virbickas J., 2000. Fish of Lithuania, Vilnius (in Lithuanian).

Vorberg R., Bolle L., Jager Z. & Neudecker T., 2005. Wadden Sea Ecosystem. Fish. No. 19: 219-236.

Whilde A., 1993. Threatened mammals, birds amphibians and fish in Ireland: Irish Red Data Book 2: vertebrates. HMSO, Belfast.

Zolubas T., 2000. Long-term expantion or temporary abundance boost in Lithuanian territorial waters in 1996-2000? Sea and environment 2(4): 102-106 (in Lithuanian).

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Perpelių Twaite Shad (*Alosa fallax*, Lacépède 1803) populiacijos būklė ir nerštinė migracija Lietuvoje

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Informacija apie perpelių (*Alosa fallax*, Lacépède 1803) populiaciją pateikta ištyrus 273 suaugusias žuvis ir 18 jauniklių per dvejus metus. Žuvys žvejotos Kuršių mariose ir Baltijos jūros priekrantėje. 2004 m. liepos pabaigoje buvo stebėtas intensyvus ir rekordiškai vėlyvas perpelių nerštas. 2005 m. gegužės mėn. pabaigoje stebėta nerštinė šių žuvų migracijos pradžia. Medžiagos rinkimo vietoje perpelės buvo vienos gausiausiai sužvejojamų žuvų rūšių 38–50 mm akytumo tinklais. Nerštinėje bandoje vyravo patinai. Standartinis patelių kūno ilgis svyravo nuo 322 iki 430 mm, patinų – nuo 280 iki 390 mm. Amžius svyravo nuo 2+ iki 9+ metų, bet dauguma buvo 4+–7+ metų amžiaus. Jaunikliai sužvejoti septyniose stotyse iš 17, bet jų gausumas nebuvo didelis. Be perpelių jauniklių, priekrantėje sužvejoti dar 18 žuvų rūšių jaunikliai.