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Identification of perch (*Perca fluviatilis*), pikeperch (*Stizostedion lucioperca*) and ruffe (*Gymnocephalus cernuus*) larvae

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A quick way to distinguish between percids at the early yolk sac stage is to count the myomeres from yolk to anus, 2 to 3 for ruffe, 4 to 6 for perch and 7 to 9 for pikeperch. Reliable identification of later larvae involves more laborious myomere counting. Ruffe has only 13 to 16 preanal myomeres whereas perch and pikeperch have at least 17. The number of postanal myomeres is higher in pikeperch (27–31) than in perch (23–26) and ruffe (22–24). In perch less than 15 to 20 mm in size, the most useful feature is the characteristic line-shaped melanophore pattern between the myomeres. The melanophores may, however, be weak or lacking in perch from turbid waters, and in clear waters thin melanophores may also exist in pikeperch. The position of the mouth and the length of jaws can be used for identifying percids after they have attained a total length of 12 mm. The number of fin rays in the anal and second dorsal fin can be counted by the time the fish are 16–18 mm in size.

1. Introduction

The importance of early-life-history studies to fishery investigations has increased dramatically during the last decades. One of the major obstacles to the use of fish larvae is the lack of adequate guides to identification.

The identification of percid larvae is based on descriptions of the early development of perch (Sundevall 1855, Nordqvist 1914, Chevey 1925, Jääskeläinen 1939, Laskar 1943, Konstantinov 1957, Disler & Smirnov 1977), pikeperch (Grimalschi 1939, Unger 1939, Dmitrieva 1957, 1960ab, Vasnetsov *et al*. 1957, Konstantinov 1957, Negonovskaya 1971, Kovalev 1976, Bastl 1978) and ruffe (Tchugunov 1928, Johnsen 1965, Disler & Smirnov 1977, Kovác 1993). Detailed comparison of the morphological development of species (e.g. Kryzhanovsky *et al*. 1953) is also helpful. Identification guidance is, however, often inadequate and a complete key is lacking (Ehrenbaum 1905–09, Kazanskii 1925, Kazanova 1953, Rogowski & Tesch 1960, Norden 1961, Virbickas 1986). Moreover, the more advanced papers have been published only in Russian (Evropeijseva 1949, Kobliskaja 1981). The crite-

ria for identification of the early stages of fish change as the fish grow, however, and the size range to be used for a certain character is not usually given. There are also mistakes in some papers, e.g. that of Grimalschi (1939), where the larvae in figs. 10 and 11 are not pikeperch larvae as claimed.

This paper presents a guide for the identification of perch (*Perca fluviatilis*), pikeperch (*Stizostedion lucioperca*) and ruffe (*Gymnocephalus cernuus*) larvae and juveniles. Particular attention is paid to the size limits at which certain characteristics are useful for identification.

2. Material and methods

Most of the characters used in the identification are based on the Russian papers referred to above. Morphological features, measurements and meristic counts were made on larvae cultivated from fertilized eggs and larval data collected from four sites on the Baltic Sea (Helsinki, Vaasa, Tvärminne, Kustavi), three rivers (Kyrönjoki, Vantaanjoki, Virojoki) and six lakes (Hiidenvesi, Lohjanjärvi, Valkiajärvi (in Puumala County), Saarlampi (in Karkkila County), and Pitkäjärvi (in Nuuksio County)) in different parts of southern Finland. A total of 230 randomly selected larvae from a collection of more than 10 000 larvae was used to check the critical variables (Table 1), which were determined on the basis of records made on the whole material. Measured larvae were fixed in 10% formalin and preserved in 80% ethanol.

The number of myomeres was counted as in Koblitskaja (1981). Light reflected at a low angle from a certain side was used together with high magnification, since the most anterior and posterior myomeres are often difficult to distinguish. The most anterior myomeres are apparently only in the epiaxial or dorsal half of the body; the first is often deltoid in shape (Snyder 1981). Pectoral fins are usually based on the second and third myomeres. The last preanal myomere is defined as the one whose posterior myoseptum ends at the rear end of the anus (see Fig. 1). Despite the chevron shape, myomeres evolved to their typical three-angled adult form at the beginning of the metalarval phase; the v-shaped form with an imaginary extension line was applied for late larvae.

3. Results

3.1. Percids and other larvae

Percids may be confused with other larvae and juveniles. A 40-mm pikeperch may be difficult to identify among hundreds of smelts (*Osmerus eperlanus*) of similar size, but when studied separately the two look very different. In brackish-water samples, percid larvae are sometimes difficult to distinguish from Gobiidae just after the yolk sac stage. The main distinctive feature is the difference in size at a certain developmental stage. Gobiidae larvae hatch (at 1.8–3.0 mm *TL*) and fill the swim bladder (at 3 mm *TL*) at a smaller size than percids (3.5–5.6 mm and 4.5–6.5 mm *TL* respectively). Fin rays become visible in Gobiidae at 6–7 mm *TL*, and in percids at 8–10 mm. The form and position of the swim bladder and also the jaws of percids and gobiids differ from each other rather early in the development of the fish.

In freshwater, the distinction between percids and other species is more obvious. It should be remembered that the two dorsal fins characteristic of percids are not visible until the first dorsal fin has begun to form, anterior to the second dorsal fin, at 10–15 mm *TL*. The following features are common to all three percids: the preanal distance changes from about 45% to 55% of the total length during larval development; yolk sac larvae are 3.4

Table 1. Key for distinguishing between perch, pikeperch and ruffe larvae and juveniles.

Character	Perch	Pikeperch	Ruffe
Myomeres between yolk sac and anus	4–6(7)	(6)7–9	2–3
Myomeres in trunk	17–19	18–21	13–16
Myomeres in tail	23–26	27–31	22–24
Melanophores over the myosepta	Distinct*, line-shaped	Thin or none	None
Jaws (*TL* > 10–12 mm)	Not beyond mid-eye	Mid-eye or beyond	Short
Rays in anal fin (*TL* > 14–15 mm)	10–12	13–16	6–10
Rays in second dorsal fin	14–17	21–27	10–15**
Lateral pigment spots or stripes after *TL*	20–30	25–35	15–20 mm

* weak or none in turbid waters
** dorsal fins united (*TL* > 10–11 mm)

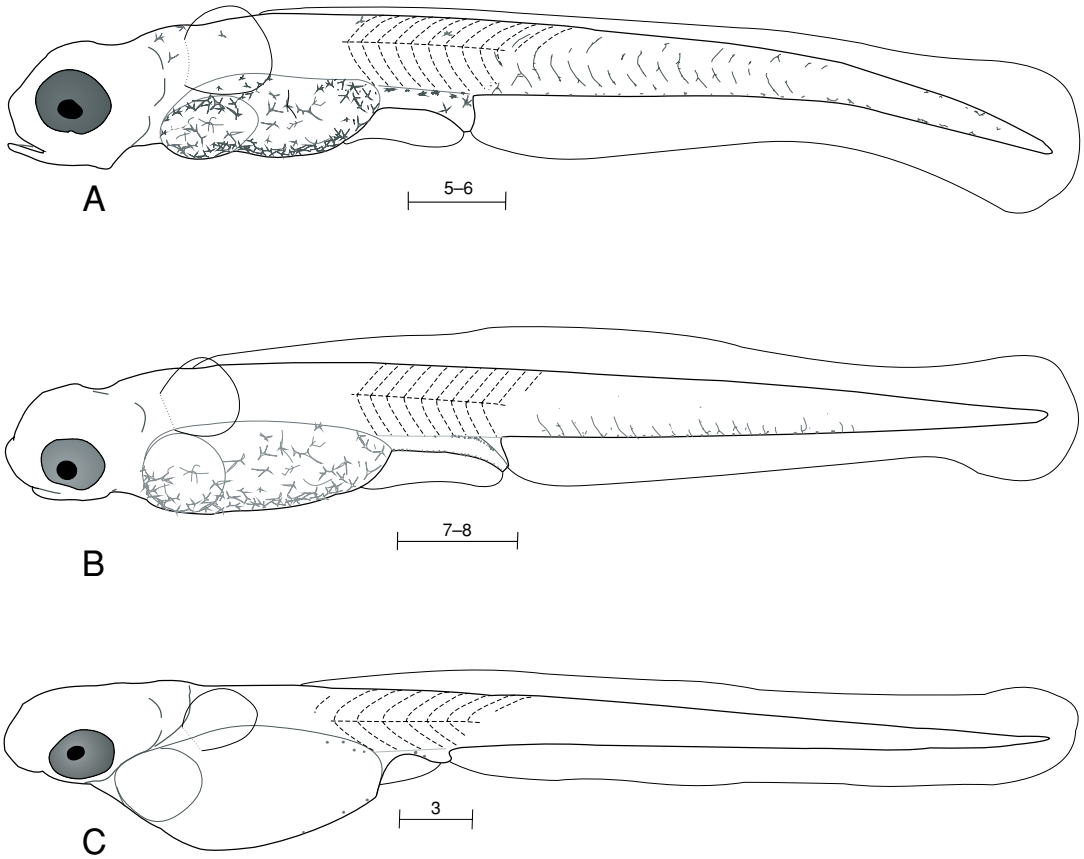

Fig. 1. The number of myomeres and the distance between yolk and anus differ in the yolk sac larvae of (A) perch, (B) pikeperch and (C) ruffe. Note also the differences in postanal pigmentation and in the development stage of the mouth.

to 7.0 mm long with more than 34 myomeres; there is one big oil globule in front of the oval yolk sac; the caudal fin has two slopes after a larval length of 14 mm; and the larvae usually have scarce pigmentation, mostly on the ventral side.

3.2. Distinguishing features of percids

Percids tend to spawn and hatch in a certain order, that is, perch, ruffe, pikeperch. The material studied here comprised perch with yolk from 9 May to 3 July, ruffe from 29 May to 3 July and pikeperch from 7 June to 20 July. The yolk-sac larvae of all three species may also occur at the same time in the same area (Urho *et al*. 1990). In southern Finland perch most frequently hatch at the end of May, ruffe at the beginning of June and pikeperch in the second half of June. In eutrophicated waters the spawning time tends to be protracted and in acidificated waters delayed.

There may be considerable differences in the size and development stage of larvae at hatching, depending on environmental conditions, e.g. temperature, light, availability of oxygen during the egg period. At hatching, however, perch is the most advanced and biggest (Fig. 2), whereas ruffe is the least developed and also the shortest. The newly hatched perch usually has pigmentation in the eyes, whereas ruffe has almost unpigmented, and pikeperch often only weakly pigmented, eyes. In ruffe and pikeperch, the base of the pectoral fins is horizontal at hatching and it takes some days for the pelvics to turn to the normal vertical position, whereas in perch, pectorals develop early and are often in a vertical position just before hatching. The swimming behaviour of the perch yolk sac larvae is therefore slightly different from

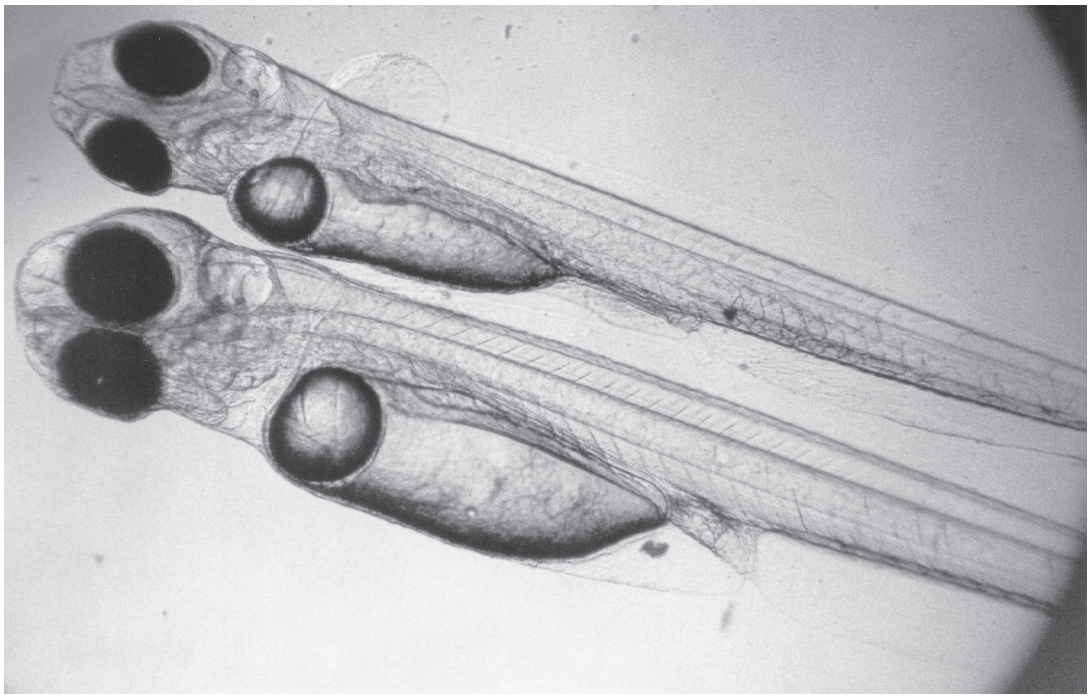

Fig. 2. Anterior part of a 5.0-mm pikeperch (above) 1–2 days after hatching (7–10 days after fertilisation) and a 5.9-mm newly hatched perch (below) (9–10 days after fertilisation). The difference lies in the size of the larvae and in the number of myomeres from yolk to anus.

that of ruffe and pikeperch. The developmental stage of the mouth in early yolk sac larvae probably best describes the developmental difference between the three species (Fig. 1). Nevertheless, I would not recommend using these features as the only identification criterion. Among percids the species already differ slightly in size and morphology at the yolk-sac stage (Figs. 1 and 2), and the differences accumulate as the fish grow (Figs. 3 and 4). These changes precede the behavioural and ecological divergence of the species.

3.2.1. Number of myomeres

The number of myomeres counted on the larvae in the subsample fitted all the selected ranges (Table 1). The counting of myomeres seems to be the most reliable, albeit laborious, way of identifying percid larvae between the yolk sac stage and the stage when the jaws and unpaired fins differentiate. The number of myomeres from yolk to anus can be counted more quickly and are also characteristic of the species (Fig. 1, Table 1).

3.2.2. Pigmentation

The appearance of a pigmentation pattern in percid larvae and early juveniles depends on their environment. The pigmentation pattern may be used in identification, but with some reservations. Line-shaped melanophores between the myomeres are typical of perch (Fig. 1a). In turbid waters, however, the pigmentation pattern of perch is much weaker than in clear waters (Fig. 5). In clear waters, pikeperch may also have somewhat similar line-shaped (but thin) melanophores, although they mostly arise from the ventral side (Figs. 1 and 2). Due to the turbidity of the water pikeperch usually has only weak ventral pigmentation (Figs. 1b and 3b). By the time perch larvae are 15 to 20 mm long, the typical line-shaped melanophores between the myotoms have become fainter; stellate melanofores start to take over (Fig. 3a) and form denser aggregates (Fig. 4a), which, at 20 to 30 mm, gradually appear as the darker banding characteristic of juvenile and adult perch. Stellate melanophore aggregates also appear in pikeperch, but slightly later, at a size of 25–35 mm and in a

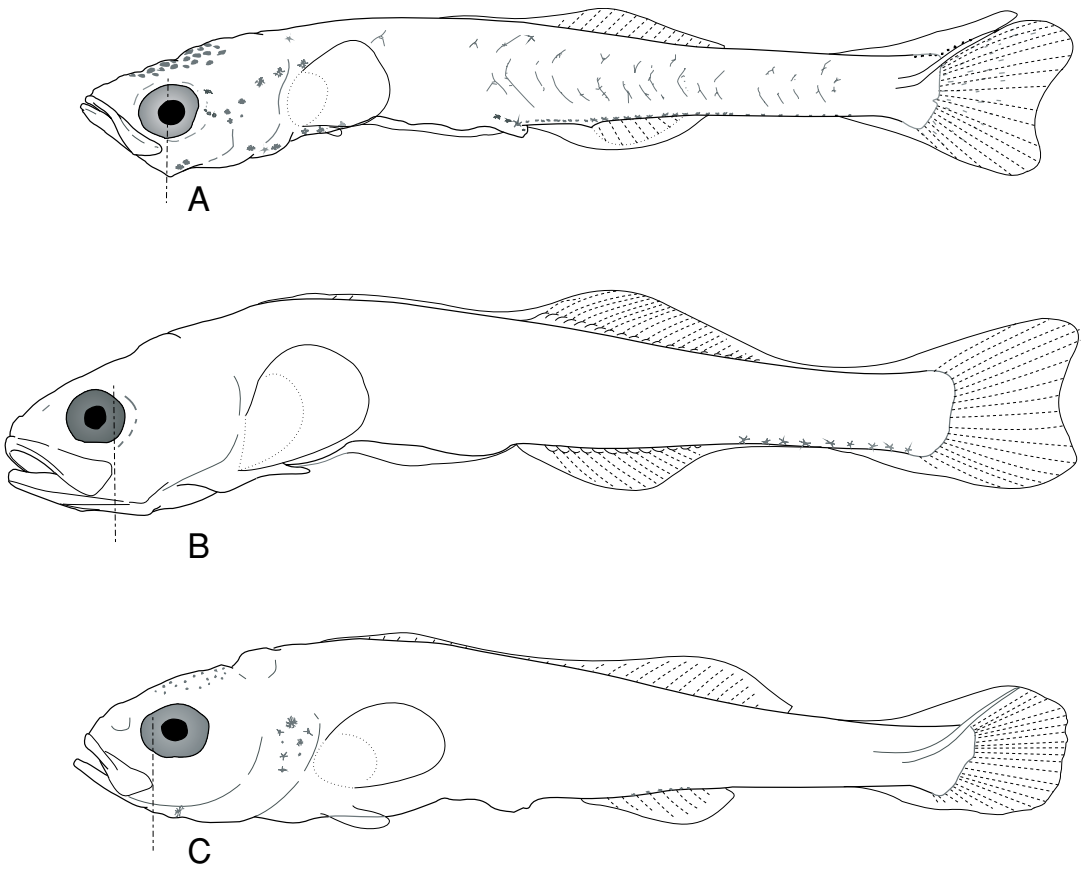

Fig. 3. Perch, pikeperch and ruffe larvae at 12, 13 and 12 mm *TL*, respectively. Note the length of jaws and second dorsal fin.

different pattern (Fig. 4b). In ruffe, as in the other species, the pigmentation is rather weak and mostly on the ventral side during the early stages (Figs. 1c and 3c). It becomes more intensive on the lateral side of ruffe at a size of 15–20 mm, taking the form of the characteristic separate darker spots, first (2–3) on the dorsal or lateral side and then in greater abundance (Fig. 4c).

3.2.3. Use of fins and jaws for identification

Once the larvae are longer than 15 mm the total number of rays in the anal and second dorsal fins can be counted, making it easy to identify perch, pikeperch and ruffe. In fact the shape and size of these fins become visible a little earlier, at 10–12-mm size. In pikeperch, the developing second dorsal and anal fin extends much further back than that in perch and ruffe (Fig. 3). The first dorsal fin does not appear until the larvae have reached a size of 15–20 mm. The mouth and the jaws already differ at 10–12 mm *TL*: In perch the distance from snout to mid-eye is equal or longer than the upper jaw but in pikeperch the upper jaw clearly exceeds the distance from snout to mid-eye (Fig. 3a and b). Ruffe even has a smaller mouth than perch, and moreover the mouth is located rather low in relation to the eyes (Fig. 3c).

4. Discussion

Fish larvae are often hard to identify because their body proportions and pigmentation may change considerably in the course of larval development. It is therefore essential to assess the size limits of larvae for certain readily identifiable characteristics. Such characteristics vary and can be greatly

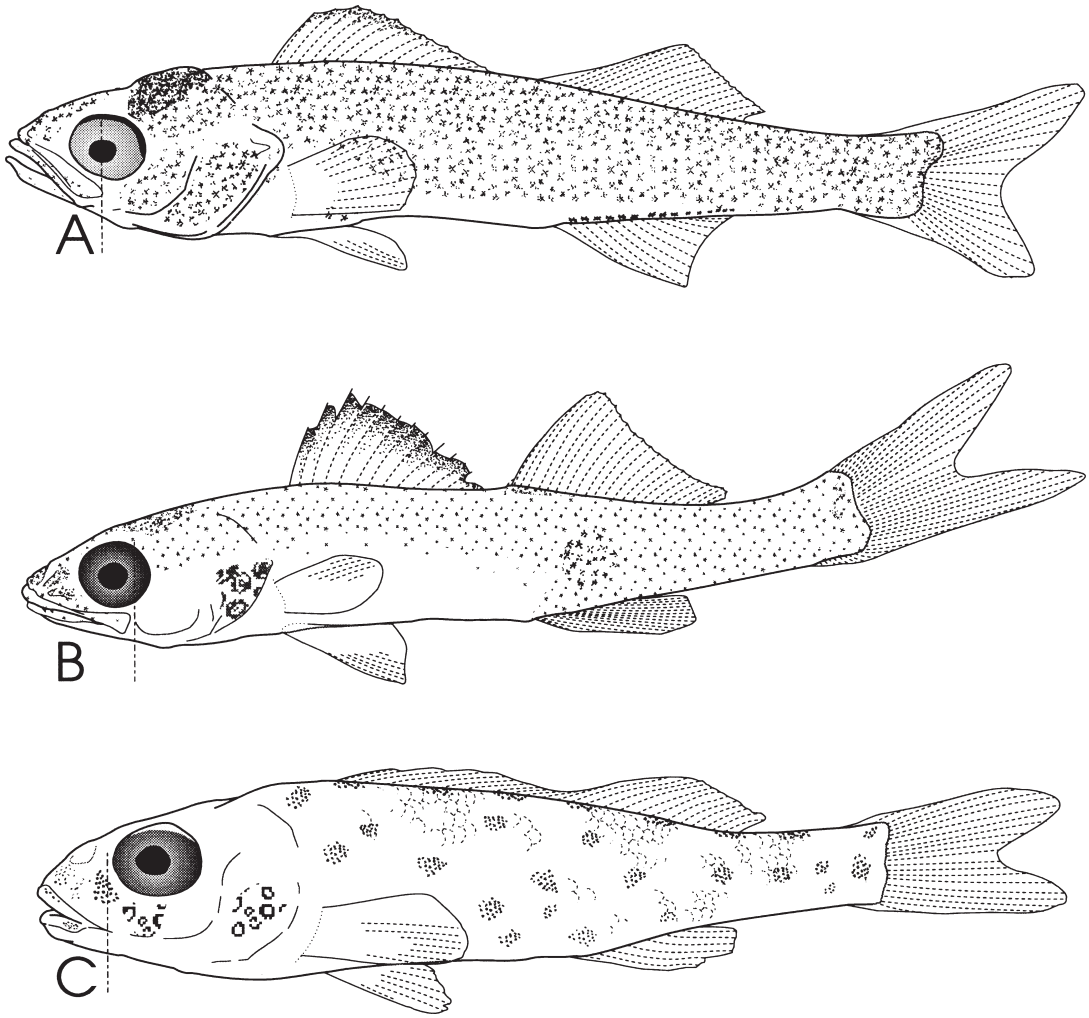

Fig. 4. Perch, pikeperch and ruffe larvae at 27, 42 and 31 mm *TL*, respectively. Note the length and position of jaws and the dorsal fins.

modified by the environment (Urho 1992). Early on the ontogeny, the meristic, unlike the morphometric, characteristics remain unchanged regardless of subsequent changes in environment, body size or shape (Lindsey 1988).

The most reliable way of identifying the three percid larvae is to count myomeres. The number of trunk segments is usually fixed well before the larvae hatch (Lindsey 1988). The counting of myomeres can be facilitated using staining, polarized light or phase contrast (Lindsey 1988). The most short-bodied of the three species, the ruffe, clearly has fewer myotoms than the others, especially in the preanal part. The difference between perch and pikeperch is shown by the number of postanal myomeres. Shortly after the larvae have hatched, the last postanal myomere may be particularly difficult to see, even under a powerful stereomicroscope, if the light is not directed at a low angle in a direction that enables a reflection to be obtained from the interface of the myomeres. There is some variation in the exact number of myomeres among populations, and, like other meristic features, the number also depends on environmental conditions during the early development (Lindsey 1988). For example, in Lake Jeziorak the mean number of vertebrae in pikeperch born in three different years ranged from 45 to 47 (Nagięć & Pirtań 1977). The myomere numbers of percids counted in

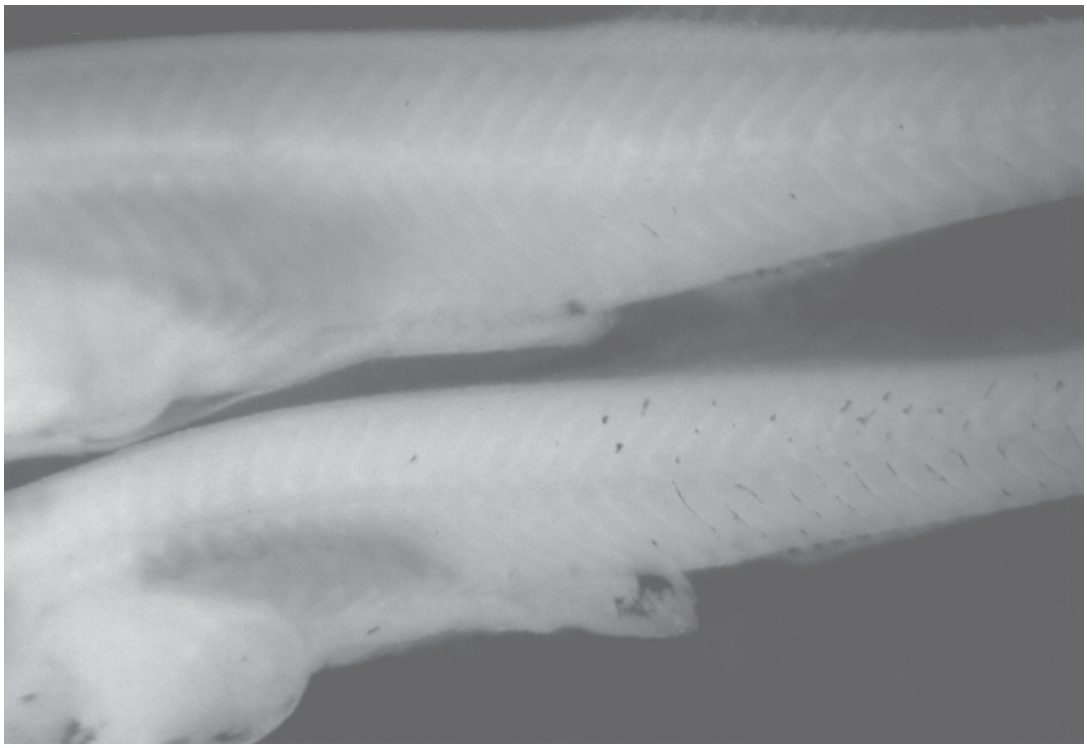

Fig. 5. Typical line-shaped melanophore pattern of perch larvae in clear water (below) and less pronounced pattern in turbid water (above).

Finnish waters are rather similar to those counted in the delta of the Volga (see Koblitskaja 1981). As counting all the myomeres in front or behind the anus is rather laborious, the number of myomeres between the anus and the yolk sac may be a more useful criterion for identification of the yolk sac larvae.

The developmental stage at hatching differs, but takes place within a certain species-specific size range, influenced by environmental conditions, such as light, temperature and the oxygen content of the water. Thus, the stage related to length may sometimes be used as an additional criterion for identification. The development of mouth and jaws proceeds at different rates in different percid species. At hatching the more developed perch have a bigger mouth than ruffe or pikeperch (Fig. 1). Before long, however, pikeperch can be recognised by the length of the upper jaw, which extends further back than that of perch. Not until the pikeperch is 10 to 12 mm long does its upper jaw reach the mid-eye, and thus distinguishes it from perch, whose jaws never extend beyond the mid-eye. Note, however, that even in pikeperch the jaw does not always seem to reach as far back if the mouth is open. Thus, the distances should be measured separately.

The pigmentation pattern should be used for identification purposes with caution, as it is probably even more sensitive to environmental conditions than the development rate. Larvae exposed to light have less intense pigmentation than those kept in the dark (Mooij 1989), and larvae from turbid waters show less intense pigmentation than those from clear waters (Urho 1994). As shown here, the absence of line-shaped pigments on the interface of myomeres does not rule out the possibility of a fish being a perch, but a larva with such an intense pigment pattern is certainly a perch.

Once the rays in the anal and second dorsal fins have developed, identification should not be a problem, although the pigmentation bands and spots characteristic of perch, pikeperch and ruffe are not visible until the scales have appeared. Other features, too, can be used to identify larvae and juveniles, e.g. swimming behaviour, body shape from the side or above, time and place of occurrence.

As there may be some overlap in meristic, morphometric and pigmentary characters, and in the number of myomeres between anus and yolk in perch and pikeperch, it is recommended that several characteristics should be used for the identification of percid larvae.

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