

Spawning marks in spined loaches (*Cobitis taenia*, Cobitidae, Teleostei)

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Abstract. In *Cobitis taenia* and, with lower intensity, also in *C. elongatoides* and *C. melanoleuca*, females bear visible spawning marks on the body sides after spawning events. These marks intensify during the spawning season but disappear a few weeks after the last spawning event. The precise origin of the spawning marks is not clear, but they seem to be produced by the male during embracement of the female. Spawning marks were not observed after spawning events of *C. bilineata*, *C. fahirae*, *C. rara*, *C. paludica*, *C. strumicae* and *C. turcica*. An example dataset from Haaren creek in northwestern Germany is given to demonstrate that these marks can be used as a tool to precisely estimate the start of reproductive season for *Cobitis* populations, separately even for different size classes.

Key words: freshwater fish, reproduction, autecology, population ecology, synchronisation

Introduction

Despite the increase of publications on spined loaches of the genus *Cobitis* over the past twenty years, data on the biology of most species are still extremely rare. In particular, the lack of detailed data on the reproductive biology of many species is painful, since reproductive biology takes a key position in the overall ecology, and therefore also evolution, of a species. Most wanted would be field data on the reproduction of spined loaches, but often it is difficult to estimate reproductive features precisely in the field. For example, in undetermined fractional spawners like *Cobitis*, the beginning of spawning depends on external factors such as temperature or food availability and may vary between years or size of females. The estimation of the duration of the spawning period is a very important feature for ecological studies, especially if estimated separately for different size-classes of females. However, to date, there has been no precise method of measuring the beginning of spawning period at the individual level.

All species of spined loaches investigated to date share the same highly specialised basic mating behaviour (Lodi & Malacarne 1990, Bohlen 2000): the male follows the female into the densest available vegetation and forms a complete ring around the female

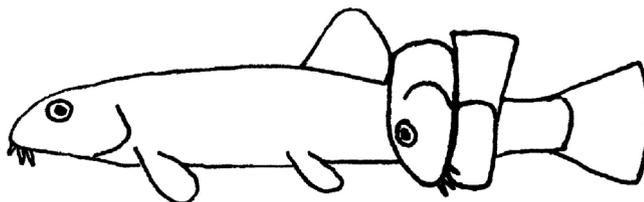


Fig. 1. Spined loaches mate with the male forming a complete circle around the female. The male is located behind the base of dorsal fin of the female, its head or pectoral fin base are close to the spot where the spawning marks can be seen after spawning of the female's sides.

(Fig. 1). When the ring is completed, the body of the male is located directly posterior to the female's dorsal fin and the head of the male is on one of the female's sides. In this position, eggs and sperm are released.

In the present study, evidence is presented that male spined loaches leave marks on the body of the female, which can be used to estimate the beginning of the spawning period for each female in a population.

Material and Methods

Laboratory observations

Different species of *Cobitis* were kept and bred over a period of 1–3 years as described in Bohlen (1999). Spawning was directly observed in *Cobitis taenia*, *C. bilineata*, *C. paludica* and *C. fahirae*; spawning behaviour was identical in all these species with the male forming a ring around the female behind the dorsal fin of the female (Bohlen 2000). Specimens of *C. elongatoides*, *C. melanoleuca*, *C. rara*, *C. strumicae* and *C. turcica* were observed shortly after spawning; maximally 6 hours after spawning had finished. After spawning events, the females were checked by eye for the presence of spawning marks.

Field observations

Specimens of *C. taenia* were captured in Haaren creek near the city of Oldenburg (northwest Germany, Weser drainage system) on 16 occasions from 23.08.1996 to 5.5.1998. Altogether, 254 adult females (total length >70 mm) were measured and checked by eye for the presence of spawning marks.

Results

Laboratory observations

In total, 229 spawning events were noted for *C. taenia*, 22 for *C. bilineata*, 19 for *C. paludica*, seven for *C. elongatoides*, two for *C. fahirae* and one event each for the remaining species. After spawning, small whitish areas had appeared on both body sides of females of *C. taenia* and, although less intense and sometimes difficult to see, also on females of *C. elongatoides* and *C. melanoleuca*. These whitish areas were located under the last ray of the dorsal fin or directly behind the base of the dorsal fin at the level of the ventral margin of the large dark blotches of the 4th Gambetta zone (Fig. 2). The whitish areas had a length of 2–4 mm and were round, squarish or elongated in shape. They gave the impression of scratched areas,

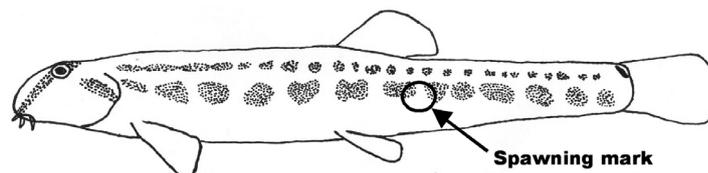


Fig. 2. Position of spawning mark on a female *Cobitis taenia*. The mark is located under the base of last ray of dorsal fin or directly behind the base of dorsal fin on height of lower margin of dark blotches in the 4th Gambetta zone.

but in no cases did infection of these areas occur, as may happen with injuries. The whitish marks remained during the reproductive period of the females, increased in intensity with each additional spawning event and slowly disappeared in the two to four weeks after the completion of the spawning period. The marks never appeared on the sides of any female without a spawning event. In singular cases, no spawning marks were observed on the body sides of a female after spawning. No such marks were observed in females of *C. bilineata*, *C. fahirae*, *C. paludica*, *C. rara*, *C. strumicae* and *C. turcica*.

Field observations

Spawning marks were observed in 59 of 254 females from Haaren creek, but not on all occasions. Details about the collection date, the numbers of females caught and the percentage of females with spawning marks are given in Table 1. During data collection, the tendency was observed that larger females had more pronounced spawning marks than smaller females, but no quantitative estimation of size or intensity of spawning marks was carried out. The frequency of spawning marks was dependent on the size of the females: females with spawning marks measured on average 96 mm total length (range 77–105 mm, n=59), while the females without spawning marks on the same dates measured on average 81 mm TL (range 70–106 mm, n=86). This indicates that spawning marks are more frequent in larger females than in smaller.

Table 1. Frequency of spawning marks in female *Cobitis taenia* from Haaren creek on 15 dates from August 1996 to May 1998. Spawning marks were observed during the spawning season in late spring and early summer and reflect the spawning activity of the population.

Date	Number of females caught	Number of females with spawning marks	Percent of females with spawning marks
5 October 1996	35	0	0
27 December 1996	7	0	0
15 March 1997	25	11	44
19 April 1997	29	18	62
19 May 1997	28	6	21
2 June 1997	9	0	0
6 July 1997	9	3	33
19 July 1997	37	20	54
20 August 1997	9	0	0
18 October 1997	10	0	0
13 December 1997	8	0	0
11 January 1998	6	0	0
21 March 1998	17	1	6
5 May 1998	6	0	0
Total	254	59	

Discussion

The observed whitish marks occurred during spawning; therefore these marks can be regarded as spawning marks. They were located exactly in that part of the body around which the male formed the ring during embracement; therefore the only reasonable explanation for their appearance is that the male caused them while embracing the female. Details on how the male caused the spawning marks were not observed since the body of the male covered the

place where the spawning mark occurred afterwards. Hard surface structures that would be able to cause scratches are the suborbital spine (erectable spine present in all Cobitidae) and the lamina circularis (ossified broadened base of the second pectoral fin ray in males of most *Cobitis*). The suborbital spine is a defensive structure, which is developed in the same manner in both sexes, and in juveniles, while the function of the lamina circularis is unknown. Since it is only present in mature males, it has to be connected with the reproduction, therefore it could be the candidate for the structure that causes the spawning marks. The spawning marks are here taken as indicator for a behavioural element of the male during spawning, which involves a strong scratching on the skin of the female. Details about this behaviour are as unknown as its function, but it could represent a signal to the female to synchronise the release of gametes. Such signals may help to avoid egg releases, since *Cobitis* spawns during the night in very dense structures. This is the first hypotheses about the function of the lamina circularis and should be tested in *Cobitis* as well as in other genera with hardened structures on the pectoral fin such as *Misgurnus*, *Paramisgurnus*, *Iksookimia* and others.

The appearance of spawning marks on the body sides of female spined loaches after spawning offers several possibilities as a tool in ecological studies. The data from Haaren creek show that spawning marks were also visible in the field, meaning they are not artefacts created by non-natural conditions in captivity. In Haaren creek, spawning marks were present from April to August, which corresponds to the major spawning period of spined loaches in Central Europe (Bohlen 1999, Erös 2000). On the other hand, the end of the spawning season may have occurred earlier, since it takes the spawning marks some two to four weeks to disappear (aquarium observation). In the data set from Haaren, two peaks of spawning mark presence appeared during 1997. This pattern points to an interruption of the spawning season during this year. In undetermined fractional spawners like *Cobitis*, the number and date of spawning events depend greatly on external conditions, so that spawning is interrupted during periods of unsuitable conditions. Little is known about the requirements for spawning in *Cobitis*, but the few available data indicate that a temperature above 18°C, dense soft vegetation and a sufficient amount of food are needed (Bohlen 1999, 2003a,b). Therefore, unsuitable conditions could potentially mean cold weather or strong currents.

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