Sexual dimorphism in two catfish species, *Mystus pelusius* (Solander, 1794) and *Glyptothorax silviae* Coad, 1981 (Teleostei: Siluriformes)

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**Abstract:** Sexual dimorphism of two catfish, *Mystus pelusius* (Solander, 1794) and *Glyptothorax silviae* Coad, 1981, is presented based on the examination of external morphology of the fish and morphology of the gonads. We observed sexual dimorphism for *M. pelusius* in the shape and position of the genital papilla. In the male, the genital papilla was a small, fleshy, pointed and broad-based structure. The pelvic fin was short and did not reach back to the genital papilla. In females of *M. pelusius* the opening of the genital structure was without any protrusion or with a very small, dot-like structure in a few specimens, which the pelvic fin reached and overlapped. In females of *G. silviae*, the base of the round genital structure was wider and had a small round protrusion. The color of the female was also darker in comparison with the male. In males the base of the round genital structure was narrower and had a longer pointed protrusion. The male body color was lighter than that of females.

**Key words:** Siluriformes, sex differences, genital papilla, body color, pelvic fin

Sexual dimorphism is a topic of lasting interest to biologists (e.g., Darwin, 1871; Lewin 1988), is common in nature, and has the potential to increase intraspecific variation in performance and patterns of resource use (McGee and Wainwright, 2013). Many vertebrate taxa exhibit sexual dimorphism, and explanations for its cause abound and are sometimes contradictory: e.g., "biological complexity is such that one can find evidence and devise arguments for proposing that large size leads to decreased survivorship … or to increased survivorship…” (Murray 1984). Sexual dimorphism, or phenotypic divergence between the sexes, is a common and often substantial form of intraspecific phenotypic variation (McGee and Wainwright, 2013).

Typically, in any fish, sex can be determined by visual inspection of the gonads (primary sexual characteristics), which normally requires dissection, and in mature fishes, these characteristics are quite evident.

The evolution of secondary sexual characteristics is usually the result of a disparity in the parental investment of males and females (Trivers, 1972; Andersson, 1994). Sexual dimorphism is a phenotypic differentiation between males and females of the same species (Dimijian, 2005). This differentiation happens in organisms who reproduce through sexual reproduction, with the prototypical example being for differences in characteristics of reproductive organs. Other possible examples are for secondary sex characteristics, body size, physical strength and morphology, ornamentation, behavior, and other bodily traits (Dimijian, 2005). Traits such as ornamentation and breeding behavior found in only one sex imply that sexual selection over an extended period of time leads to sexual dimorphism (Dimijian, 2005).

Many teleost fishes do not exhibit any sexual dimorphism, even during the spawning season, and do not show sexual characteristics or permanent ornaments. On the other hand, some fishes show permanently dimorphic traits that are not necessarily associated with internal fertilization (Rapp Py-Daniel and Fernandez, 2005). When present, sexual characteristics can be easily recognized in some species, e.g., *Aphanius* (Esmaeili et al., 2014; Teimori et al., 2014), whereas, in some others (e.g., some catfishes), a detailed examination is required for identification of these characteristics (Godinho, 2007).

The catfishes (order Siluriformes) comprise 39 families and well over 3709 species found worldwide in fresh waters.
Although two families are primarily marine (Eschmeyer and Fong, 2015). In contrast, Iran has four families, including Bagridae, Heteropneustidae, Siluridae, and Sisoridae. Catfishes are important food and sport fishes in many parts of the world and smaller species are popular in the aquarium trade. The larger species are significant predators on commercially important fishes (Coad, 2014).

The catfishes of the family Bagridae are found in fresh waters of Africa and Asia with about 205 valid species (Eschmeyer and Fong, 2015). Within this family, the moderately speciose genus Mystus Scopoli, 1777 (with nearly 45 species) consists of small to medium-sized fish found predominantly in freshwater habitats in East, South, and Southwest Asia. Only one species, Mystus pelusius (Solander, 1794), is known from Iran and it is found in such rivers as the Arvand, Bahmanshir, Karun, Karkheh, Gav Masiah, Jarrahi, and Zohreh rivers in the Tigris-Karun basin, which drain to the Persian Gulf (Esmaeili et al., 2010; Coad, 2014). The 4 pairs of barbels, a strong spine in both the dorsal and pectoral fins, and elongate and strong adipose fin are key characters of this fish (Coad, 2014). So far, no report on sexual dimorphism for Mystus pelusius is available (Coad, 2014).

The sisorid or sucker catfishes are found in Asia from Turkey as far east as Borneo. There are 218 species in two subfamilies (Eschmeyer and Fong, 2015). They are mostly small (as small as 2 cm), although some are very large (2 m). Members of the sisorid catfish in Iran have been recognized as belonging to the genus Glyptothorax Blyth, 1860. So far, no report on sexual dimorphism for any catfish species in Iran is available (Coad, 2014).

For better understanding of species taxonomic status and also for breeding and culture purposes it is necessary to distinguish males and females accurately based on external characters.

The objective of this study was to prove the existence of sexual dimorphism in two catfishes, Mystus pelusius (Bagridae) and Glyptothorax silviae (Sisoridae).

A total of 21 specimens of Mystus pelusius (ZM-CBSU J1038; J1040–J1043; J3288–J3303, 107–203 mm SL; 17.2–91.8 g weight) were collected from the Karun River, Tigris basin, Iran, using angling gear during March 2012 and January 2014 and 25 specimens of Glyptothorax silviae (ZM-CBSU H918–H935; H967–H973, 47–82 mm SL; 1.77–10.1 g weight) were collected from Kooomareh Sorkhi River, Helleh tributary (Persis basin), using electrofishing gear in June and December 2010. The collected specimens were anesthetized in 1% clove solution and were fixed in 5% formaldehyde, stored in 70% ethanol, and deposited in the Zoological Museum-Collection of Biology Department, Shiraz University (ZM-CBSU). Bioethics rules and regulations of Shiraz University were followed while collecting, handling, and fixing the specimens. Fish identifications were carried out based on the work of Coad (2014). Fishes were examined externally, and whenever any structure appeared to show some consistent dimorphism, they were separated into putative sexes using the dimorphic feature. Each fish was then dissected to check the accuracy of the prognosis by visual determination of sex.

Based on the examination of external morphology of the fish and morphology of the gonads for sexual dimorphism, we observed sexual dimorphism in M. pelusius in the shape and position of the genital papilla. In the male, the genital papilla was a small, fleshy, pointed and broad-based structure. The pelvic fin was short and did not reach back to the genital papilla, whereas in females the opening of the genital structure was without any protrusion or with a very small, dot-like structure in a few specimens, which the pelvic fin reached and overlapped (Figures 1 and 2; Table). Based on the obtained results, 12 male and 9 female specimens were sexed.

Identification of the sexes in G. silviae was done by differences in genital papilla and coloration for 25 studied specimens (8 females and 17 males). In females the base of the round genital structure was wider and had a small round protrusion. The color of the female was also darker in comparison with males. In males the base of the round genital structure was narrower and had a longer pointed protrusion. The color was light in comparison with that of the female (Figures 3 and 4).

Guaranteeing the transference of genetic information to subsequent generations is a fundamental task in all living beings. The success of this process is related to differences in the access to mating, or sexual selection (Darwin, 1871). Sexual dimorphism can be the result of a variety of factors, including both sexual and natural selection. Different reproductive roles, niche divergence between the sexes, preference of one sex for particular traits of the other sex, and intrasexual competition can drive sexual differences in external structures (Darwin, 1874; Slatkin, 1984; Shine, 1989; Parker, 1992; Andersson, 1994), which has to be checked for both studied catfishes, M. pelusius and G. silviae.

Secondary sexual differences used as signals are most likely to occur in pairing, territorial, and bottom-dwelling species and therefore should be present in many freshwater riverine forms (Reynolds, 1970). The most common forms
of sexual dimorphism towards which analyses have been targeted are sexual differences in body size (sexual size dimorphism), sexual differences in coloration (sexual color dimorphism), and sexual differences in body shape (sexual shape dimorphism) (see Andersson, 1994; Möller and Birkhead, 1994; Dunn et al., 2001; Stuart-Fox and Ord, 2004; Fairbairn et al., 2007). Although sexual differences in body size (sexual size dimorphism) were not found in either of the studied catfishes, sexual color dimorphism was observed in G. silviae. Sexual size differences (larger size) have been reported for males of many cichlids (e.g., Irancichla hormuzensis, Lamprologus callipterus) and females of poeciliids (e.g., Gambusia holbrooki). Sexual color dimorphism is also found in many cyprinodontids (e.g., Aphanius).

Generally, the genital pore, the size of the head, and the shape of the body and abdomen of the fishes and the body coloration of both sexes have been already examined for

**Figure 1.** Sexual dimorphism in Mystus pelusius. Female: ZM-CBSU J3297, 168 mm SL; J3299, 182 mm SL; J3303, 196 mm SL; Male: ZM-CBSU J3298 200 mm SL; J3300, 162 mm SL; J3301, 184 mm SL (from up to down in each column).

**Table.** Descriptive statistical data for genital papilla position of male and female M. pelusius.

<table>
<thead>
<tr>
<th>Character</th>
<th>M (n = 12)</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance between pelvic fin origin and genital papilla in % SL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M (n = 12)</td>
<td>9.45</td>
<td>15.10</td>
<td>12.15</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>F (n = 9)</td>
<td>9.66</td>
<td>11.74</td>
<td>10.42</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Distance between genital papilla and anal fin origin in % SL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M (n = 12)</td>
<td>2.81</td>
<td>6.23</td>
<td>4.15</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>F (n = 9)</td>
<td>5.76</td>
<td>8.84</td>
<td>7.43</td>
<td>1.2</td>
<td></td>
</tr>
</tbody>
</table>
Figure 2. Differences between the shape and position of the genital papilla in female and male specimens of *Mystus pelusius*. Female: ZM-CBSU J3297, 168 mm SL; J3299, 182 mm SL; Male: ZM-CBSU J3298, 200 mm SL; J 3300, 162 mm SL; J3301, 184 mm SL (from up to down in each column).

Figure 3. Sexual dimorphism in genital papilla in *Glyptothorax silviae*. Female: ZM-CBSU H922, 63 mm SL; H924, 54 mm SL; Male: ZM-CBSU H918, 81 mm SL; H969, 65 mm SL; H921, 75.5 mm SL; H919, 78.5 mm SL (from up to down in each column).
finding a practical way of discerning the sexes. The area of the genital pore was observed to be quite helpful for identification of the sexes (Hossain and Islam, 1983). The same has been found in both M. pelusius and G. silviae. Intensification of sexual dichromatism in permanently dichromatic species or development of nuptial coloration during the breeding season is characteristic of many species of fishes (Kodric-Brown, 1990).

Although sexual dimorphism is known in several fish groups including catfishes (Davis, 1959; Breeder and Rosen, 1966; Cross, 1967; Flickinger, 1969; Doha, 1974; Musa and Bhuiyan, 2006), our findings are the first to demonstrate sexual dimorphism in Mystus pelusius and G. silviae. These findings would be helpful in conservation and management programs, fisheries, and aquarium industry.

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