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Reproductive biology of largescale tonguesole *Cynoglossus arel* in coastal waters of Bandar Abbas, Persian Gulf, Iran

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ABSTRACT

The objectives of this study were to determine the reproductive cycle of largescale tonguesole *Cynoglossus arel*, a commercially valuable flatfish species, in coastal waters of Bandar Abbas, along the south coast of Iran in the Persian Gulf. From October 2009 to September 2010, 905 fish were collected in monthly samples, and their length, weight, sex, gonad weight, and maturity status recorded. These data revealed that ovary weight in females is low from July to September, then increases to a peak in February followed by a decrease, indicating that the peak spawning season is from February to March with some spawning lasting until June. Males showed a corresponding seasonal pattern in testis weight, although with much less pronounced seasonal differences than gonad weight in females. Five maturity classes were described based on ovarian and testicular histology, corresponding with macroscopic analysis of gonads. The spawning season in *C. arel* is prolonged, similar to several other tropical flatfish species, and larger adult females tended to have an even more prolonged spawning period than smaller, presumably younger adult females. Combined, our results indicated that *C. arel* is a winter-to-spring batch spawner with an asynchronous type of ovarian development.

1. Introduction

Worldwide, flatfishes (Pleuronectiformes) are of great commercial and ecological significance. However, the overwhelming majority of research on their reproductive biology, exploitation and management has focussed on species living in temperate seas, especially the North Atlantic and North Pacific; by comparison, knowledge on the reproductive biology of tropical flatfish species remains limited (Rijnsdorp and Witthames, 2005). Yet tropical flatfishes provide an important food source to the inhabitants in many coastal communities, such as along the shores of the Indian Ocean (Gibson, 2005). In the Persian Gulf, five species in the family of tonguesoles (Cynoglossidae) are caught and marketed fresh, frozen, dried, or as salted fish products (Gibson, 2005). These include largescale tonguesole *Cynoglossus arel,* fourlined tonguesole *Cynoglossus bilineatus,* hooked tonguesole *Cynoglossus carpenteri,* shortheaded tonguesole *Cynoglossus kopsii,* and speckled tonguesole *Cynoglossus puncticeps*. All are valued for their delicious meat, and largescale tonguesole *C. arel* in particular is an important source of protein in the diet of local communities in southern Iran (personal communication).

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This species is distributed throughout the Persian Gulf and Oman Sea (Yasemi et al., 2007) and can be found at the continental shelf down to 125 m depth (Fischer and Bianchi, 1983). Although there is not a directed fishery for largescale tonguesole, it is taken in considerable quantities as bycatch in the local shrimp trawl fisheries (Topp and Hoff, 1972). Nominal catches of tonguesoles from the western Indian Ocean (FAO Fishing Area 51) have previously been reported as about 1000 t in 1981, all taken by Pakistan (Fischer and Bianchi, 1983); as this only includes the reported catch, it is likely that this does not represent the full commercial significance of tonguesoles which may currently be considerably higher.

So far, research on tonguefishes in the Persian Gulf included the identification of closely related species by means of morphometric and meristic characteristics (Yasemi et al., 2007) and the recent description of a new species, *Cynoglossus persicus*, from Iranian coasts (Kousha et al., 2008). Elsewhere, the reproductive biology of *C. arel* and *Cynoglossus lida* has been studied in southern India (Rajaguru, 1992), where the length–weight relationships in *Cynoglossus macrostomus* and *C. arel* have also been described (Jayaprakash, 2001), as well as growth, mortality (Kutty, 1967), reproductive biology, and fisheries in related tonguesole species (Seshappa, 1973, 1974, 1980; Ramanathan et al., 1977). In the Persian Gulf, knowledge on reproductive biology of tonguesoles is limited to macroscopic studies on *C. arel* (summarised in Ghaffari et al., 2011) which might partly reflect less scientific attention due to the species' relatively small size (total length range 11–33 cm in females, 10–31 cm in males; Ghaffari et al., 2011). The general seasonality of reproductive and body condition indices showed that *C. arel* is a winter–spring spawner (Ghaffari et al., 2011). This study complements earlier work on large-scale tonguesoles by including macroscopic analyses of maturation and reproductive condition, but also focuses on the gonad histology using microscopic techniques (Narimatsu et al., 2007). Gonad histology, although more costly and time-consuming than macroscopic analyses, can provide an independent assessment of maturity and a more detailed insight into the process of oogenesis (McBride et al., 2013).

The purpose of this study was to determine the reproductive biology of *C. arel* in coastal waters of the Persian Gulf near Bandar Abbas, Iran. To do so, this paper (1) characterises the phases of ovarian follicle and testicular development and the stages of ovarian and testicular maturation; (2) determines the spawning season, spawning periodicity, type of spawning and size at first maturity; and (3) assesses demographic trends in spawning periods.

2. Materials and methods

2.1. Collection and processing

In this study a total of 905 specimens of *C. arel* (493 females, 412 males) were collected monthly during day time, from October 2009 to September 2010, from the coastal waters of Bandar Abbas, south coast of Iran (27°17′N, 56°26′E) (Fig. 1). Commercial trawling nets were used during the shrimp fishery season, and trammel and gill nets during other seasons.

Total length (TL) of each individual was measured to the nearest 1 mm, and body weight (BW) recorded to the nearest 0.1 g. The gonads of each specimen were also weighed to the accuracy of 0.01 g (GW), while the sex was determined by examination of the gonads either with the naked eye or with the aid of a binocular microscope, if necessary, and the gonads in females were macroscopically classified. Gonad length (GL) was measured to the nearest 1 mm. For both

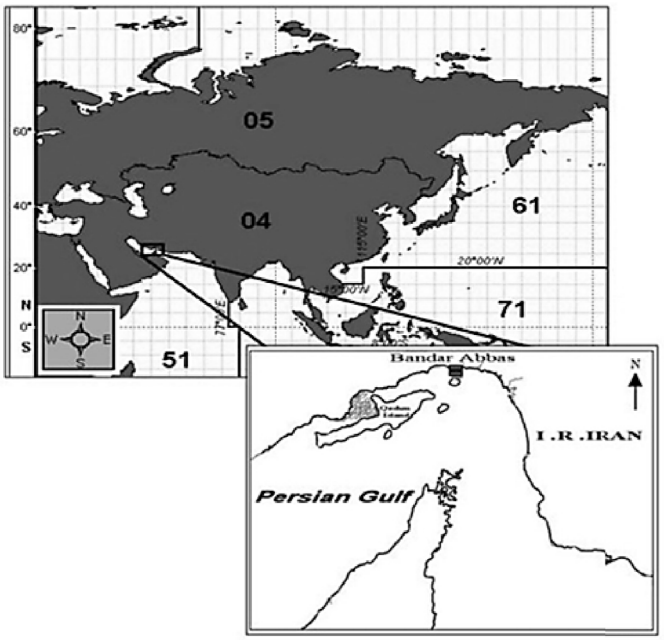

Fig. 1. Location of sampling in coastal waters of Bandar Abbas, Persian Gulf, Iran.