



First records of several sicydiine gobies (Gobiidae: Sicydiinae) from mainland China

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Abstract: Surveys based on observation were conducted in clear streams in the mainland of southern China, and five sicydiine gobies, including four species new to the region, were recorded. All these fishes were never found to be common, and some were very rare. Two of them are considered to be threatened globally and the others are considered to be of regional conservation concern. Habitat destruction, modification and pollution are the main threats to these species; however, collection conducted for ornamental fish trade/ private aquarium use also constitutes a considerable risk to them. To protect these amphidromous species, the stream-ocean corridor should remain open naturally (i.e. no man-made obstacle), the stream environment such as the bottom and the flow should be maintained in a natural condition and harvesting activities should be strictly controlled.

Keywords: China, Guangdong, Hong Kong, Sicydiinae, Sicydiine gobies, *Sicyopus*, *Stiphodon*.

Chinese Abstract: 本研究在華南大陸的河溪進行，共發現了五種瓢鰕虎魚亞科的魚，其中四種為華南大陸新記錄。被發現的種群的數量均十分稀少，有些種更呈極度稀有狀態；當中兩個品種應獲全球性保育關注，餘下的亦至少應獲區域性保育關注。生境破壞、人工改造及污染固然會直接影響這些魚類；但對於數目這麼少的品種而言，商業或私人進行的採集亦為不可忽視的威脅。要保護這些洄游種，河海之間的通道應暢順無阻（如無人為障礙物），河溪流量及環境（如河床）亦要保持自然，而採集行為也應受到嚴格規管。

INTRODUCTION

Sicydiine gobies are amphidromous species inhabiting clear streams (Keith 2003). In many tropical and subtropical islands a few species are very abundant and are utilized as food fish by local people (Keith 2003; Lin 2007), although this kind of harvesting is considered highly unsustainable (Keith 2003). In recent years some colourful species, especially those of the genera *Stiphodon*, *Sicyopterus* and *Sicyopus*, have also become popular in the ornamental fish trade (Ekaratne 2000; Lin 2007; pers. obs., Image 1). Wild-caught individuals are currently the sole source for this trade, as the reproductive cycle of these gobies is too complex for breeding on a commercial scale (Keith 2003; Yamasaki & Tachihara 2006). This form of exploitation, whether by amateur or professional collectors, has already been considered a threat to these fishes (Ekaratne 2000; Yamasaki & Tachihara 2006; Lin 2007). The amphidromous nature of these species also indicates that they are sensitive to environmental changes, even if the scale of the impact is slight (Keith 2003; Yamasaki & Tachihara 2006; Keith et al. 2009). Overall, it is generally believed that many sicydiine gobies are highly vulnerable (Keith 2003; Watson et al. 2005; Yamasaki & Tachihara 2006; Keith et al. 2009); many are also believed to be in danger of extinction (Keith 2003; Watson et al. 2005).

Most sicydiine gobies are found in the Indo-Pacific region (Parenti & Maciolek 1993; Keith 2003), and new species have usually been described from isolated islands or island chains (archipelagos) such as the Philippines, Indonesia, Japan and Vanuatu (Sakai & Nakamura 1979; Watson & Kottelat

1995; Watson 2008; Keith et al. 2009). In contrast, few have been recorded from continental landmasses. As an example, four genera of the Sicydiinae have been recorded from Taiwan, namely *Lentipes*, *Sicyopterus*, *Sicyopus* and *Stiphodon* (Lin 2007; Wu & Zhong 2008). This is compared to only one species of *Stiphodon* recorded from mainland China (Lee et al. 2004).

The present study reports the occurrence of five species of sicydiine gobies from mainland China, with four of them being new records for this area. Besides providing updated data on the distribution of these species, their dispersion mode and conservation status are discussed.

MATERIALS AND METHODS

During April to December 2009, 29 small to medium-sized streams (ca. 1-15 m wide) along the coastal region of Guangdong Province (including Hong Kong), southern China, were visited (Fig. 1). Fishes in all streams were surveyed by snorkeling/ direct observation along the streamside and recorded by waterproof cameras (Sanyo Xacti CA8, Canon IXUS 870IS with housing WP-DC26, Canon Powershot G9 with housing WP-DC21, Canon Powershot G10 with housing WP-DC28, Canon IXY 510IS with housing WP-DC32). Some fishes were also captured and kept in a small tank for in situ photography and making meristic (primarily fin-ray) counts; all were subsequently released. Most male sicydiine gobies could be easily identified by their colour patterns (following Watson & Chen (1998); Watson (1999); Nakabo (2000); Chen & Tan (2005); Lin (2007) and Wu & Zhong (2008)). However, one species could not be readily identified and high quality photographs of this species were sent to an expert on sicydiine gobies (Ronald Watson) for identification.

Exposing the exact locations of these fishes would not provide additional information on their distribution range, but could attract aquarium hobbyists to deplete the stocks (see result section for the abundances of these fishes). This is contradictory to the purpose of this study – to understand and help conserving these rare species. Accordingly, no detailed site information is provided in this paper.

RESULTS

Four *Stiphodon* species; *S. atropurpureus*, *S. imperorientis*, *S. multisquamus* and *S. percnopterygionus*; and one of *Sicyopus* (*S. zosterophorum*) were identified in the material collected for this study. Except for *S. atropurpureus*, these species have not been previously reported from mainland China. In particular, *S. imperorientis* and *S. multisquamus* were previously

thought to be endemic to Iriomote Island (Japan) and Hainan Island (China), respectively (Watson & Chen 1998; Wu & Zhong 2008). The approximate area where material was collected for this study is indicated in Figure 1.

Out of the 29 streams surveyed, *S. atropurpureus* was observed in seven streams and fish abundance recorded at each stream ranged from one to 30 individuals. Both males and females were observed. *Stiphodon imperorientis* was only observed in one stream and two males were identified. Although one presumed female of this species was observed in the same stream, the identity of this individual could not be confirmed. *Stiphodon multisquamus* was observed in six streams, and both males and females were identified. However, this species was not as abundant as *S. atropurpureus* and fish numbers at each stream ranged from two to six individuals. *Stiphodon percnopterygionus* was observed in only one stream by the author, and a single male was identified. Nevertheless, a local aquarium hobbyist claimed that one male individual had also been observed in another stream. One very small population (one male and two females) of *S. zosterophorum* was observed in a single stream by the author. Another population (claimed to be seven individuals) was found by a group of aquarium hobbyists in another stream. Unfortunately, the latter population is suspected to be depleted by the persons who discovered them. Descriptions of all these species and a key to the males are given. Meristic counts are based on measurement conducted in the present study and information collected from literatures such as Watson & Chen (1998), Nakabo (2000) and Wu & Zhong (2008).

***Stiphodon atropurpureus*:** D1: VI, D2: I-9, A: I-10, P: 15. The species ranges from 3-5 cm in total length (TL).

Male: body, snout and cheek iridescent green/ blue/ purple; first dorsal fin not elongated/ filamentous; first dorsal fin with narrow red margin (Images 2, 3 & 4).

Female: body white/ pale buff with two prominent transverse stripes (Image 5).

***Stiphodon imperorientis*:** D1: VI, D2: I-9, A: I-10, P: 15. A large sized fish about 6-7 cm in TL.

Male: pectoral fin spotted; body grey or dark with iridescent blue/ green/ purple lateral bars; snout and cheek iridescent blue/ green/ purple; first dorsal fin elongated (Images 6 & 7).

Female: pectoral fin partially spotted; body with two prominent transverse stripes (no female was identified in the present study, description is based on illustration from Nakabo (2000)).

***Stiphodon multisquamus*:** D1: VI, D2: I-9, A: I-10, P: 15. A large sized fish about 7-8 cm in TL; pectoral fin spotted.

Male: upper one-third of body khaki and lower part silvery grey/ grayish brown with 9-10 lateral bars (darker or with a bluish tinge in some individuals); first dorsal fin elongated and usually slightly filamentous (Images 8, 9, &

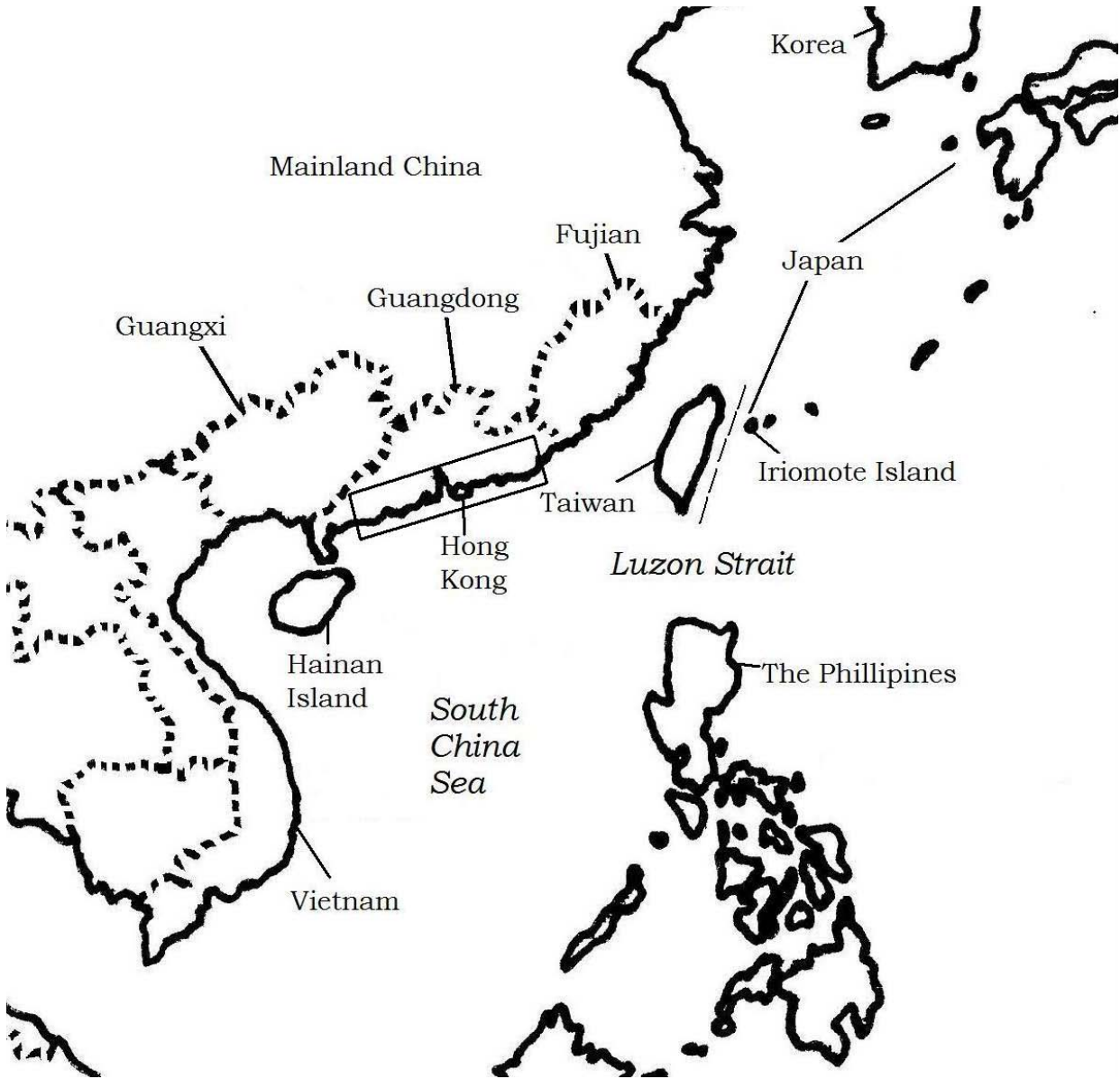


Figure 1. Locations of Guangdong and nearby regions. Surveyed streams are located within the rectangle.



Image 1. Sicydiine gobies (*Stiphodon atropurpureus* and *Sicyopus zosterophorum*) in the tanks of a pet shop.



Image 2. *Stiphodon atropurpureus* (male).



Image 3. *Stiphodon atropurpureus* (male)



Image 4. *Stiphodon atropurpureus* (male) during courtship display



Image 5. *Stiphodon atropurpureus* (female).



Image 6. *Stiphodon imperorientis* (male) during courtship display.



Image 7. *Stiphodon imperorientis* (male).



Image 8. *Stiphodon multisquamus* (male).



Image 9 *Stiphodon multisquamus* (male) showing darker colour with a slight bluish tinge.



Image 10 *Stiphodon multisquamus* (male) showing the elongated first dorsal fin.



Image 11. Dorsal view of *Stiphodon multisquamus* (male).



Image 12. Dorsal view of *Stiphodon multisquamus* (another male).



Image 13 *Stiphodon multisquamus* (female).



Image 14 *Stiphodon multisquamus* (another female).



Image 15 *Stiphodon multisquamus* (female) with light blue ventrum.



Image 16 *Stiphodon percnopterygionus* (male), blue colour form (Photo by H.T. Cheng).

10); predorsal midline usually without scales or with very few scales (Images 11 & 12).

Female: body cream with two transverse stripes, sometimes with dull lateral bars; dorsum with gold bars; ventrum light blue (Images 13, 14 & 15).

***Stiphodon percnopterygionus*:** D1: VI, D2: I-9, A: I-10, P: 14. The species ranges from 3-5 cm in TL.

Male: colour highly varied; body, snout and cheek iridescent blue/ green/ purple; usually with lateral bars (indistinct in some individuals); first dorsal fin elongated (Image 16); some individuals orange in life (Image 17).

Female: body with two prominent transverse stripes

(no female was identified in the present study, description is based on illustration from Nakabo (2000)).

***Sicyopus zosterophorum*:** D1: VI, D2: I-9, A: I-10, P: 15. The species ranges from 3-5 cm in TL.

Male: anterior half of body dark grey and brown/ yellowish brown, posterior half yellow, green and orange; two thick dark bars on anterior half of body, two more dark bars below second dorsal fin and one dark bar on caudal peduncle (Image 18).

Female: body light brown without obvious stripe or bar (Image 19).



Image 17. *Stiphodon percnopterygionus* (male), orange colour form (Photo by W.W. Chau).



Image 18 *Sicyopus zosterophorum* (male).



Image 19 *Sicyopus zosterophorum* (female).

DISCUSSION

In general, adults of sicydiine gobies live and breed in freshwater streams. The larvae drift downstream passively, and live planktonically in the marine environment. When they reach the post-larval stage, they actively return to freshwater streams (Fitzsimons et al. 1996; Keith 2003; Yamasaki & Tachihara 2006; Yamasaki et al. 2007; Iida et al. 2008). Since these species have a planktonic larval stage in the sea, ocean currents would play a key role in their distribution (Keith et al. 2009). For instance, larvae of some sicydiine gobies are believed to be transported from southern regions (such as the Philippines) to Taiwan/ Japan by the northward-flowing Kuroshio Current (Lin 2007; Yamasaki et al. 2007). The coast of South China has a complex current system (Morton & Morton 1983). In winter, the current flows from northeast to southwest along the coast, while the reverse is true in summer. A branch of the Kuroshio Current also passes through the Luzon Strait and approaches the South China coast. This complex current system may explain some of the findings of this study: larvae of *S. atropurpureus* and *S. zosterophorum*, which mainly appear in the tropics (Watson & Chen 1998; Watson 1999), would be brought by the Kuroshio Current from tropical regions such as The Philippines to Guangdong, while *S. multisquamus*, the species previously thought to be restricted to Hainan, would be carried to the present study area by the ocean current prevailing in summer. Given this ocean current system, it is also believed that these gobies would have a wider range than that observed at present. For instance, besides Guangdong, these fishes may be found in Guangxi and Fujian (Fig. 1). Indeed, *S. atropurpureus* is believed to occur in Fujian (Ronald Watson pers. comm.). Moreover, in view of the present distribution of *S. imperorientis*, it is believed that this species is likely to be found in eastern Taiwan as well.

In the study area, sicydiine gobies were never found to be common or abundant and some were very rare. *Stiphodon atropurpureus*, the most frequently

encountered species, was only found in fewer than a quarter of the streams surveyed. This scarcity may be due to the study area (Guangdong) being at the periphery of the species distributions. *Stiphodon atropurpureus* and *S. percnopterygionus* are widely distributed (Watson & Chen 1998; Wu & Zhong 2008); the former is common in the Philippines (Watson & Chen 1998), while the latter is fairly common in southern Japan and eastern Taiwan (Watson & Chen 1998; Yamasaki & Tachihara 2006). *Sicyopus zosterophorum* also has a wide range, and has been recorded in New Caledonia, Indonesia, The Philippines, Taiwan and Japan (Watson 1999). Even so, the importance of conserving these species should not be overlooked, and conservation efforts should be assessed on a regional/ national scale. For example, the Ministry of Environment, Japan has listed *S. atropurpureus* and *S. zosterophorum* as critically endangered, and has suggested ways to conserve these species, owing to their rarity in Japan (Ministry of the Environment, Japan 2007, 2010). On the other hand, the present study also indicates that *S. imperorientis* and *S. multisquamus* are still scarce, even though they have now been shown to have a wider distribution range than was previously known. *Stiphodon multisquamus* is considered to be very rare in Hainan Island, sufficiently so to be considered endangered in China (Wu & Zhong 2008). Watson & Chen (1998) believed that *S. imperorientis* is rare as only ten individuals were collected in their study. This species is also considered to be critically endangered in Japan (Ministry of the Environment, Japan 2007). Considered in combination with findings of the current study, it is believed that *S. imperorientis* and *S. multisquamus* should be considered as of high conservation concern on both regional and global scales, while other species should at least be of regional conservation concern. Indeed, *S. imperorientis* has recently been placed on the IUCN Red List (IUCN 2010).

During the present study, many streams were found to be adversely impacted seriously. Certain streams have been concreted or channelized, while some have

even been filled or culverted. Artificial structures such as dams and pipes to divert stream water for irrigation or domestic use were commonly seen. Many streams were also found to be receiving untreated sewage from nearby houses. All these human-induced impacts are considered serious threats to sicydiine gobies, as they would lead to habitat loss, increase the sedimentation rate and thus affect the breeding of the fishes, and block the migration pathway (Fitzsimons et al. 1996; Brasher 2003; Keith 2003; Yamasaki & Tachihara 2006; McDowall 2007; Keith et al. 2009). In order to protect these species, the flow and environment (i.e. streambed) of the stream should be kept natural, and the stream-ocean corridor should remain open (Fitzsimons et al. 1996; Keith et al. 2009). Even in the absence of other conservation measures, avoiding the aforementioned impacts would be highly beneficial to these species. In addition to environmental degradation, harvesting activity is considered a threat to these fishes (Ekaratne 2000; Yamasaki & Tachihara 2006; Lin 2007). It has been suggested in Japan that regulations should be set up to strictly control this kind of activity (Ministry of the Environment, Japan 2010). The Government of Sri Lanka has even prohibited the trade of certain sicydiine gobies in order to stop their harvesting for the aquarium trade (Wijesekera & Yakupitiyage 2001). In view of the small population sizes of the fishes observed, it is considered that they are highly susceptible to overexploitation and thus similar measures should be adopted in southern China.

CONCLUSION

This study provides data indicating that streams in the coastal region of southern China, even small-sized ones, provide habitats for many sicydiine gobies; and all of them are considered to be of high conservation concern in mainland China. Two of the species known from here, *S. imperorientis* and *S. multisquamus*, are considered very rare on a global scale (Wu & Zhong 2008; IUCN 2010). To protect these gobies, their habitats (i.e. streams in coastal regions) should be maintained in natural condition, and man-made environmental impacts on them should be

avoided. Also, in view of the rarity of these species, it is deemed necessary to set up regulations to control harvesting activities.

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Key to sicydiine gobies (male) of mainland China

- | | | |
|-----|---|------------------------------------|
| 1a. | Pectoral fin soft rays 14, dorsal fin soft rays 10..... | <i>Stiphodon percnopterygionus</i> |
| 1b. | Pectoral fin soft rays 15, dorsal fin soft rays 9..... | 2 |
| 2a. | First dorsal fin not elongated..... | 3 |
| 2b. | First dorsal fin elongated..... | 4 |
| 3a. | Body mainly dark, yellow and brown, with lateral bars..... | <i>Sicyopus zosterophorum</i> |
| 3b. | Body, snout and cheek iridescent green/ blue/ purple..... | <i>Stiphodon atropurpureus</i> |
| 4a. | Body grey or dark with iridescent blue/ green/ purple lateral bars, snout and cheek iridescent blue/ green/ purple..... | <i>Stiphodon imperorientis</i> |
| 4b. | Body khaki and silvery grey/ grayish brown with 9 – 10 lateral bars, first dorsal fin usually slightly filamentous, predorsal midline without scales or with very few scales..... | <i>Stiphodon multisquamus</i> |

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