

# A goby-fry fishery in the northern Colombian Pacific Ocean

by

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**ABSTRACT.** - Migrations between freshwater and marine environments are a common strategy among gobies of the Sicydiinae sub-family. Sicydiinae post-larvae occur in high density to the extent of supporting artisanal fisheries. Here, we document for the first time in the tropical eastern Pacific Ocean (Colombia), an artisanal fishery based on sicydiine post-larvae (*Sicydium salvini*) returning to relatively short and steep rivers of the coast. The migration and harvesting is comparable to that of sicydiines elsewhere in the world (e.g. Dominica, West Indies) with a lunar periodicity and the use of similar fishing methods. Harvesting can be as much as 1.37 ton/month at a single village of ca. 5000 inhabitants. This catch corresponds to a removal of ca. 20 million post-larvae from the population. This fishery is unmanaged in Colombia, but represents an important alternative seasonal protein source for local villagers. Given the likely human population increase predicted for this area of the Colombian Pacific, a careful monitoring programme of this fishery is recommended.

**RÉSUMÉ.** - Des pêcheries de post-larves de gobies sur la côte nord Pacifique de la Colombie.

La migration entre les eaux douces et marines sont communes chez les gobies de la famille des Sicydiinae. Les post-larves de ces espèces sont en général en forte densité et supportent des pêcheries artisanales. Dans cet article sont décrits pour la première fois dans le nord-est de la Colombie des pêcheries de ce type, basées sur des post-larves de *Sicydium salvini* qui recrutent dans les rivières côtières. Les migrations et récoltes sont similaires à celles observées ailleurs dans le monde (e.g., Dominique, Caraïbes) avec une périodicité liée aux phases lunaires et l'utilisation d'engins de pêche semblables. Les récoltes atteignent parfois 1,37 tonnes/mois pour un village d'environ 5000 habitants, ce qui correspond à un prélèvement de plus de 20 millions de post-larves. Cette pêche n'est pas gérée durablement mais représente un apport alternatif saisonnier important en protéines. En prévision de l'augmentation de la population dans cette zone de Colombie, un programme minutieux de gestion de cette pêche est recommandée.

Key words. - Artisanal fishery - *Sicydium* - Amphidromy - Eastern Pacific - Colombia.

Fisheries based on the juvenile-return of anadromous taxa [*sensu* Bell (2009)] have been documented in different tropical areas of the world that share environmental conditions such as high rainfall, torrential streams and volcanic habitats (Bell, 1999). The majority of these fisheries have been regarded as local and artisanal (McDowall, 2007). Yields however peaked in some areas (i.e., Philippines in 1930s) at volumes of 20,000 t.year<sup>-1</sup> (Manacop, 1953), and nowadays, many of these fisheries have declined considerably. Bell (1999) suggests that declines are due to land-use changes causing habitat degradation, and that overfishing alone of these species was unlikely to be responsible for population declines.

Several authors have found that goby-fry fisheries are mostly based on species of sicydiine gobies (Sicydiinae; Manacop, 1953; Bell, 1999). This group shows a very distinctive life cycle, which includes spawning by adults in rivers, and drift of newly hatched larvae downstream to the sea, post-larval residency (feeding and growth) of ca. 30-169

days at the sea, and the return of post-larvae and small juveniles to the river where they complete their life cycle (Keith, 2003; Lord *et al.*, 2010). It is now recognised that at least 70 fish species display such a life strategy (McDowall, 2009). Our aim was to describe aspects of a goby-fry fishery in the tropical eastern Pacific region (Northwestern Colombia), where such fisheries have not yet been documented.

## MATERIALS AND METHODS

**Study site.** The Colombian Pacific coast lies within one of the most isolated marine biogeographical regions of the world, namely the tropical Eastern Pacific (Robertson *et al.*, 2004). Common seascapes include estuaries, mangrove forests, sandy beaches and rocky shores with few coral reefs (Glynn and Ault, 2000). Part of the northern Colombian Pacific comprises the Baudó Range (Punta Ardita – Cabo Corrientes), which is a coastal mountain range. Its western

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flank is a 250 km coastline dominated by steep cliffs (up to 70 m high) intercalated with sandy beaches located principally near river mouths (Correa, 1996). The highest points within these mountains reach 700-1000 m. The longest river in the Baudó range is the El Valle River with a total length of 25 km. Additional smaller rivers include the Chorí, Jurubirá and Coquí rivers (Lobo-Guerrero, 1993). Annual rainfall in the region is considered the highest in the Americas and among the highest in the world (between 8000 and 13000 mm; Poveda and Mesa, 2000). Tides are semi-diurnal with amplitudes of up to 4.5 m. The study area lies ca. 9 km north of a marine protected area (Utría National Natural Park) and in the middle of two of the main municipalities with relatively low human population densities (Bahía Solano and Nuquí; Fig. 1).

In February 2010, three days before the new moon, we documented the artisanal collection of the goby-fry during three days at a single locality (El Valle) in the northern Colombian Pacific coast (Fig. 1). The documentation included direct observation of the harvesting activity at sandy shores adjacent to El Valle River mouth. During observations a complete characterization of the number of persons involved in the activity, the collection methods, the means of preserving and selling the catch and an approximation of the capture per unit effort was made. Additionally we collected a number of samples from the catch to identify the main species being collected and followed upstream migration of these post-larvae along the El Valle River. Samples of these post-larvae were also collected to compare with the ones collected at the harvesting point. Semi-structured interviews with key informants at the village (El Valle) were carried out. The main topics covered in interviews included aspects of the traditional means of harvesting and consumption of the goby fry and the history of exploitation in the area.

## RESULTS AND DISCUSSION

Goby-fry fisheries have been documented in a number of localities worldwide including the Caribbean Sea and the Pacific and Indian Oceans. The phenomenon has been noted mostly on volcanic oceanic islands, but it is also observed in continental areas (Bell, 1999). In the Colombian Caribbean coast, Silva-Melo and Acero (1990) documented a small fishery of *Sicydium antillarum* (locally called "Tití") at the mouth of two rivers near a densely populated city (Santa Marta). The fishery documented here is the first report, to our knowledge, of a fishery of this kind on the Colombian Pacific Coast. It is likely that this fishery exists in other areas of Pacific Panama or Costa Rica. Cooke and Jiménez (2008)

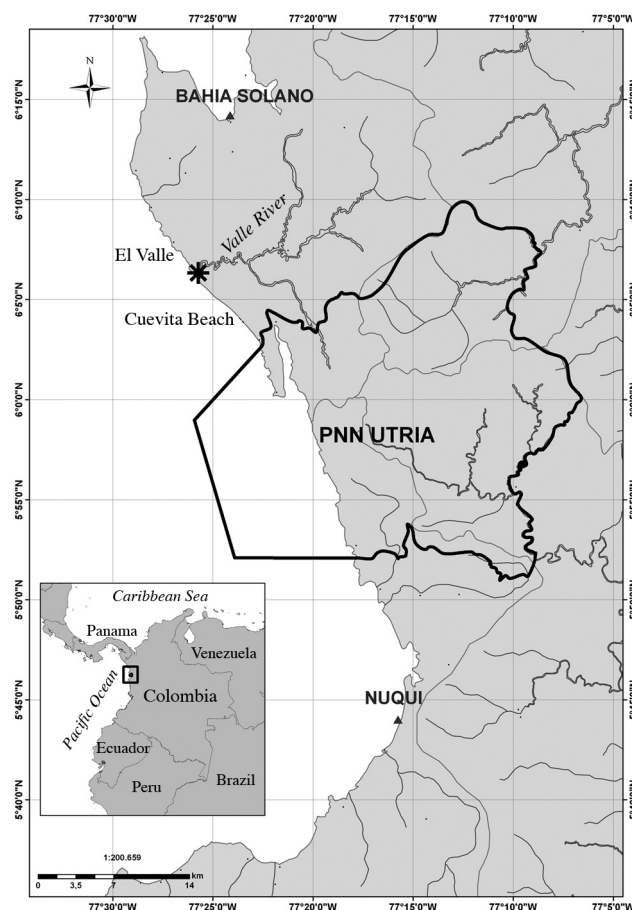


Figure 1. - Map of the area where the goby-fry artisanal fisheries is most prevalent in the Colombian Pacific coast. The fishery was monitored at El Valle village, north of the Utría National Park.

reported on the harvest by local communities of pipefish migrating up stream on the Azuero Peninsula in the Pacific of Panama. This harvest may include, as was noted in our sampling, juvenile gobies and small crustaceans. Similarities in the environmental conditions (presence of coastal moun-

Table I. - Morphometric and meristic data for *Sicydium salvini* post-larvae and juveniles captured at the mouth of El Valle River and ca. 1 km up-stream in the river. Standard and total lengths are given in mm. Head length, eye diameter and preanal-fin length presented as percentage (%) of standard length.

	<i>Sicydium salvini</i> (post-larvae)			<i>Sicydium salvini</i> (juveniles)		
	N	Mean	Range	N	Mean	Range
Total length	7	23	22-25	7	50	58-42
Standard length	7	20	19-21	7	41	47-34
Eye diameter	7	4.96	5.58-4.31	7	4.91	5.15-4.30
Head length	7	23.26	24.19-21.46	7	25.31	28.32-22.18
Preanal-fin length	7	52.39	53.76-50.76	7	57.61	60.23-55.15
Anal spines	7	-	9-10	7	10	10
Dorsal spines	7	-	5-6	7	6	6
Dorsal fin rays	7	10	10	7	-	10-11

tain ranges) where these *Sicydium* gobies and their associated fisheries occur were found in the Colombian Pacific (Lyons, 2005).

### Goby-fry species and by-catch

Although 99% of the catch corresponds to one species (*Sicydium salvini* Ogilvie-Grant 1884), some other species are caught and subsequently discarded by local people. We identified among the organisms discarded in the fishery: isopods, decapod crustaceans (Hippoidea), and post-larval and juvenile fish. Among fish, individuals from Polynemidae, Mugilidae, Pristigasteridae, Carangidae, Syngnathidae (*Pseudophallus* sp.) and Gobiesocidae (*Gobiesox* sp.) were common. Members of the latter two families were found to migrate upstream with the sicydiine goby-fry.

*Sicydium salvini* can reach a maximum length of 14 cm and is reported from Costa Rica to Central Panama in the Pacific (Catalog of Fishes California Academy of Sciences; Lyons, 2005), but its distribution according to our identifications includes the northern Colombian Pacific. Another species of *Sicydium* occurs on the Central Colombian Pacific Coast (Dagua River; *Sicydium hildebrandi*), but our identification of the collected material in El Valle resembled that of *S. salvini* (Tab. I, Fig. 2). The meristic features of the post-larvae found in this study and those reported by Beltrán-León and Ríos (2000) for Gobiidae sp. 3 are similar; however, additional pigmentation around the head, gills and ventral area of *S. salvini* post-larvae prevent us to confidently assign these to Gobiidae sp. 3. It needs to be confirmed if the distribution of *S. salvini* post-larvae can extend as far as 10-40 miles offshore as the Gobiidae sp. 3 reported by Beltrán-León and Ríos (2000) does.

### Description of harvesting activity

Goby-fry harvesting took place five days after the last quarter and three days before the full moon. In February 2010, these dates coincided with the first spring tide of the month. According to local fishermen, goby-fry harvesting is carried out throughout the year near the first spring tide of each month. However, some fishermen mentioned that har-

vesting was not possible in the past due to an almost total absence of these goby-fry in this locality. These pulses of goby-fry harvesting related to lunar phases have also been observed in other areas (e.g., Dominica, West Indies; Bell, 1999), but can also differ from other places where peaks of harvesting activity are distant from the full or new moon

### Time of harvesting

In February 2010, harvesting of goby-fry took place for three consecutive days. The peak of activity (maximum number of people harvesting) occurred on the second day (ca. 95 persons). This day, 44.6% women and 55.4% men were carrying out the activity. The first and third day of collection were characterised by a markedly lower number of people at the beach (18 and 10 persons respectively). During the three days that the harvesting was monitored, people would start the activity between 5:00-6:00 am and would end at 8:00-9:00 am. However, total harvesting time was influenced by the storage capacity of each collector at disposal,



Figure 2. - *Sicydium salvini* post-larvae (A), juvenile (B) and adult (C) caught in artisanal fisheries on sandy beaches and upstream in El Valle, Colombian Pacific. Note the translucent colour of the larvae and its mouth orientation compared to the adult specimen.



Figure 3. - Goby-fry harvesting at El Valle, northern Colombian Pacific. A: Goby-fry harvesting method; B: Mosquito net with the catch from a "haul" of goby-fry; C: People depositing the catch into plastic containers.



and when catches were bountiful, collection was completed ahead of time.

From the interviews, people pointed out that the number of persons harvesting the goby-fry was highly variable and was dependent on the day of the week when the goby-fry migration was first noticed. If harvesting coincided with a weekend the number of people participating in the activity increased. A greater number of people of course, can contribute to the activity (including young people) on nonworking days. The gender balance of the people harvesting goby-fry seems to have changed over time. In previous years, this activity was regarded as an almost exclusively feminine activity. However, as people have found this activity profitable, the number of men participating has increased.

### Harvesting location

In February, the collection took place along ca. 500 m of the beach known as Cueva (6°6.007'N, 77°25.792'W). Although the collection sites for goby-fry are relatively fixed, interviewees acknowledged that the best collection sites can vary according to the month and commented that sometimes goby-fry entered very small streams along the Cueva Beach, rather than entering the El Valle River mouth. Respondents also mentioned that harvesting could also take place in the afternoon if they enter the river and follow the goby-fry migration up-stream. However, the most common place of harvesting was on the beach.

### Harvesting methods and ways of preservation

People in El Valle use mosquito nets to catch the goby-fry regardless of the harvesting location (Fig. 3). Mosquito net sizes are 3-4 m long and 1.2-2.0 m wide and are operated by two persons, each of them holding one side of the mosquito net (Fig. 3). These two persons would move into the splash zone of the beach observing goby-fry schools. Wherever they locate the goby-fry, the mosquito net would be submerged into the water and then lifted to see the catch (Fig. 3). After inspecting the catch, a third person would help to put the catch into a plastic container. This procedure was repeated until the group of three fishermen filled all of their storage containers with goby-fry.

### Catch per unit effort – CPUE

We made estimates of CPUE of goby-fry despite the difficulty of doing so in this artisanal fishery. We calculated the number of “hauls” that was typically required of two fishers to fill a 5-gallon container. After watching different groups, a mean number of 8 hauls was considered a fair approximation. We also observed that a group of three persons capturing goby-fry would harvest three 5-gallon containers full of goby-fry in a day. We then calculated that a 5 gallons container full of goby-fry reached a weight of ca. 14.5 kg CPUE was thus calculated for a group of three people to be 43.54

kg/day. Similarly, we extrapolated the total weight of goby-fry that was harvested during the peak day of activity based on the number of fishermen observed that day. A total of 1379 kg (1.38 ton) was calculated. We calculated the total number of post-larvae that could be extracted according to the weight harvested to be 19,431,680. This was done extrapolating the number of post-larvae observed in one pound of goby-fry.

### Market and consumption practices

Goby-fry is currently sold almost entirely at the local village (El Valle) with some of the catch transported to a nearby town (Bahía Solano, 18 km away) where a much higher price can be negotiated. In our interviews, villagers pointed out that in the past goby-fry was not sold, it was rather exchanged among villagers or even given freely among families. Old collectors agreed that the goby-fry abundance has decreased over time resulting from commercialisation in local markets and associated overharvest. This fishery is often ignored even at the national level, but constitutes an important alternative for animal protein consumption at the local level and represents an important periodic input to local freshwater and marine food webs. While Bell (1999) considers that land use changes to be more important than overfishing of these post larvae as the source of population decline, we advise that these fisheries be monitored and managed. Human disturbance to rivers in the form of direct habitat destruction or flow interruptions could also represent an important threat affecting the fishery and the movement of several species migrating between rivers and coastal areas (Jenkins *et al.*, 2009). Accounting for these two threats and following the trajectory of catches within and between years could further help to support conservation measures given the likely human population increase due to government development plans predicted for this area in the coming years which may bring new challenges for coastal zone conservation.

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