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Perciformes: Pomacentridae), from Reunion Island,
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**FIRST RECORD OF THE LARGE CAERULEAN DAMSELFISH,
POMACENTRUS CAERULEOPUNCTATUS (ACTINOPTERYGII: PERCIFORMES:
POMACENTRIDAE), FROM REUNION ISLAND, SOUTH-WEST INDIAN OCEAN**

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Abstract. The large caerulean damselfish, *Pomacentrus caeruleopunctatus* Allen, 2002, is recorded for the first time from Reunion Island. Two individuals were observed and photographed between January and March 2012 on L'Hermitage reef, located on the west coast of the island. A review of high-resolution profile photographs of these two individuals shows that their external morphological characteristics agree well with those reported in the original description of the species. These observations suggest an extension of the known distribution of the species, previously restricted to the Seychelles Islands, Madagascar, and Tanzania, to the Mascarene Archipelago, and moreover the known depth range of this species.

Keywords: *Pomacentrus caeruleopunctatus*, first record, distribution extension, Reunion Island, connectivity

INTRODUCTION

The latest checklist of Reunion Island fish species included 984 marine and freshwater species belonging to 164 families, with 964 species occurring in marine habitats (Fricke et al. 2009). These included 45 species of the family Pomacentridae and the following four *Pomacentrus* species: *Pomacentrus agassizii* Bliss, 1883; *Pomacentrus caeruleus* Quoy et Gaimard, 1825; *Pomacentrus pikei* Bliss, 1883; and *Pomacentrus trichrourus* Günther in Playfair et Günther, 1867. The large caerulean damselfish, *Pomacentrus caeruleopunctatus* Allen, 2002 (Fig. 1A), had not been recorded yet from the waters of the island. Our observations were made in an effort to continuously update the Reunion Island fish inventory, as up-to-date knowledge of local biodiversity is indeed necessary for the authorities in charge of the management and conservation of coastal ecosystems.

What should be emphasized, those uncommon coral reef fishes are poorly known. According to the original description (Allen 2002), *Pomacentrus caeruleopunctatus* lives in areas of mixed live corals and rubble, with an estimated depth range between 5 and 15 m; it is moreover believed to feed on plankton. Its current known distribution includes islands northwest of Madagascar, where the species was considered endemic (Fricke et al. 2018a, 2018b), and the Seychelles Islands (South African

Institute for Aquatic Biodiversity, SAIAB). Furthermore, the species has also been identified off Tanzania, based on a photograph by E. Tyler acknowledged by Allen (Froese and Pauly 2018).

MATERIAL AND METHODS

Observations of *Pomacentrus caeruleopunctatus* were carried out by skin diving on L'Hermitage fringing reef (also known as Saint Gilles-La Saline reef), located on the Reunion west coast. Reunion (21°07'S, 55°32'E) is part of the Mascarene Archipelago (south-west Indian Ocean). It is located about 680 km east of Madagascar and 170 km west-southwest of Mauritius. The L'Hermitage reef is less than 8 km long; its maximum width is 500 m, and the mean depth is 1.2 m.

Two *P. caeruleopunctatus* individuals were observed in 2012; the first one on 18 January and again on 11 February, and the second one on 1 March. The two individuals differed in colour patterns, as well as size, the second one appearing larger and presumably older. Both were found at about 1.2 m depth on the reef flat, in areas of mixed *Porites lutea* (Hexacorallia), degraded colonies of *Acropora* spp. (Hexacorallia), and *Millepora exaesa* (Hydroïdolina), on a sandy-detrital substrate. A total of 37 photographs were taken with a Canon EOS 7D body fitted with a Canon 60 mm ESF macro lens.

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Total lengths were estimated in situ, taking into account the underwater visual sizes overestimations or underestimations (Edgar et al. 2004). High-resolution profile photographs were then used to estimate standard length, head length, body depth, caudal peduncle length, caudal peduncle depth, snout length, and fin-ray counts (dorsal, anal, pectoral, and caudal fins). In accordance with Allen's description, body depth and head length were expressed as proportions of standard length, and caudal peduncle length, caudal peduncle depth, and snout length as proportions of head length. Table 1 compares the morphometric and meristic characters of the two individuals with documented data from the species description.

RESULTS

The total length of the first individual (Fig. 1B) was estimated to be 6 cm. Body oval, compressed; head densely covered with small, intense blue spots from the tip of the snout to the dorsal fin origin; lower part of the head and opercles less densely coloured due to larger spotted scales; dark blue bar on posterior margin of preopercle, and bluish grey bar on upper margin of opercle, with an intense blue spot at the upper part of the opercle margin; body with large greenish grey scales with a dark grey margin; each scale with two or three intense blue horizontally-elongate spots from the opercle to the caudal peduncle not included; scales of the caudal peduncle each with one circular spot; scales of lowest part of the body and peduncle slightly yellowish, spots on these scales becoming pale purple; base of dorsal and anal fins covered by scaly sheaths; dorsal and anal fins blackish grey with a marginal and two sub-marginal blue stripes, radial blue lines and inter-radial blue spotted scale rows; caudal fin emarginate; posterior edge and bony rays of caudal fin intense blue, other rays slightly yellowish with pale blue spots, membrane translucent; pectoral fins rays pale yellow, membrane translucent; a black spot on the upper pectoral fin base; pelvic fins bright yellow with first ray intense blue, the second ray ending in a short filament.

The total length of the second observed individual (Fig. 1C) was estimated to be 9 cm. Appearance similar to that of the first individual, with the following exceptions: body slightly more slender and uniformly dark coloured;

pectoral fins with a black base; pelvic fins pale smoky yellow with the edges and end of the second ray being blackish blue; radial dark grey lines on spinous portion of dorsal and anal fin; blue spot darker at the upper part of the opercle margin.

DISCUSSION

In general, both individuals matched the description of the holotype and three paratypes of *Pomacentrus caeruleopunctatus* (see Allen 2002), except for minor differences (Table 1). They also fit well with the descriptions of the adult and juvenile colour patterns provided by Allen (2002). The diagnosis of the adult included the following: body mainly blue with dark grey scale margins; scales usually with 2–3 intense blue, horizontally-elongate spots; narrow blackish bar on rear margin of preopercle; wider blackish bar on rear upper margin of opercle; pectoral fin with blackish bar across base. All these characteristics were found in our larger individual. As documented by a photograph of a roughly 4 cm SL individual, colour pattern of the juvenile was similar to the adult's, except for the following features: the pelvic fins were a brighter, the dark bar on the upper edge of the opercle was intense blue, and there was a blackish spot on the upper pectoral fin base rather than a narrow bar across the entire fin base. These characteristics agreed well with our smaller individual except for the intensely blue bar on the upper edge of the opercle (which was bluish grey in our individual). This discrepancy may be due to the larger size (and probably age) of this specimen, with an estimated standard length of 4.92 cm.

Pomacentrus caeruleopunctatus is part of the *Pomacentrus coelestis* species complex, which includes *Pomacentrus auriventris* Allen, 1991, recorded from Christmas Island, eastern Indonesia, and Palau (Allen and Erdmann 2012, Fricke et al. 2018a); *Pomacentrus coelestis* Jordan et Starks, 1901, recorded from Christmas Island and widely distributed in the Pacific Ocean; *Pomacentrus micronesianus* Liu, Ho et Dai, 2013, recorded from Kwajalein Atoll (Marshall Islands); *Pomacentrus alleni* Burgess, 1981, recorded from the eastern Indian Ocean; *Pomacentrus caeruleus*, widely distributed in the western and northern central Indian Ocean; and *Pomacentrus similis* Allen, 1991, recorded from the north-eastern Indian

Table 1
Selected morphometric and meristic characters of *Pomacentrus caeruleopunctatus* from Reunion Island determined based on photographs

Reference	Absolute value		Proportional value				Dorsal rays	Anal rays	Pectoral rays	Principal caudal rays
	SL [mm]	BD [in SL]	HL [in SL]	CPI [in HL]	CPd [in HL]	Snout [in HL]				
Allen (2002) (<i>n</i> = 4)	62.0–72.9	2.0–2.3	3.3–3.6	2.2–2.8	1.9–2.1	4.1–5.1	XIII, 13	II, 15	18	15
Reunion, specimen 1	ca. 49.2	2.1	3.3	2.4	2	4.8	XIII, 13	II, 14	18	15
Reunion, specimen 2	ca. 75.6	2.5	3.4	2.4	2.3	4	XIII, 13	II, 15	N/A	N/A

SL = standard length; BD = body depth, HL = head length, CPI = caudal peduncle length, CPd = caudal peduncle depth, Snout = snout length.

Ocean and Indonesia (Fricke et al. 2018a). Considering the respective distributions of the species in this complex, *P. caeruleopunctatus* individuals found in Reunion could only be confused with *P. caeruleus* (Fig. 2).

Pomacentrus caeruleopunctatus appearance is relatively similar to that of *Pomacentrus caeruleus*. The two species are very close relatives, and it seems difficult to tell them apart genetically, possibly because *P. caeruleopunctatus* is an incipient species, as suggested by Sorenson et al. (2014). According to Allen (2002), *P. caeruleopunctatus* meristic proportions are similar to those of *P. caeruleus*, although the two species may be distinguished by their body depth, maximum size, and the number of blue marks per scale.

As field estimates and photograph-based measurements are less accurate than laboratory examinations, we used the colour patterns documented by Allen (2002) to distinguish the two species. These patterns include body colouration, scales colour, and the number of blue spots on each scale. In *Pomacentrus caeruleus* 1) the main part of the body is intensely blue and its posterior part, along with the posterior part of dorsal fin and the whole anal and caudal fins, are predominantly bright yellow, 2) all scales of the blue part of the body are entirely blue and exhibit a dark blue margin, 3) scales usually exhibit only one blue spot per scale, these spots being mainly visible in the posterior part of the body. In our individuals 1) the body colour was uniformly dark, except for the lowest part of the body and the caudal peduncle in the juvenile, which were slightly yellowish, 2) scales were greyish green with a dark grey margin, and 3) the majority of them distinctly exhibited three blue spots. As a result, we concluded that the fish we observed off Reunion were individuals of *Pomacentrus caeruleopunctatus*.

These findings extend to the Mascarene Archipelago the known distribution of the species, previously restricted to the islands northwest of Madagascar, Seychelles Islands, and Tanzania. Given that 1) over 1000 km straight line distance separates Reunion from the nearest site of this distribution, 2) pomacentrids are demersal spawners, 3) demersal egg-born larvae generally remain in the vicinity of their natal reef (Leis 1982), usually through the active avoidance of passive advection through vertical migration (Paris and Cowen 2004), and 4) members of this family apparently cannot delay their metamorphosis following competency, which limits their potential of dispersion (Wellington and Victor 1989), this record raises the issue of the origin of the two *Pomacentrus caeruleopunctatus* individuals observed in Reunion waters.

Marine connectivity assessment must consider both the physical processes of hydrodynamic transport (horizontally and vertically) and biological traits of larvae. At regional scales, larval dispersal is mainly determined by the pelagic larval duration (PLD) of species (Treml et al. 2012). The PLD of *Pomacentrus caeruleopunctatus* is unknown, but it is documented for some others pomacentrids. According to Brothers et al. (1983) estimations based on an otolimetric study for 11 species of pomacentrid larvae, mean age at recruitment ranges from 21 to 24 days, and

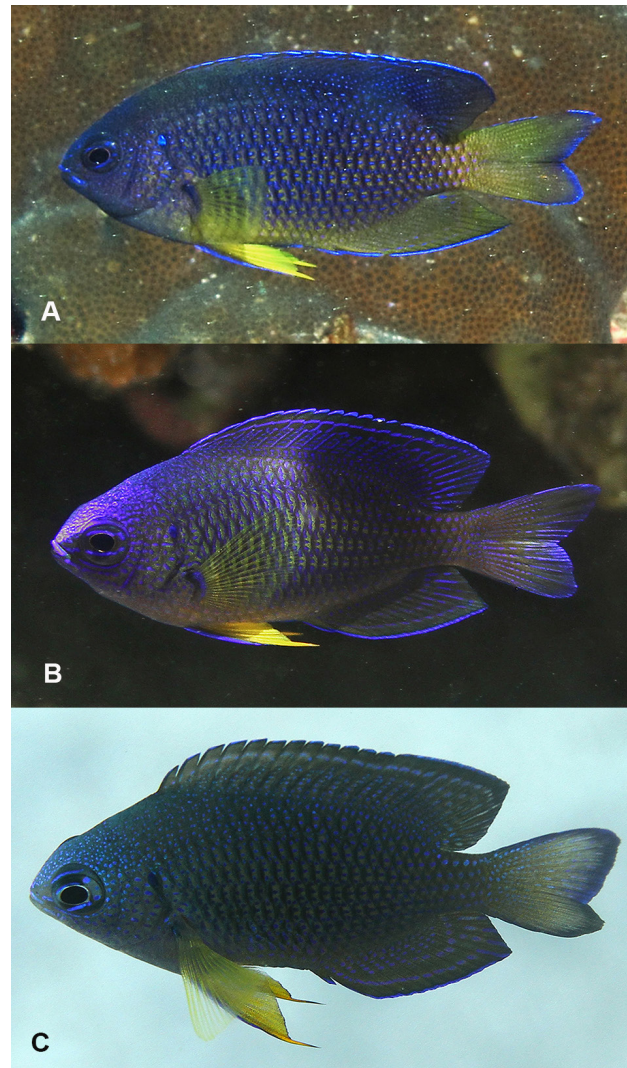


Fig. 1. Individuals of *Pomacentrus caeruleopunctatus* from Madagascar and Reunion Island (field photographs); (A) Individual photographed off Nosy Fanihy Island (Madagascar), about 45 km from the Mitsio Archipelago, the type locality (image by A. Prouzet); (B) First individual recorded from Reunion, 18 January 2012, ca. 4.9 cm SL; (C) Second individual observed at Reunion, 1 March 2012, ca. 7.5 cm SL (images by P. Bourjon)



Fig. 2. *Pomacentrus caeruleus*; individual photographed at Reunion, ca. 3 cm SL (image by P. Bourjon)

these findings were confirmed by subsequent studies (Wellington and Victor 1989). Although the PLD may vary among species, pomacentrid PLDs have been shown to have a low variance (Wellington and Victor 1989), hence we assume that the PLD of *P. caeruleopunctatus* is likely within this range.

Larval dispersal is particularly difficult to assess empirically. This is partly due to the ability of larvae to influence their dispersal from the time the caudal fin forms, and probably before (Leis 2010). Nevertheless, Fisher et al. (2000) report that the Ambon damselfish, *Pomacentrus amboinensis* Bleeker, 1868, is unable to significantly influence its dispersal pattern before 12–15 days after hatching (PLD estimated to be about 20 days according to these authors). While it is unsafe to compare the abilities of a known species with yet undocumented abilities of another (Leis 2010), we can assume that *Pomacentrus caeruleopunctatus* is similarly unable to influence significantly its dispersal for at least the first half of its larval phase (around 11–12 days), and consequently is likely to passively drift with surface currents during this period. In fact, genetic connectivity studies in the Western Indian Ocean show that larval dispersal may be consistent with regional current patterns (Dorenbosch et al. 2006, Visram et al. 2010, Muths et al. 2012, 2014, Simpson et al. 2014).

A model-based assessment of connectivity patterns between reef ecosystems in the south-western Indian Ocean was performed (Crochelet et al. 2016). This model, based on data collected over five years (2006–2010), included coastal and island reefs located between 2°N and 35°S and 25–70°E, i.e., east African coast from Somalia southward to northern South Africa, and eastward from the north Seychelles islands to the Mascarene Archipelago. The modelling suggests that, for a 30-day PLD (the median value tested), the connectivity between reefs in the area is fragmented with high interconnectivity within sub-regions and lower connectivity within the study area. Islands of the Mascarene Archipelago are well interconnected from 20 days of dispersal (no connection for PLD = 10 days), but they are isolated from the other reefs of the area (distinct cluster).

Furthermore, in a previous study, Crochelet et al. (2013) examined the probable origin of larvae of the honeycomb grouper *Epinephelus merra* Bloch, 1793, following massive recruitment in Reunion Island. Using a hydrodynamic connectivity model, they estimated that 1) none of the larvae released from Rodrigues, Saint Brandon Rocks, Tromelin, and Madagascar could reach Reunion within the 34 days of the study period, and 2) larvae released from Mauritius reached Reunion east coast after four days and west coast study sites after 15 days (otolith analyses resulted in a 29-day PLD). Given that the model predicted that larvae released at Reunion would be carried south-westward, the authors concluded that the larvae cohort probably originated from Mauritius Island. This conclusion is consistent with local circulation, since the high resolution modelling strategy used by Pous

et al. (2014) suggests that the currents around Mauritius and Reunion are oriented south-westward.

Since the assumed mean PLD of *Pomacentrus caeruleopunctatus* ranges from 21 to 24 days and its larvae are supposed to be relatively passive for the first 11–12 days of their PLDs, the strongest likelihood is that the individuals observed in Reunion Island originate from Mauritius. Consequently, the presence of this species in Mauritius can be considered probable, although it was not reported.

Our study also extends the known depth range of this species. According to Allen's (2002) observations, *Pomacentrus caeruleopunctatus* depth range is 5–15 m. One specimen in the SAIAB collection was obtained at Ile du Nord (Seychelles) at a depth of 16 m (SAIAB 79272), and the individuals from Reunion were observed at a depth of 1.2 m. The updated depth range should, therefore, be 1–16 m.

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