# A NEW Alien Fish Species Discovered in Trinidad: This is NOT Another Lionfish Talk!

# Una NUEVA Especie de Pez Alienígena Descubierta en Trinidad: ¡Esto NO es Otra Charla sobre el Pez León!

# Une NOUVELLE Espèce de Poisson Exotique Découverte à Trinidad: Ce n'est PAS une Autre Discussion sur le Poisson-papillon!

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**EXTENDED ABSTRACT**

**Introduction**

With increased globalization, the spread of alien species is also expanding. One such species is the Regal Demoiselle, *Neopomacentrus cyanomos* (Bleeker 1856); a small, diurnal, planktivorous damselfish native to reef habitats throughout the Indo-West Pacific Ocean (Allen 1991). This species grows up to 10 cm and can be found from 1-30 m depths, often in large aggregations (Allen 1991). Its life history characteristics provide it with the capabilities to become established and possibly invasive outside its native range. In aquaria females lay 1500 - 2800 demersal eggs per clutch in a nest prepared by a male, who guards and fans the clutch, and culls infertile eggs (Rohini Krishna et al. 2016, Setu et al. 2010). In such situations females reproduce approximately every 4 days, with eggs hatching after 3-5 days (Rohini Krishna et al. 2016, Setu et al. 2010). Larvae are then planktonic for 17 - 32 days before settling onto reefs (Leis and Carson-Ewart 2003, Rohini Krishna et al. 2016, Setu et al. 2010). These reproductive characteristics are similar to those of damselfishes native to the Greater Caribbean (Robertson et al. 1990). In aquaria juveniles reach maturity ~11 months after hatching at 57 - 73 mm in length (Rohini Krishna et al. 2016, Sreeraj and Gopakumar 2004). There is indirect evidence that adults of this species begin life as females and by 80 cm TL change sex to become males (Sreeraj and Gopakumar 2004).

In 2013, this species was discovered in the southwest corner of the Gulf of Mexico, where it was already well established (González-Gándara and de la Cruz-Francisco 2014). It is now known to occur throughout the southern, western and northern Gulf of Mexico (Robertson et al. 2018, Schofield and Neilson 2019). Three hypotheses have been proposed to explain how this species reached the Western Atlantic Ocean:

i) Via the aquarium trade,
ii) In ballast water of commercial shipping, and
iii) Carriage by offshore petro-platforms relocated from the native range (Robertson et al. 2018).

There is no substantial evidence to support the aquarium-release hypothesis: areas where the species has been introduced are not regions with high investment in the aquarium business or hobby. In addition, this species is small, lives in aggregations and is less aggressive than territorial Caribbean damselfishes; hence it is not likely to be released from tanks that it has outgrown or because it has eaten or bullied other tank members.

Commercial shipping transport: this would be a long and difficult journey for this species, either as larvae or adults. Ballast water tanks are dark and closed and thus do not provide any inflow of ocean water (food) outside of cargo offloading stops. Sea chests (cavities on the outside of vessel hulls that contain water intakes and are connected to the sea by external grates) on ships might provide conditions suitable for small planktivores such as *N. cyanomos*, which potentially could live inside such structures. However, this species was not first found adjacent to major ports, which would be expected if it was transported by commercial shipping.

The hypothesis that currently holds the most potential is that *N. cyanomos* was transported by mobile infrastructure (rigs and vessels) associated with the offshore petroleum industry. A lot of this infrastructure is constructed in the Indo-West Pacific, e.g. Singapore, and towed or propelled in water slowly around South Africa into the Atlantic Ocean. Offshore drill rigs, drill ships and support vessels all have sea chests and hull irregularities that could provide shelter for this species. The latter two also have moon pools (essentially a hole through the center of the hull of a large vessel that can be opened to provide a protected space for equipment and divers to move in and out of the water) that, in some cases, are closed only with grated covers, providing continuous connections to the sea. Aggregations of *N. cyanomos* commonly associate with new and old shipwrecks that provide structural shelter equivalent to that available on mobile infrastructure (Robertson et al. 2019). The areas where *N. cyanomos* was introduced in the Gulf of Mexico are all in close proximity to large offshore oil and gas fields. We predicted that if this species was introduced by petro-infrastructure then it would also be found at other Atlantic offshore fields. To test this hypothesis we assessed whether or not this alien species was present on reefs and

shipwrecks around the western end of the island of Trinidad, Trinidad and Tobago, another tropical Atlantic region with extensive, long-standing, offshore oil and gas activities.

## Methods

Dives were performed at 7 sites around the north-western islands and peninsula of Trinidad from July 8-10, 2019 (Figure 1). Three divers (the authors plus S. Baksh) searched each of these sites for > 25 minutes, recorded numbers of adults (> 5 cm), juveniles (> 2 cm to < 5 cm) and new recruits (1.5 - 2 mm). Subsequently three additional sites were surveyed on July 17, September 8 and October 23, 2019 via snorkelers familiar with the species and total counts of *N. cyanomos* were provided. The search dives and snorkels varied in time and area surveyed and we were therefore unable to standardize the data. Estimates of distribution were done in ArcGIS 10.4 using the buffer tool to establish a 1500 m buffer from land to incorporate all the survey sites as well as to include local diver knowledge seen.

## Results and Discussion

We found *N. cyanomos* at all of the sites we visited and the species appears to be well established since we mostly encountered adults and relatively high abundances of them (Figure 2). This species was found inhabiting shallow rocky outcrops, coastal underwater caves and shipwrecks. Abundances on the ten sites we surveyed ranged from 3-955 (Figure 1), with up to ~300 adults in a single aggregation. At several sites, we saw males courting females and guarding egg clutches confirming that local reproduction is occurring. A video we took of an aggregation at one of our survey sites can be seen at:

https://www.youtube.com/watch?v=6BK0kcilX4Y.

## Conclusions

*N. cyanomos* has become successfully established at a second geographic location 3000 km from the part of the Gulf of Mexico where it was first recorded. To better understand the introduction and connectivity of these populations, we plan to perform genomic analysis to identify relationships between the Trinidad population, native populations and those in the Gulf of Mexico. Additional future work will include identifying the age structure of the population to determine how long they have been in Trinidad and monitoring water parameters such as dissolved oxygen and salinity to see how well adapted they are to conditions in western Trinidad, which are estuarine. We surmise that this species was likely introduced to both Trinidad and the Gulf of Mexico via the transport of oil and gas rigs and their support vessels from the Indo-West Pacific. These two locations, the only western Atlantic sites where this species currently is known, are regions with extensive oil and gas industries. Given its spread throughout the Gulf of Mexico, where it

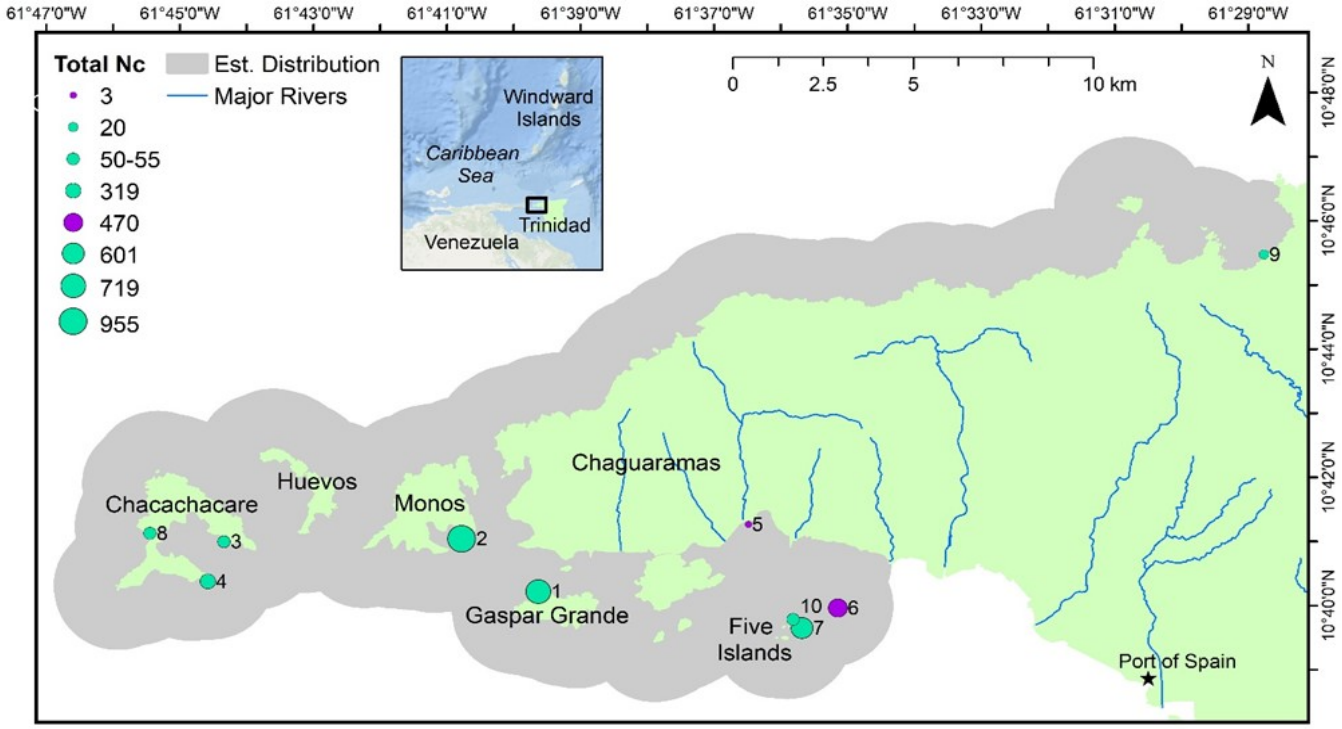


**Figure 1.** Map of north-western Trinidad showing the estimated distribution of *Neopomacentrus cyanomos* (Nc) determined from local diver knowledge and a 1500 m buffer from land. Survey sites are shown as circles of various sizes based on number of *N. cyanomos* (Total Nc) encountered. Purple circles are ship wrecks and the other sites are hardbottom features such as rocky outcrops and coastal caves. Sites 8 -10 were surveyed via snorkelling and the other sites via SCUBA diving. Major rivers are depicted to show the influence of freshwater to the area.

lives on both natural and artificial reefs, its ability to colonize the estuarine environment of Trinidad, and the fact that it has relatively long-lived pelagic larvae, it is also likely that *N. cyanomos* will colonize other areas in the Caribbean Sea in the near future. The ecological implications of the existence of this alien species in abundance in both the Gulf of Mexico and Trinidad remain to be explored. *N. cyanomos* could compete for food with native planktivores, which include various damselfishes, and with a range of native species for shelter in protective holes and crevices in hard-reef structures.

KEYWORDS: *Neopomacentrus cyanomos*, Regal Demoiselle, introduced species, damselfish, Gulf of Paria

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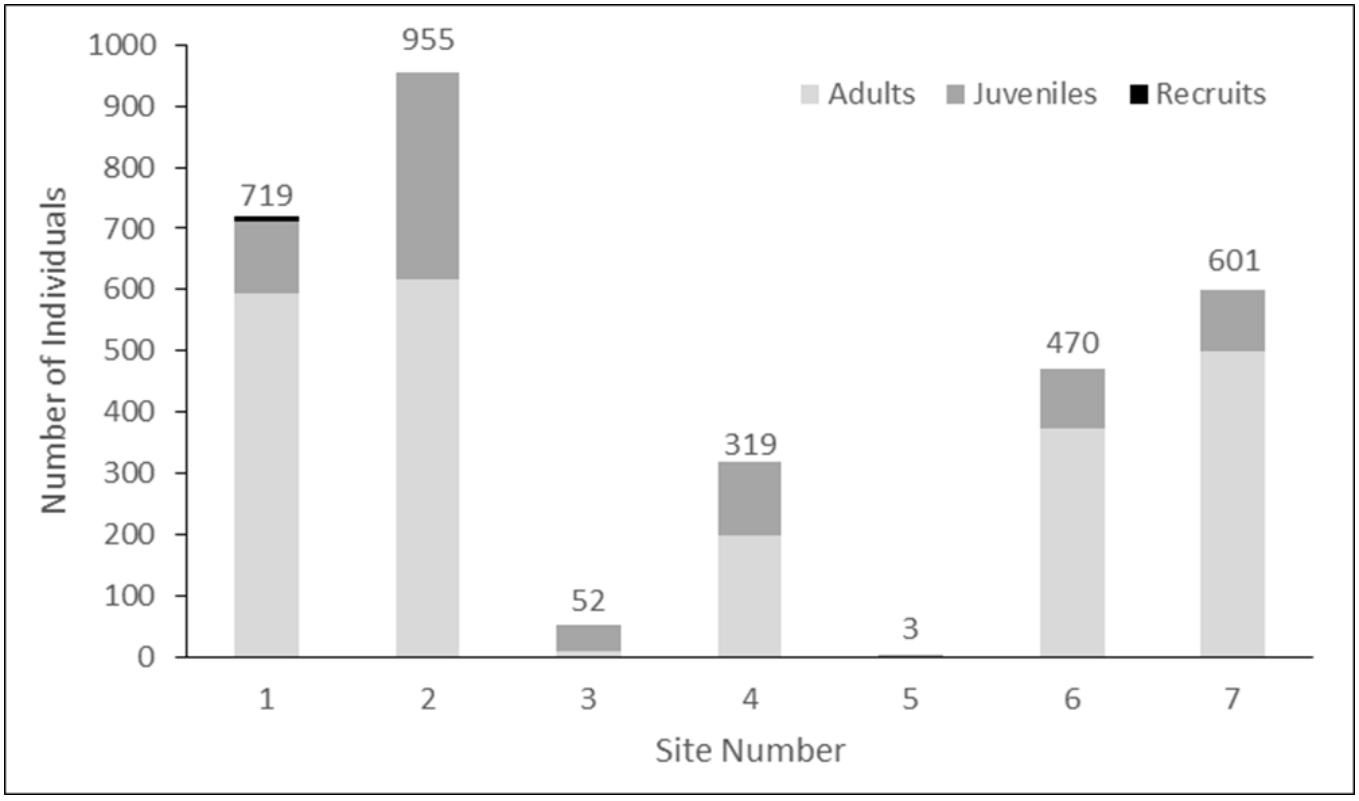


**Figure 2**. Numbers of adults, juveniles and recruits of *Neopomacentrus cyanomos* found at each of the dive sites. Locations of the dive sites can be seen in Figure 1.