Journal of Fisheries
Volume 14 Issue 3 December 2026
Open Access

eISSN 2311-3111
pISSN 2311-729X

DOI: https://doi.org/10.17017/j.fish.1356

Original Article

Initial studies on the captive breeding and egg development of Andaman damsel, *Pomacentrus alleni* Burgess, 1981

Ambarish P. Gop[1] • Gautam A. S.[1] • Anju Lekshmi P.[1] • B. Santhosh[1] • Liyakhath Ali[1] • Al Ameen N.[1] • Vishnu P. G.[1] • S. Surya[1] • Anuraj A.[2] • Sudarshan K. S.[2] • Krishna Sukumaran[1] • G. Rathi Bhuvaneswari[1] • F. Muhammed Anzeer[1] • K. S. Aneesh[1] • Dispin Das Y.[1] • Boby Ignatius[2] • Rema Madhu[2] • V. V. R. Suresh[2] • Grinson George[2]

[1] *Vizhinjam Regional Centre of ICAR-Central Marine Fisheries Research Institute, Thiruvananthapuram 695521, Kerala, India*
[2] *ICAR-Central Marine Fisheries Research Institute, Kochi 682018, Kerala, India*

Correspondence
Ambarish P. Gop; Vizhinjam Regional Centre of ICAR-Central Marine Fisheries Research Institute, Thiruvananthapuram 695521, Kerala, India
ambarish.gop@icar.org.in

Manuscript history
Received 17 June 2026 | Accepted 6 August 2026 | Published online 12 August 2026

Citation
Gop AP, Gautam AS, Lekshmi P A, Santhosh B, Ali L, Al Ameen N, Vishnu PG, Surya S, Anuraj A, Sudarshan KS, Sukumaran K, Bhuvaneswari GR, Anzeer FM, Aneesh KS, Das Y D, Ignatius B, Madhu R, Suresh VVR, George G (2026) Initial studies on the captive breeding and egg development of Andaman damsel, *Pomacentrus alleni* Burgess, 1981. Journal of Fisheries 14(3): 143213. DOI: 10.17017/j.fish.1356

Abstract
The marine ornamental fish industry is a global multi-million-dollar trade dealing in live fish and other marine organisms for aquariums. This industry has seen significant growth in recent years; however, it still relies heavily on wild populations. Pomacentridae is the family that contributes most to the worldwide marine ornamental fish trade. This forms the first report on the captive breeding and egg development of Allen's damsel or Andaman damsel, *Pomacentrus alleni* Burgess, 1981. Captive breeding and egg development of the wild-caught specimens of Andaman damselfish was conducted in the Vizhinjam Regional Centre of ICAR-CMFRI. The wild-collected broodstock required four months to achieve the first successful spawning. Fecundity observed was from 1070±127 eggs from a female brooder of 5.7 cm TL. The eggs were capsule shaped, measuring 856.91±66.61 µm, with a single oil globule. Hatching rate was 90.6±1.9%. The incubation time was recorded as 107±7.1 hr. Newly hatched larvae had a total length of 1.84±0.11 mm; standard length 1.65±0.03 mm. The present study evaluated the broodstock development and spawning potential of *P. alleni* under captive conditions, providing insight into the sustainable use of such marine fish resources.

Keywords: captive breeding; damsel; marine fish; ornamental fish; Pomacentridae; *Pomacentrus alleni*

1 | INTRODUCTION

Damselfishes are primarily marine, reef-associated fishes of more than 425 species among 29 genera classified in the family Pomacentridae (Allen *et al*. 2022; Fricke *et al*. 2022). These species are in high demand in the ornamental fish trade due to their bright colour and their ability to adapt to captive conditions (Setu *et al*. 2010). According to Cañedo-Orihuela *et al*. (2023), nearly half of the global marine ornamental fish trade is dominated by species of the Pomacentridae family, with damselfishes accounting for the majority, most of which are wild-caught. These forms pose the greatest threat to ecosystems worldwide (Biondo and Burki 2020). Successful captive breeding has been reported for approximately 338 marine ornamental

© The Author/s; Creative Commons BY-NC-SA 4.0 License

fish species across 37 families, of which around 39 species belong to the Pomacentridae (Pouil *et al*. 2020; Cañedo-Orihuela *et al*. 2023). In the marine ornamental fish trade, around 98% of specimens are wild-collected from coral reefs in tropical countries (Madhu *et al*. 2020). The development of breeding and larval rearing protocols can reduce the exploitation of ornamental fishes from the wild (Anzeer *et al*. 2019).

Pomacentrids are considered the most conspicuous and abundant fishes in many reef habitats (Fishelson 1998). The taxonomic monograph by Allen (1991) remains a baseline for information on species identification, morphological descriptions, and global distribution records across the family Pomacentridae. Five species of the Pomacentridae family, *Amphiprion sebae*, *A. clarkii*, *Pomacentrus caeruleus*, *Dascyllus trimaculatus*, and *Neopomacentrus nemurus* collectively account for more than half (57.9%) of the overall marine ornamental trade in India (Prakash *et al*. 2017). Although research on breeding and behavioural patterns of Pomacentrid fishes has been conducted across many species, studies on egg development are lacking in this group (Ghosh *et al*. 2012). Likewise, early larval stages have been studied in comparatively few damselfish species (50), even though the total number is much higher (Muñoz-Cordovez *et al*. 2019; He and Berumen 2023). This represents only 15% of the total number of damsel species (Murphy *et al*. 2007). More than 90% of economically significant marine ornamental fish that come from wild coral reef ecosystems worldwide (Fotedar and Phillips 2011; Sweet 2016). The successful mass production of the three-spot damselfish *D. trimaculatus* has demonstrated the practical feasibility of captive seed production for pomacentrid ornamental fishes (Anikuttan *et al*. 2019). Detailed embryonic staging has been documented for the percula clownfish *Amphiprion percula*, providing comparative baseline data on early development within pomacentrids and allied marine ornamental fishes (Dhaneesh *et al*. 2009). A comprehensive molecular phylogenetic revision by Tang *et al*. (2021) has refined genus-level classifications within the Pomacentridae family.

The genus Pomacentrus comprises 79 species (Allen *et al*. 2020). *Pomacentrus alleni* is a damselfish reported from the Indo-Pacific region, characterised by vibrant neon-blue colouration, a bright yellow anal fin, and a dark streak along the base of its tail (Burgess 1981). Species within the family Pomacentridae are in exceptionally high demand in the global marine ornamental trade, which is the most popular marine ornamental fish family and accounts for 43% of all traded marine fish (Anikuttan *et al*. 2023). The species commands a high market price currently and is in demand in the aquarium fish trade (Blue Zoo Aquatics 2026). Breder and Rosen (1966) documented egg-laying behaviour and settlement with ventral fin characteristics in the same genus. There has been no information available to date on the breeding of Andaman damsel.

The present study provides baseline information on captive breeding for the one commercially important damselfish species, and this is the first-ever report of broodstock development, breeding and egg development of *P. alleni* Burgess, 1981.

2 | METHODOLOGY

2.1 Broodstock collection and quarantine

Six adult specimens of Andaman damsel were collected from the Kanyakumari Coast (Figure 1). The total length of the collected fish ranged from 3.9 to 4.2 cm. It was not possible to visually identify the sexes of the individuals during collection due to the absence of sexual dimorphism, specifically in size. Fish were collected using hand nets and transported to the research hatchery of the Vizhinjam regional centre of ICAR-CMFRI, Kerala, in oxygenated polythene bags at a packing density of 1 fish per 1000 ml of seawater. After approximately 1 hour of temperature acclimatisation in a 100-litre beaker, the fish were transferred to two 500-L polypropylene (PP) tanks for quarantine. Feeding began 24 hours after transfer. Daily, 10% of the water was exchanged to maintain water quality.

2.2 Recirculatory system for broodstock development

After a two-week quarantine, the fish were stocked into 500 L PP tanks containing 480 litres of seawater, which were connected to a recirculating aquaculture system (RAS) (Figure 2). The system contains a flow-through which connects 10 PP tanks via a single drainage pipe, supplemented by two overhead tanks with a capacity of 1500 L for storing seawater and fresh water, as needed for broodstock management. Each tank has a wide V-shaped bottom so waste can be drained easily with the flow of water. Each tank has a total volume of 490 L (70 cm height) and is equipped with an aeration supply to ensure adequate dissolved oxygen levels. The system comprises an Emaux SC050 (Guangdong, China) model pump with a flow rate of 15.2 m^3 h^{-1}. The sand filter used in the system is Emaux V 500. The Eumax UV light disinfection system (NT-UV75, Guangdong, China) is also used in the RAS. Water exchange of 5–10% was performed every 7 days, as stocking density was kept low and regular water quality monitoring indicated that ammonia, nitrite, and nitrate levels were within optimal ranges. Freshwater was used once every two weeks to maintain the salinity of 30–32 ppt.

A natural photoperiod (12 D: 12 L) was maintained in the hatchery for the species. Water temperature ranged from 27.1 to 29.8°C, pH from 7.9 to 8.2, and salinity from 33 to 35 ppt. Different types of hideouts were provided for broodstocks: 6-cm-diameter PVC pipes (hanging and T-shaped bottom-placed), clay pots with two extra holes (one on top and one on the side), and tiles. Adult fish (Figure 3) were monitored daily for aggression and spawning dynamics over the next few weeks.

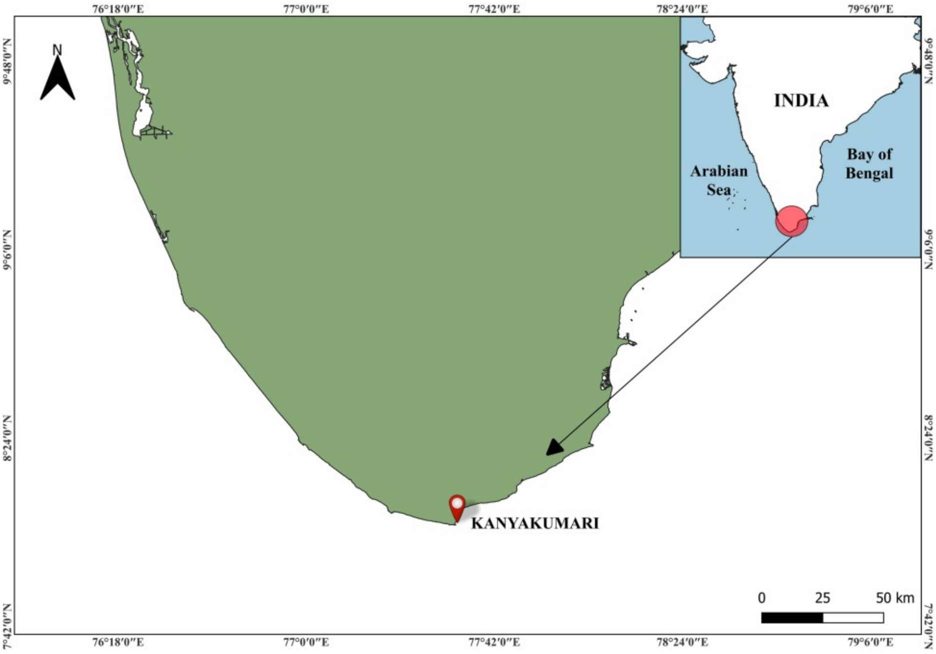

FIGURE 1 Map of southern India showing the location of Andaman damsel *Pomacentrus alleni* brood collection.

FIGURE 2 Tanks with recirculating aquaculture system (RAS) used for broodstock development of Andaman damsel *Pomacentrus alleni*.

2.3 Breeding behaviour

After 18 months of broodstock conditioning, one male fish (5.5 cm and 5.3 g) and one female fish (5.7 cm and 5.5 g) exhibited distinctive breeding colouration and courtship behaviour (Figure 4). Sexual dimorphism was evident at this stage; the male displayed a neon blue colour with a yellow wash near the bottom of the body, extending down to the anal fin, whereas the female displayed a slightly muted neon blue compared with the male. The male fish cleaned the hideout three days prior to egg-laying. To document courtship and spawning, behavioural observations of the breeding pair were conducted by two observers. The broodstock tank was monitored visually three times daily, morning, afternoon and evening, for a duration of 30 minutes per session. Specific behavioural patterns, including swimming patterns, pair formation, and the exact timing of spawning events, were recorded manually in a daily logbook to accurately determine the spawning intervals and reproductive behaviour of *P. alleni* under captive conditions.

FIGURE 3 Male brooder of Andaman damsel *Pomacentrus alleni*.

2.4 Feeding

Broodstock tanks were fed three times daily. Fresh squid meat was cleaned, chopped, and fed around 9:00 am. Ready-made pellets (Hikari Marine - S, WA Special Marine feed) of varying sizes (500 to 800 µm) were fed at noon (around 1.00 pm). Brown Mussel *Perna indica* meat was used to feed around 5.00 pm. Fish were also fed *ad libitum* each time and monitored carefully for any differences in swimming or feeding patterns.

2.5 Spawning

The first spawning occurred in the early morning (7–9 IST) with 1000–1200 eggs (Figure 5). Fecundity was estimated by counting the number of eggs within a known subsampled area and extrapolating this density to the total surface area of the egg patch. The eggs adhered to the substrate (PVC pipes) via adhesive tendrils. After spawning and fertilization, the male diligently guarded and aerated the eggs. The eggs were elliptical, measuring 856.91 ± 66.61 µm, with a single oil globule. On the day of spawning, the eggs were transparent, making them difficult to detect underwater. As development progressed, their colouration gradually shifted, turning metallic grey by the day of hatching. If any eggs failed to develop properly, the male carefully removed them to maintain the clutch's health.

2.6 Egg development

After spawning, a few eggs were scraped with a microtome blade and observed under a microscope (ZEISS Primostar 3, Germany) at 4x and 10x magnification. The eggs were kept in a sterilised container containing seawater at room temperature to avoid affecting embryonic development. Water was exchanged regularly to reduce the chances of egg decay or ciliate infestation. The room temperature was maintained at (29.0±0.5°C) during all embryonic observations. A random sample of 15 to 20 eggs was collected and examined microscopically at each developmental stage. Photos were taken using (ZEISS Axiocam 105 colour) at different stages of egg development.

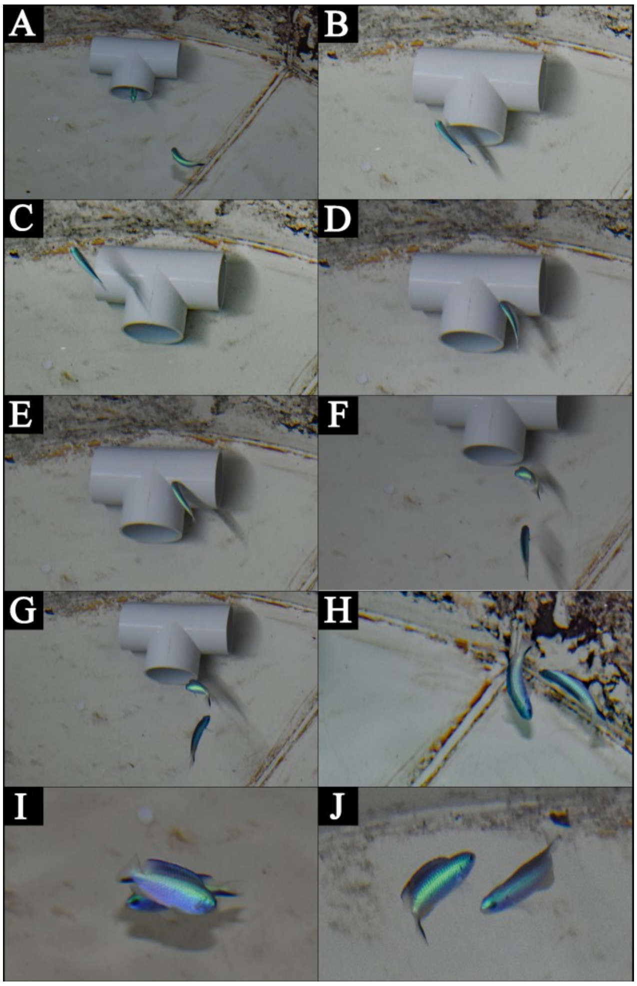

FIGURE 4 Courtship behaviour of Andaman damsel *Pomacentrus alleni*. (A) Male fish are cleaning the T-shaped PVC hideout prior to spawning; (B) clear territorial behaviour shown by male fish; (C) continuous monitoring over the territory; (D) cleaning the surface; (E) corners cleaning; (F) courtship initiation; (G) signal jump; (H) rapid swimming pattern. (I) rubbing the body side by side; and (J) close and round courtship movements.

2.7 Hatching

After 65–70 hrs of spawning, the PVC hideout was carefully removed from the brooder tank to the hatching tank using a bucket. A 500 L yellow-coloured FRP tank was prepared for hatching. Around 300 L of sterilised seawater was added to the hatching tank. The eggs were then slowly placed in this tank to acclimate to the new seawater (15 min). A disc-shaped air stone with a fine air-bubble flow was kept near the eggs to maintain stable dissolved oxygen levels. The eggs usually hatch between 18:45 and 19:15 hours. The next morning, the hideout was removed, and any dead eggs were siphoned out using a small air tube (5 mm diameter). Brown algae, green algae and live copepod nauplii (6 nos. ml^{-1}) were provided in the morning (9–10 am). The first 10 days had no water exchange; thereafter, 10% of the water was removed daily from the bottom using narrow tubes (20 mm diameter), and 10–15% of fresh seawater was added back with minimal disturbance until the 25th day of post hatch (DPH); later, 15% of the water was exchanged daily. Physico-chemical parameters such as atmospheric temperature, water temperature, salinity, dissolved oxygen, total ammoniacal nitrogen (TAN), NH_3–N, NH_4–N and pH were monitored regularly (APHA 1998).

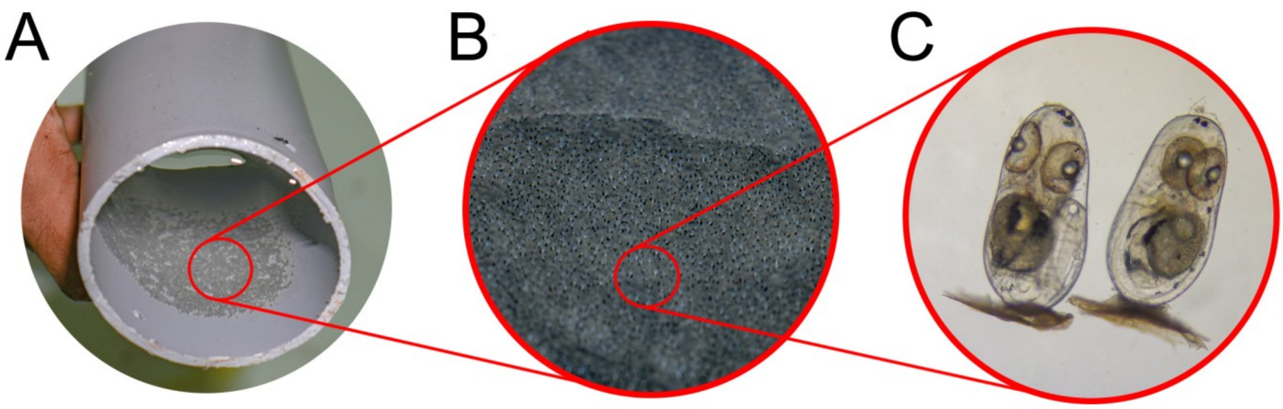

FIGURE 5 Eggs of Andaman damsel *Pomacentrus alleni* attached to the hideout.

3 | RESULTS

3.1 Pairing and breeding behaviour

The present study reports the reproductive behaviour and spawning dynamics of *P. alleni* under captive conditions and describes successful pair formation, courtship, spawning, and hatching. The observed reproductive patterns under captive conditions were generally consistent with breeding patterns reported for other pomacentrid fishes, such as Green chromis (*Chromis viridis*) (He and Berumen 2023; Rekha *et al*. 2024). One large male and one female were selected from the colony of six adults and kept in breeding tanks, as is ideal for the genus *Dascyllus* (Asoh and Yoshikawa 2003; Anzeer *et al*. 2019).

Territorial behaviour is very evident in male Andaman damselfish. The breeding pair naturally formed from the group of six broodstock and was selected for observation based on distinct pairing behaviour and territorial dominance. Pre-spawning courtship was also observed for the pair. Prior to the spawning, the male fish are constantly moving in and around the PVC hideout (T-shaped) provided in the broodstock tanks in a particular pattern. It was cleaning the surroundings and the hideouts for hours. This type of ‘cleaning’ behaviour is usually associated with nest preparation, which can improve adhesion of eggs to the substratum. Similar observations have been made for male fish of several pomacentrids, which actively clean and defend spawning territories before and after spawning (Gopakumar *et al*. 2002). The males of *Amblyglyphidodon indicus* (Maldives damselfish) clean the substrates through repeated biting and scraping before spawning and remain in close proximity to the nest until hatching (He and Berumen 2023). There are cases in which males care for the eggs by cleaning them and fanning seawater over developing embryos, a very active parental care behaviour. Similarly, in cloudy damsel, *Dascyllus carneus* males display strong nest preparation and territorial behaviour associated with reproductive success (Randall and Allen 1977; Anzeer *et al*. 2019). Similar breeding behaviour has been reported for pomacentrids like *D. aruanus*, *D. trimaculatus*, *D. melanurus* and *D. reticulatus* (Tanaka 1999).

During this study, regular maintenance of hygienic conditions in the broodstock tank appeared to facilitate the breeding of *P. alleni*. We observed that the accumulation of organic debris often coincided with a decrease in courtship and spawning behaviours. Removing these factors can help create a suitable environment for breeding *P. alleni*. Similar parental cleaning behaviour and nest maintenance have been widely reported in damselfishes, highlighting the importance of environmental stability during reproduction (Petersen and Hess 1991).

It was observed that Andaman damsels showed a strong preference for PVC pipes over clay pots as spawning shelters. Although clay pots are frequently used in broodstock tanks, the brooders repeatedly showed interest in the PVC hideouts for courtship and spawning. A comparable preference was observed in some other damsels for PVC-based substrates. Hattori and Casadeva (2016) reported that cleaning the substratum and sudden changes in the male behaviour and dance movements indicate breeding behaviour.

Compared with other substrates such as ceramic tiles, a significant spawning preference for vertical PVC pipes was observed in captive-bred blue-green chromis (*C. viridis*; Rekha *et al*. 2024). Males of *A. indicus* often choose and clean the spawning area before depositing eggs on artificial hard platforms, such as abandoned PVC pipes (He and Berumen 2023). These observations collectively indicate that T-shaped or vertical PVC structures can serve as shelters for the damsels, thereby improving security for spawning success and reducing stress under captive conditions.

The courtship behaviour in *P. alleni* was evident. It involves specific patterns and behaviours before and during spawning. Male fish exhibited a distinct swimming pattern: they rapidly exited the hideout, moved towards the water surface, and then immediately returned to the shelter. This observed “signal jump” can be referred to as a critical reproductive behaviour (Tanaka 1999), which indicates the spawning readiness of the species. Similar courtship displays involving rapid vertical swimming or exaggerated body movements are widespread across the family Pomacentridae (Mann and Lobel 1995). Courtship movements resembling swimming displays and rapid vertical "dives upward" have been described in *D. albisella*, *Stegastes partitus*, and *D. carneus*, in which males actively use these energetic displays to signal genetic vigour and attract females to the spawning site (Mann and Lobel 1995; Anzeer *et al*. 2019).

In this study, it was observed that male fish did the side-to-side rubbing of the body near the entrance of the hideout. This movement appeared to be an invitation for the female to enter the shelter. These types of swimming patterns and behaviours in pomacentrid fishes are usually associated with pair formation and spawning. According to Wickler (1967), the breeding behaviour within the genus has been found to be similar and unique. Similar courtship interactions involving quivering body movements, circling, and nest-associated tactile displays have been described in *N. cyanomos* and appear essential for successful mate acceptance and spawning synchronization (Setu and Ajith Kumar 2010).

If the female also began exhibiting breeding behaviour, both would engage in a very specific swimming pattern, which is a strong indication of pair formation. After pair formation and the first successful spawning, subsequent spawnings occurred approximately every 5 days; this average spawning interval was calculated across 15 consecutive spawning cycles. In tropical damselfishes, short spawning periodicity is common. The blue sapphire damselfish, *Chrysiptera springeri*, has a spawning interval ranging from 4 to 7 days (Chambel *et al*. 2014), whereas the spawning periodicity of *C. viridis* is recorded at a mean interval of roughly 5.59±0.96 days under captive conditions (Rekha *et al*. 2024). In *D. carneus*, slightly elongated spawning intervals are reported, i.e., from 7 to 15 days (Anzeer *et al*. 2019). These results clearly show that pomacentrid brooders can attain high reproductive potential and repeatedly spawn even under captive conditions when water quality parameters, feed, and compatible mates are available.

The reproductive behaviours observed in this study of *P. alleni* closely resemble those reported in pomacentrid fishes, including territorial behaviour in males, shelter cleaning, a specific swimming pattern, pair formation, and repeated spawning. The strong preference for PVC hideouts over clay pots and the comparatively short spawning interval recorded in this study, indicate specific adaptations of the Andaman damsel. These results indicated the potential for large-scale seed production of this high-value ornamental pomacentrid fish.

3.2 Spawning

Spawning is normally observed in early mornings. The eggs of Andaman damselfish (*P. alleni*) are demersal, capsule-shaped, and adhesive, with a size of 856.91±66.61 µm. In *P. amboinensis*, egg size is reported as 1.2–1.3 mm (Kavanagh and Alford 2003). Egg size of *D. carneus* reported from a range of 754.3 µm to 625 µm, with a length and width range from 534.01 to 450 µm (Sreeraj 2002; Gopakumar *et al*. 2009; Anzeer *et al*. 2019). This capsule shape closely resembles the egg characteristics reported for other pomacentrids such as *P. amboinensis* (Murphy *et al*. 2007). Early morning spawning was also reported in other pomacentrids (Gopakumar *et al*. 2009; Rohini Krishna *et al*. 2016). The eggs are characterized by a highly transparent chorion and contain a high amount of yolk with prominent, variable-sized oil globules, which act as the main energetic reserve throughout early development. These egg traits have been documented in the Pomacentridae family, including *Chrysiptera parasema* (Olivotto *et al*. 2003), *D. carneus* (Anzeer *et al*. 2019), and *C. viridis* (Rekha *et al*. 2024).

Eggs per batch cluster for *P. alleni* were estimated at 1070±127. In *D. carneus*, 5000–6000 eggs per spawning were reported (Randall and Allen 1977; Sreeraj 2002; Gopakumar *et al*. 2009), whereas Cobb (1975) reported 5900–8260 eggs in each spawning for the same species. The morphological characteristics of *P.alleni* eggs are very similar to Tanaka's (1999) description of eggs from other Pomacentrid species. During the final hours of incubation, the transparent eggs gradually become translucent.

The observed hatching percentage is 90.6±1.9%. Danilowicz and Brown (1992) reported hatching rates as

100% for *D. albisella* and 80% for *D. aruanus*. In the case of *D.carneus* hatching percentage was 90.6 to 98.81% (Anzeer *et al*. 2019). Continuous spawning of *D. carneus* was reported at an interval of 12 days (Sreeraj 2002). In *D. albisella*, spawning was reported to peak in June by Stevenson (1963) and from June to September by Asoh and Yoshikawa (2003). During the 12-month observation period of this captive study, the peak spawning activity for *P. alleni* occurred between February and May. Captive broodstock conditioning and larval rearing protocols have also been successfully refined for other marine ornamental species beyond pomacentrids, including the forktail blenny *Meiacanthus atrodorsalis* (Moorhead and Zeng 2011), showing progress in captive breeding across marine fish families.

3.3 Incubation and hatching dynamics

In the family Pomacentridae, hatching timelines show variations based on the egg shape and environmental parameters: Hatching in *P. alleni* occurs exclusively during the first 1 to 2 hours of darkness. This nocturnal hatching mechanism is driven by an endogenous circadian rhythm designed to minimise visual encounters with reef predators at the moment the planktonic larvae emerge into the water column. This biological mechanism is a preserved survival strategy across the family and matches the hatching behaviours recorded for *C. parasema* (Olivotto *et al*. 2003), *D. carneus* (Anzeer *et al*. 2019), and Red Sea anemonefishes (He and Berumen 2023).

3.4 Embryonic development and timeline

The initial cleavage, which splits the blastodisc into equal blastomeres, happens quickly following successful fertilisation. The egg reaches the 2-cell stage within 1-hour post-fertilization (hpf). The multicelled morula stage, which is attained at approximately 8 hpf, is the result of subsequent synchronous divisions. According to Rohini Krishna *et al*. (2016), this fast early cell division occurs in species like *N. cyanomos*, where early holoblastic cleavage is finished within the first few hours following fertilization. By 9 hpf, some *Chromis limbaughi* eggs also displayed 100% epiboly (Félix-Berumen *et al*. 2026).

In *P. alleni*, the early blastula stage occurred in 9–12 hpf, and the blastocoel developed internally beneath the blastoderm layer. The late blastula stage occurred around 15 hpf, and the margins of the blastoderm thickened to form a 'germ ring' around 20 hpf. During gastrulation, the blastoderm expands over the yolk mass via epiboly. In *P. alleni*, the yolk is covered by the germ ring progression until the blastopore fully closes, creating the embryonic axis. In all pomacentrids, this phase is strongly temperature-dependent. According to He and Berumen (2023), the pace of epiboly in Red Sea damselfishes is directly regulated by environmental thermal stability. Gastrulation in *P. alleni* occurred without developmental problems at a stable 28°C, which is consistent with findings for *C. parasema* (Olivotto *et al*. 2003) and *C. viridis* (Rekha *et al*. 2024). Dhaneesh *et al.* (2012) described the breeding biology and embryonic development of the skunk clownfish *Amphiprion akallopisos*, identified salinity as a critical environmental parameter for larval survival under captive conditions.

Around 33–42hpf, the early segmentation stage occurs, in which the head region thickens, and somites appear. In *C. limbaughi*, the cephalic and caudal regions appeared in 42hpf (Félix-Berumen *et al*. 2026). Tailbud and optic vesicles formed around 53–64hpf.

Organogenesis is characterised by the clear differentiation of the embryonic head, optic vesicles, and distinct somites along the trunk. Early in organogenesis, the optic buds become prominent, and Kupffer's vesicle can be discerned at the tail bud. In *P. alleni*, melanin deposition around the optic lenses is observed during the pre-hatching period at 78–88 hpf (Figure 6). This pattern of heavy ocular pigmentation prior to hatching is a classic trait of pomacentrids, which emerge as well-developed, visually oriented, planktonic larvae capable of immediate active hunting (Murphy *et al*. 2007; Anzeer *et al*. 2019).

As development progresses, at 97–102 hpf, the ready-to-hatch embryo shows the onset of rhythmic heart pulsations, and the embryo exhibits spontaneous twitching movements within the chorion. The embryo is fully formed, with clear brain segments and a tail wrapped around the inner wall of the egg capsule (Figure 6).

Newly hatched larvae (Figure 6) were small, pelagic and distributed evenly in the water column. Total length was 1.84±0.11 mm; standard length 1.65±0.03 mm. Body depth measured 0.19±0.01 mm; In 1 dph larvae, yolk sac measured 0.21±0.01 mm. In the same genus of *Pomacentrus*, 2.5 mm hatchling was reported in *P. amboinensis* (Murphy *et al*. 2007). According to Cobb (1975), the overall length of freshly hatched *D. carneus* larvae was much shorter (1.4 mm) than *P. alleni*. Other Dascyllus damselfish species, such as *D. aruanus*, *D. trimaculatus*, *D. melanurus*, and *D. reticulatus*, had recently hatched larvae ranging from 2.08 to 2.50 mm (Tanaka 1999). It was 2.5 mm for *D. albisella* (Stevenson 1963) and 2.2 mm for *D. aruanus* and *D. albisella* (Danilowicz and Brown 1992). In *C. limbaughi* hatchling size reported as 2.54±0.17 mm by Félix Berumen *et al*. (2026).

This study provides important preliminary insights into the captive breeding and egg development of *P. alleni*, a major limitation must be acknowledged: all observations and data were derived from a single breeding pair. Hence, the reproductive parameters, larval development details, and specific spawning behaviours recorded here may not fully represent the species' overall breeding biology. To confirm the accuracy of these initial findings and to establish a more robust understanding of the reproductive patterns of the species, further captive breeding studies using multiple breeding pairs are strongly recommended.

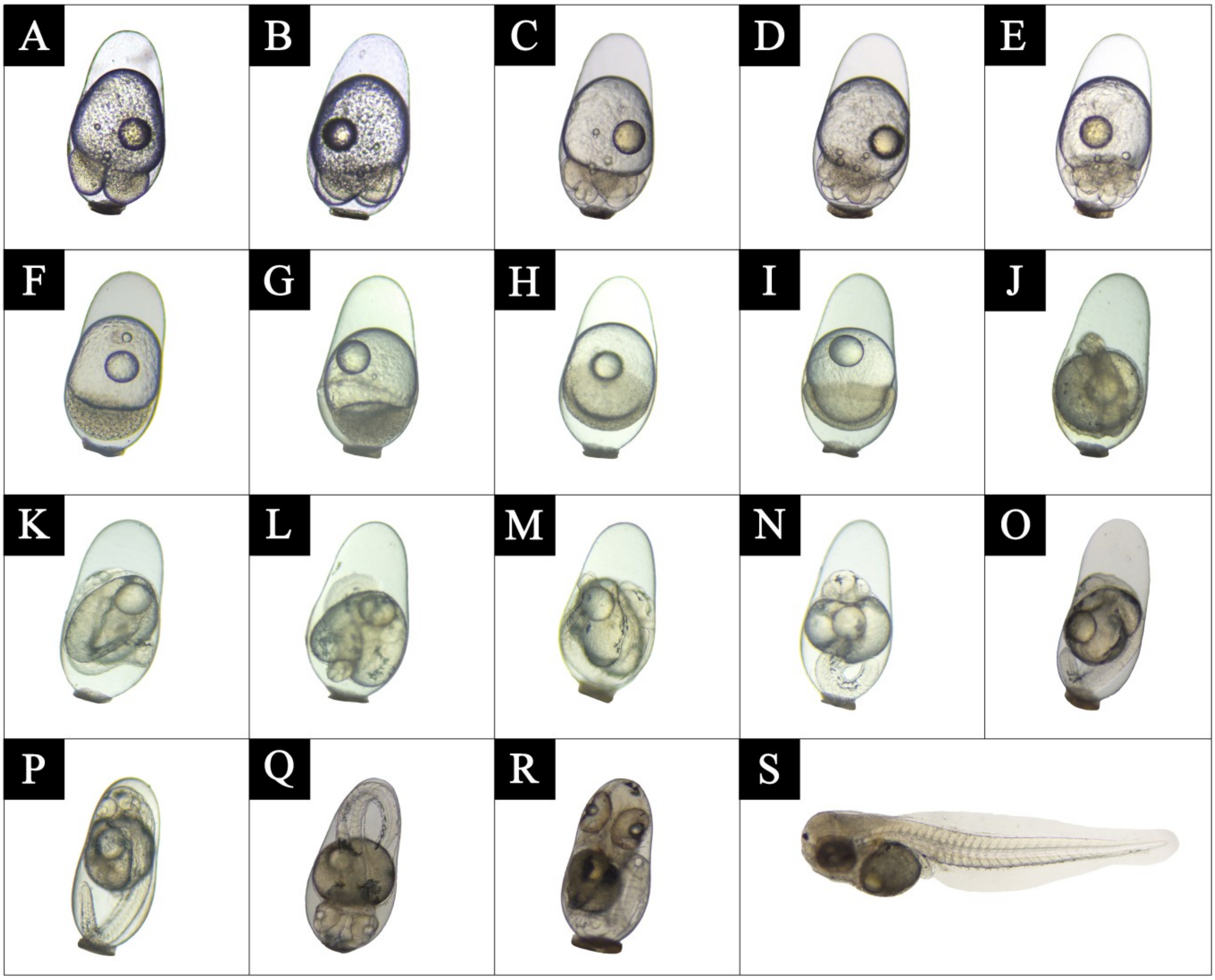

FIGURE 6 Egg development of Andaman damsel *Pomacentrus alleni*.

5 | CONCLUSIONS

Broodstock development, successful spawning, and egg development of Andaman damsel were achieved for the first time in captivity. Once pair formation is stable, species with clear courtship and territorial behaviour exhibit constant spawning with comparatively short intervals between spawnings. Although the larvae did not survive after 4 dph, we believe this work will help to refine the seed production protocol for the species, thereby supporting the sustainable use of this high-value marine ornamental fish.

ACKNOWLEDGEMENTS

The study was supported by the Indian Council of Agricultural Research (ICAR), Department of Agricultural Research and Education, Government of India. A.P.G., A.S.G. and A.L.P. acknowledge funding and fellowships from the BIRAC-funded project 'Development of breeding and supply centre for damsel fishes'. Part of the research was conducted under the project "All India Network Project on Ornamental fish breeding and culture", funded by ICAR. The authors are grateful to Dr A. Gopalakrishnan, former Director, ICAR-CMFRI, for his technical guidance during the study.

ETHICAL APPROVAL

All applicable international, national and/or institutional guidelines for the care and use of animals were adhered to in this study.

CONFLICT OF INTEREST

The author declares no conflict of interest.

AUTHORS' CONTRIBUTION

A.P.G. conceived and designed the experiments; drafted the manuscript. A.S.G., A.L.P. and L.A. conducted the experiment. V.P.G., K.S.S., and A.A. prepared the table and the figures. B.S., S.S., and A.A reviewed the manuscript. G.R.B and K.S revised manuscript. F.M.A, K.S.A and D.D.Y helped in manuscript revision. B.I., R.M., V.V.R.S., and G.G: supervision.

AI-USE STATEMENT

The authors did not use generative AI or AI-assisted tools during the generation, analysis, or drafting phases of this manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on reasonable request from the corresponding author.

REFERENCES

Allen GR (1991) Damselfishes of the world. Mergus Publishers, Melle, Germany. 271 pp.

Allen GR, Erdmann MV, Ningsih EY (2020) *Pomacentrus andamanensis*, a new species of damselfish (Teleostei: Pomacentridae) from the Andaman Sea, Indian Ocean. Journal of the Ocean Science Foundation 36: 38–48.

Allen GR, Erdmann MV, Pertiwi NPD (2022b) Description of three new species of damselfish belonging to the *Pomacentrus philippinus* group (Pomacentridae) from Melanesia and the eastern and central Indian Ocean. AQUA, International Journal of Ichthyology 28(1): 1–26.

Anikuttan KK, Jayakumar R, Abdul Nazar AK, Tamilmani M, Sakthivel M, … Ebeneezar S (2019) Successful mass production of three-spot damselfish through captive breeding. ICAR-CMFRI Marine Fisheries Information Service Technical & Extension Series 242: 7–8.

Anikuttan KK, Tamilmani G, Madhu K, Rameshkumar P, Sakthivel M, … Bavithra R (2023) Marine ornamental fish production for economic empowerment. In: Winter school on mariculture technologies for income multiplication, employment, livelihood and empowerment. ICAR-Central Marine Fisheries Research Institute, Kochi, pp. 204–211.

Anzeer FM, Aneesh KS, Abraham MV, Darsana S, Santhosh B, … Yoyak G (2019) Breeding, early development and larval rearing of cloudy damsel, *Dascyllus carneus* Fischer, 1885. Aquaculture 505: 374–385.

APHA (1998) Standard Methods for the Examination of Water and Wastewater, 20th edn. American Public Health Association, New York.

Asoh K, Yoshikawa T (2003) Gonadal development and non-functional protogyny in the Indian damsel fish (*Dascyllus carneus*). Journal of Zoology (London) 260: 23–39.

Biondo MV, Burki RP (2020) A systematic review of the ornamental fish trade with emphasis on coral reef fishes: an impossible task. Animals 10(11): 2014.

Blue Zoo Aquatics (2026) Rolland's damselfish. Available at https://www.bluezooaquatics.com. Accessed on 17 May 2026.

Breder CM, DE Rosen (1966) Modes of reproduction in fishes. T.F.H. Publications, Neptune City, New Jersey. 941 pp.

Burgess WE (1981) *Pomacentrus alleni* and *Amphiprion thiellei*, two new species of pomacentrids (Pisces: Pomacentridae) from the Indo-Pacific. Tropical Fish Hobbyist 30(3): 68–69, 72–73.

Cañedo-Orihuela H, González-Félix ML, Pérez-Velázquez M (2023) Maturation, reproduction and larval culture of pomacentrids for the ornamental fish trade: successes and challenges. Reviews in Fish Biology and Fisheries 33: 1155–1197.

Chambel J, Severiano V, Pedrosa R (2014) Reproductive behaviour and embryonic development of the Citrinis Clown Goby (*Gobiodon citrinus*) and Blue Sapphire Damselfish (*Chrysiptera springeri*). Frontiers in Marine Science 1: 130.

Cobb RV (1975) Spawning cloudy damsels. Marine Aquarist 6(7): 46–49.

Danilowicz BS, Brown CL (1992) Rearing methods for two damselfish species, *Dascyllus albisella* (Gill) and *D. aruanus* (L.). Aquaculture 106: 141–149.

Dhaneesh KV, Ajith Kumar TT, Shunmugaraj T (2009) Embryonic development of percula clownfish, *Amphiprion percula* (Lacepede, 1802). Middle-East Journal of Scientific Research 4(2): 84–89.

Dhaneesh KV, Nanthini Devi K, Ajith Kumar TT, Balasubramanian T, Tissera K (2012) Breeding, embryonic development and salinity tolerance of Skunk clownfish *Amphiprion akallopisos*. Journal of King Saud University – Science 24(3): 201–209.

Félix-Berumen RD, Pérez-Velázquez M, González-Félix ML (2026) Initial studies on captive breeding of *Chromis limbaughi*: paving the way for its conservation and sustainable production. Aquaculture and Fisheries 11: 997–1007.

Fishelson L (1998) Behaviour, socio-ecology and sexuality in damselfishes. Italian Journal of Zoology 65: 387–398.

Fotedar RK, Phillips BF (2011) Recent advances and new species in aquaculture. Wiley-Blackwell, 461 pp.

Fricke R, Eschmeyer WN, van der Laan R (eds) (2022). Eschmeyer's catalog of fishes: genera, species, references. Online version, updated 1 Nov. 2022. http://research.calacademy.org/research/ichthyology/catalog/fishcatmain.asp [Accessed 17 May 2026].

Ghosh S, Kumar TTA, Balasubramanian T (2012) Embryology of Maldives clownfish, *Amphiprion nigripes* (Amphiprioninae). Journal of Ocean University of China 11(2): 174–180.

Gopakumar G, Madhu K, Madhu R, Ignatius B, Krishnan L, Mathew G (2009) Broodstock development, breeding and seed production of selected marine foodfishes and ornamental fishes. Marine Fisheries Information Service, Technical and Extension Series 201: 1–9.

Gopakumar G, Sreeraj G, Ajithkumar TT, Sukumaran NT, Raju B, … Benziger VP (2002) Breeding and larval rearing of three species of damselfishes (family: Pomacentridae). Marine Fisheries Information Service, Technical & Extension Series 171: 3–5.

Hattori A, Casadeva M (2016) Sex change strategies and group structure of the damselfish. In: Frédérich B, Parmentier E (Eds.), Biology of Damselfishes. Taylor & Francis, CRC Press, 1: 55–83.

He S, Berumen ML (2023) Egg development and hatching in two Red Sea damselfishes. Frontiers in Marine Science 10: 1235919.

Kavanagh KD, Alford RA (2003) Sensory and skeletal development and growth in relation to the duration of the embryonic and larval stages in damselfishes (Pomacentridae). Biological Journal of the Linnean Society 80: 187–206.

Madhu K, Madhu R, Mohandas MP, Vijayan MT, Baby ST (2020) Marine ornamental fishes and their breeding: CMFRI initiatives. In: The Blue Bonanza: A Manual for On-the-Job Training Programme for VHSE Students on Advances in Fisheries & Aquaculture Techniques (pp. 130–149). ICAR-Central Marine Fisheries Research Institute, Kochi. (CMFRI Training Manual Series No. 23/2020).

Mann DA, Lobel PS (1995) Passive acoustic detection of sounds produced by the damselfish, *Dascyllus albisella* (Pomacentridae). Bioacoustics 6(3): 199–213.

Moorhead JA, Zeng C (2011) Breeding of the forktail blenny *Meiacanthus atrodorsalis*: broodstock management and larval rearing. Aquaculture 318(1–2): 248–252.

Muñoz-Cordovez R, de la Maza L, Pérez-Matus A, Carrasco SA (2019) Embryonic and larval traits of the temperate damselfish *Chromis crusma* reveal important similarities with other Pomacentridae throughout the family's thermal range. Journal of Fish Biology 95(2): 613–623.

Murphy BF, Leis JM, Kavanagh KD (2007) Larval development of the Ambon damselfish, *Pomacentrus amboinensis*, with a summary of pomacentrid development. Journal of Fish Biology 71(2): 569–584.

Olivotto I, Cardinali M, Barbaresi L, Maradonna F, Carnevali O (2003) Coral reef fish breeding: the secrets of each species. Aquaculture 224(1–4): 69–78.

Petersen CW, Hess HC (1991) The adaptive significance of spawning synchronization in the Caribbean damselfish *Stegastes dorsopunicans* (Poey). Journal of Experimental Marine Biology and Ecology 151(2): 155–167.

Pouil S, Tlusty MF, Rhyne AL, Metian M (2020) Aquaculture of marine ornamental fish: overview of the production trends and the role of academia in research progress. Reviews in Aquaculture 12: 1217–1230.

Prakash S, Kumar TTA, Raghavan R, Rhyne A, Tlusty MH, Subramoniam T (2017) Marine aquarium trade in India: challenges and opportunities for conservation and policy. Marine Policy 77(5): 120–129.

Randall HA, Allen GR (1977) A revision of the damselfish genus *Dascyllus* (Pomacentridae) with the description of a new species. Records of the Australian Museum 31(9): 349–385.

Rekha MU, Haslamathbi T, Bharathi S, Akash S, Shilpa PN, … Sarkar UK (2024) Understanding the captive breeding, spawning behaviour, and early ontogeny of *Chromis viridis* (Cuvier, 1830): a systematic study. Aquaculture 589(3): 740966.

Rohini Krishna MV, Anil MK, Neethu Raj P, Santhosh B (2016) Seed production and growth of *Neopomacentrus cyanomos* (Bleeker, 1856) in captivity. Indian Journal of Fisheries 63(3): 50–56.

Setu SK, Ajith Kumar TT, Balasubramanian T, Dabbagh AR, Keshavarz M (2010) Breeding and rearing of regal damselfish *Neopomacentrus cyanomos* (Bleeker, 1856): the role of green water in larval survival. World Journal of Fish and Marine Sciences 2(6): 551–557.

Sreeraj G (2002) Studies on the reproductive biology, breeding and larval rearing of selected marine-ornamental fishes belonging to the family Pomacentridae (PhD Thesis). ICAR-Central Institute of Fisheries Education, Central Marine Fisheries Research Institute, Mumbai. 185 pp.

Stevenson RA (1963) Life history and behaviour of *Dascyllus albisella* Gill, a pomacentrid reef fish (PhD dissertation). University of Hawaii. 221 pp.

Sweet T (2016) The state of marine breeders' art, 2017. CORAL, 13(6). Available at: http://www.reef2rainforest.com/2016/11/17/coral-magazines-captive-bred-marine-fish-species-list-for-2017/

Tanaka Y (1999) Reproductive behaviour, eggs and larvae of four *Dascyllus* species in the aquarium. Journal of School of Marine Science and Technology, Tokai University 47: 223–244.

Tang KL, Stiassny MLJ, Mayden RL, DeSalle R (2021) Systematics of damselfishes. Ichthyology and Herpetology 109(1): 258–318.

Wickler VW (1967) Vergleich des Albaichverhaltens einiger paarbildender sowie nichtpaarbildender Pomacentriden und Cichliden (Pisces: Perciformes). Zeitschrift für Tierpsychologie 24(4): 457–470 (in German).