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COHABITATION OF THREE SPECIES OF ANEMONEFISHES IN THE HOST SEA ANEMONE *STICHODACTYLA MERTENSII* (CNIDARIA, ACTINIARIA, STICHODACTYLIDAE) AND THE UNIQUE CASE OF SYMBIOSIS OF *AMPHIPRION PERIDERION* (POMACENTRIDAE, AMPHIPRIONINAE) WITH THIS SEA ANEMONE SPECIES IN NHA TRANG BAY (SOUTHERN CENTRAL VIETNAM)

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For the first time, three species of anemonefishes – *Amphiprion clarkii, A. sandaracinos*, and *A. perideraion* – have been observed cohabiting in the host sea anemone *Stichodactyla mertensii*. This is also the first description of the symbiosis between *A. perideraion* and this species of host sea anemone. *A. clarkii* was represented in the sea anemone by the pair and the subadult, *A. sandaracinos* was represented by the pair and two juveniles, and *A. perideraion* was represented only by the juvenile, estimated to be 2.5–3 months old. Observations of this symbiosis were conducted in the northwestern part of Hon Mun Island in Nha Trang Bay. It was shown that the juvenile of *A. perideraion* occupied the same niche in the host sea anemone as the pair of *A. sandaracinos* that had previously inhabited the sea anemone. Consequently, the juvenile of *A. perideraion* was subjected to constant attacks by the pair of *A. sandaracinos*. For this reason, juvenile of *A. perideraion* spent only approximately 70 % of its time at the edge of the host sea anemone's oral disc, and 30 % of its time on the substrate near the sea anemone. The presence of juvenile of *A. perideraion* outside the sea anemone for a significant period of time significantly increased their vulnerability to predatory attacks and led to its death. It was shown that symbiosis between three anemonefish species and the sea anemone *S. mertensii* is possible, but unstable and short-lived. Currents in the area where the *S. mertensii* was found were analyzed, and the most likely direction of the current that carried the larva of *A. perideraion* to this sea anemone was determined.

Keywords: host sea anemones, *Stichodactyla mertensii*, *Heteractis crispa*, *Heteractis magnifica*, anemonefishes, *Amphiprion clarkii*, *Amphiprion sandaracinos*, *Amphiprion perideraion*, Nha Trang Bay, Vietnam

The symbiosis of anemonefishes (Pomacentridae, Amphiprioninae) and sea anemones (Cnidaria, Actiniaria) is a canonical example of marine symbioses. Numerous publications and a number of general reviews are devoted to the species composition of these symbioses (Allen, 1980, 1991; Dunn, 1981; Fautin, Allen, 1997; Camp et al., 2016; da Silva, Nedosyko, 2016; Emms et al., 2020; Bennett-Smith et al., 2021; García-Jiménez et al., 2025).

The vast majority of studies devoted to this issue describe symbioses between one species of anemonefish and a sea anemone. Cohabitation of two anemonefish species in one host sea anemone is observed much less frequently and has been reported for the following species: *Amphiprion clarkii* and *A. perideraion* in symbiosis with the sea anemone *Heteractis crispa*[1] (Hattori, 1995, 2002), *A. clarkii* and *A. sandaracinos* in symbiosis with the sea anemone *Stichodactyla mertensii* (Astakhov, 2002; Bos, 2011; Hayashi et al., 2018), *A. clarkii* and *A. leucokranos* in symbiosis with the sea anemone *S. mertensii* and *A. sandaracinos* and *A. leucokranos* in symbiosis with the sea anemone *S. mertensii* (Elliott, Mariscal, 2001). It should be noted that the symbiosis of two species of anemonefishes in one sea anemone is based on the fact that each species of anemonefish occupies its own ecological niche. *A. clarkii* spends a significant part of its time outside the host sea anemone, hovering above it and protecting it from unwanted intrusion, whereas each of the above-mentioned anemonefish species: *A. perideraion*, *A. sandaracinos*, and *A. leucokranos*, which live together with *A. clarkii*, spends almost all of its time on the sea anemone's oral disc (Hattori, 1995, 2002; Elliott, Mariscal, 2001; Bos, 2011; Hayashi et al., 2018). As a result of this division of ecological niches, no antagonism arises between *A. clarkii* and the above-mentioned species. A special case is the joint symbiosis of two anemonefish species: *A. sandaracinos* and *A. leucokranos*, which occupy the same niche in the sea anemone *S. mertensii*. In this case, a reasonable assumption is made that *A. sandaracinos* takes *A. leucokranos* for its own species (Elliott, Mariscal, 2001), since the latter, with a high degree of probability, is a hybrid of *A. chrysopterus* x *A. sandaracinos* (Fautin, Allen, 1997; Elliott, Mariscal, 2001; Allen, Erdmann, 2012).

There are no data in the literature on the cohabitation of three species of anemonefishes in one host sea anemone.

The study of the cohabitation of two or more anemonefish species within a single host sea anemone is particularly important due to the reported extreme declines in the number of symbiotic sea anemones following periods of abnormally high sea surface water temperatures in these areas (Hattori, 2002; Thomas et al., 2014). Such symbioses have the potential to contribute to the conservation of anemonefish species diversity while the species diversity and abundance of their host sea anemones decline.

Material and methodology

In the period 2003–2024, the authors conducted studies of the species composition of anemonefish–host sea anemone associations on the reefs of the northwestern part of Hon Mun Island under the program for studying the biodiversity of coastal waters of Vietnam of the Joint Russia–Vietnam Tropical Science and Technology Research Center.

[1] The authors are aware of a recent paper by a group of researchers (Titus et al., 2024) who presented a new view on the nomenclature of the host sea anemones of anemonefishes, however, in the presented paper the authors use the old nomenclature of the host sea anemones developed by Fautin (2016), the leading specialist in this group of animals.

Of particular interest was the large host sea anemone *S. mertensii*, which we first observed in June 2003 on a reef off the northwest coast of Hon Mun Island (Figure 1). Throughout the observation period (2003–2024), the sea anemone remained in its current location and was inhabited by two species of anemonefishes. However, in June 2023, a unique symbiotic association was observed within this anemone, the description of which is the subject of this article.

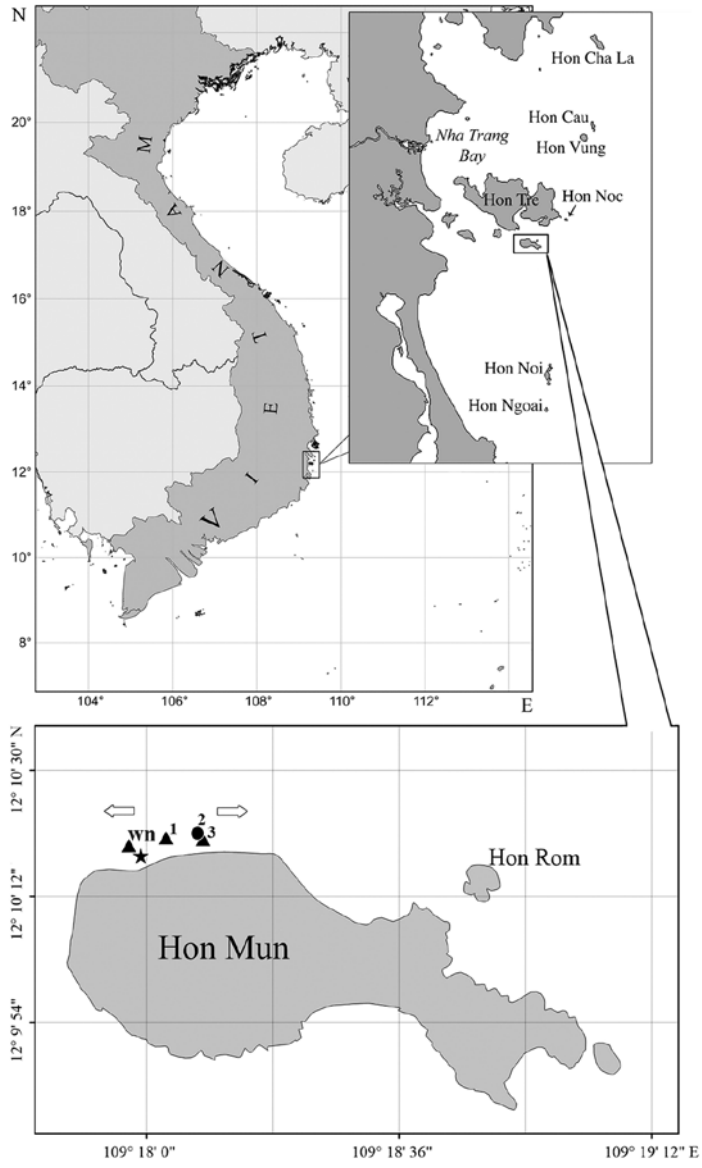


Fig. 1 – Location of the host sea anemone *Stichodactyla mertensii*, in which the juvenile of *Amphiprion perideraion* was observed, and the surrounding host sea anemones: ★ – *Stichodactyla mertensii*; ▲1 – *Heteractis crispa* is located at a distance of 130 m from *Stichodactyla mertensii*; ●2 – *Heteractis magnifica* – at a distance of 290 m from *Stichodactyla mertensii*; ▲3 – *Heteractis crispa* – at a distance of 310 m from *Stichodactyla mertensii*; the anemones are numbered according to their distance from *Stichodactyla mertensii* (2023); ▲wn – *Heteractis crispa*, without a number, is located at a distance of 15 m from *Stichodactyla mertensii* (2024). Direction of currents: ⇦ – flood current, ⇨ – ebb current

Results and discussion

The coral reef in the area of the host sea anemone *S. mertensii* is represented by extensive colonies of the branching coral *Porites cylindrica* (Poritidae), interspersed with gravel areas. The *S. mertensii* sea anemone is located on a heavily eroded, dead, massive coral surrounded by a colony of *P. cylindrica*. This sea anemone has been inhabited throughout the observation period (since 2003) by spawning pairs and juveniles of two anemonefish species: *A. clarkii* and *A. sandaracinos*. In June 2023, a symbiotic association of anemonefishes was noted in this anemone, consisting of the adult pair and subadult of *A. clarkii*, the adult pair of *A. sandaracinos*, two juveniles of the same species, and the juvenile of *A. perideraion*. The pair and subadult of *A. clarkii* occupied the horizon above the anemone, moving away from the anemone to a distance of up to 7 m (Figure 2).



Fig. 2 – The pair and subadult of *Amphiprion clarkii* high above the host sea anemone *Stichodactyla mertensii*. 2023. Photo by D. A. Astakhov

Noticing the approach of a diver, the anemonefishes began attacking him from a distance of several meters, displaying threatening postures, striking their masks, and biting. The anemonefishes then moved toward the host sea anemone and took up a defensive position directly in front of it, continuing to attack the diver (Figure 3).

Another anemonefish species, *A. sandaracinos*, did not participate in repelling the diver and was located on the host sea anemone's oral disc. This species included a spawning pair and two juveniles. In addition, the juvenile of *A. perideraion* was found on the sea anemone's oral disc, which is unique for two reasons. First, the juvenile of *A. perideraion* was the third anemonefish species to inhabit a single sea anemone, and such a phenomenon has not been described in the

literature. Second, the symbiosis of *A. perideraion* with the sea anemone *S. mertensii* has not been reported in the literature, and it is unique to this anemonefish species and this sea anemone species (da Silva, Nedosyko, 2016). In our opinion, based on laboratory breeding of *A. perideraion* (Astakhov et al., 2006), the age of the juvenile was 2.5–3 months.

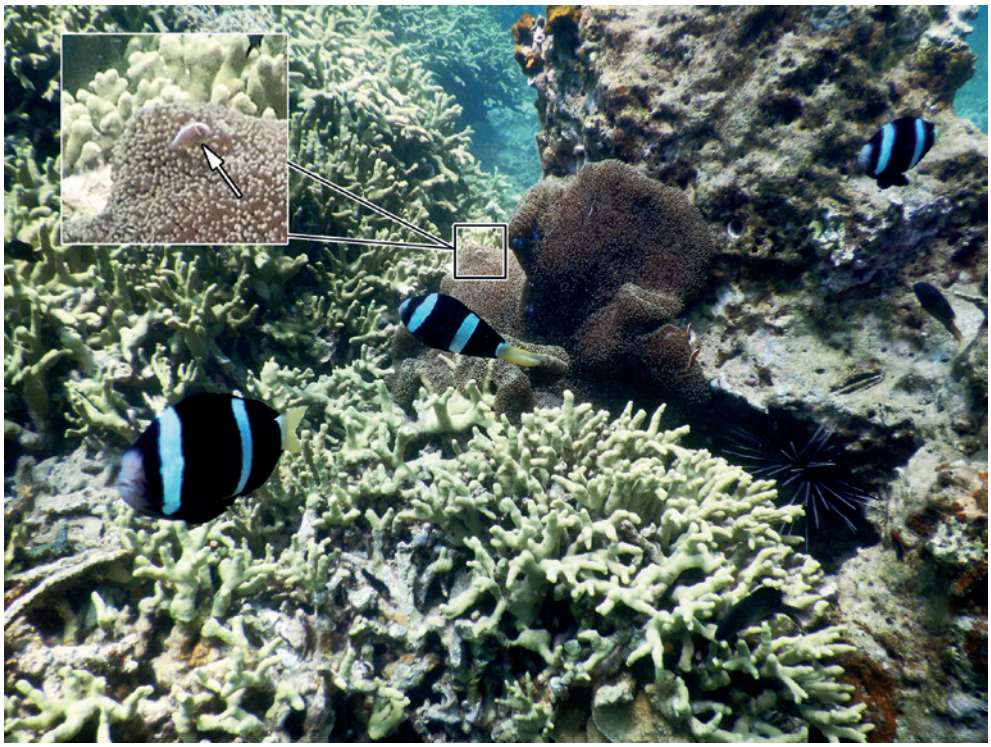


Fig. 3 – Species composition of anemonefishes inhabiting the host sea anemone *Stichodactyla mertensii*: *Amphiprion clarkii* – the pair and the subadult; *Amphiprion sandaracinos* – the pair and 2 juveniles (1 juvenile is beyond the edge of the oral disc and is not visible in the photo); *Amphiprion perideraion* – the juvenile on the edge of the oral disc of the host sea anemone (enlarged area); depth 4 m. 2023. Photo by D. A. Astakhov

The juvenile of *A. perideraion* was located at the edge of the host sea anemone's oral disc and moved only along the disc's edge (Figure 3 and Figure 4 a), attempting to hide in the host sea anemone's oral disc folds (Figure 4 b). The pair and two juveniles of *A. sandaracinos* controlled the entire oral disc of the sea anemone *S. mertensii*. The pair was located primarily in the central part of the sea anemone's disc, while the juveniles were located closer to the disc's periphery. Both juveniles and adults of *A. sandaracinos* exhibited aggression toward the juvenile of *A. perideraion.*

Upon detecting the juvenile of *A. perideraion* in close proximity, the juvenile of *A. sandaracinos* displayed a threat posture (Figure 4c), attracting the attention of the adults of *A. sandaracinos*, which then drove the juvenile of *A. perideraion* beyond the edge of the sea anemone's oral disc (Figure 4d). The juvenile of *A. perideraion* was forced to move along the edge of the anemone's oral disc, continually being attacked by the pair of adult fishes, who either drove it off the disc and onto the substrate (Figure 4e) or it took refuge under the sea anemone's disc (Figure 4f). Hand timing revealed that approximately 70 % of the time,

the juvenile of *A. perideraion* was located on the periphery of the *S. mertensii* oral disc, and the remaining 30 % of the time, it was outside the disc on the coral substrate. Being outside the sea anemone's oral disc posed a clear danger to the juvenile of *A. perideraion* due to the abundance of small predators hiding in the *P. cylindrica* coral.

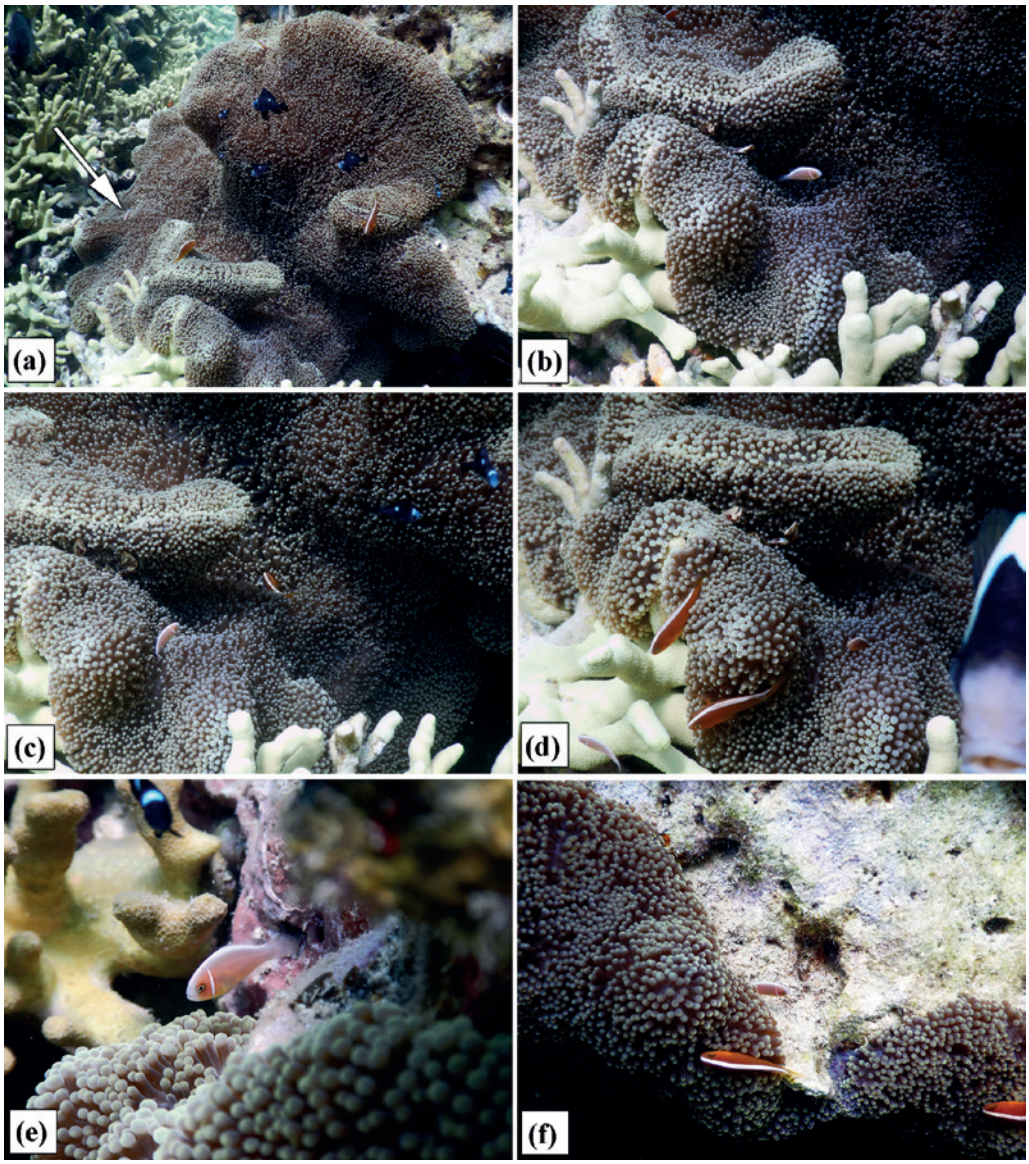


Fig. 4 – Movement of the juvenile of *Amphiprion perideraion* along the oral disc of the host sea anemone *Stichodactyla mertensii:* (**a**) – the juvenile of *Amphiprion perideraion* is located on the edge of the oral disc of the sea anemone and moves only along its edge; (**b**) – the juvenile of *Amphiprion perideraion* tries to hide under the fold of the oral disc of the sea anemone; (**c**) – the juvenile of *Amphiprion sandaracinos* demonstrates a threatening posture towards the juvenile of *Amphiprion perideraion*; (**d**) – the pair of adults of *Amphiprion sandaracinos* attack the juvenile of *Amphiprion perideraion* and drive it beyond the edge of the oral disc of the sea anemone; (**e**) – the juvenile of *Amphiprion perideraion* beyond the edge of the oral disc of the sea anemone on the substrate; (**f**) – the pair of adults of *Amphiprion sandaracinos* drive the juvenile of *Amphiprion perideraion* under the edge of the oral disc of the sea anemone; depth 4 m. 2023. Photo by D. A. Astakhov

This situation perfectly illustrates the theory, described in the literature, of different niches occupied by two anemonefish species when colonizing a single host sea anemone. One anemonefish species lives primarily above the anemone, while the other species lives directly on the sea anemone's oral disc. This distribution of anemonefish species within the sea anemone reduces competition and aggression and allows the symbiotic fishes to permanently coexist within the same sea anemone (Hattori, 1995, 2002; Bos, 2011; Hayashi et al., 2018).

In our case, all ecological niches in the host sea anemone were already occupied, and the invader, *A. perideraion*, was perceived as a competitor by the pair of resident *A. sandaracinos* and was subjected to constant aggression. During a census of host sea anemones and anemonefishes in this location in 2024, *A. perideraion* was not detected in either the host sea anemone *S. mertensii* or the surrounding host sea anemones, indicating its extinction. This suggests that symbiosis between three anemonefish species in a single host sea anemone is possible, but unstable and short-lived.

Now let's look at the routes by which the larva of *A. perideraion* was transported to the host sea anemone *S. mertensii*. Tidal currents run parallel to the northern coast of Hon Mun Island (Figure 1). With a flood current flowing from east to west, i.e., from the sea to Nha Trang Bay, the larva of *A. perideraion* would have been carried by the flood current over the host sea anemones *H. crispa* and *H. magnifica* and only then reached the sea anemone *S. mertensii*. Moreover, the sea anemones *H. crispa* and *H. magnifica* are symbiotic with *A. perideraion* (Fautin and Allen, 1997; da Silva, Nedosyko, 2016), and the larva carried by the flood current would have inevitably settled in one of these sea anemones. This means that the movement of the larva of *A. perideraion* into the sea anemone *S. mertensii* occurred from a different direction.

Another possible transfer vector for the larva of *A. perideraion* to the sea anemone *S. mertensii* is the ebb current flowing from west to east, i.e., from Nha Trang Bay to the sea. In this direction, anemones symbiotic with *A. perideraion* are absent along the coast of Hon Mun Island, reaching the *S. mertensii*. In 2024, 15 m northwest of the sea anemone *S. mertensii*, a small sea anemone *H. crispa* (Figure 1) inhabited by juveniles of *A. clarkii* was discovered among coral branches. In 2023, this anemone undoubtedly already existed in this location, but it was too small and we were unable to detect it among the branches of the *P. cylindrica* coral. *H. crispa* has a slow growth rate, as demonstrated by experimental cultivation of this anemone species (Scott and Harrison, 2008). However, in 2023, the odor of the sea anemone *H. crispa* could have attracted the larva of *A. perideraion*, but it did not settle in this sea anemone, possibly because it identified it as too small (Hattori, 2002) or was too far from this sea anemone. Thus, the remaining option is that the larva settles in the sea anemone *S. mertensii* during its transport by the current directly to this sea anemone's location. Anemonefishes (in particular, *A. perideraion*) have a well-developed olfactory system (Pashchenko et al., 2024). The olfactory system plays a decisive role in the search for a symbiotic sea anemone during the late larval stage of anemonefish development. It has been experimentally shown that anemonefish larvae perceive chemical signals from sea anemones at a distance of up to 8 m and are capable of covering this distance and settling into the sea anemone (Elliott et al., 1995). It is noteworthy that the sea anemone *S. mertensii*

was not previously considered symbiotic for *A. perideraion* (Fautin and Allen, 1997; da Silva, Nedosyko, 2016). We have shown that this is not the case and that *A. perideraion* can use it as the symbiotic host. *A. perideraion* could likely use the sea anemone *S. mertensii* for long-term symbiosis if the niche on the sea anemone's oral disc were not already occupied by another species (*A. sandaracinos*).

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СОВМЕСТНОЕ ОБИТАНИЕ ТРЕХ ВИДОВ АНЕМОНОВЫХ РЫБ В АКТИНИИ *STICHODACTYLA MERTENSII* (CNIDARIA, ACTINIARIA, STICHODACTYLIDAE) И СЛУЧАЙ УНИКАЛЬНОГО СИМБИОЗА *AMPHIPRION PERIDERAION* (POMACENTRIDAE, AMPHIPRIONINAE) С ЭТИМ ВИДОМ АКТИНИИ В ЗАЛИВЕ НЯЧАНГ (ЮЖНАЯ ЧАСТЬ ЦЕНТРАЛЬНОГО ВЬЕТНАМА)

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Впервые обнаружено совместное обитание трех видов анемоновых рыб: *Amphiprion clarkii, A. sandaracinos* и *A. perideraion* в актинии *Stichodactyla mertensii*. Это является первым описанием симбиоза *A. perideraion* с данным видом актинии. *A. clarkii* был представлен в актинии парой взрослых рыб и крупным мальком, *A. sandaracinos* был представлен парой взрослых рыб и двумя мальками, а *A. perideraion* – только мальком, имеющим возраст (примерно) 2,5–3 месяца. Наблюдения за отмеченным симбиозом проводились в северо-западной части острова Хон Мун залива Нячанг. Показано, что малек *A. perideraion* занял в актинии ту же нишу, что и заселившая актинию ранее пара *A. sandaracinos*. В силу этого, малек *A. perideraion* подвергался постоянным атакам со стороны пары *A. sandaracinos*. По этой причине малек *A. perideraion* находился только около 70 % времени на краю орального диска актинии, а 30 % времени проводил на субстрате вблизи актинии. Присутствие малька *A. perideraion* в течение значительного периода времени вне актинии значительно повышало его уязвимость от атак хищников и привело к его гибели. Показано, что симбиоз трех видов анемоновых рыб с актинией *S. mertensii* возможен, но является неустойчивым и кратковременным. Проведен анализ течений в районе нахождения актинии *S. mertensii* и определено наиболее вероятное направление течения, которое перенесло личинку *A. perideraion* к этой актинии.

Ключевые слова: симбиотические актинии, Actiniaria, *Stichodactyla mertensii*, *Heteractis crispa*, *Heteractis magnifica*, анемоновые рыбы, Pomacentridae (Amphiprioninae), *Amphiprion clarkii, Amphiprion sandaracinos*, *Amphiprion perideraion*, залив Нячанг, Вьетнам

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三种海葵鱼共同栖息于同一种海葵 STICHODACTYLA MERTENSII (CNIDARIA, ACTINIARIA, STICHODACTYLIDAE) 中，以及在芽庄湾（越南中部南部）记录到的 AMPHIPRION PERIDERAION (POMACENTRIDAE, AMPHIPRIONINAE) 与该种海葵形成的独特共生案例

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首次发现三种海葵鱼*Amphiprion clarkii*、*A. sandaracinos* 和 *A. perideraion*共同栖息于同一株 *Stichodactyla mertensii* 海葵中。同时，这也是 *A. perideraion* 与 *S. mertensii* 共生关系的首次记录。*A. clarkii* 由一对成鱼和一条亚成鱼组成；*A. sandaracinos* 由一对成鱼和两条幼鱼组成；而 *A. perideraion* 仅由一条估计年龄为2.5–3个月的幼鱼代表。对该共生体的观测于芽庄湾昏门岛西北部进行。研究表明，*A. perideraion* 幼鱼在海葵中占据了与先前定居的 *A. sandaracinos* 成对个体相同的生态位。因此，*A. perideraion* 幼鱼不断受到 *A. sandaracinos* 成对的攻击。由于这一原因，*A. perideraion* 幼鱼仅有约70 %的时间停留在海葵口盘边缘，其余30 %的时间则在海葵附近的基质上活动。*A. perideraion* 幼鱼长时间脱离海葵的保护，显著增加了其被捕食者攻击的风险，并最终导致其死亡。研究表明，三种海葵鱼与 *S. mertensii* 海葵的共生虽然在理论上是可能的，但实际上是不稳定且短暂的。对 *S. mertensii* 海葵所在区域的海流进行了分析，确定了最有可能将 *A. perideraion* 幼鱼携带至该海葵的海流方向。

关键词： 共生海葵，*Stichodactyla mertensii*，*Heteractis crispa*，*Heteractis magnifica*，海葵鱼，*Amphiprion clarkii*，*Amphiprion sandaracinos*，*Amphiprion perideraion*，芽庄湾，越南

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