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NOTE ON MASS OCCURRENCE OF SEA URCHINS ON PATONG BEACH, PHUKET, THAILAND

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ABSTRACT: Aggregations of the red sea urchin, fire urchin, false fire urchin, or blue-spotted sea urchin *Astropyga radiata* (Leske, 1778), Diadematidae, were found as dense bands above the sea-level on Patong Beach, Phuket Island, Thailand on 2nd March 2021. Totally 8 specimens were collected, its morphological characters were confirmed by four specimens, while their digestive tracts as well as gonads of other four individuals were investigated in order to test the hypotheses that the mass occurrence was caused by plentiful food on the beach or if it was due to mass reproduction. The dissected digestive tracts contained of food pellets with densely packed fragments of the red algae, *Hypnea* sp. They grow along the Patong coast at that time. Detached such algae can drift towards the beaches in large quantities during certain winds or currents. Decaying algae could have been detected by the sea urchin's chemosensory epithelia and attracted them for feeding to the shore at high tide. The tide had probably decreased faster than the sea urchin locomotion, so that the emerging sea urchins were trapped when their heavy bodies and spines gradually sunk into the sand. If mass reproduction would have caused the occurrence, the gonads in the different individuals would have been in the same reproductive stage – ripe or recently spent. Histological studies showed that they were in different reproductive stages, so this hypothesis is rejected. The possibility on mass occurrence of *A. radiata* on Patong Beach is they were aggregated for feeding.

Keywords: red sea urchin, fire urchin, false fire urchin, blue-spotted sea urchin, *Astropyga radiata*, stomach content, histological study

INTRODUCTION

Aggregations of sea urchins or other organisms have been observed for feeding as well as reproduction (Könnecker and Keegan 1973; Dare 1982; Hanlon 1998). Sea urchin aggregation, presence of three or more individuals in cohesive groups, is a common phenomenon in coastlines (Yu *et al*. 2022). Between October 2003 and July 2005, seasonal occurrence and aggregation behavior of the sea urchin *Astropyga pulvinata* was reported in Bahia Culebra, Costa Rica (Alvarado 2008). The average density was 0.13 ± 0.12 individuals per square meter, with two maximal values of 0.38 and 0.37 individuals per square meter for January 2004 and April 2005, respectively. However, such studies in Thai waters have been limited and inadequate.

In July 14, 2012, approximately 400 individual of sea urchins were reported along 200 meters on the beach of Lon Island, Phuket. Most likely it was caused by the waves washing up on the shallows during the strong winds because it was found that part of the sea urchins found were still alive (MGR online July 16, 2012). However, the species and its density were not reported.

The red sea urchin, fire urchin, false fire urchin, or blue-spotted sea urchin, *Astropyga radiata* (Leske, 1778), is widely distributed along the Indian ocean to the Pacific Ocean from east coast of Africa to Hawaiian Islands (Lane *et al*. 2000; Schoppe 2000; Putchakarn *et al.* 2017). This sea urchin species inhabits sandy sea floor at 1–70 meters depth (Mortensen 1940; Lane *et al*. 2000; Samyn 2003). It is found most often in sandy and seagrass habitats

surrounding reefs, where it grazes seagrasses as well as attached algae (personal observations).

About ten synonyms exist for this sea urchin because of colour variation (Kroh and Mooi 2023). However, this species can be identified by its V-shaped, spine-lacking areas along with lines of blue dots and is therefore called the blue-spotted sea urchin.

In Thai waters, the blue-spotted sea urchin was found both in the Gulf of Thailand, Chon Buri Province (Phai Islands), Trat Province (Chang and Kood Islands), Chumporn Province and along the coast of the Andaman Sea from Ranong to Satun provinces, on sandy bottom and seagrass beds (Putchakarn *et al*., 2017).

On 2nd March, 2021, aggregations with hundreds of blue-spotted sea urchin, *Astropyga radiata*, occurred along Patong Beach, Phuket, Thailand (Fig. 1). We hypothesized that they were aggregated for feeding or reproduction. To test the hypotheses, we examined the digestive system and reproductive organs of the blue-spotted sea urchin collected there. If they were aggregated for feeding, we should find macroalgae accumulated along the shore as well as large amounts of them in the digestive tract. If they were aggregated for mass reproduction, we should find their gonads containing mature gametes or being recently spent.

MATERIALS AND METHODS

Aggregations of sea urchins were found on Patong Beach (7.895439° N, 98.294973° E), Phuket, Thailand about 5–6 A.M. of 2nd March 2021. Immediately, staff of Patong municipality removed most of them for safety purpose. Thus, we obtained 8 specimens, and used 4 of them for identification and the other 4 for complimentary investigations on digestive tracts and histology of reproductive organs.

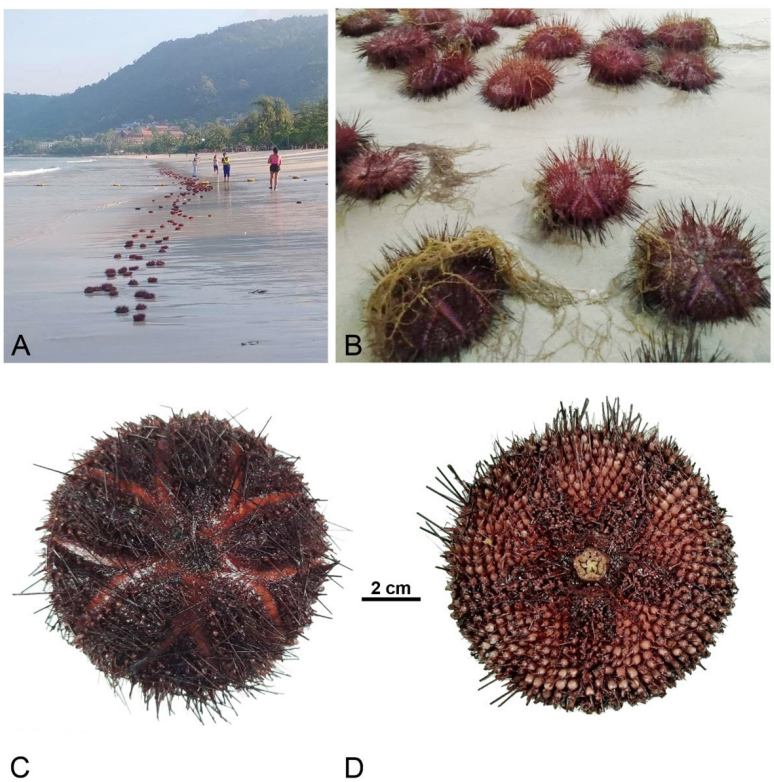

Figure 1. Blue-spotted sea urchins, *Astropyga radiata.* (A) aggregated along Patong Beach, Phuket, Thailand, on 2nd March 2021; (B) Detached algae on the shore; (C) Aboral side; (D) Oral side. Photographs A and B courtesy of Patong Development Foundation.

To test the feeding hypothesis, the digestive tracts of four blue-spotted sea urchin were dissected out from the oral side, and food composition was examined, for example, fulness of intestine, number of food pellet, *etc*. Moreover, we searched for aggregations of macroalgae along Patong Beach to find a relationship to the food in the digestive tract.

To test the hypothesis of assembly for reproduction, we studied histology of reproductive organs. The gonads were investigated at the histology laboratory, Phuket Marine Biological Center. The entire gonads of each specimen were fixed in 10% formalin for 3 days. Then, each fixed gonad was divided into small pieces (1 x 1 x 0.2 cm). This tissue was placed in a small plastic cassette and installed into the Spin Tissue Processor STP 120 for 13 hrs. to dehydrate fixative and water according to USER'S MANUAL Version 01/20. Then, the tissue was embedded using Tissue Embedding CENTER EC 350 according to User manual Version 10/19. A microtome was used for 3–6 microns paraffin sections. They were placed on glass slides and stained by hematoxylin and eosin, covered with glass coverslips and examined. The gonad maturation, the stages given by Giorgi and Demartini (1977), and Hahn (1989) were applied. If the hypothesis of aggregation for reproduction was correct, the result should have contained a high proportion of mature gonad development (stage IV) or late (stage III).

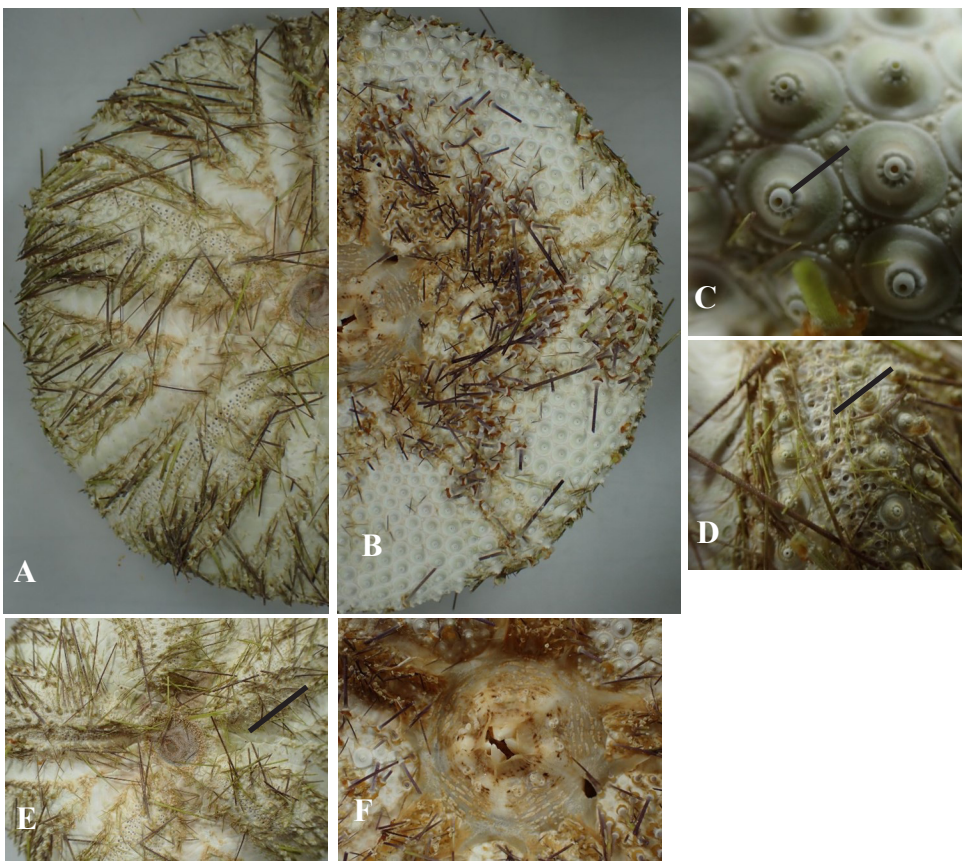

Figure 2. Morphology of *Astropyga radiat*a collected from Patong Beach, Phuket, Thailand. (A) Aboral side; (B) Oral side; (C) Primary tubercle, perforate and crenulate; (D) Ambulacral area show uniserial pore-pares and arcs of primary tubercle, Primary and secondary spines with verticillate surfaces; (E) Apical system with five elongated genital plates (arrow) into the interambulacra between the aboral bulging ambulacra; (F) Peristome, with skin cover and lantern with teeth that are grooved on their inner surfaces.

RESULTS

The morphological characters of the blue-spotted sea urchin *Astropyga radiata* (Leske, 1778) are shown in Fig. 2A–F.

Digestive tract of *Astropyga radiata* from Phuket, Thailand

Digestive system of *A. radiata* (Fig. 3A) is similar to the general features of a sea urchin described in the textbook by Ruppert *et al*. (2004). Mouth with 5 distal teeth of the Aristotle's lantern. Connecting from the Aristotle's lantern is an esophagus with bead-like appearance (Fig. 3B, C). Inner wall of the bead-like esophagus forms longitudinal folds reminiscent of the intestine rugae (Fig. 3D). A long, thinner-wall intestine circles the inner cavity of the body. The intestine also circles the body cavity, connecting to the rectum and anus.

Intestinal contents

In the intestines of all four *Astropyga radiata* specimens, 70–90% of their length contained food pellets (Fig. 4A). Shape of the pellets varied from rounded to fusiform (Fig. 4B). Average size with standard deviation of the widest length of the pellets was 3.78±1.05 mm (n=50). Each of the pellets contained densely packed algal fragments (Fig. 4C) of the red alga *Hypnea* sp. (Fig. 4D).

Histology of the gonads

The four sectioned specimens (40 slides) of *Astropyga radiata* were all males. Three stages of the gonads were found, I: post spawning (2 specimens), stage II: growth of storage cell (1 specimen), and stage III: development of reproductive cells (1 specimen)

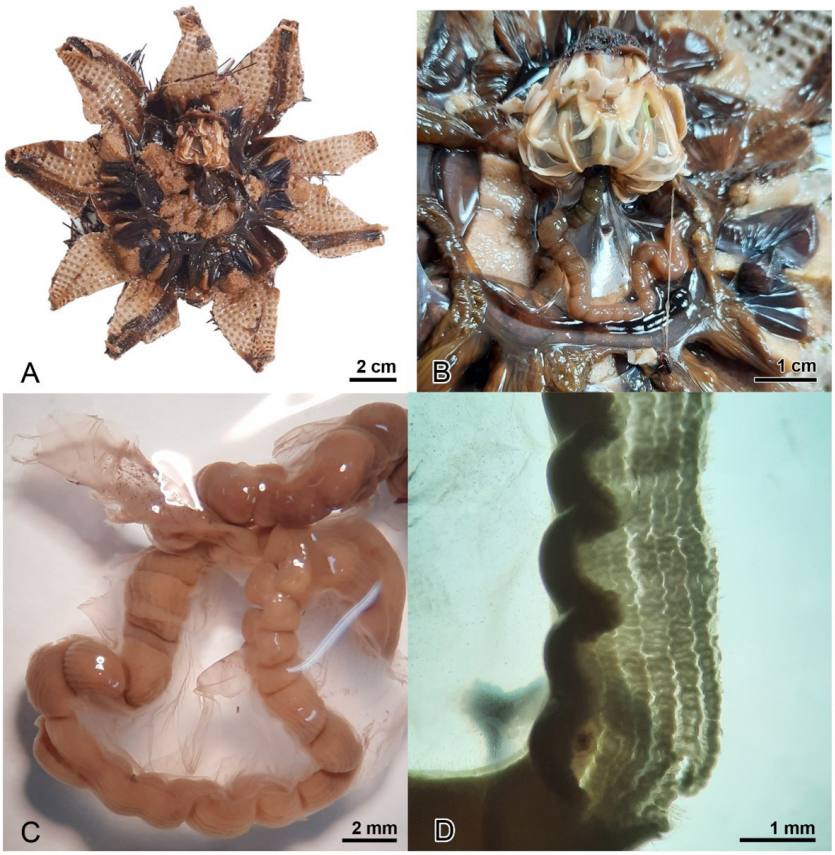

Figure 3. Digestive tract of *Astropyga radiata* collected from Patong Beach, Phuket, Thailand. (A, B) General features of internal organs dissected from the oral side; (C) External characters of esophagus; (D) Inner wall of esophagus.

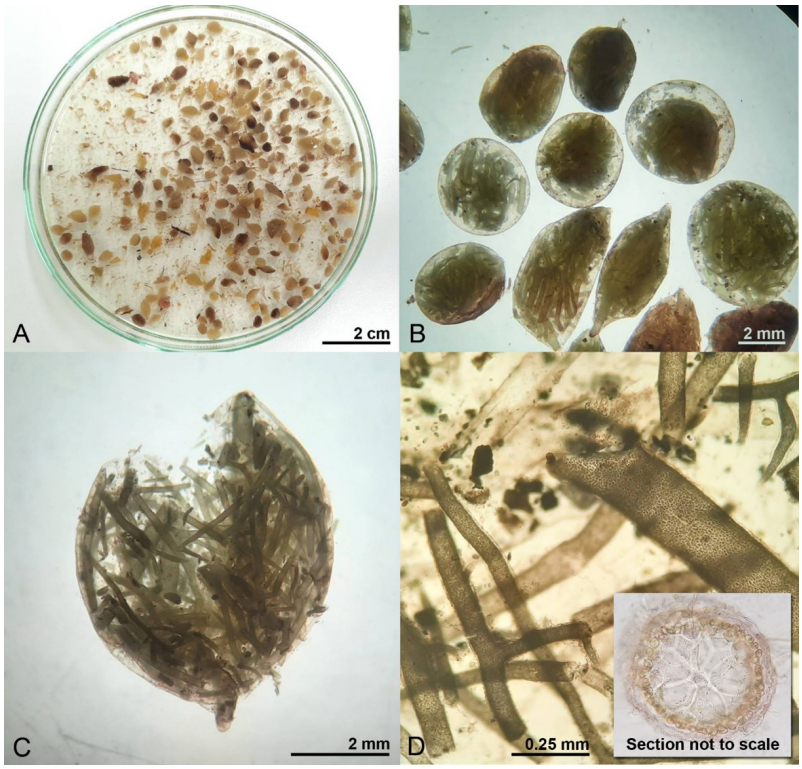

Figure 4. Food pellets obtained from the intestines of *Astropyga radiata* aggregated along Patong Beach, Phuket, Thailand. (A–C) Food pellets; (D) Fragments of the red alga *Hypnea* sp., extracted from the pellets.

(James *et al*. 2018). Stage I generally occurs about a few months after gamete release. Most of the cells were storage cells, while reproductive cells were inconspicuous (Fig. 4A, B). In stage II, reproductive cells were distinctly formed at the middle of the gonad. Toward this stage, both reproductive and storage cells increase in size and number (Fig. 4C). During stage III, reproductive cells dominated the center of the gonad tissue, meanwhile storage cells decreased in proportion to the reproductive cells (Fig. 4D).

DISCUSSION AND CONCLUSION

The presence of the red alga *Hypnea* sp., in food pellets of the blue-spotted sea urchin, as well as the floating masses of the red algae at that period (Fig. 6) (MGR Online 17th March, 2021), motivates us to propose that the blue-spotted sea urchin came to feed on the red algae before 5.00 A.M. During 5.00–6.00 A.M., the sea level decreased greatly, probably faster than the locomotion of the sea urchins, so that they were trapped on the beach above the sea level. Thus, this probably caused the blue-spotted sea urchin aggregation along Patong Beach (MGR Online 17th March 2021). Our results support the hypothesis of aggregation for feeding.

If the hypothesis of aggregation for reproduction was correct, the result should have contained a high proportion of mature gonad development (stage IV) or late (stage III). However, our histological results revealed three stages of the gonad tissue including 2 specimens with stage I (post spawning), 1 specimen with stage II (growth of storage cells), and 1 specimen with stage III (development of reproductive cells). Therefore, the hypothesis of aggregation for reproduction as a possible cause of the mass occurrence of the blue-spotted sea urchin was rejected.

Our result suggested that mass occurrence of blue-spotted sea urchin (*Astropyga radiata*) on Patong Beach, Phuket on 2nd March, 2021 possibly due to aggregation behavior for feeding on red algae, *Hypnea* sp.

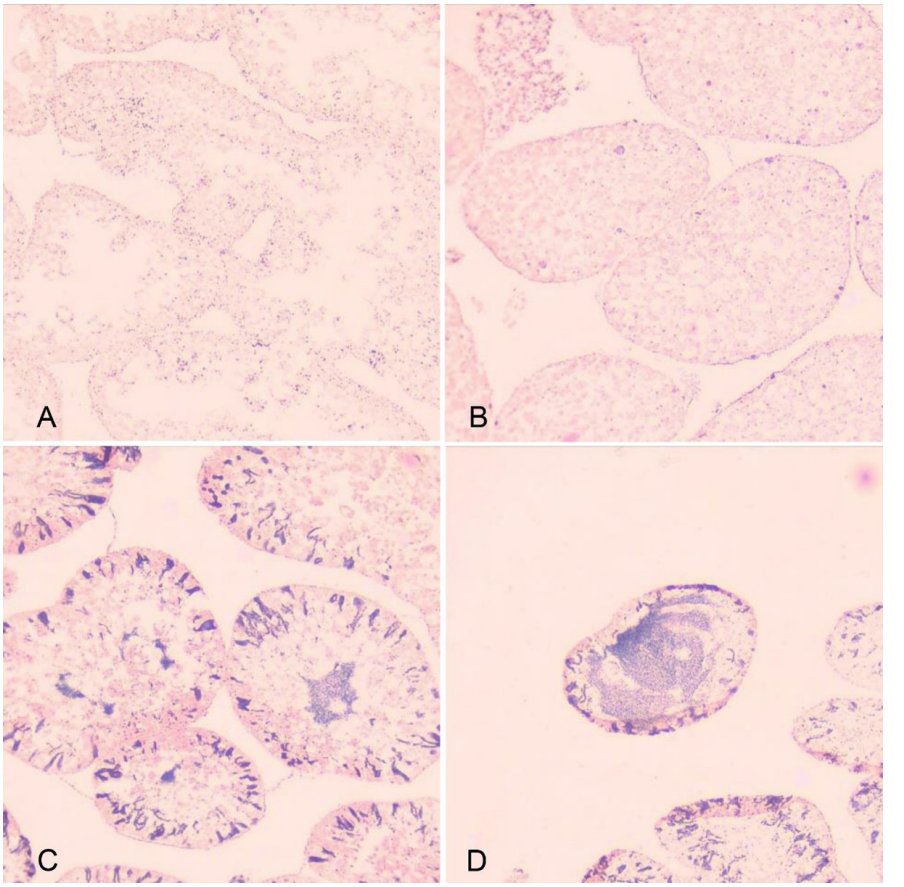

Figure 5. Developmental stages of the gonads of male *Astropyga radiata*. (A, B) Stage I: post spawning (2 specimens), (C) Stage II: growth of storage cells (1 specimen), (D) Stage III: Development of reproductive cells (1 specimen).

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Figure 6. Accumulated algae along the shore photographed at 12.00–13.00 P.M. (Left top picture: Patong Development Foundation, and Patong Baywatch Team).

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