

Life and Death at Chek Jawa

Text and photographs by **Loh Kok Sheng**

Chek Jawa is a rare jewel in the the eastern coast of Pulau Ubin, an off-shore island northeast of Singapore, its coastal habitat encompasses six rare ecosystems. This unique intidal environment narrowly escaped destruction by reclamation, but now is plagued by a mysterious mass die-off of its residents. Loh Kok Sheng gives some insights as to what might have happened. A last-minute rescue of Chek Jawa...

I can still recall the moments of trepidation that had nature lovers at the edge of their seats, just before it was announced that Chek Jawa would be deferred from reclamation. The statement was made at the very last minute, and brought to close weeks of desperate rallying for public support. With more than 1,000 people visiting this intertidal flat on a single day, Chek Jawa set a precedence in Singapore to be the first nature site to receive so much attention. Indeed, with its high biodiversity and six ecosystems, Chek Jawa has earned a special place in the hearts of many Singaporeans (*Figure 1*).

Mass die off-January 2007

The high profile success story of saving a piece of nature was eventually followed by years of peaceful conservation. Unfortunately, nobody could have predicted a mass die-off that would vastly change the once densely populated landscape of Chek Jawa.

What happened after a period of exceptional high rainfall in January 2007 marked the beginning of any nature volunteer's nightmare. We discovered a large range of distressed or already dead marine animals (*Figure 2*). As the smell



Figure 1. Chek Jawa is lauded for its high biodiversity with six distinct ecosystems (clockwise from top left: coral rubble, sandy shore, seagrass lagoon and mangrove). The other two ecosystems are coastal hill forest and rocky shore. Photograph credits: Ria Tan (www.wildsingapore.com) and N. Sivasothi.

of death permeated the air, the scene was heartbreaking to witness.

Prominent marine animals such as carpet anemones (*Stichodactyla haddoni*) looked distorted, bloated, or had already disintegrated into many pieces. Ball sea cucumbers (*Phyllophorus* sp.) that usually burrow under the sand

had surfaced looking like deflated ping pong balls. It was the first time we could see so many sea cucumbers above the sandbar-but they were all dead. Even the magnificent knobbly sea stars (*Protoreaster nodosus*) were not spared-the dead and decaying were strewn across the shore (*Figure 3*).



Figure 2. Mass die-off at Chek Jawa in January 2007 where many dead and dying bodies of marine animals were strewn over the intertidal flat. Photograph credit: Ria Tan

Lim (1984) revealed in his hydrological study that the waters surrounding Chek Jawa are seasonally subjected to salinity depressions due to freshwater flooding from Johor River, especially during the monsoon months of December and January.

What exactly caused the mass die-off?

Among the various questions raised, the most frequent was ‘what caused the mass die-off?’ Many nature enthusiasts believed it had to do with the heavy rains and flooding events that took place immediately before. Lim (1984) revealed in his hydrological study that the waters surrounding Chek Jawa are seasonally subjected to salinity depressions due to freshwater flooding from Johor River, especially during the monsoon months of December and January.

Around 17-20 December 2006 and 11-14 January 2007, freshwater input was particularly intense. Many flooding events occurred in different parts of Malaysia and Singapore with reports of widespread damage and disruption.

Cumulative rainfall level showed a surge of 350 mm for each of those



Figure 3. Clockwise from top left, dying carpet anemones, sponges and echinoderms in January 2007. Photograph credits: Ria Tan and Ron Yeo

months. The Johor River water level heights for 18-20 December 2006 described a regular fluctuation which corresponded to low and high tides; but on 19 December the water rose steeply up to a very high level of 6.57 metres, and possibly higher by 21 December 2006. Although river water level data were not available for January 2007, a similar rise probably occurred, corresponding to another rainfall surge of 350 mm in that month.

Dr Wong Poh Poh, an expert in coastal geomorphology with the Department of Geography, National University of Singapore, suggested that land reclamation at western Pulau Tekong could have narrowed the channel of the Johor Straits, leading to an increase in velocity towards the direction of Chek Jawa. Hajisamae and Chou (2003) and Koh and Lee (2006) stated in their studies that Johor Straits is lined with man-made coastal modifications, with South Johor increasingly urbanised to cater for a rapidly growing population. These changes could have caused faster runoff of freshwater into the straits, thus amplifying the intensity of salinity reduction during monsoon periods.

The evidence suggests that the mass die-off was related to the heavy rainfall in December 2006 and January 2007. The next question is whether salinity per se was the key factor that led to such a huge number of deaths?

It is possible that other factors potentially associated with flooding, such as algal blooms, changes in sea surface temperature, pollutants, disease or the lack of oxygen were responsible. Dr Dan Rittschof, Professor of Zoology from Duke University, USA, noted that the mass die-off affected mostly soft bodied animals that are unable to tolerate large salinity fluctuations due to the greater permeability of their tissues.

Because marine creatures require saline conditions to maintain their osmotic pressure, an extreme decrease in salinity will offset their osmotic balance leading to stress and, eventually, death. Animals such as crabs, periwinkles and drills are physiologically better adapted



Figure 4. The sandbar once hosted several carpet anemones, as indicated by the white arrows. After the mass die-off, no carpet anemones could be found. These pre and post-mortality photographs were used to compare differences, such as recruitment rates, over time.

to salinity changes, and this may explain why they survived. Salinity readings taken during that period revealed that the levels in the eastern Johor Straits were about six parts per thousand (ppt), almost five times less than the normal salinity levels of the Johor Straits.

The recovery

Prior to the major flood of 2007, many different varieties of exotic and common marine creatures were easily sighted by visitors of Chek Jawa. So what was Chek Jawa like after the mass die-off? I joined Dr Rittschof, Mr Sivasothi and Dr Peter Todd to investigate the state of Chek Jawa post-January 2007 and to monitor the recovery from May 2007. As part of my undergraduate project with National University of Singapore, my volunteer friends and I carried out extensive surveys to determine species diversity and abundance and recruitment patterns.

Our transect surveys did not reveal

any distinct recovery trends, except for an increasing abundance of tubeworms over time. Therefore, we conducted finer-scale studies on specifically targeted marine fauna to obtain a better picture of recovery of Chek Jawa (Figure 4).

A previous study headed by Joseph Lai, the first person to bring Chek Jawa to the public notice, indicated that carpet anemones were once abundant. He recorded an average of 112 carpet anemones ranging up to 40 cm in diameter along the transect belt studied. However, when these transects were replicated after the mass die-off, only six medium sized (~15 to 19 cm in diameter) carpet anemones were found.

Pre- and post-mortality photographs of Chek Jawa groundscapes were also analysed. Post-mortality photographs revealed a lower abundance of anemones at the sand bar, where they used to be found littered all over like sand mines. According to

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an anemone expert, Dr Daphne Fautin from the Division of Biological Sciences, University of Kansas, USA, carpet anemones can live for several centuries. With such a long lifespan, the time taken to re-build their population is also very long. Furthermore, the remaining few adult carpet anemones would possibly invest more energy into recovery and survival than reproduction.

How about the peacock anemones (Order Ceriantharia)? A drop in their abundance was also observed by Dr Rittschof after the mass die-off. When they were surveyed between October 2007-2008, an increase in the average number of peacock anemones was recorded within the transect set up to monitor their abundance and sizes (Figure 5).

Of all the echinoderms formerly common at Chek Jawa, cake sand dollars (*Arachnoides placenta*) and sand stars (*Astropecten sp.*) are the only two that

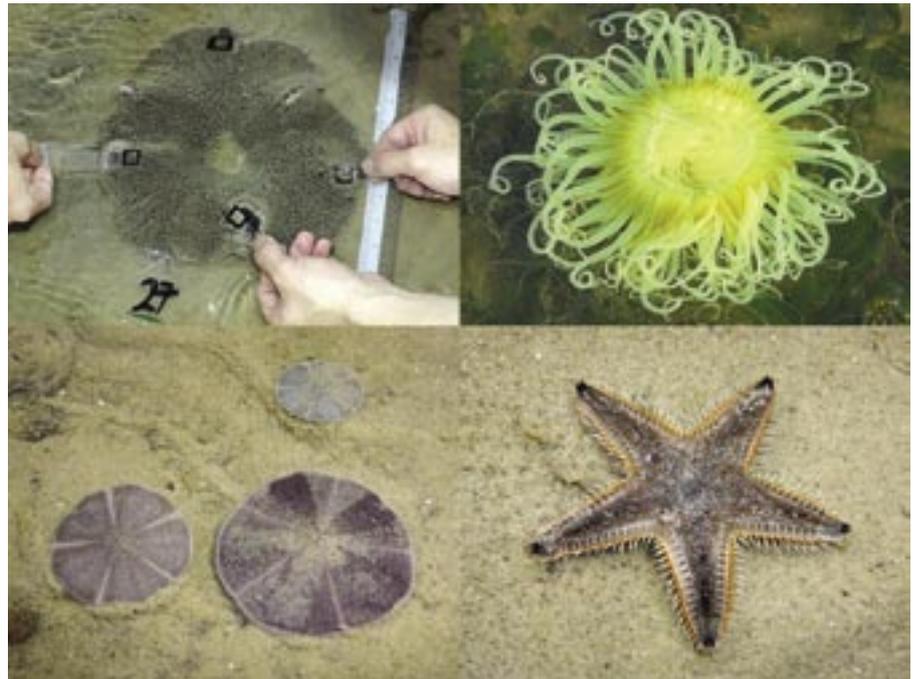


Figure 5. Marine animals surveyed: Clockwise from top left, carpet anemone, peacock anemone, sand star and sand dollars.



Figure 6. Large areas of the intertidal flat were colonised by mounds of asian date mussel beds. Circled is one of the many large black patches of the mussel bed mounds.



Figure 7. The one-centimeter long asian date mussel is a successful invasive species.

The majority of the new Chek Jawa residents are generally juvenile forms or small-sized suggesting recruitment rather than migration. The shores within the vicinity of Chek Jawa (ie Changi Beach and Pulau Sekudu) could have helped enhance larval recruitment to reseed Chek Jawa because these shores were less impacted by the freshwater surges.

remain abundant after the mass die-off and we recorded high densities across all size classes. Nonetheless, the population of the common sea star (*Archaster typicus*) seemed to have dropped dramatically. They were mostly seen disintegrating during the mass die-off and were not sighted for the following 11 months. Once found in large numbers, only five common sea stars could be located at the low-water level mark of the sand bar during a survey in December 2007. Thankfully, all is not lost, as the team found more than 20 in January 2008.

The invader-friend or foe?

During June 2007, we observed a peculiar phenomenon which has never been recorded in Chek Jawa before! Several large mounds of asian date mussels (*Musculista senhousia*) had colonised a large area of the seagrass lagoon and sand bar. These opportunistic creatures possibly require significant disturbances, such a big mortality event, during which there is low inter-species competition that facilitates successful invasion (Figure 6, 7).

Although each individual mussel is no bigger than a fingernail, collectively, they can impact Chek Jawa in various

ways. Not only will the mussel beds be able to dominate and exclude native species by aggregating in large numbers, they can also restrict growth of seagrass at the lagoon. Although it might seem like these mussels are the enemy, the byssal mats do in fact provide additional habitat for other species such as snails to settle on.

A bi-monthly study to measure the area covered by mussel beds showed a peak in December 2007 and a subsequent decline in January 2008. By August 2008, we could not find any living mussels at all. Such a disappearance of the once extensive mussel population suggests the possibility that with the recovery of Chek Jawa is in progress. Preliminary diet studies of sand stars from Changi suggest that they feed on the mussels, and this could account for their decrease in abundance.

What is the future for Chek Jawa?

After more than two years, Chek Jawa appears to be recovering slowly and steadily from the mass die-off. Even though the abundance of certain species such as sand dollars and sand stars are almost as high as before, species like the

carpet anemones presently only represent ~10% of their previous abundance.

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Chek Jawa is now a designated protected area and hopefully this will enhance natural recovery. Our surveys provide some insights into the mass die-off in Chek Jawa, as well as the stability and fragility of the ecosystems represented there. This is not the end of Chek Jawa's story. As I continue my monitoring and studies of Chek Jawa, I hope to witness the return to its previous high diversity and abundance of charismatic marine creatures. The mass die-off of marine life at Chek Jawa emphasises the vulnerability of intertidal systems and the need to protect what is left of our shores. 🌿



Figure 8. Marine life that can still be found at Chek Jawa.

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