Unexpectedly High Sea Urchin Diversity in Hou-Bi-Hu Lagoon, Southern Taiwan

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Hou-bi-hu Lagoon (HBHL, 120°44'50.83"E, 21°56'49.43"N), located inside Kenting National Park (KNP), is a small reef lagoon in southern Taiwan with an area of only 0.33 km^2. In 2002, 500 artificially fertilized and raised hairy urchins, *Tripneustes gratilla* (Linnaeus 1758), with an average wet weight/per individual of 25.2 g, were released into the lagoon. The HBHL was then declared a protected area by Kenting National Park in 2003 (Chao 2006). *Tripneustes gratilla* is a common sea urchin in the shallow waters of Indo-West Pacific reefs, and a keystone species that consumes algae in reefs (Clark and Rowe 1971). The food eaten by T. *gratilla* varies with its habitat (Lawrence and Agatsuma 2001); it mainly eats macroalgae, crustose coralline algae, and sand containing macroflora (Ogden et al. 1989). Although formerly abundant in southern Taiwan, the hairy urchin has become rare due to overharvesting. Before the release, almost no hairy urchins could be found in the HBHL due to collection by local fishermen.

The substrate of the HBHL is smooth and shallow, and is mainly composed of sand and fragments of coral debris. The tidal range is 0.5~3.0 m at the spring tide. Living corals are sparse in the lagoon. The round mass coral *Porites lutea* and branching coral *Porites nigrescens* are the most common corals on the substrate. HBHL is protected seawards by an outer reef, so waves and currents inside the lagoon are weak, making this habitat suitable for the hairy urchin and other urchins. After protection for 7 years, the hairy urchins are abundant in the lagoon (Fig. 1).

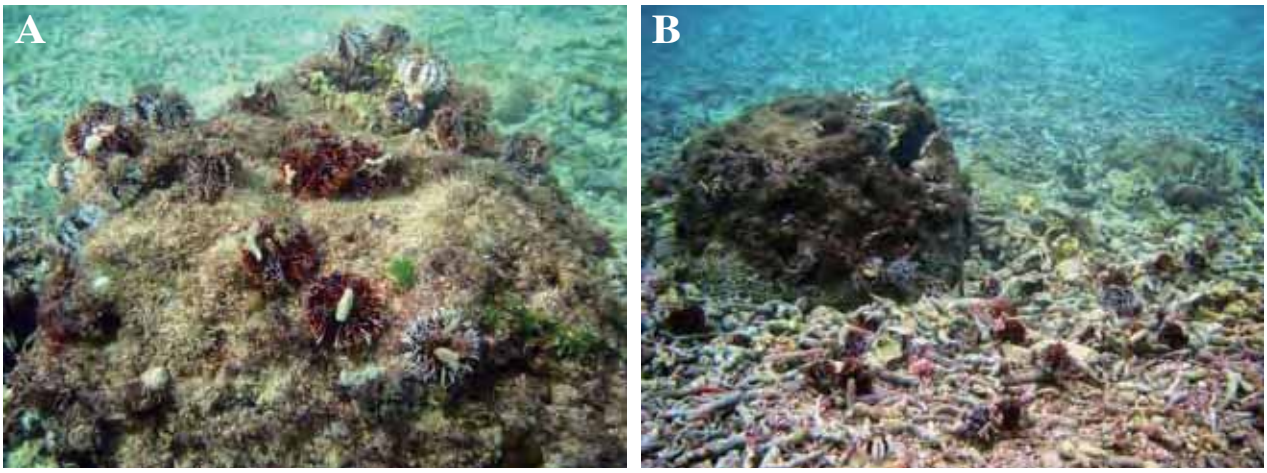

Fig. 1 The hairy urchin *Tripneustes gratilla*. A, B. High density of the hairy urchin in Hou-bi-hu Lagoon.

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In June 2010, four 10 x10-m quadrates in areas with high urchin concentrations were randomly established to calculate densities of the hairy urchin. The density was 30.5 ± 8.7 individuals/100 m^2. In addition, 17 species of other urchin species were recorded in the lagoon

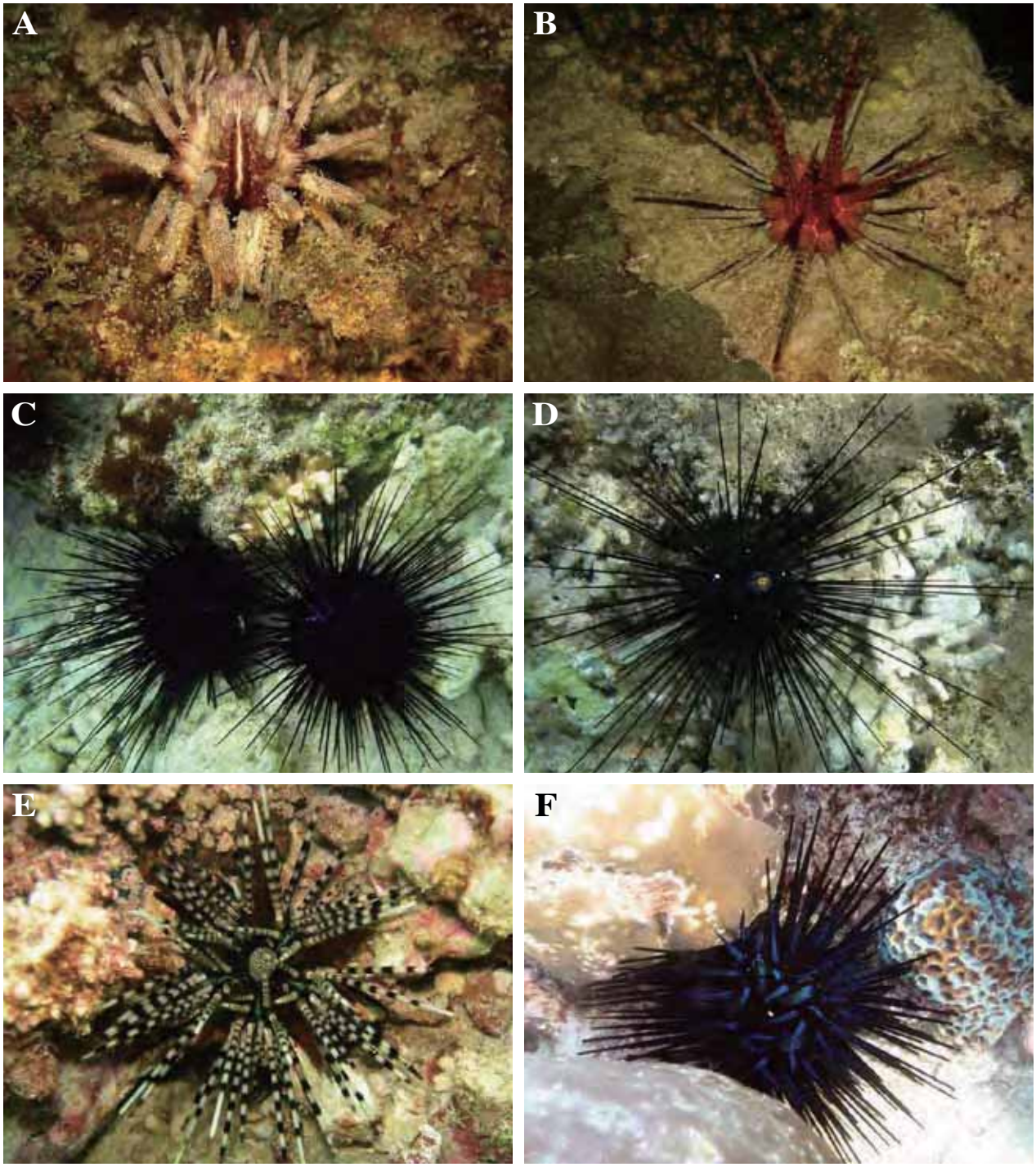

Fig. 2.
A. *Eucidaris metularia*; test diameter, 3.5 cm.
B. *Prionocidaris baculosa*; test diameter, 6.5 cm.
C. *Diadema savignyi*; test diameter, 7.0 cm.
D. *Diadema setosum*; test diameter, 6.5 cm.
E. *Echinothrix calamaris*; test diameter, 6.5 cm.
F. *Echinothrix diadema*; test diameter, 6.5 cm.

(Figs. 2-4). To date, 23 species of urchins have been recorded from KNP (Chao 2005), and 78% (18 species) were found in HBHL (Table 1), suggesting that this lagoon is suitable for sea urchin conservation, especially of the hairy urchin.

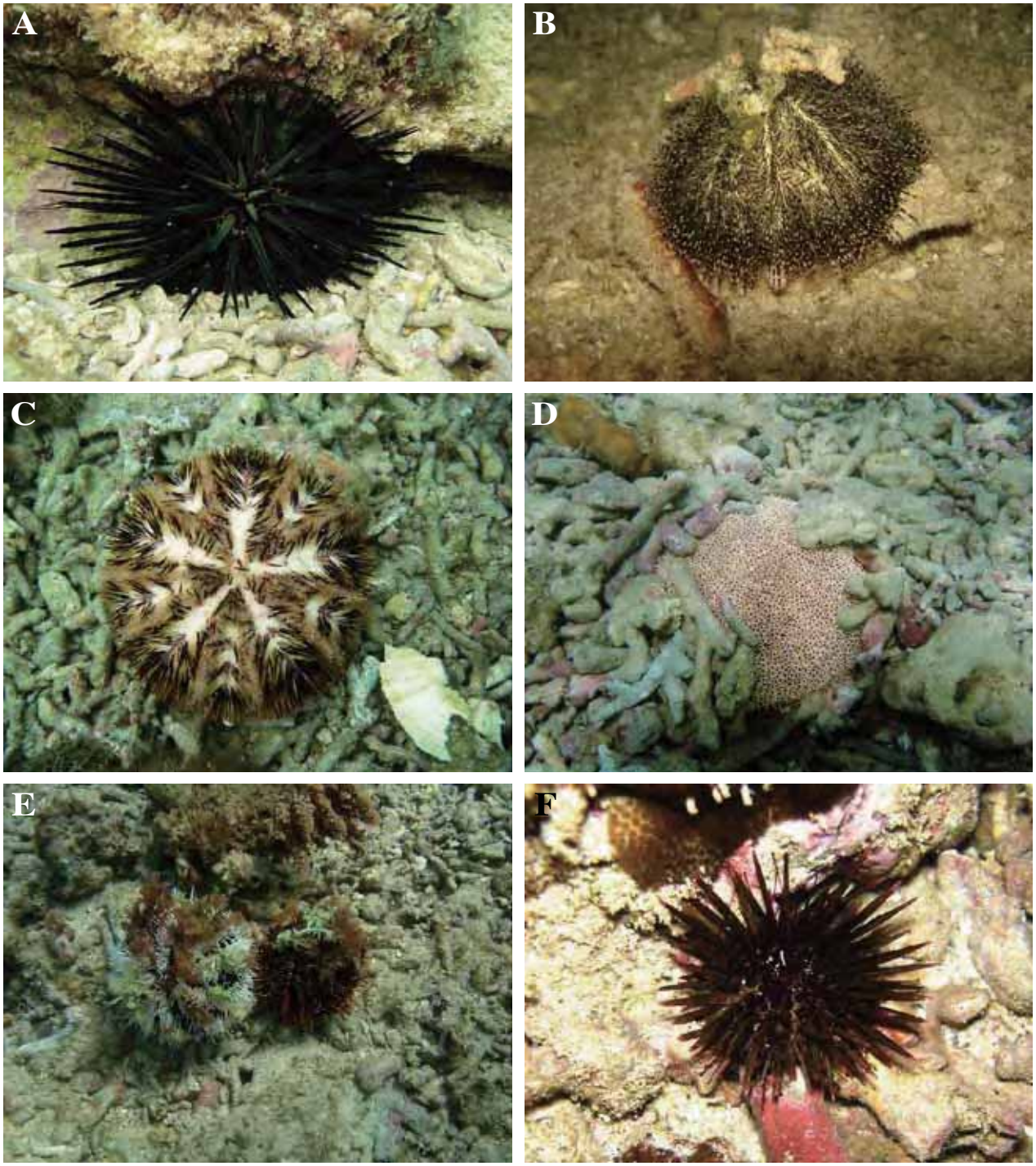

Fig. 3.
A. *Stomopneustes variolaris*; test diameter, 7.0 cm.
B. *Salmacis sphaeroides*; test diameter, 7.5 cm.
C. *Pseudoboletia maculate*; test diameter, 9.0 cm.
D. *Toxopneustes pileolus*; test diameter, 12.0 cm.
E. *Tripneustes gratilla*; test diameter, 9.0 cm.
F. *Anthocidaris crassispina*; juvenile, test diameter, 2.5 cm.

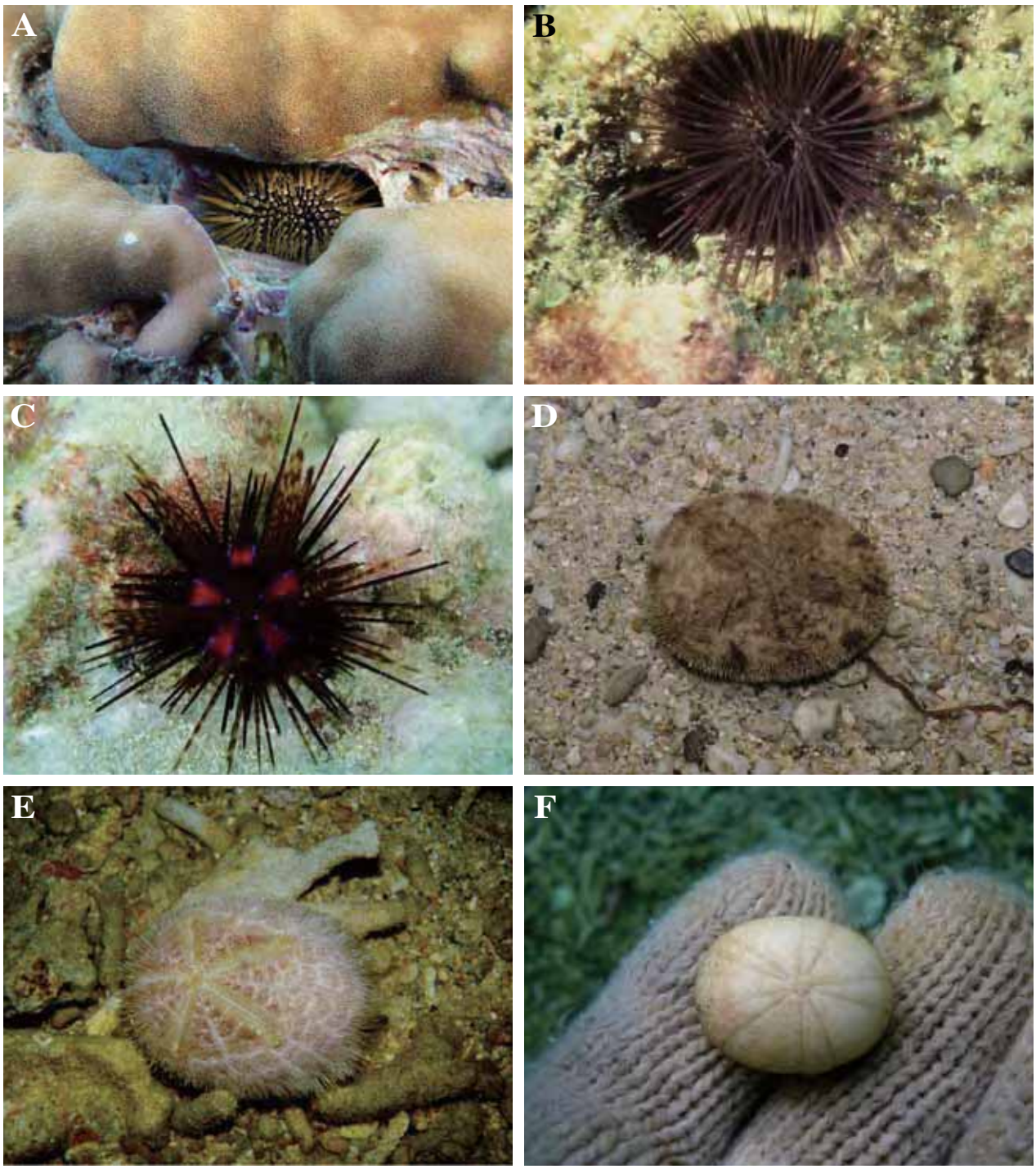

Fig. 4.
A. *Echinometra mathaei*; test length, 5.0 cm.
B. *Echinostrephus molaris*; test diameter, 2.5 cm.
C. *Astropyga radiate*; test diameter, 1.5 cm.
D. *Clypeaster reticulates*; test length, 5.5 cm.
E. *Brissus latecarinatus*; test length, 5.0 cm.
F. *Echinoneus cyclostomus*; test length, 3.0 cm.

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Table 1. Sea urchins of Kenting National Park, Taiwan, and those found in Hou-bi-hu Lagoon

Taxa	Hou-bi-hu Lagoon
Echinoidea 海膽綱	
Cidaroida 頭帕目	
Cidaridae 頭帕科	
**Eucidaris metularia* (Lamarck, 1816) 冠棘眞頭帕	+
**Prionocidaris baculosa* (Lamarck, 1816) 環鋸棘頭帕	+
Diadematoida 冠海膽目	
Diadematidae 冠海膽科	
Astropyga radiata (Leske, 1778) 星肛海膽	+
Diadema savignyi (Michelin, 1845) 沙氏冠海膽	+
Diadema setosum (Leske, 1778) 刺冠海膽	+
Echinothrix calamaris (Pallas, 1774) 環刺棘海膽	+
**Echinothrix diadema* (Linnaeus 1758) 冠刺棘海膽	+
Arbacioida 皇冠海膽目	
Stomopneustidae 口鰓海膽科	
Stomopneustes variolaris (Lamarck, 1816) 口鰓海膽	+
Echinoida 海膽目	
Temnopleuridae 刻肋海膽科	
Mespilia globules (Linnaeus, 1758) 高腰海膽	−
**Salmacis sphaeroides* (Linnaeus, 1758) 雜色角孔海膽	+
Toxopneustidae 毒棘海膽科	
Pseudoboletia maculata Troschel, 1869 斑蘑海膽	+
Toxopneustes pileolus (Lamarck, 1816) 喇叭毒棘海膽	+
Tripneustes gratilla (Linnaeus, 1758) 白棘三列海膽	+
Echinometridae 長海膽科	
**Anthocidaris crassispina* (A. Agassiz, 1863) 紫海膽	+
Echinometra mathaei (de Blainville, 1825) 梅氏長海膽	+
Echinostrephus molaris (de Blainville, 1825) 紫叢海膽	+
Heterocentrotus mammillatus (Linnaeus, 1758) 石筆海膽	−
Holectypoida 全雕目	
Echinoneidae 斜海膽科	
Echinoneus cyclostomus Leske, 1778 卵圓斜海膽	+

Table 1.

Taxa	Hou-bi-hu Lagoon
Clypeasteroida 盾形目	
Astriclypeidae 星盾海膽科	
Astriclypeus manni Verrill, 1867 曼氏孔盾海膽	−
Clypeasteridae 盾海膽科	
Clypeaster reticulatus (Linnaeus, 1758) 網盾海膽	+
Fibulariidae 豆海膽科	
Fibularia ovulum Lamarck, 1816 卵豆海膽	−
Spatangoida 猥團目	
Brissidae 壺海膽科	
Brissus latecarinatus (Leske, 1778) 脊背壺海膽	+
Spatangidae 猥團海膽科	
Pseudomaretia alta (A. Agassiz, 1863) 海蟬	−

"+" Indicates its presence in the lagoon; "–" indicates its absence from the lagoon; "*" indicates a new record for Kenting National Park.

台灣南端後壁湖潟湖內高多樣性的海膽

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本短文報導台灣南端後壁湖潟湖內高多樣性的海膽，此潟湖位於墾丁國家公園海域範圍內，面積僅0.33平方公里，在2003年被墾丁國家公園管理處劃設為海膽保護區，經過近7年嚴格禁止採捕及保育，潟湖內海膽種類及數量豐富，經濟種白棘三列海膽的密度在2010年6月在密集區達30.5+8.7/100 m^2。潟湖內目前已記錄到18種海膽，佔了墾丁海域海膽的78%，墾丁海域共記錄23種海膽。本研究顯示此潟湖非常適合作為海膽保護區，特別是白棘三列海膽。這18種海膽的彩色圖片亦呈現在本文中。

關鍵詞：棘皮動物，海膽，潟湖，台灣。