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# Landing history of 'urus' and its influence on the bird ecosystem in Dongdao Island, Xisha Islands of South China Sea

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## ABSTRACT

The Dongdao Island of Xisha Islands is an epitome of the island eco-system of South China Sea, and red-footed booby (*Sula sula*) and *Pissonia grandis* are typical species of the island community. However, a large herbivore 'urus' (actually cattle) is now threatening the survival of other species. We analyzed the lithology, as well as organic carbon and nitrogen concentration and isotopes of the sediment core DY2 sampled from the 'Cattle Pond' of Dongdao Island, Xisha Islands. Combined with the isotope results of modern cattle and seabird droppings, we identified the eco-geological characteristic of the 'urus'. According to the AMS<sup>14</sup>C dating of the lumpy cattle excreta and charcoal on the interface layer, we determined the landing time of 'urus' and identified a population booming after the landing as shown in the isotope profiles. The 'urus', actually cattle, is a special species in the whole island eco-system, but it could disrupt the offshore ecosystem irreversibly; therefore 'urus' population needs to be controlled on a proper level. This research proposed a possible method to study the history of invasive species.

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## 1. Introduction

Xisha Islands (Paracel Islands, 15°47'–17°08'N, 111°10'–112°55'E), located in the north of South China Sea (SCS), is part of the western Pacific warm pool (Deser and Wallace, 1990; Yan et al., 2011a). The islands are mainly derived from coral reefs. Modern climate observation of Xisha Islands shows a typical tropical marine monsoon climate, with annual mean air temperature over 26 °C, precipitation of 1500 mm and evaporation capacity of 2400 mm per year. During the past decades, Xisha Islands is always one of the important research sites for the study of ecology and climate change. Since Sansha City was established in Xisha Islands in 2012, Xisha Islands has been subject to increasing attention around the world. Early field work focused on macrobiology, but in recent days, sequential observation systems for both creatures and climate were built (Exploration Group of Xisha Islands of Institute of Soil Science of Chinese Academy of Sciences, 1977, Zhao, 1996, Hainan Ocean Administration, 1999). Using the high-resolution profiles of oxygen isotope and other indexes of coral or tridacna, we have reconstructed detailed climate and environment information of SCS down to the Quaternary, especially the Holocene (Yan et al., 2013, 2014; Deng et al., 2014).

The sediment of the Cattle pond in Dongdao Island provided important materials for the hydrological reconstruction and the study of climate system variations (Yan et al., 2011a, 2011b). Xisha Islands mainly consists of coral islands and has unique but fragile island eco-system far from the land. However, massive coral mortality events have been observed in recent years, likely a sign of global warming (Yu et al., 2012).

Dongdao Island (Lincoln Island) is one of the typical islands of Xisha Islands, with a land area of 1.55 km<sup>2</sup> and an elevation of about 5 m. Guano-phosphate ore was abundant on the surface before, but has been mined during 20th century. The island's east, south and west are surrounded by sand barriers, its northern shores has some beach rock and *Tridacna*, and its central area is mainly covered by *Pisonia grandis* woodland. In the woodland, there are black phosphoric soils and a large number of birds, especially some rare species such as red-footed booby. The status of these seabirds is not optimistic according to the recent observations (Cao et al., 2005). A little pond called 'Cattle Pond' in the southeast of the island contains sediments. The geochemical evidence and palaeo-environmental record from the sediments inferred the changes of seabird population and related eco-system along the past 1800 years (Liu et al., 2006b, 2008). And the extraordinary sand layers in the sediments together with heavy coral and shell fossils far into the island suggested a large tsunami around 1024 CE (Sun et al., 2013).

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There is also a group of wild cattle or “urus” living in the central forest of the island of the Dongdao Island. This non-original species has a dominated effect on the eco-environment of the whole island. In this paper, we report the landing history of the ‘urus’ and discuss its impacts on the eco-system of the Dongdao Island.

## 2. Material and methods

### 2.1. Sample collection

Xisha Islands is located in the northwest part of the South China Sea and consists of a large proportion of coral islands. It has wet warm summer and dry cold winter due to East-Asian Monsoon (Hainan Ocean Administration, 1999). The study area Dongdao

Island is in the northeast of Xisha Islands, and its eco-environment is in good condition. Red-footed booby (*Sula sula*), other seabirds, and so called ‘urus’ (cattle) spread over the central part of the island in the forest of *Pissonia grandis* and multiple shrubs. A crescent-shaped pond inside the sand barrier in the southeast of the land is named as ‘Cattle Pond’ because the ‘urus’ is drinking water there. The ‘Cattle Pond’ is 150 m long and about 10 m wide; it expands into 2000 m<sup>2</sup> in the summer and nearly dries up in the winter (Fig. 1).

We collected a sediment core DY2 in the central part of the ‘Cattle Pond’ using a PVC pipe in 2003. It’s 126 cm long. Field observation indicated that the layers changed significantly and the grain was clear and not disturbed. The surface layer of 25 cm was black and enriched with organic matters. Cattle and birds

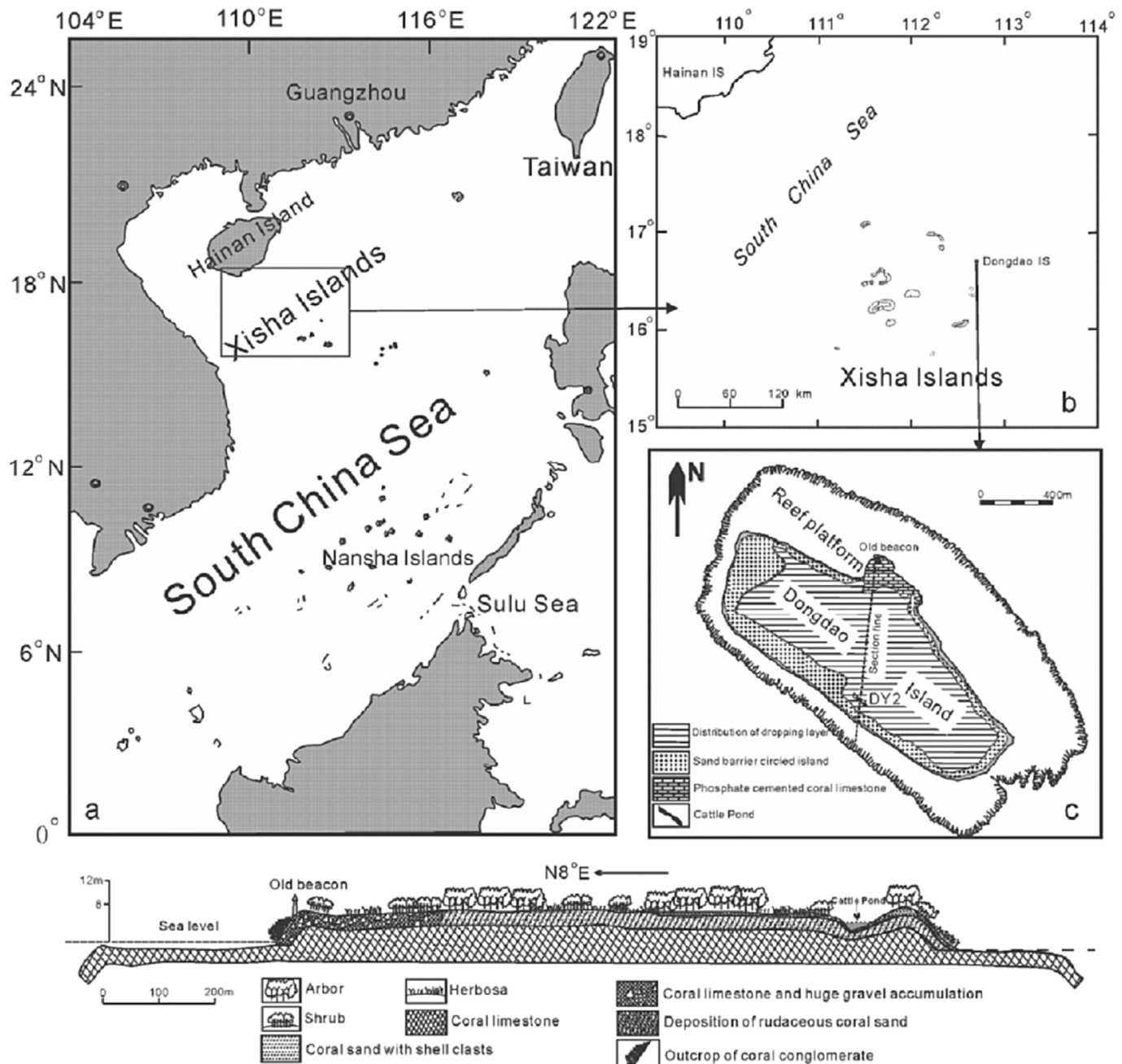


Fig. 1. Maps of the location of the Xisha Islands (a), the Dongdao Island (b), the sampling site of DY2(c) and the distribution of morphological zones. The section drawing of the marked section line from old beacon to Cattle Pond in Figure (c) is at the bottom. Revised from Liu et al. (2006b).

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