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TANGLE NET FISHING, AN INDIGENOUS METHOD USED IN BALICASAG ISLAND, CENTRAL PHILIPPINES

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ABSTRACT. **–** Tangle nets set in deep water on steep cliffs off the Philippine island of Balicasag have obtained numerous interesting species in recent years. A detailed description of the fishing gear and its use, as observed in Balicasag Island, central Philippines, is provided. Tangle net fishing has been shown to efficiently collect specimens from areas that cannot be easily sampled using conventional gear such as trawls and dredges. Tangle nets, therefore, can be used to complement other methods during marine biodiversity surveys.

KEY WORDS. **–** Tangle net, Balicasag, Philippines, Brachyura, biodiversity.

INTRODUCTION

The rich species diversity of the marine environment is well documented. Even in the deep-sea, the diversity has been found to be much higher than originally expected (see Bouchet, 2006). As we increase our explorations, it has become obvious that there are in fact many "cryptic marine habitats" that boast of a high diversity, but for various reasons, have been poorly sampled, and as such, their diversity, substantially under-appreciated.

Through colleagues in malacology, the authors have been aware of an island in the Philippines, Balicasag, which has been the source of many new and/or rare species of gastropods, many of very high commercial value, for over a decade. In early 1999 and 2000, the first author had discussions with Lawrence Liao, then of the University of San Carlos in Cebu, as well as Father Florante Camacho, President of the Holy Name University in Bohol, about trying to better document the brachyuran fauna for the islands of Panglao and Balicasag in Bohol. Some years earlier, Tomoki Kase from the National Science Museum in Tokyo, had also been doing malacological work there (e.g., see Kase & Ishikawa, 2003; Wani, 2004; Wani et al., 2005), and also found that the fishermen in the area were bringing up many interesting crustaceans and molluscs. In fact, the first paper on the crab fauna there was by Kase's Japanese carcinological colleague, Masatsune Takeda and the third author, who reported on a large number of rare and interesting species (Takeda & Manuel, 2000). In 2002, the first author, together with Lawrence Liao, reported on a remarkable new species of pseudoziid crab from the same island (Ng & Liao, 2002). Between the Philippine, Japanese and Singaporean scientists, and more recently with the French, many new species of crustaceans have been discovered from this Island (see below).

The wealth of new and rare crustacean species from Balicasag Island compelled the present authors to try and understand the reasons for this. Through interviews with the fishermen, visiting the site and working with them over the last eight years, we now understand why the richness is so unexpected and why their fishing methods are so successful.

THE ISLAND OF BALICASAG

Balicasag is situated about 8 km (4 nautical miles) southwest of Panglao Island, which in turn is off the southwestern tip of Bohol Island, one of the major islands (together with Panay, Negros, Cebu, Samar and Leyte) comprising the Visayas, the central region of the Philippines (Fig. 1). Bathymetric studies (conducted during the Panglao 2005 deep-sea survey, see Richer de Forges et al., 2005) show that Balicasag Island is the exposed peak of an underwater hill rising from a depth of about 700 m. Interestingly, the western portion of Balicasag Island is on the edge of an underwater cliff, with a steep vertical gradient within a short horizontal distance from the shore (Fig. 2).

The steep reef slope below depths of 100 m is one of the many "cryptic marine habitats" for which little is known (see Dennis & Aldhous, 2004; Ng, 2007). They cannot be reached by SCUBA divers, and even with special rebreather devices, there are still very severe restrictions on dive-time and depth that can be reached. This steep and often very rocky habitat also cannot be dredged or trawled effectively or at all due to the steep gradient (inclined ca. 45° or more from the horizontal). Some trapping has been done, but this has yielded mixed results as they tend to capture mainly larger carnivorous or scavenging species. Modern submersibles can easily reach these habitats, but collecting cryptic and/or faster moving animals remains problematic. Nevertheless, this vertical drop-off apparently hosts a large variety of marine life, which the locals have exploited to their benefit.

THE USE OF TANGLE NETS

In a paper on dromiid crabs in which they reported on many rare and new species, McLay & Ng (2004: 4) made the following observation about the fishermen at Balicasag:

> "The fishermen in these islands use tangle nets set at depths ranging from 10–400 m to collect gastropod shells for the trade. These nets, which may be 50 to 100 m long, are normally left for several days prior to retrieval. On retrieval of the nets, the valuable shells are separated and the by-catch is sorted. Crustaceans and echinoderms are preserved in alcohol or formalin, with the larger specimens dried and mounted; and these are sold to tourists as curios when they visit. Most of the crab material reported here are from these

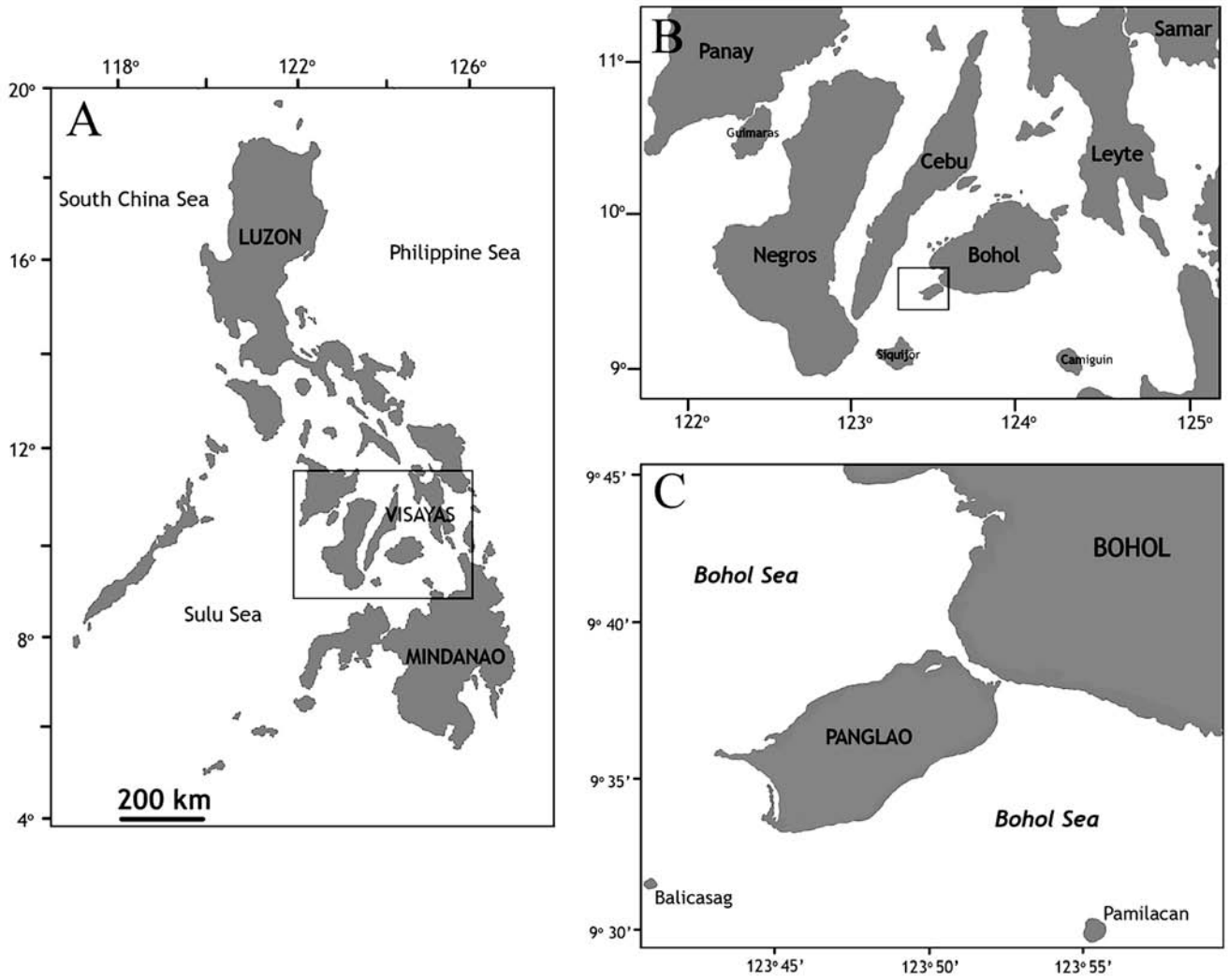

Fig. 1. Maps of: A, the Philippines, box-area: Visayas; B, the Visayas islands, central Philippines, box area: southwest Bohol and nearby islands; C, southwest Bohol, Panglao, Balicasag and Pamilacan Islands.

preserved by-catches. The reef shelf itself on Balicasag is narrow (ca. 100–150 m), and on the northwestern side of the island, the shelf drops off abruptly to depths of 300 to 400 m. It is normally very difficult to collect on these steep sea-cliffs: divers are limited to relatively shallow depths and the vertical walls cannot be effectively dredged or trawled. Previously, only traps have been able to obtain specimens from such a habitat. The use of tangle nets is thus a novel way to sample the rich animal life occurring here and many interesting taxa have been reported thus far... The fishermen at Balicasag fish in a more or less ad-hoc manner, although some do specialize in working in deeper waters (greater than 200 m, for those who have the long nets and winches), with most of the others focusing on shallow waters. Their by-catches are, however, accumulated over many months, and as such, it is often difficult to determine specific capture depths. Based on fishermen's individual catches, talking to them about their fishing methodologies, consideration of other diagnostic deep-water species (echinoderms and fish), and examining their gear, we have been able to make estimates on depths on some occasions."

Tangle nets have in fact been in use by the fishermen of Balicasag Island for decades. This indigenous fishing method has primarily been designed for catching benthic marine life, particularly molluscs and crustaceans, for food and the collectors' trade.

DESCRIPTION OF FISHING METHOD

The tangle nets are made of thin, light nylon netting material, black or colorless, with a mesh size of about 2.5 cm square, which is suspended on two 5-mm thick, yellow or blue nylon ropes serving as the upper and lower edges of the net. The dimensions of a single, rectangular net are

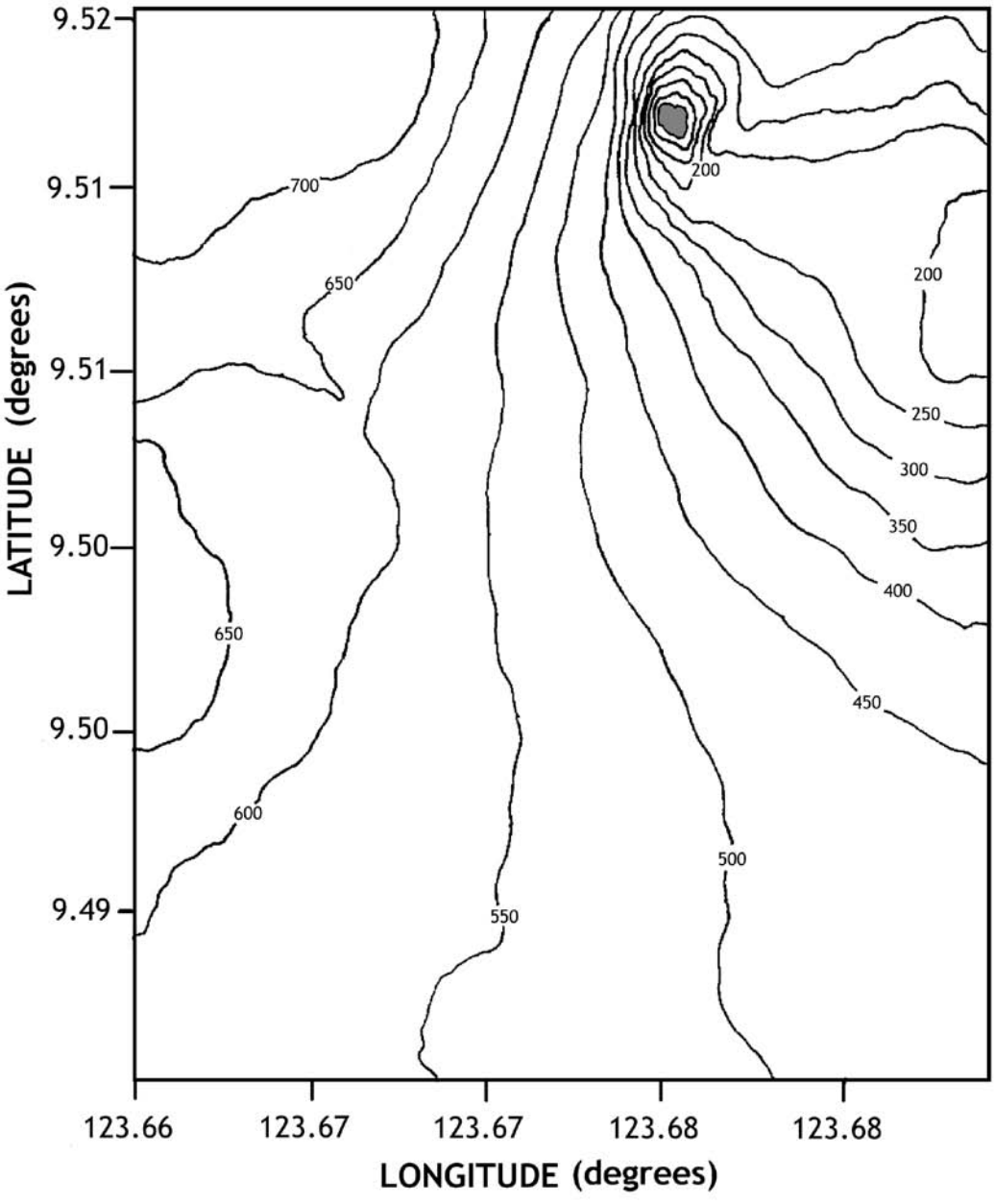

Fig. 2. Bathymetry of seas around Balicasag Island (in grey). Adjacent contour lines represent change of 50 m in depth.

usually about 1 m in height and about 50 m in length. They can, however, be connected together to form longer nets as necessary or desired. Small lead or ceramic sinkers are attached onto the nylon rope on the lower edge of the net at regular intervals.

To deploy the net, one end is weighed down by a rock attached to a guide rope, which is continuous with the rope forming the lower edge of the net. The rest of the net is lowered by hand as the fisherman's boat moves slowly along a line projected by the fisherman. The other end is connected by a very long lead rope to a large plastic or styrofoam buoy. The buoy basically marks the position of the net and aids in the location and retrieval of the net, it does not aid in the flotation of the net. With the lead rope, the net can be deployed to depths of 50 to 500 m.

While many of the fishermen deploy the nets in shallow waters or in flatter areas, especially on eastern side of the island; several have mastered the necessary skills to lay these nets in much deeper waters on sharply inclined slopes on the western slope (Fig. 2). To accomplish this, the nets are initially laid vertically in the water column, away from the slope. A good deal of skillful maneuvering by the fisherman is then necessary to position the net so that it settles on the steep submerged slope (Fig. 3). The net is then left overnight but more usually for 24 to 48 hours. As crustaceans and molluscs crawl over the net, they get entangled and caught in the meshwork. The fisherman then retrieves the net by taking the buoy out of the water, and fitting one end of the lead rope onto a wooden reel mechanism mounted on the boat. The fisherman then commences to pull the net up by manually cranking the reel, and gathering the lead rope

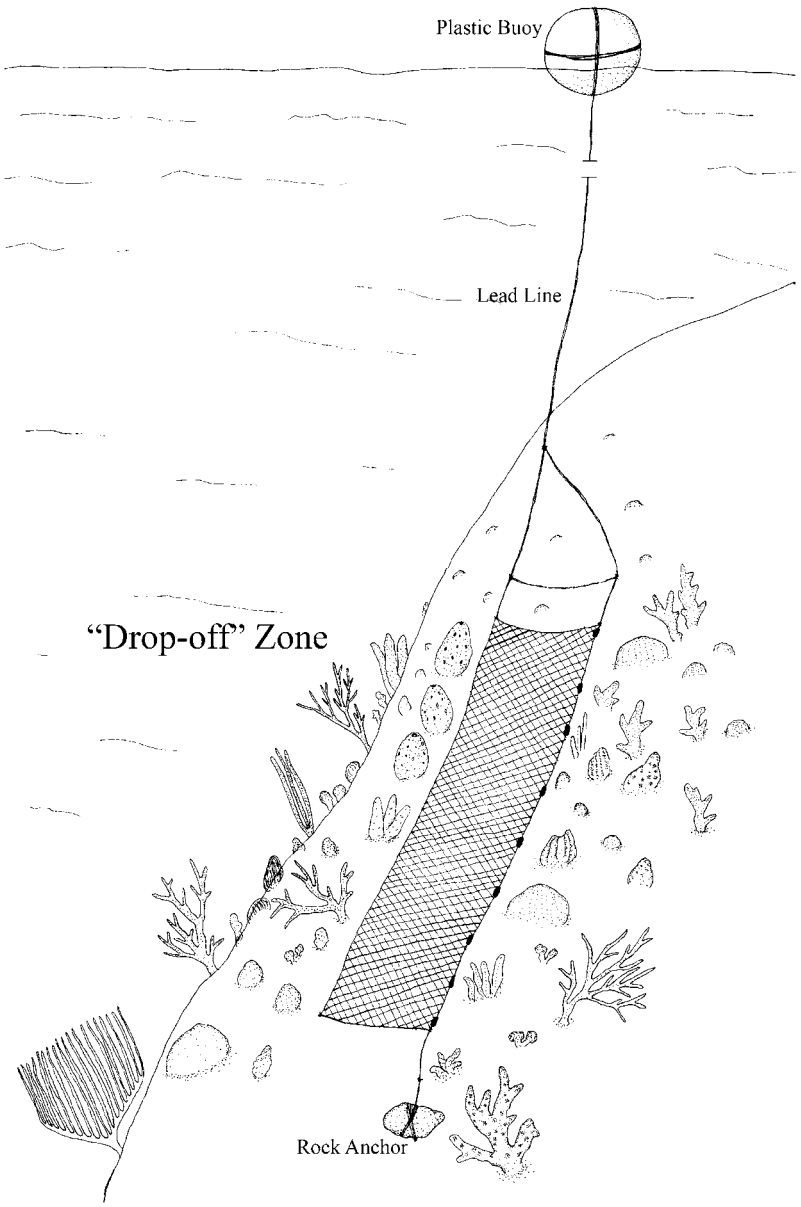

Fig. 3. Schematic diagram (not drawn to scale) showing how a tangle net is positioned against the near-vertical underwater cliff wall (drop-off zone) found near Balicasag Island.

(Fig. 4A). Sometimes, the fisherman has to maneuver the boat to untangle the net if it gets snagged in the irregular underwater terrain. Also, as the net is being dragged up gently along the slope, it may pick up additional debris and benthos along its path. Once most of the lead rope has been gathered in the reel and the leading end of the net is almost breaking the surface, the fisherman gathers the net by hand and brings it into the boat (Fig. 4B, C). It is noted that only the fishermen who specialize in fishing at greater depths utilize the wooden reel as dragging the nets up by hand is far too difficult otherwise.

The fisherman then goes back to shore to process the catch (Fig. 4D–F). A typical haul will contain intact or broken pieces of sponges, ascidians, gorgonians, crinoids and soft corals, as well as coral rock and animals at least one cm at the longest axis. All of these are removed from the net by several people (usually family members and friends), with

Fig. 4. A Balicasag fisherman at work: A, towing up the tangle net through the lead line, by means of the hand-powered, wooden reel mechanism; B and C, hauling in the net proper by hand as it breaks the water surface; D, paddling back to shore once the catch is in; E–G, untangling the catch and cleaning out the net.

a mat underneath, to catch anything that might fall off it. Any specimens caught in the net are carefully disentangled. Some specimens collected may not be entangled in the net but merely associated with large sessile corals and sponges or rocks that have been brought up; and these are also usually carefully examined.

The fishermen traditionally used these deep-set nets to catch interesting molluscs for sale to collectors. That many of these turned out to be rare or even new has fueled interest among professional malacologists and collectors alike. Only within the last decade have the fishermen also taken to keep large and/or strange deep-sea crabs, lobsters and even echinoderms. The fishermen preserve them in formalin, and then set and dry them in the sun for sale to tourists as curios. Talking to fishermen as well as shell-dealers based in Cebu (perhaps one the largest shell-trading centres in the world), some of these crustaceans have even been sold through middlemen to places as far away as Russia and the United States. It is certainly a lucrative trade.

Interviewing the various fishermen who specialize in deep-netting, they are clearly very experienced and know the terrain of the island and currents very well. They comment that it is not easy and it is only through experience that they do not lose too many nets. They are also very familiar with the fauna in the waters. Often, examining their catches, we have asked them about the depth, habitat and sometimes even behaviour of some of the rare or strange crustaceans they have brought up (often alive), and in 90% of the cases, it corroborates what we know about the species. Some species (e.g. *Cyrtomaia echinata*), they acknowledge are caught only when they set their nets very deep, near the bottom—something they rarely do as it is not only difficult but risky (see Richer de Forges, 2007a). They also know their fauna very well – easily distinguishing shallower and deeper water congeners, e.g. between *Calappa bicornis* and *Calappa ocularia*, respectively (see Ng, 2003). In a few cases, we also obtained corroboration through the species of fish and echinoderms that were preserved together with the samples.

DISCUSSION

The deep-water tangle net fishing method was developed by the fishermen of Balicasag Island to exploit the steep terrain off the western part of the island. This is a habitat that renders trawl and seine nets useless for sampling. The high degree of diversity and potential endemism seen in this area may perhaps be due to increased primary production due to nutrient-laden upwellings from the deep as seen in seamounts (see Richer de Forges et al., 2000). It is also clearly a habitat which is far richer than it has been given credit for, and has been neglected in terms of its biodiversity significance. Between 1999 and 2004, the deep-set nets from Balicasag have resulted in many major carcinological discoveries. The extensive material from these fishermen over the last few years fills up dozens of drums in the Philippine National Museum, Zoology Museum of the University of San Carlos, National Science Museum in Tokyo, and Raffles Museum in Singapore. Even up to now, not all the material has been studied. Still, what has been published has been remarkable.

Takeda & Manuel (2000) reported on dozens of new records from the Philippines. Ng & Liao (2002) described a new species of the genus *Euryozius* (Pseudoziidae), *E. camachoi*, from five specimens—the genus is otherwise represented in the Indo-West Pacific by two other species, one from the Indian Ocean and the other from French Polynesia—but in both cases, only from one specimen each! Material passed by the authors to Crosnier (2002) for his revision of the portunid genus *Parathranites* Miers, 1886, resulted in the description of two new species, *P. granosus* and *P. tuberogranosus*. While both species were also found in other countries from trawls, what surprised Crosnier was the large number of specimens of both taxa from Balicasag (in litt. to PKLN). Ng (2003) described a new species of deep-water *Calappa*, *C. ocularia* from Balicasag, as well as added five new records for the Philippines. From material sent to her by the authors, Galil (2003) described a beautifully patterned new species of leucosiid, *Euclosia scitula* Galil, 2003. Ng & Ho (2003) described a new species of deep-water goneplacoid crab, *Mathildella rubra* from the material, only the third species in the genus at that time. Ahyong (2004) reported 16 species of stomatopods from Balicasag from the fishermen's collections passed to him for study by the authors; several were new records, four were new species and one was even the representative of a new genus (*Gonodactyloideus rubrus*, *Lysiosquilla isos*, *Carinosquilla balicasag*, *Visaya lira*). Galil & Takeda (2004) described four new species of calappids just from Balicasag: *Mursia baconaua*, *M. buwaya*, *M. diwata* and *M. mameleu*, one-sixth of all known species in the genus. Komatsu et al. (2004) then reported two new species (*Raylilia intermedia* and *Tokoyo triloba*) and six new records of leucosiids from there. McLay & Ng (2004, 2005) reported many new and rare species of dromiids and dynomenids from Balicasag, inclusing two new dynomenids *Paradynomene quasimodo* and *Hirsutodynomene vespertilio*. Most recently, Takeda & Manuel reported on a new pilumnid (*Viaderiana kasei*) (2003) and many new records of Homolidae (2007) from there; whilst Castro (2007) and Tan & Ng (2007) based many new records and species of goneplacids and parthenopids respectively on the Balicasag material.

The success of the deep-set tangle nets was further exploited when it was used in a major Franco-Philippine expedition in 2004, spearheaded by Philippe Bouchet (Muséum national d'Histoire naturelle, MNHN) and Danilo Largo (USC). The Panglao 2004 Marine Biodiversity Project, became a unique multi-national initiative that surveyed the Panglao area intensively with a wide diversity of methods. In addition to Balicasag, tangle nets were used in more areas, including Pamilacan Island and Maribojoc Bay on Panglao. The authors helped to oversee the crustacean collections from this ambitious project, and the new collections substantially augmented the samples we had collected up to that time. More new and/or rare species were added. Because of the success of using tangle nets in the Philippines they were also brought to and proved useful in another similar expedition, Santo

2006, on the island of Espiritu Santo, Republic of Vanuatu in the South Pacific. Our pre-expedition material, together with the specimens from 2004, have resulted in several more major carcinological papers, viz. Ng & Castro (2007), Ng & Manuel-Santos (2007), Manuel-Santos & Ng (2007), Galil & Ng (2007), Richer de Forges & Ng (2007a–c), Chan & Ng (2008), Mendoza & Ng (2008), based on material caught by deep-set tangle nets.

This large and remarkable collection of new species and new species records serves to emphasize the strong potential of tangle nets as a tool for biodiversity research. The special nature of tangle nets allows them to be deployed in places (e.g., steep underwater slopes) where other conventional methods, such as trawl nets and dredges, cannot. Future expeditions will certainly benefit by using tangle nets in tandem with other conventional methods. In this age of fast-shrinking and increasingly threatened natural reserves, the need for biodiversity surveys cannot be emphasized strongly enough (e.g., see Dennis & Aldhous, 2004; Bouchet, 2006). Improved sampling methods can thus speed up this process of discovery before all is lost.

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