

Life to 450 m depth at Isla del Coco, Costa Rica

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Abstract: Isla del Coco is the summit of a seamount 500 km southwest of Costa Rica's mainland. The island is surrounded by a platform about 18 km long that trends in a southwest-northeast direction with a break in slope at around 180 m deep. Since 2006 the *DeepSee* submarine, with a 450 m depth capability, has been exploring the deep-water environments of Isla del Coco. Videos have been taken and several preliminary conclusions reached about the deep-water fauna of the island. First, the fauna changes rapidly at about 50 m depth; second, the fauna is highly diverse, with many new species likely; third, even though the distance between the north and south sides of the island is less than 8 km, the faunas seem to be different, possibly due to the influence of differing deep-water currents on each side of the island; and fourth, groups of organisms that were thought to be absent in the eastern Pacific Ocean have now been photographed. DeepSee has opened a new window to a very little known world of Isla del Coco. More studies are necessary to understand the deep-water faunas, and their relation to shallow water organisms and environments. This information will be important for management and conservation of the marine biodiversity of Isla del Coco. *Rev. Biol. Trop.* 56 (Suppl. 2): 189-206. Epub 2008 August 29.

Key words: Isla del Coco, Cocos Island, Costa Rica, deep environments, submarine.

Isla del Coco comprises the summit of a seamount on the Cocos Ridge, a submarine mountain range that extends from the Galápagos to the southern part of Costa Rica. The island is surrounded by a platform about 18 km long that trends in a southwest-northeast direction with waters as deep as 180 m (Lizano 2001). Below that depth the sides of the island are very steep down to the crest of the extended ridge at about 1000 m deep, and the decline then continues to the base of the ridge at over 3,000 m.

The first recorded underwater observations at Isla del Coco were in 1905, during an expedition organized by the government of Costa Rica in search of putative treasures left on the island. A diver named Gustavo Rodríguez went down with a hard hat (scaphander) and

produced some sketches, the only record of this dive (Weston 1992). The next diver was William Beebe during his voyage aboard the *MV Arcturus* (Cortés 2008a). During his visit to the island in 1925, Beebe dove with a brass helmet, and published his underwater observations in his book "The Arcturus Adventure" (Beebe 1926a, b). Prior to that time and to the present, most deep-water sampling has been undertaken by dredging or trawling, e.g. during the Steamer *Albatross* expedition of 1891 (Agassiz 1892), or the many expeditions of the Allan Hancock Foundation (Fraser 1943, Cortés 2008a). This type of sampling is usually done over soft sediments, so we know little of what lives on hard substrates in deep water. The few samples from hard substrates comprised of damaged organisms.

After the development of the self contained underwater breathing apparatus (SCUBA) by Émile Gagnan and Jacques-Yves Cousteau in 1943, many divers have explored the undersea world of Isla del Coco. These include Hans Hass, who dove at the island in 1954 during his *Xarifa* expedition (Cortés 2008a); Christopher Weston, who did the same in 1959 and many times since (Weston 1992); and Philippe Cousteau during a filming expedition in 1976. The first scientific use of SCUBA at Isla del Coco was during the RV *Searcher* expedition in 1972. They used SCUBA to 31 m on the leeward side of the island (Bakus 1975). Since then, SCUBA has been used extensively down to 40 m or more (Cortés 2008a, b).

In 1986, for the first and only time until now, a submersible was used at Isla del Coco as part of the SeaPharm Project, a pharmaceutical prospecting expedition. The *Johnson-Sea-Link I* submarine of the Harbor Branch Oceanographic Institution, Fort Pierce, Florida, was deployed around the Galápagos Islands and Isla del Coco (Cairns 1991a, Cortés 2008a, b). At Isla del Coco, six immersions were undertaken between November 30th and December 3rd, ranging from 105-785 m. Many deep-water organisms were collected and two papers were published, one on the deep-water corals (Cairns 1991a) and another on the stylasterids (Cairns 1991b). Many specimens of several taxonomic groups, including octocorals (Breedy & Cortés 2008), were filmed and collected, and many represent new species.

Recently, the submersible *DeepSee*, with capability to 450 m depth, has been used for tourism at Isla del Coco. In this paper, we describe the *DeepSee* submersible, observations made of the underwater environment and organisms, and comment on the richness and possible new species observed to 450 m depth around Isla del Coco.

The *DeepSea* Submersible: *DeepSee* is a custom built one-atmosphere submarine, capable of carrying one pilot and two passengers to a depth of 450 m (Fig. 1). The submersible was designed and developed from its keel up, and

built by SeaMagine, USA. In 2008 a mechanical arm was added. Unlike most other submarines that require a launch-and-retrieve support vessel for each dive, *DeepSee* was designed to allow its passengers to board and disembark it while floating alongside the mother ship. Recently, a dedicated support vessel, *Argo* (Fig. 2), was acquired, and it has been refitted as the platform for the submarine and diving operation. It will facilitate launching and retrieving of *DeepSee* in open waters, and will provide an excellent platform for scientific expeditions.

DeepSee is equipped with strong lights, a High Definition Video camera that documents the dives, and has the most advanced underwater navigation system: USBL system, Doppler navigation, and forward-looking sonar. This allows the pilot to navigate with great accuracy and to return to the same dive sites as needed. It has a 6 hour operational time and can reach 1.5 knots.

Passengers can use their cameras from inside the acrylic sphere taking advantage of the powerful lights. The clear 8.4 cm thick sphere literally disappears when submerged and offers the viewers a unique and unobstructed view (Fig. 3).

DeepSee has been diving at Isla del Coco since March 2006. During the initial period of testing and training, numerous habitats between 50-450 m have been explored. In March 2007, the south side of the island was explored for the first time.

Deep environments and organisms:

There is a long break along the Coco platform running from northeast to southwest, running from 180-460 m, which is the maximum operating depth of the submarine. This break, which was named “The Wall”, is a shear volcanic drop off. Rocks surrounded by sand are present just above the platform break (Fig. 4, 5). Moray eels (*Gymnothorax* spp.) (Fig. 6), groupers, thread-fin basses (*Pronotogrammus multifasciatus* Gill, 1863), brotulas (Family Ophidiidae), Two spot batfish (Fig. 7), crabs (Fig. 8), antennariid frogfishes (Fig. 9), and Jellownose fish (Fig. 10) have been observed. This area lies between



Fig. 1. The submarine *DeepSee* at Isla del Coco. Photograph by Undersea Hunter Group.



Fig. 2. The support ship *Argo* leaving Puntarenas during recent sea trials. Photographs by Jenaro Acuña.



Fig. 3. View of “The Arch” from inside the submarine. Photograph by Undersea Hunter Group.

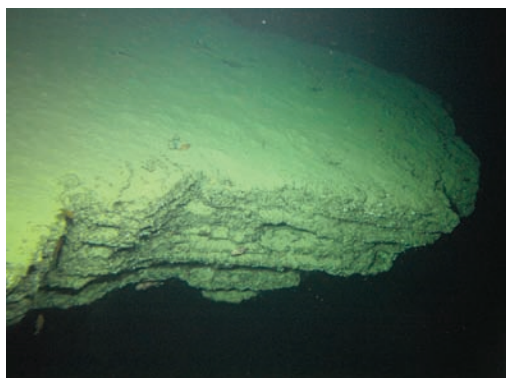


Fig. 4. Rock ledge above the shelf break (“The Wall”) covered with sand. Photograph by Undersea Hunter Group.



Fig. 5. Isolated rocks surrounded by sand, inhabited by an Olive grouper (*Epinephelus cifuentesi* Lavenberg and Grove, 1993) and numerous Threadfin bass (*Pronotogrammus multifasciatus* Gill, 1863). Fish identified by John McCosker, California Academy of Sciences. Photograph by Undersea Hunter Group.

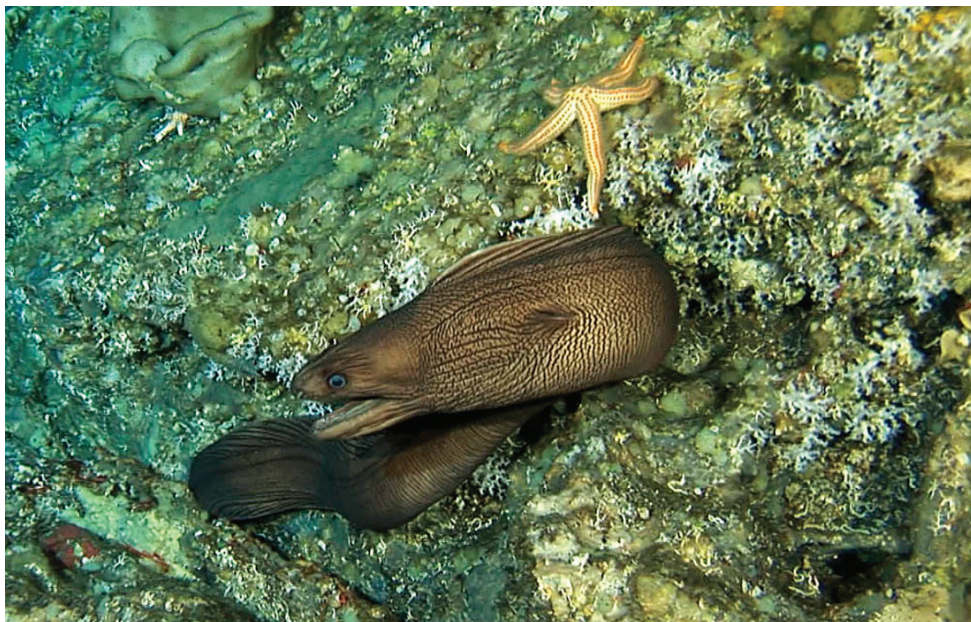


Fig. 6. Moray eel (*Gymnothorax* sp.), sea star and sponge on octocoral covered rock, adjacent to sandy bottoms. Photograph by Undersea Hunter Group.



Fig. 7. Two spot batfish, *Zalieutes elater* (Jordan and Gilbert, 1882), on the sandy bottom between 160-180 m deep. Identified by John McCosker, California Academy of Sciences. Photograph by Undersea Hunter Group.



Fig. 8. Apparently *Pleuroncodes monodon* (Milne Edwards, 1837), of the Family Galatheidae (left), and crabs of the Family Lithodidae (right). Identified by Rita Vargas, Museo de Zoología, Escuela de Biología, Universidad de Costa Rica. Photograph by Undersea Hunter Group.





Fig. 9. Antennariid frogfish.
Photograph by Undersea Hunter Group.

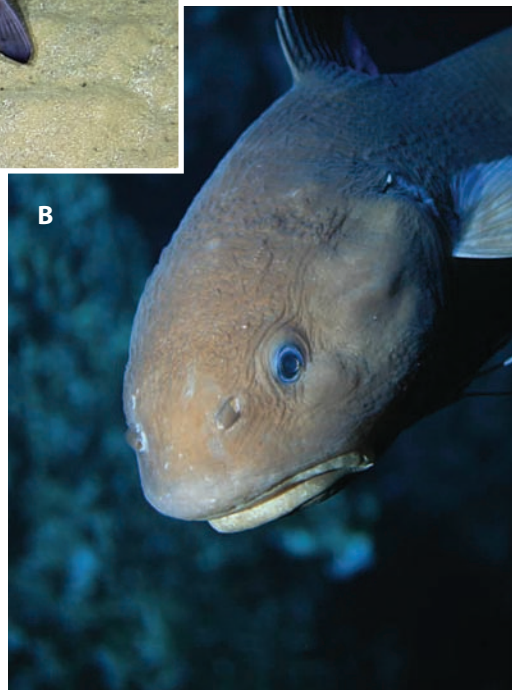


Fig. 10. Adult Jellownose, *Guentherus altivelis* Osório, 1917, Family Ateleopidae.
Identified by Tomito Iwamoto, California Academy of Sciences. Photograph by Undersea Hunter Group.

DISCUSSION

160-180 m depth, visibility is generally around 30 m horizontally and water temperature varies around 13°C. Along the break, at 180 m, visibility is generally about 50 m horizontally, temperature around 11°C, and the currents very mild. The smoothtail devil ray, *Mobula thurstoni* (Lloyd, 1908), not previously known below 100 m depth (Robertson & Allen 2006; Fishbase, <http://www.fishbase.org/>), has been observed at 180 m and deeper (Fig. 11). Deeper along the wall, deep-water corals (Fig. 12), soft corals (Fig. 13), and large silicious sponges were present (Fig. 14). From 250-450 m, 3-4 m long prickly sharks, *Echinorhinus cookei* (Pietschmann, 1928), have been observed and photographed (Fig. 15), as well as numerous large groupers.

On the north side of the island, the platform stretches from Isla Manuelita for 2 to 3 km offshore and down to 180 m depth. In this area, there are several seamounts, covered with marine life (Fig. 16), including octocorals (Fig. 17) and a dense coverage of black corals (Fig. 18). The platform on the north side of the island is mostly sandy and provides a unique habitat for eels, crabs, sea urchins (Fig. 19), batfishes, threadfin anglerfish (Fig. 20), and flounders. Even though no jellyfish have been reported for Isla del Coco (Rodríguez and Segura-Puertas 2008), one was photographed during a dive (Fig. 21).

On the south side of the island, the platform extends much further offshore, to 8 km distance where it breaks to deeper water (Lizano 2001). The area that has been explored, to 100 m depth, was found to be very different from that investigated on the north side. Here the platform is mostly rocky and the coverage of coral is thicker with different species. An arch is present at 90 m (Fig. 22) with dense populations of fish (Fig. 23). A group of five female and male ragged tooth sharks, *Odontaspis ferox* (Risso, 1810), ranging from 2.5-4 m long, have been found regularly (Fig. 24). Assuming the identification of this species is correct, this represents a new record for Isla del Coco (Bussing & López 2005, Garrison 2005, Robertson & Allen 2006).

DeepSee has revealed an unknown world at Isla del Coco. The diversity of organisms in deeper waters is apparently very high, many species have never been seen in shallow waters, and some shallow water species were not expected to live so deep. The difference in the fauna between the shallow (< 50 m) and deeper waters is surprising. At around 50 m depth, where the thermocline is located most of the time (O. Lizano work in progress), an abrupt change in the fauna is evident. Thus, there is no gradual reduction of shallow-water fauna and corresponding increase in deep-water fauna with depth: the change is very abrupt and obvious. More detailed studies are needed to quantify the change with depth and correlate it with physical parameters.

Another surprise emerged from the few dives made on the south, namely the substantial differences between communities on the two sides of the island, even within equivalent depths and habitats. The area around the island is not great, hence major differences were unexpected. Maybe this dissimilarity is due to the difference in current regimes, with southwest currents on the south of the island, while the north is exposed to currents from the mainland (Lizano 2008), thus exposing those sides to different faunas. More quantitative and temporal studies are needed to corroborate these empirical observations.

The presence of species in some taxonomic groups, for example nephtheid soft corals (Fig. 13), was unexpected. The nephtheids are very common in the Indo-West Pacific (Fabricius & Alderslade 2001) but have never been observed or collected in the eastern Pacific. From the available photographs, it is clear that several if not many new species are present in the deep waters. With the new arm, *DeepSee* will have collecting capabilities. The collection of specimens is necessary to prove the hypotheses proposed above, and is a requirement for the description of any new species.

The experience with the *DeepSee* has highlighted our extremely limited knowledge

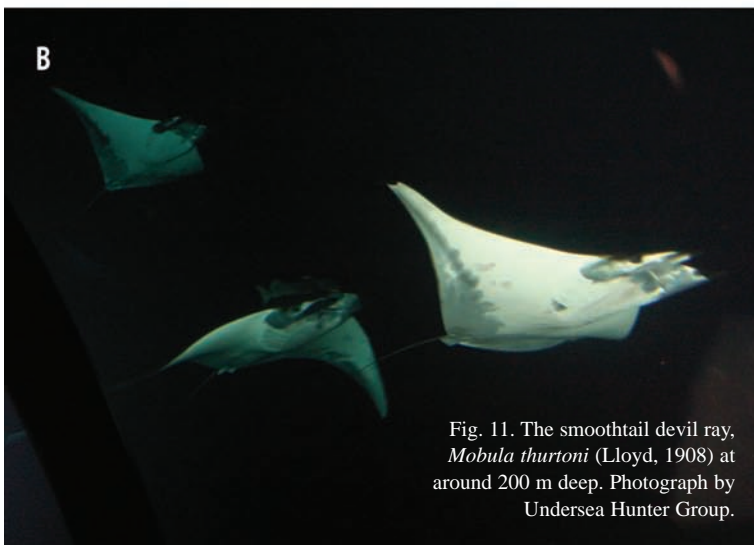


Fig. 11. The smoothtail devil ray, *Mobula thurtoni* (Lloyd, 1908) at around 200 m deep. Photograph by Undersea Hunter Group.

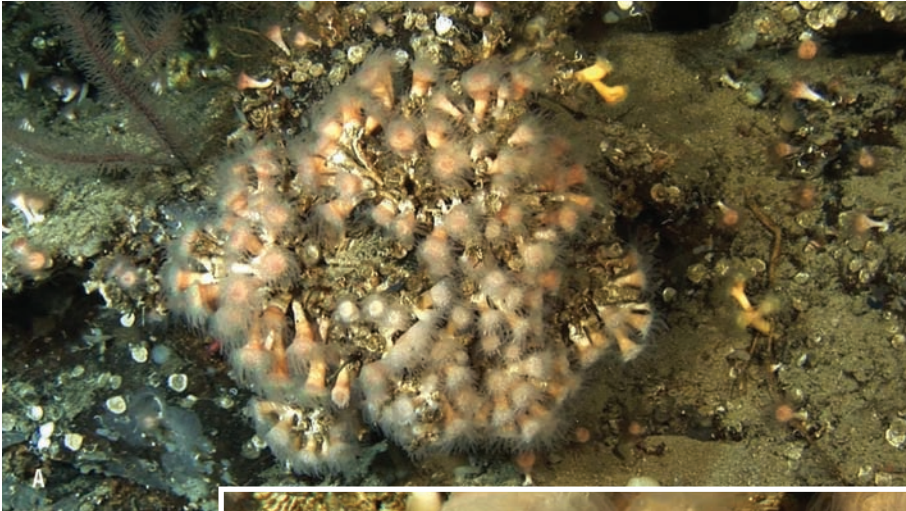


Fig. 12. The deepwater coral, probably *Desmophyllum dianthus* (Esper, 1794), also known as *D. cristagalli*. Identified by Stephen D. Cairns, National Museum of Natural History, Smithsonian Institution, Washington, D.C. Photograph by Undersea Hunter Group.

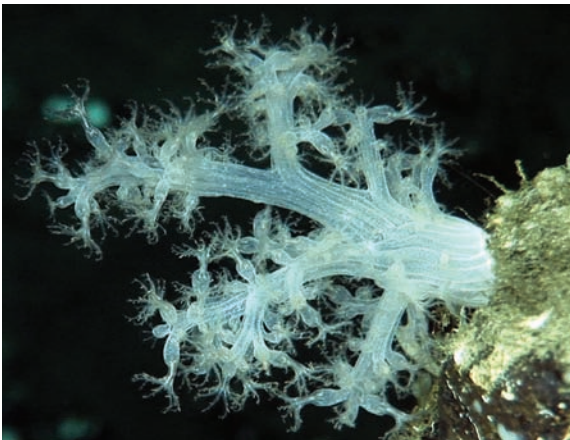


Fig. 13. Soft coral of the Order Alcyonacea, Family Nephtheidae. Identified by Leen van Ofwegen, Leiden Museum, The Netherlands. Photograph by Undersea Hunter Group.

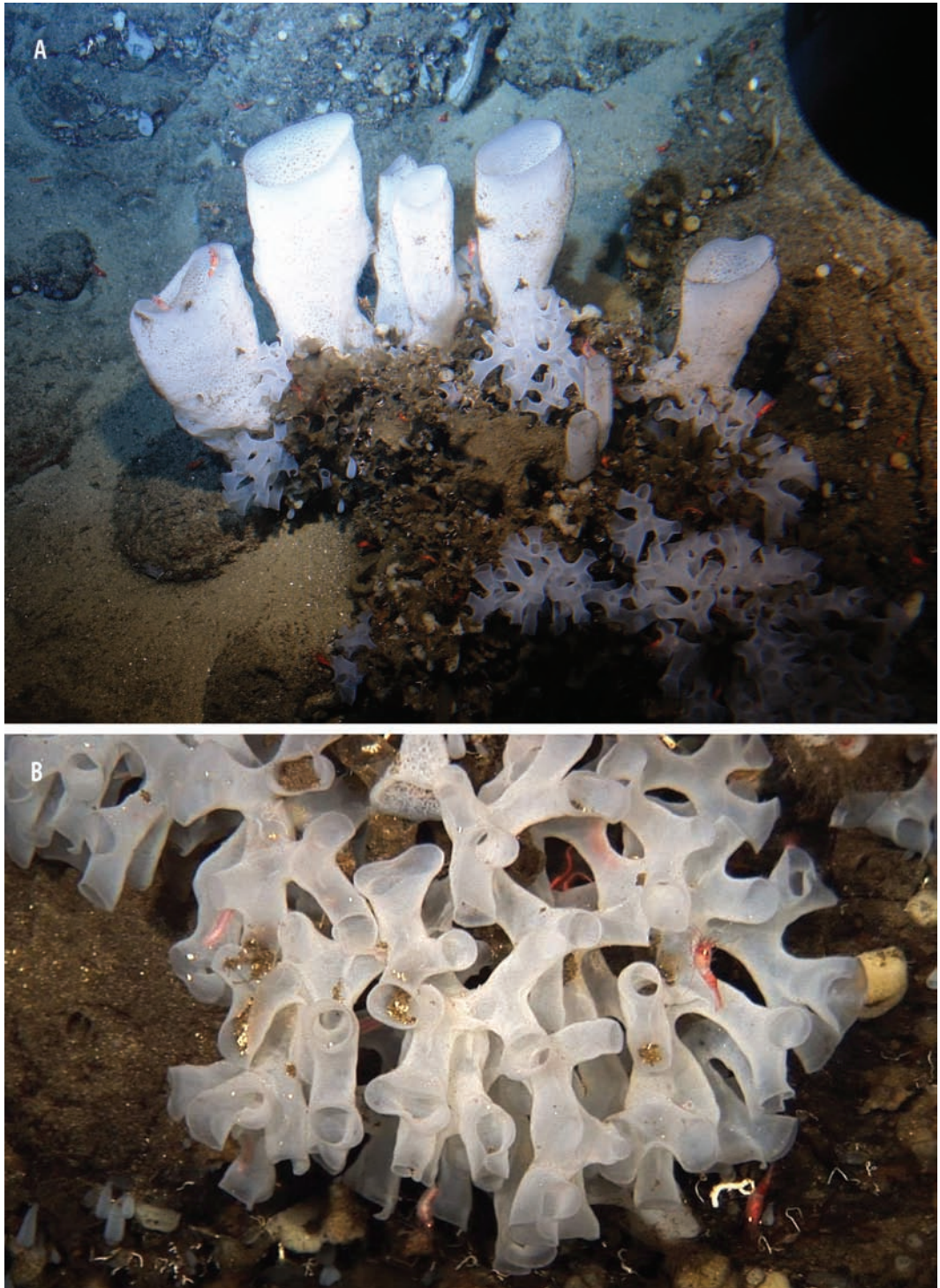


Fig. 14. Silicious or glass sponges, Class Hexactinellida. Right, Family Farreidae. Identified by Allen Collins, National Museum of Natural History, Smithsonian Institution, Washington, D.C. Photograph by Undersea Hunter Group.

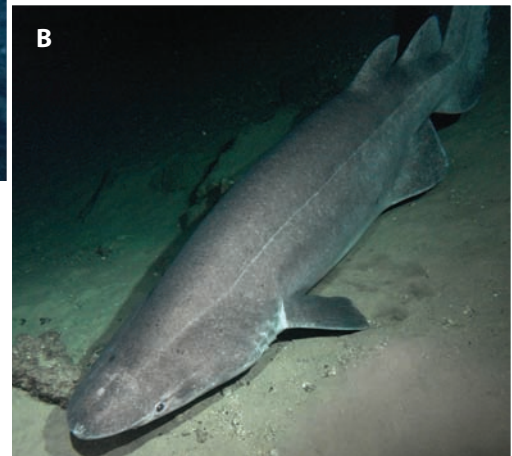
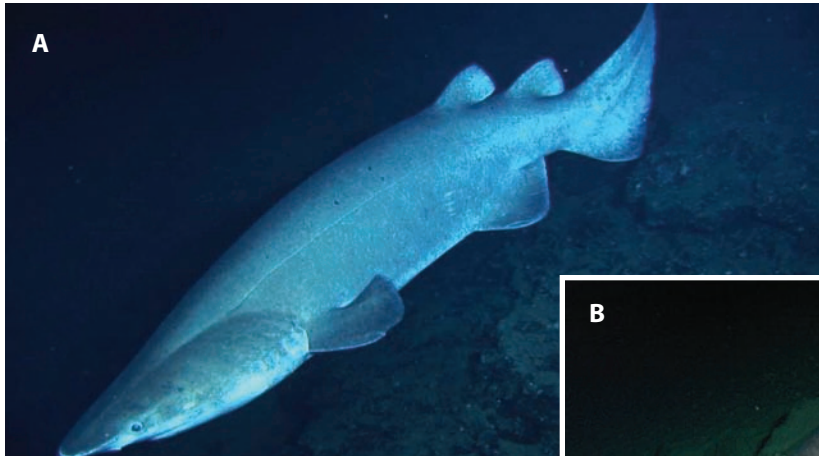


Fig. 15. Three to four meter long prickly sharks, *Echinorhinus cookei* Pietschmann, 1928, have been observed between 250-450 m. Photograph by Undersea Hunter Group.



Fig. 16. Panoramic view of seamount called "Everest". Photograph by Undersea Hunter Group.



Fig. 17. Detail of rock with octopus within octocorals. Photograph by Undersea Hunter Group.



Fig. 18. Black corals. Photograph by Undersea Hunter Group.



Fig. 19. Adult Jellownose fish, *G. altivelis*, and a sea urchin, apparently *Centrocidaris doerderleini* (A. Agassiz, 1898). Order Cidaroida, Family Cidaridae. Fish identified by John McCosker, California Academy of Sciences, and sea urchin identified by Harilaos Lessios, Smithsonian Tropical Research Institute, Panamá. Photograph by Undersea Hunter Group.

Fig. 20. Threadfin anglerfish, *Lophiodes spilurus* (Garman, 1899) north of Manuelita. Identified by John McCosker, California Academy of Sciences. Photograph by Undersea Hunter Group.

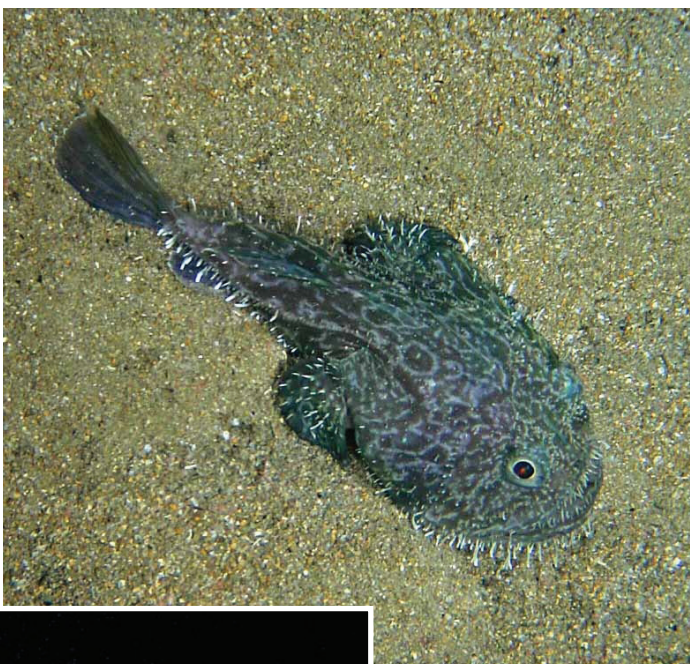


Fig. 21. Jellyfish (Class Scyphozoa) photograph during one of the dives. Photograph by Undersea Hunter Group.



Fig. 22. "The Arch" at 90 m deep. Photograph by Undersea Hunter Group.



Fig. 23. Dense populations of *Catalufa, Cookeolus japonicus* (Cuvier, 1829), at "The Arch". Identified by John McCosker, California Academy of Sciences. Photograph by Undersea Hunter Group.



Fig. 24. Ragged tooth shark, *Odontaspis ferox* (Risso, 1810), at “The Arch”. Photograph by Steve Drogin.

of deep-water habitats and faunas, while also revealing the importance of these poorly known environments. We do not know what connections exist between the shallow and deep waters around Isla del Coco. For example, preliminary observations indicate that hammerhead sharks, *Sphyrna lewini* (Griffith and Smith, 1834), travel at night to deep waters (over 300 m) to feed (Arauz & Antoniou 2006).

DeepSee has opened a new window into the deep-water biodiversity of Isla del Coco, and we have just scratched the surface. Off the insular platform, beyond 180 m depth, the island drops to about 1000 m, the top of the Cocos Ridge, and then slopes more gradually to 3,000 m at the base of the ridge and start of the abyssal plains (Lizano 2001).

Knowledge of the deep-water fauna of Isla del Coco and other parts of the ocean, and their relation to shallow water organisms, is

important for the management and conservation of this poorly known component of the marine biosphere.

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History, Smithsonian Institution, Washington, D.C.; Harilaos Lessios, Smithsonian Tropical Research Institute, Panamá; John McCosker and Tomito Iwamoto of the California Academy of Science, San Francisco, California. Stephen Cairns, John McCosker, Steve Drogin, Graham Edgars, and Giacomo Bernardi for a review the paper; we thank them for their corrections and suggestions.

RESUMEN

La Isla del Coco es la cima de un monte submarino localizado a 500 km al suroeste de la costa continental de Costa Rica. La isla está rodeada por una plataforma de 18 km de largo en dirección suroeste-noreste, y que presenta un cambio en la pendiente a unos 180 m de profundidad. Desde el 2006, el submarino *DeepSee*, con capacidad de inmersión de hasta 450 m, ha estado explorando los ambientes de aguas profundas de la Isla del Coco. Se han tomado videos y se puede llegar a varias conclusiones preliminares sobre la fauna de estos ecosistemas. Primera, hay un cambio marcado entre las faunas someras, menos de 50 m, y las de más profundidad; segunda, la fauna profunda es muy diversa, y es posible que se encuentren muchas especies nuevas; tercera, aunque la distancia entre el lado norte y sur de la isla no es muy grande, las faunas parecen ser diferentes, probablemente debido a la corrientes de aguas profundas que llegan a cada lado de la isla; y cuarta, se han visto organismos que no se sabía que vivían en el Océano Pacífico Oriental. *DeepSee* ha abierto la ventana a un mundo desconocido de la Isla del Coco. Es necesaria la realización de más estudios para entender esta fauna y su relación con las aguas someras, lo cual va a ser importante para el manejo y la conservación de este componente de la biodiversidad marina de la Isla del Coco.

Palabras claves: Isla del Coco, Costa Rica, ambientes profundos, submarino.

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