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Short Communication

First record and distributional extension to Rapa Nui (Easter Island) of the slipper lobster *Scyllarides haanii* (Crustacea, Decapoda, Scyllaridae)

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ABSTRACT. A male specimen of the Aesop slipper lobster *Scyllarides haanii* was found in the coastal vicinity of Ahu Tongariki (27°07'33"S, 109°16'37"W), Rapa Nui. Its taxonomic determination was carried out by a detailed morphological examination and a DNA barcoding identification analysis by sequencing the cytochrome oxidase subunit 1 (*COX*1) gene. *S. haanii* has a wide geographic distribution with occasional presence from the Indo-Pacific to the Hawaiian Archipelago, including the Red Sea, Japan, Korea, China, Taiwan, Indonesia, Australia, Reunion, and French Polynesia; from 10 to 135 m of depth, preferably on rocky bottoms. This record extends the geographical distribution of *S. haanii* to Rapa Nui. It increases to five the species number of marine lobsters present on the island: a Palinuridae, *Panulirus pascuensis* and four Scyllaridae, *Parribacus perlatus*, *Arctides regalis*, *Scyllarides roggevenni*, and now *S. haanii*. This finding derived from the local initiative Pilotos to promote the sustainable management of coastal species, led by the Rapa Nui Sea Council ("Koro Nui o te Vaikava"), the elected authority in charge of the co-administration of Multiple Uses Marine Protected Area (MUMPA). The specimen will be deposited in the Crustacean Collection of the MNHNCL: accession number in GenBank (MW699539.1).

Keywords: *Scyllarides haanii*; Aesop slipper lobster; DNA barcoding; multiple-use marine protected area

Initially, for the remote Rapa Nui (Easter Island), which is one of the furthest places in the Pacific Ocean, only three species of marine lobsters had been collected and scientifically reported (Holthuis 1972, 1991): a spiny lobster (Palinuridae), *Panulirus pascuensis*, and two slipper lobsters (Scyllaridae), *Parribacus perlatus* and *Scyllarides roggeveeni*. Later, just a couple of decades ago, the first discovery of adult specimens of another slipper lobster was made in the waters of Rapa Nui, *Arctides regalis*, a species native to the Hawaiian Archipelago (Retamal 2000).

Recently, the discovery in the waters of Rapa Nui of a specimen of the scyllarid *Scyllarides haanii* (De Haan, 1841), v. ns.: Aesop slipper lobster (FAO name); ridgeback slipper lobster (Hawaii); gran langosta chata costera (Spanish) or Rarape Nui (Rapa Nui), has come to confirm some ancient sightings of that great flat lobster made by island fishermen. *S. haanii* has a wide geographic distribution extending from the Indo-Pacific with an occasional presence in the Red Sea, Japan, Korea, China, Taiwan, Indonesia, Australia, Reunion, French Polynesia the Hawaiian Archipelago. The current record of Aesop slipper lobster on Rapa Nui represents a range extension in the Eastern Pacific Ocean of 4200 (km) east from French Polynesia and 7500 (km) southeast from the Hawaiian Archipelago. It also represents the fourth Scyllaridae species in the subtidal environment of the island, and it constitutes the fifth record of marine lobsters for Rapa Nui.

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The examined material consisted of a male specimen of *S. haanii*, which was collected as part of the activities carried out in the local initiative Pilotos to promote the sustainable management of coastal species in Rapa Nui, an initiative led by the Rapa Nui Sea Council. It was extracted manually by night apnea diving in the Ahu Tongariki sector (27°07'34"S, 109°16'34"W) at a depth of 3.5 m on December 17, 2019 (Fig. 1), with *P. perlatus* (Rarape) being the target species for fishing. The specimen was found in a coral substrate, specifically on top of *Porites lobata*. A detailed morphological analysis of the external anatomy was carried out on this specimen, comparing it with the description of other species of the same genus, *Scyllarides roggevenni*, Holthuis (1967, 1972, 1985), an endemic scyllarid species to Rapa Nui and Salas y Gómez Islands. In addition, the description of *S. haanii* is based on material from the Hawaiian Archipelago (Holthuis 1963) plus more lately scientific publications, based on material from different locations of the extensive geographic distribution of this species (Morin & MacDonald 1984, Holthius 1991, Chan 1998, Poupin 2010, Wardiatno et al. 2016) were reviewed.

For molecular identification, pereiopods' DNA was extracted using the E.Z.N.A.® tissue DNA kit (Omega Bio-Tek) following the instruction from the manufacturer. The amplification was carried out using 40 ng of DNA sample, 1x PCR Buffer, 200 mM dNTPs, 0.2 mM of each HCO2190 (5'-TGTAAAACGACGGCCAGTGGTCAACAAATCATAAAGATATTGG-3' and LCO1490 (5'- CAGGAAACAGCTATGACTAAACTTCAGGGTGACCAAAAAATCA-3' (Folmer et al. 1994) tailed primers with M13F(-21) and M13(-27) universal oligonucleotides (underlined in sequences), 2.5 mM $MgCl_2$ and 0.5 U Thermo Scientific™ Dream Taq DNA polymerase in a final volume of 50 mL. The thermal profile considered an initial denaturation step at 95ºC for 2 min, 35 cycles at 94ºC for 30 s, 54ºC for 30 s, and 72ºC for 1 min, with a final extension at 72ºC for 12 min. PCR products were cleaned up using Favorgen™ PCR/GEL kit following the manufacturer's instruction and quantified before sequencing in a NanoDrop 2000™ spectrophotometer. Sanger sequencing was performed in Macrogen (South Korea) using the M13 universal primers. Forward and reverse raw sequences were aligned, manually edited, and trimmed to 630 bp with Sequencher™ version 5.4.6 (Gene Codes Corporation) to obtain a consensus sequence.

Measurements of this *S. haanii* male specimen (Fig. 1) are: 110 mm carapace length; 282 mm total length; specimen width at the level of the pleura of the carapace 102.1 mm, and its total weight was 780 g. It stands out among its main morphologic characteristics like a dorsal surface and a general arched body line (Fig. 2a). Pubescent body, covered with small rounded tubercles. The domed carapace (that is, with a curved shape that covers a space between side walls) is subrectangular, whose length equals 1.24 times the width; anterior half narrower than posterior; with a strong, noticeable, and deep cervical sulcus; dorsal surface with pregastric, gastric and two small cardiac teeth, which protrude very little, or only slightly. Carapace furrows, broad post cervical, broad marginal, not pointed, shown as a diffuse and superficial line; transverse intestinal region, thicker and voluminous towards the middle sector, marked and delimited by the narrow groove of the posterior marginal edge of the carapace, which is transverse, curved at the anterior border and straight at the posterior distal border. The eyes are small and subspherical; there is an internal orbital margin with three teeth: the largest lateral and intermediate ones. Antennae broad, flattened, and plate-shaped, with a distal margin with finely rounded teeth; anterior border of the third antennal segment with a middle and a terminal spine. Robust ambulatory legs are sub-equal in shape and carinate; dorsal sector of meropodites notoriously carinated; the first ambulatory leg originates in the distal sector of the meropodite, a conspicuous and pointed spine, surrounded by a conspicuous and pointed spine on both sides by 1-2 shorter teeth. The abdomen is generally granular, except in the anterior proximal half of the first segment,

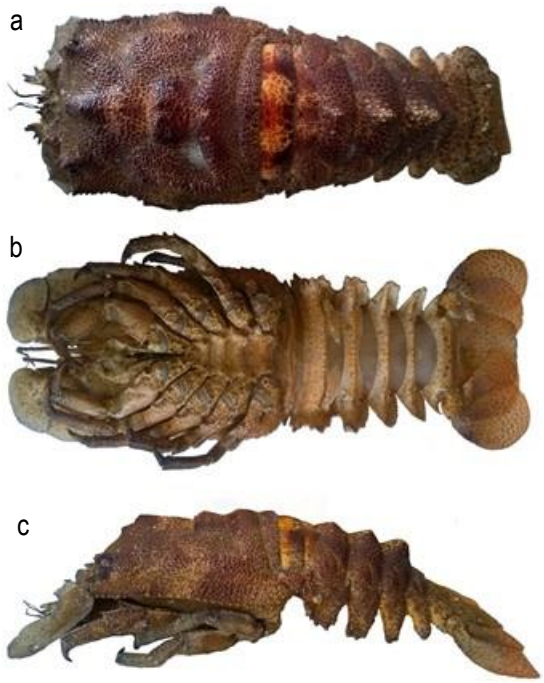

Figure 1. *Scyllarides haanii*. a) Dorsal view of the male specimen, captured in Rapa Nui, b) ventral view of the same specimen, c) side view.

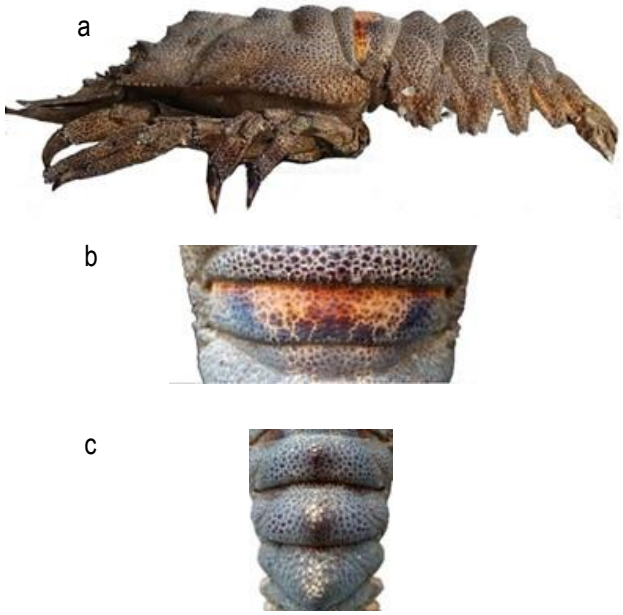

Figure 2. *Scyllarides haanii*. a) General and lateral contour of the body, b) posterior dorsal half of the first abdominal segment, c) dorsal cusps of the abdominal segments 2-4 midline sector.

smooth and stained. It has two sub-triangular red spots, one on each side, and between them, there is an irregular red one, which is sub-triangular with a wide base and whose length equals approximately half of the lateral ones (Fig. 2b); the posterior sectors of the distal half of the first abdominal somite are also granulated (Fig. 2c). From the second to the fourth abdominal somites, there is a progressive elevation in the median line, of which the fourth somite is the highest, with the shape of a hump, and whose top is slightly displaced backward and ends in a delicate obtuse point from where it falls abruptly forming a slightly concave line towards the fifth segment. From the second to the fifth abdominal somite, the basal part of the pleurae with a curved line directed towards the posterior end of each pleuron. Pleurae are downward directed. Pleuron of the second abdominal somite surrounded by pointed teeth with a wide base; third segment pleuron with three distally broad-based teeth and finely crenulated anterior and posterior borders; pleuron of the fourth and fifth abdominal somites narrower towards the distal sector and with anterior and posterior edges also finely denticulated.

When comparing this specimen with the original description of *S. haanii*, and with what has been established around the morphology of the specimens of this species registered from Indonesia (Wardiatno et al. 2016) and those published from the Hawaiian Archipelago (Morin & MacDonald 1984), the following

Figure 3. *Scyllarides haanii*. Side view of the abdomen.

differences were observed: 1) the pregastric, gastric and cardiac teeth of the dorsal surface of the carapace, although it is conspicuous, are very tiny and do not protrude strongly, 2) the midline of the second and third abdominal segments are not strongly striated and, like all the cusps of the elevations of the abdominal segments 2-4 they are formed by tubercles slightly larger and whitish than those which are darker that cover the rest of the body (Figs. 2c and 3), the posterior (distal) half of the first abdominal segment has three defined and non-diffuse subtriangular red-speckled spots, 4) the pleuron of the second abdominal somite is surrounded by broad-based pointed teeth that are obtuse towards the tip, unlike the relatively slightly longer, thinner and pointed, narrower-based teeth of the *S. haanii* recorded from Indonesia and from the Hawaiian Archipelago. These minimal observable differences in the external morphology of this *S. haanii* specimen are probably the natural ones that are possibly found among specimens of a species colonizing a relatively new environment geographically located at a very great distance from the original type locality. These characteristics make it possible to differentiate this specimen of *S. haanii* from the other scyllarid, *S. roggeveeni*, an endemic slipper lobster from islands Rapa Nui and Salas y Gómez, with whose diagnostic characters (Báez & Ruiz 1985, Williams 1986, Holthuis 1991) it has been compared. Another notable difference is the general bathymetric distribution of *S. haanii*, established between 10 and 135 m, probably on rocky bottoms (Holthuis 1991). Nevertheless, the specimen from Rapa Nui was captured in the subtidal environment at 3.5 m of depth on a coral substrate.

Key to differentiate adult *S. haanii* from *S. roggeveeni*

Abdominal segments 2 to 4 successively increase in size at the dorsal midline without forming a carina. The fourth abdominal segment forms a hump whose apex is offset slightly backward where it ends in a blunt-pointed edge and falls abruptly in a slightly concave vertical line toward the fifth abdominal segment. The transverse and posterior dorsal sector of the first abdominal somite with two conspicuous sub-triangular

lateral spots, among which there is a third sub-triangular one with a broad base and whose length equals half of the lateral spots length. Pleuron of the second abdominal somite surrounded distally by of broad base pointed teeth…….. *Scyllarides haanii*

Abdominal segments 2 through 4 successively increase in size at the dorsal midline, forming a carina. Transverse and posterior dorsal sectors of the first abdominal somite with two circular lateral spots and numerous small spots between them. The fourth abdominal segment does not form a hump. Pleuron of the second abdominal somite surrounded distally by rounded teeth……. *Scyllarides roggeveeni*

The consensus sequence (GenBank accession number MW699539.1) was queried against the reference sequences available on Barcode of Life Data System v4 (http://www.boldsystems.org) using the BOLD Identification System (Ratnasingham & Hebert 2007, 2013). Only two *COX*1 sequences for *S. haanii* were found in this database, topping the match list with the highest sequence similarity of 97.72%. Alternatively, the species was identified using the best close match criteria, where a specimen is successfully identified if the sequences with the smallest distance to query are all conspecific and within the 95th percentile of all intraspecific distances (Meier et al. 2006), as was the case for the sequence obtained from the *Scyllarides* specimen analyzed here. Once the corresponding analyzes have been completed, the specimen will be deposited in the Crustacean Collection of the Museo Nacional de Historia Natural de Santiago de Chile, being preserved in alcohol (70-90%).

Although various investigations on the biology and fishery of Scyllaridae species have been carried out worldwide for decades, these studies have been very limited and sporadic compared with those carried out on spiny and claw lobsters (Briones-Fourzán & Lozano-Álvarez 2015). Within the wide distribution of *S. haanii*, it is caught locally, and it is sometimes taken incidentally in traps intended for the fishing of other lobster species without posing an apparent threat to their populations due to large-scale fishing operations (MacDiarmid et al. 2009). In the genus *Scyllarides*, there is great variability regarding the species' social behavior (Spanier & Lavalli 2007). *S. haanii* has been reported to behave in a solitary manner (Morin & MacDonald 1984). It has been captured in the Hawaiian Islands by sport diving and bycatch in traps destined for other lobsters, and the only ovigerous female recorded was found in the winter season. For all the aspects mentioned above, along with the still little existing scientific information, since the year 2000, the Northwestern Hawaiian Islands (NWHI) Coral Reef Ecosystem Reserve established, as a precautionary measure, the prohibition of commercial lobster fishing for an indefinite time. Thus, the lobster fishery indirectly does not represent a continuous threat to this species in that archipelago (DiNardo & Moffitt 2007).

The presence of *S. haanii* in coastal waters of Rapa Nui, confirmed by taxonomic analysis based on morphological examination and molecular study, together with the considerably increasing range of geographical distribution of the species to the south-central sector of the Southeast Pacific, adds with this record a fourth Scyllaridae species to the marine resources of Easter Island. At the same time, it also extends to this species the concern of the Rapa Nui Sea Council to investigate, monitor, and prevent potential modification of the ecosystem that may derive from the natural introduction of these exotic species to the island's marine environment.

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