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The Rarape *Parribacus perlatus* Holthuis 1967, and two other slipper lobsters (Crustacea, Decapoda, Scyllaridae) on the coral *Porites lobata* from the coastal marine ecosystem of Rapa Nui (Easter Island)

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ABSTRACT. *Parribacus perlatus* (c.n.: Rarape) is an endemic scyllarid lobster from the coastal marine ecosystems of Rapa Nui (Easter Island) and Motu Motiro Hiva (Salas y Gómez Island). Thanks to the initiative of the Rapa Nui Ocean Council ("Koro Nui o te Vaikava"), elected co-administrative authority of the Multiple-Use Marine Coastal Protected Area (MU-MCPA), on the coral *Porites lobata* were collected a total of 104 *P. perlatus* specimens : 19 (2019), 60 (2020), and 7 (2021), all obtained in Hanga Nui, plus 18 (2023) in Hanga Ho'onu. Specimens of *Arctides regalis* and *Scyllarides haanii* were also captured in the same habitats. Taxonomic determination was performed through detailed morphological examination and molecular identification, using DNA barcoding and phylogenetic reconstruction. Along with the geographical and bathymetric distribution of *P. perlatus*, general ecological aspects, fecundity, and stomach contents were evaluated. *P. perlatus* plays an essential role in the community structure of the *Porites lobata* reef from the Rapa Nui coastal ecosystem. There, it has a diet consisting of 17 coastal food items. Ovigerous females, carapace length (CL) ranged between 5.8 and 6.8 cm, had an egg production from 25,631 to 47,678 eggs. *P. perlatus* also has been found in Rapa Island, the Polynesian archipelago. This report allowed us to suggest scientific management measures to prevent rarape overfishing.

Key words: Multiple-Use Marine Coastal Protected Area; *Porites lobata; Parribacus* fecundity; stomach contents; *Arctides regalis; Scyllarides haanii;*

RESUMEN. *Parribacus perlatus* (n.c.: Rarape) es una langosta escilárida endémica de los ecosistemas marinos costeros de Rapa Nui y Motu Motiro Hiva (Isla Salas y Gómez). Gracias a la iniciativa del Consejo del Mar de Rapa Nui ("Koro Nui o te Vaikava"), autoridad coadministradora elegida del Área Marina Costera Protegida de Múltiples Usos (AMCP-MU), se recolectó sobre el coral *Porites lobata* un total de 104 ejemplares de *P. perlatus*: 19 (2019), 60 (2020) y 7 (2021) obtenidos en Hanga Nui, cerca del Ahu Tongariki, y 18 (2023) en Hanga Ho'onu. También fueron capturados en los mismos hábitats algunos ejemplares de *Arctides regalis* y *Scyllarides haanii*. La determinación taxonómica se realizó mediante examen morfológico detallado e identificación molecular, utilizando código de barras de ADN (DNA barcoding) y reconstrucción filogenética. Junto con la distribución geográfica y batimétrica de *P. perlatus*, se evaluaron aspectos ecológicos generales, fecundidad y contenido estomacal. *P. perlatus* desempeña un papel esencial en la estructura de la comunidad del arrecife de *Porites lobata* del ecosistema costero de Rapa Nui. Presenta una dieta compuesta por 17 items alimentarios costeros. Las hembras ovígeras de rarape, con una longitud de caparazón (CL) entre 5,8 y 6,8 cm, presentaron una producción de huevos entre 25.631 y 47.678 huevos. *P. perlatus* también ha sido registrada en Isla Rapa, en el archipiélago de la Polinesia. Este informe permitió sugerir medidas de manejo científico para prevenir la sobreexplotación del Rarape.

Palabras clave: Área Marina Costera Protegida de Múltiples Usos; *Porites lobata; Parribacus* fecundity; stomach contents; *Arctides regalis; Scyllarides haanii*

INTRODUCTION

In the coastal waters of Rapa Nui (Eastern Island), there is a scyllarid lobster, *Parribacus perlatus* Holthuis, 1867, known locally as Rarape, which is of interest to local gastronomy and tourism. It is one of the five species of marine lobsters in the coastal ecosystem of this island. From them, only the spiny lobster *Panulirus pascuensis* Reed 1954 (Palinuridae) has been officially exploited and recognized as a local artisanal fishery. On the contrary, the *P. perlatus* and *Scyllarides roggeveeni* Holthuis 1963 (c. n.: monkfish) have been considered only potential or secondary resources (Retamal & Arana, 2016). These should be added: *Arctides regalis* Holthuis 1963 and *Scyllarides haani*i De Haan 1841, both captured occasionally at low levels, and only for local consumption (Báez et al., 2022). According to Boyko (2003), the annual catch of *P. perlatus* and *S. roggeveeni* has increased as the population of *Panulirus pascuensis* has declined. However, *P. perlatus* has not been considered part of the traditional and artisanal fisheries of the island (Yáñez et al., 2007; Castilla et al., 2014), despite this species gaining importance in commercial fishing on Rapa Nui. Due to its emerging yet increasing demand, studies are needed to understand this new fishery, which remains largely unknown and therefore poses a threat to the sustainable exploitation of this species, a situation similar to that faced by other scyllarid lobsters in different parts of the world (Sharp et al., 2007). Without fishery management measures, careless exploitation could soon lead to overfishing of *P. perlatus* and other slipper lobster species on Rapa Nui. According to the scientific literature on *P. perlatus*, aside from the description of the species (Holthuis, 1967) and other taxonomic aspects (Poupin, 2003), there is no information on its role in the coastal ecosystem of Rapa Nui. *Parribacus perlatus* coexists with the rest of the island's invertebrate populations, some of which have also been subject to intense fishing pressure and changes driven by artisanal extractive activities, as occurs with corals and some mollusks (Boyko, 2003). The extractive pressure exerted on all marine species of Rapa Nui must be understood to have a strong effect not only on *P. perlatus* and other scyllarids living around the island, but also on the coastal ecosystem where they and other marine lobster species reside. When considering the extraction of lobsters, it is necessary to keep in mind how little is known about the life cycles of the pelagic and benthic fauna in the enormous expanse of the Central Pacific, to which Rapa Nui and Salas y Gómez Island belong. The extreme isolation of Rapa Nui and the natural vulnerability that characterizes the island marine ecosystems (Smith, 1986), together with the cyclical effects of the El Niño Southern Oscillation (ENSO) and global climate change (Briones-Fourzán & Lozano-Álvarez, 2015), make it necessary to accelerate the scientific knowledge of the species that make up the communities integrating the coastal ecosystems. It is for this reason that the Rapa Nui Ocean Council ("*Koro Nui o te Vaikava"*), the elected authority in charge of the co-administration of this island's Multiple-Use Marine Coastal Protected Area (MU-MCPA), has the initiative and concern to develop Pilot projects to advance in the identification and implementation of actions for the monitoring and management of coastal marine resources. One of these pilots considered the study of *P. perlatus* a priority. Consequently, the main objective of this research is to contribute to the knowledge of *Parribacus perlatus* and, at least, to leave the constancy of the occasional occurrence of the other two slipper lobsters, *Arctides regalis* and *Scyllarides haanii,* both of which are now resident in the same *Porites lobata* environment from the Rapa Nui coastal ecosystem.

1. *Parribacus perlatu*s (Rarape) morphological and biometric analysis

Sample collection

Rarape samples having as a fishery objective the capture of *P. perlatus* (n=104) (Table 1) were obtained in Rapa Nui on different dates and localities (Fig.1). All were collected on the *P. lobata* coral reef. These specimens were extracted manually at night by apnea and autonomous Scuba diving at depths between 2.5 to 5 m; these sleeper lobsters were 19 (2019), 60 (2020), and 7 (2021) captured in Hanga Nui, sector near Ahu Tongariki (27°07'34" S, 109°16'34" W), plus 18 specimens (2023) obtained in Hanga Ho'onu (Fig. 2 and 3). Seven other specimens from *A. regalis* (Table 2) and three from *S. haanii* (Table 3); the other slipper lobsters inhabiting the same coral habitat were collected occasionally.

Morphological and Biometric Analysis

Sex was registered for all the collected animals. Measurements considered were total length (TL) and carapace length (CL), recorded for all specimens of *P. perlatus, A. regalis,* and *S. haanii* with a vernier caliper meter foot (precision 0.05 mm) and the weight (W) of each on a scale with 0.1 g of precision (Tables 1, 2, and 3). The three variables were compared between males and females using a two-sample Wilcoxon rank-sum test. The linear relationship between W and CL was explored using simple regression analysis ($W = \beta_0 + \beta_1 CL$, where β_i denotes the regression coefficient). Statistical analyses were performed using R (R Core Team, 2026). In the laboratory, molting status was confirmed, and the stomachs were dissected to examine their contents under a stereomicroscope. Each item was identified taxonomically to the highest possible level and counted to determine the percentage of prey across all specimens.

In non-oviferous females of *P. perlatus*, the pleopods which could evidence the existence of oviferous setae, were reviewed to use and confirm the possibility of sexual maturity (Gregory and Labisky, 1981; Piñeiro et al., 2011; Lipcius and Herrnkind,1987). The possible presence of a spermatophore attached to the posterior ventral part of the plastron was also searched in females without eggs to detect the state of maturity. The body surface of all collected specimens was reviewed, and a record of the epibionts found was left, as well as the details of the differences observed when comparing these specimens with the published description of the external anatomy of all the collected scyllarid species.

The study of all this collected material was carried out based on the review of the descriptions and published works (Holthuis 1963; Holthuis 2006; Retamal 2000 and 2004), which was complemented and confirmed with the molecular analysis of specimen identification for all the captured species (*P. perlatus*, *A. regalis*, and *S. haanii*). Part of the material collected and reviewed will be deposited in the Museo Nacional de Historia Natural of Chile in Santiago (MNHNCL), Chile, and in the Invertebrate Collection of the Quintay Marine Research Center (CIMARQ) at Universidad Andrés Bello, Valparaíso, Chile.

2. Molecular identification

DNA was obtained from one representative individual of *P. perlatus* and *A. regalis* from the pereiopods using the E.Z.N.A® tissue DNA kit (Omega Bio-Tek) according to the manufacturer's instructions. Two µL of this DNA were used directly to perform PCR reactions. The *COX1* gene fragment (~700 bp) and *16S rDNA* fragment (~560 bp) were amplified with Folmer et al. (1994) and Palumbi et al. (2002) primers, respectively. Both primer pairs were synthesized with the 5' end containing the M13 universal sequencing primer (Table 4). PCR reactions were performed in 50 µL of the final volume containing 25 µL of 2x PCRBIO Taq Mix Red (PCR Biosystems Inc.), 0.06 mM of each primer, and 2 µL of DNA sample. The thermal profile included an initial denaturation step at 95ºC for 3 min, 40 cycles at 94ºC for 15 s, annealing at 50ºC for 30 s and 72ºC for 1 min, and a final extension at 72ºC for 6 min. PCR products were cleaned up using the Favorgen™ PCR/GEL kit according to the manufacturer's instructions and quantified prior to sequencing with a NanoDrop 2000™ spectrophotometer (Thermo Fisher Scientific). Bidirectional Sanger sequencing was performed in Macrogen Chile SpA using the M13 universal sequencing primers. Forward and reverse raw sequences were aligned using Geneious Prime 2023.0.4, manually edited, and trimmed. The GenBank accession numbers for the sequences are MW699537 (*COX1*) and OR230010 (*16S rDNA*).

Molecular specimen identification was performed using DNA barcoding and phylogenetic analysis. The *COX1* consensus sequence was first queried against the reference sequences on the Barcode of Life Data System v4 (http://www.boldsystems.org) using the BOLD Identification engine (Ratnasingham & Hebert 2007, 2013). Secondly, a phylogenetic analysis was performed combining the sequences of *COX1* and *16S rDNA* for *P. perlatus*, along with 22 other pairs of sequences (*COX1+16S*) from the subfamilies Ibacenae and Arctidinae mined from NCBI (Table 5). The *COX1* and *16S rDNA* sequences were aligned using default MUSCLE parameters (Edgard 2004). The resulting alignment was used to construct a maximum-likelihood (ML) phylogenetic tree with the RAxML 8.2.11 plugin in Geneious Prime 2023.0.4 (Guindon et al., 2010), using the GTR nucleotide evolution model and a gamma distribution. The rapid bootstrapping algorithm and search for the best-scoring ML tree were performed with 1000 bootstrap replicates. The partitioning used for the

evolutionary model was as follows: 1-648 bp for *COX1* and 649-1198 bp for 16S rDNA. Sequences of *COX1+16S* from *Evibacus princeps* were used as outgroups (Table 5).

3. Fecundity.

The fecundity of *P. perlatus* was determined using the described methodology (Kensler 1968) used for the study of *Jasus edwardsi,* the synthesis of which is as follows: The total ovigerous mass of the given ovigerous female was extracted, which was carefully separated from the pleopods and placed in a fine mesh to extract remains of liquid. From this mass, a total weight was obtained. Next, a subsample of 1.0 g of eggs was extracted from this mass and carefully counted. Subsequently, the number of eggs counted in 1 g was multiplied by the weight of the total ovigerous mass to obtain the total number of eggs carried by each ovigerous female (Table 6). . Additionally, the length and width of 25 eggs were measured with a vernier caliper meter foot (precision 0.05 mm), and Spearman's rank correlation coefficient (r_s) was computed in R (Fig. 9). .

4. Stomach content analysis.

The *P. perlatus* specimens were kept frozen to analyze their diet and then transported to the laboratory. There, they were analyzed in their condition to determine whether they were empty or full of content and the degree of digestion the material had reached. The stomachs of each specimen and their contents were extracted. The content was kept in ethanol 70% for later sorting and taxonomic determination to establish the closest species through the available literature (DiSalvo et al., 2007; Ortega-Jiménez et al., 2024)

RESULTS

1 *Parribacus perlatus* (Rarape) morphological and biometric analysis

Today situation of *P. perlatus* in the coastal area of Rapa Nui is shared with the four other species of marine lobsters from the Infraorder Achelata, which have been recorded for the waters of Rapa Nui (Easter Island) (Báez et al. 2022): *Panulirus pascuensis* (Fam. Palinuridae), c. n.: ura, which is the one officially recognized as a fishery. The other four belong to the Scyllaridae family: *Scyllarides roggevenni, S. haanii, Parribacus perlatus,* and *Arctides regalis*. The Palinuridae lobsters are identified by their thin, cylindrical antennae with a long, multi-articulated flagellum, while the Scyllaridae have short, flattened antennae (Holthuis, 1985). Within the Scyllaridae of Rapa Nui, the Subfamily Ibacinae is represented by the genus *Parribacus* and the Subfamily Arctidinae by the genera *Arctides* and *Scyllarides*.

Classification and Checklist of Marine Lobsters from Rapa Nui (Chan 2010)

Kingdom: Animalia
Phylum: Arthropoda
Order: Decapoda
Suborder: Macrura Reptantia Bouvier, 1917
Infraorder: Achelata Scholtz & Richter, 1995
Family Palinuridae, Latreille, 1802
Genus: *Panulirus* White, 1847
Species: *Panulirus pascuensis*, Reed, 1954; type locality: Easter Island
Family: Scyllaridae Latreille, 1825
Subfamily Ibacinae Holthuis, 1985
Genus: *Parribacus* Dana, 1852
Species: *Parribacus perlatus* Holthuis, 1967; type locality: Easter Island
Subfamily Arctidinae Holthuis, 1985
Genus *Arctides* Holthuis, 1960
Species: *A. regalis* Holthuis, 1963; type locality: Hawaii
Genus *Scyllarides*, Gill, 1898
Species: *S. roggeveeni* Holthuis, 1967; type locality: Easter Island
S. *haanii* (De Haan, 1841); type locality: Japan

Key to distinguish the marine slipper lobsters of the genera *Arctides, Scyllarides*, and *Parribacus* found in the Rapa Nui marine environment

1a. Carapace distinctly arched. Dorsal surface of the body relatively smooth, not scaly or tuberculate. Mandibular palp trisegmented 2

1b. Carapace noticeably depressed, with a deep cervical incision along the lateral margin. Dorsal surface of the body coarsely scaly and tuberculate. Mandibular palp bisegmented ..... *Parribacus*

2a. First abdominal somite smooth dorsally, without a transverse groove; shows a pattern of colored spots. Orbits closed in the lower half of the anterior part, either by the intercalated plate or a lobe of the internal orbital angle. Carapace lacking a postorbital spine. Abdominal somites (apart from a median ridge) without distinctive dorsal sculpturing on either side of the midline ..... *Scyllarides*

2b. First abdominal somite with a distinct transverse groove dorsally. Orbits open anteriorly; intercalated plate poorly developed or absent. Carapace with a postorbital spine. Abdominal somites with prominent dorsal sculpture on either side of the midline ..... *Arctides*

Parribacus perlatus Holthuis 1967 was preliminarily described based on the following material: Holotype: A female (CL: 53 mm) which has a spermatophore covering practically the entire first abdominal sternite and was collected in Anakena, NE of Easter Island, on January 19, 1965 by the Medical Expedition 1964-1965 (Sta. F. 90). This specimen was deposited in the collection of the Rijksmuseum van Natuurlijke Historie, Leiden, Netherland (Reg. No. Crust. D. 21257). Of four paratypes, two specimens, a male (CL 40 mm) and a female (CL 43 mm) that had been collected in Anakena on December 30, 1964 by the same expedition were deposited in that same collection (col. Rijksmuseum van Natuurlijke Historie, Reg. No. Crust. D. 21240); the other two female paratypes (CL: 44 and 48 mm), captured in Hanga Ho'onu Bay, NE of Easter Island, on March 16, 1956, they were deposited in the Zoological Museum of Oslo, Norway. Subsequently, other specimens were collected on Easter Island during night torch fishing on January 30, 1976, D-10784: ovigerous female. D-10797: male. D-10800: ovigerous female. D-10950: a juvenile (post larva), III-1978. D-10636: ovigerous female. D-10899: male. Male sizes, CL: 69.9-50.7 mm and CW: 76.0-71.7 mm; females, CL: 63.8-51.7 mm and CW: 84.5-72.9 mm; youth, CL: 25.7 mm and CW: 23.1 mm. The dorsal surface of the body is of variable color between reddish brown and red, with paler spots. All this later material is deposited in the MNHNCL (Báez & Ruiz, 1985).

In the description of *P. perlatus* Holthuis, 1967, some characters were described based on the comparison with some characteristics of the slipper lobsters of the great macrozone of the central Pacific Ocean, namely: *Parribacus caledonicus*, *Parribacus scarlatinus*, and *Parribacus holthuisi*. According to the preliminary description (Holthuis, 1967), the main characteristics that separate it as a distinct species from the others are: *Parribacus perlatus* has six teeth along the outer margin of the fourth antennal segment (excluding the apex), a feature that distinguishes it from *P. caledonicus*. Additionally, *P. perlatus* exhibits less slender teeth on the terminal antennal segment and more robust pereiopods, which differentiate it from *P. scarlatinus*. Additionally, the transverse grooves on the back of the abdominal somites, which are not clearly delimited, separate it from *P. holthuisi*. With the definitive description of *P.perlatus*, complementary observations were added (Holthuis, 1972), where it was emphasized that this species is different from *P. scarlatinus* by the spinulous and rough shell *P. perlatus* presents, in addition to the tuberculous anterior half of the abdominal somites, the elevated anterior part of the carinae, medial dorsals of the second and third abdominal somites, the most robust teeth of the distal segment of the antenna, the most robust legs and the ornamentation of the sternum. In addition, *P. perlatus* also "differs from *P. caledonicus* because *P. perlatus* has a more scabrous shell, as well as the carina of the second and third abdominal somites it presents, along with having only six lateral teeth in the fourth segment of the antenna, as well as by the shape of the sternum" (Holthuis, 1972: p. 47). A complementary morphological background on *P. perlatus* and all other species of the genus and family Ibacinae was later included (Holthuis, 1985).

To understand the situation of *P. perlatus* in the Rapa Nui marine coastal ecosystem and its affinities with some other *Parribacus* slipper lobsters living in the Pacific Ocean, it is necessary to know that already six species of the genus *Parribacus* have been described (Holthuis, 1991), of which four are distributed in the extensive macroregion of the central Pacific. These slipper lobsters are, namely: *P. holthuisi* Forest, 1954 tropical; 12ºS - 26ºS, 154ºW - 13W and distributed in the eastern central Pacific; French Polynesia, from 0 to 5 m depth on sandy bottoms of coral reefs; *P.scarlatinus* Holthuis, 1960 ranges from Kapingamarangi, Micronesia, through the Marshall Islands, Gilbert and Phoenix Islands to the Marquesas, from 0 to 23 m depth; 5ºN -12ºS, 152ºE - 137ºW in shallow waters, on or near reefs; *P. caledonicus* Holthuis, 1960 from Queensland, Australia to Samoa, from 0 to 20 m of depth. Tropical; 9ºS - 26ºS, 150ºE-169W, in surface waters over reefs, generally on the exposed side, often in surge channel (Poupin, J. & M. Juncker, 2010).

Morphological and Biometric Analysis

The TL for *P. perlatus* was significantly different between sexes (*p-value* = 0.0023), ranging from 11.2 to 18 cm in females (mean 14.71 ± 1.43 cm) and from 12.3 to 17.5 cm (mean 15.57 ± 1.15 cm). The CL was also significantly different between sexes (*p-value* = 0.0128), ranging from 5 to 7 cm in females (mean 6.16 ± 0.45 cm) and from 5.1 to 7 cm in males (mean 6.4 ± 0.31 cm). Considering frequency distributions for TL and CL, females also showed a weight significantly lower than males (141.53 ± 29.48 g v/s 156.10 ± 24.81 g, *p-value* = 0.0056) (Fig. 4). The total rarape weight-carapace length linear relationship was weak in females (R^2 = 0.1459) and males (R^2 = 0.2645) (Fig. 5).

Regarding the sex ratio, to date, there is no estimation of the total population sex ratio of *Parribacus perlatus* around Rapa Nui Island. However, the calculated proportion of adults of both sexes of *P. perlatus* coexisting simultaneously on the coral *Porites lobata* captured in Hanga Nui was 1.14:1 (males: females). A recent study (Navarrete-Taito et al., 2025) showed that *P. perlatus* captured on Rapa Nui had CLs ranging from 55 mm to 135 mm. Although the number of measured specimens was low, the size distribution presented a positive asymmetry. As observed in previous studies (Navarrete-Taito et al., 2012; Navarrete-Taito et al., 2021), it was confirmed that the size of *P. perlatus* females was larger than that of the males.

2 Molecular Specimens Identification

DNA barcoding analysis shows that the sequence of our specimen of *P. perlatus* matches that of *P. perlatus* from National Taiwan Ocean University, voucher NTOU M01045 (GenBank Accession No. KJ150685), with 99.51% similarity in the *COX*1 gene. Phylogenetic reconstruction shows a well-defined monophyletic clade for *Parribacus* species, where *P. perlatus* is clearly separated from *P. antarcticus* and *P. japonicus* (Fig. 6). These results indicate a solid specimen identification at the species level. Also, DNA barcoding analysis of *Arctides regalis* specimens confirmed their specific identification with very high confidence (see below).

3 Fecundity of *Parribacus perlatus*

The CL of the captured ovigerous females (April 2019) varied between 5.8 and 6.8 cm. Egg production for this size ranged from 25,631 to 47,678 eggs (average 38,146 ± 6396 eggs) (Tabla 6) (Fig. 7). The eggs of these ovigerous females were at approximately the same stage of development (with a lot of yolk and egg yolk yellow, from light vermilion to pumpkin colored). *Parribacus perlatus* eggs in stage I of embryonic development are ovoid, slightly longer than wider (Fig. 8). Based on the available information obtained from this analyzed material, it was deemed appropriate to recommend a ban on the capture of females with eggs and a ban on the capture of females and males with a CL of less than 70 mm. Regarding the ban on extracting the species, it was also reported, based on our direct observations from 2019 to 2021, as well as the results of interviews w conducted from 2022 to 2025 with experienced divers who have extracted *P. perlatus* on the island. They share their knowledge as: “each year, *P. perlatus* ovigerous females can be seen from October to April of the following year”. *Parribacus perlatus* female sexual maturity would be reached when they have, approximately, a carapace length of 5.5 cm. A spermatophore was observed only once, attached to the first abdominal sternite of an adult female. This finding suggests the onset of the reproductive season for this slipper lobster in the region. A similar condition is observed in the female holotype of *Parribacus perlatus*, which also bears a

spermatophore on the first abdominal sternite and was captured on January 19, 1965. A moderate positive correlation was observed between egg length and width (r_s = 0.594, p = 0.0017, Fig. 9).

4 Stomach contents of *P. perlatus*

No empty stomachs were found. The stomach contents were highly crushed; therefore, a specific taxonomic determination could be reached in only a few cases (Table 7). The main invertebrate species found in the Rarape stomach contents and their habits were mainly based on Rehder, 1980; Osorio, 2018; Codoceo, 1974, and several others:

Phylum Mollusca

Clase Polyplacophora

Familia Mopaliidae

Plaxiphora (Mercatora) mercatoris

In pools from the middle to lower intertidal and up to 15 m deep. Endemic to Rapa Nui Island (Osorio, 2018)

Clase Gastropoda

Familia Cerithiidae

Cerithium sp.

In coral reef

Familia Naticidae

Natica ochrostigmata

In sand and coral bottoms, at a depth of 18 m

Fam. Siphonaridae

Siphonaria sp.

Clase Bivalvia

Familia Nuculanidae

Nuculana anakena

In sand and pebbles between 10 and 100 m deep.

Phylum Echinodermata (irregular)

Familia Brissidae

Brissus latecatrinatus

From the recorded items, it was also observed that *P. perlatus* was consuming the food resources available on the coral *Porites lobata*. These items were: Sediments, indetermined bivalve shell, benthic polychaete, planktonic polychaete, indeterminate organic matter, polyplacophore, porifera, echinoid, gastropod, particles, hydrozoan, foraminifera, gammarid amphipod, algae (highly digested), *Collisella* type gastropod, remains of decapods, and cnidarian. Of these, the highest frequencies were: Sediments (15), decapods (10), calcareous particles (9), and Porifera (7) (Table 7).

Other slipper lobster species found in the same coastal environment where *P. perlatus* lives

Two other Scyllaridae species, namely *Arctides regalis* (c.ns.: Rarape Ura; Ula-papapa, in Hawaii) and *Scyllarides haanii* (c.n.: Rarape Nui), are sporadically collected on the coral *Porites lobata* from the Rapa Nui coastal ecosystem. According to island fishermen, a few specimens of both species are sporadically caught in multipurpose artisanal fishing, scuba diving, or by apnea, and the catches are destined for local consumption and gastronomic tourism.

Arctides regalis (Fig. 10). It is a slipper lobster native to the Hawaiian Archipelago, which was detected a little over two decades ago in the waters around the Hotu Marotiri, Rapa Nui (Retamal 2000 and 2004). Its holotype (Holthuis, 1963 and 2006) is a male specimen (CL: 48 mm), collected from a reef near Coconut Island, Kaneohe Bay, O'ahu, Hawaii, April 1959; it is housed in the carcinological collection of the Rijksmuseum van Natuurlijke Historie (Reg. No. Crustaceans D. 17700). A female paratype (CL: 41mm) also from Hawaii was

initially deposited in the carcinological collection of the Allan Hancock Foundation, Los Angeles, California (Holthuis 2006), and it is now part of the collection of the Natural History Museum of Los Angeles County, U.S.A. (LACMNH). Of the three described species in the genus, *A. regalis* was considered conspecific with *A. guineensis* (Spengler), which is found in the Atlantic Ocean, rather than with *A. antipodarum* Holthuis, a native species of Australian and New Zealand waters. The CL of the examined *Arctides regalis* females captured in Rapa Nui ranged from 41 to 60 mm.

The main morphological characters of *Arctides regalis* are: Carapace with a dorsal surface bearing a row of three simple spines behind the gastric spine (Retamal, 2000). The abdomen has a varied ornamentation on both sides of the midline and broad lobes on the lateral portions. The bare areas are separated from the ornamented areas by narrow, setose sutures that occupy almost half their length, from the second to the fifth segment. The second to fifth ambulatory legs have orange stripes on the propodite, carpopodite, and meropodite. The antennae have a distal margin of the fifth or last segment bearing large denticles, a characteristic that allows for morphological comparison with those of *A. guineensis*. *Arctides regalis* has an extensive geographic distribution in the Indo-western Pacific, Hawaii, Mauritius, La Réunion, Maldives, central Japan, Noumea, New Caledonia, 16 miles east of Johnston Island (larvae, Johnson 1971), and the central Pacific. Its bathymetric distribution in this wide expanse of the Pacific varies approximately 5 to 15 meters; nevertheless, this range could reach 5-50 m. It inhabits caves, more exposed outer sectors (Retamal, 2004), reefs, and lava tubes. Being nocturnal scavengers of habitats, they feed on gastropods, bivalves, crabs, and shrimp (Holthuis, 2006).

These occasional captures of *A. regalis* on *Porites lobata* coral (Table 2 and Fig. 11) allowed us to document the species presence in the coastal ecosystem of Rapa Nui through morphological examination and to complement this with molecular identification of the specimens. Using a male specimen, a molecular analysis was carried out whose results were based on a curated *COX*1 sequence of 673 bp showing a 99.70% identity with *A. regalis* (GenBank Accession No. KJ150685), a native species of Hawaii, along with phylogenetic reconstruction (Fig. 6), thus confirming the solid identification of these specimens as belonging to this species present in the coastal ecosystem of Rapa Nui.

Scyllarides haanii. The background of this second non-native species living now on Rapa Nui, collected in the same coral environment as *Porites lobata* as *P. perlatus* samples, was summarized when it was detected for the first time (Báez et al., 2022).

DISCUSSION

Rapa Nui and the small Salas y Gómez Island are located in the center of the Pacific Ocean, being, on the one hand, the farthest places from other regions of the world and, on the other hand, probably among the least explored marine areas on the planet. There is very little information on seabed characteristics in the sector, and there is a lack of scientific research regarding the characteristics and dynamics of the water masses in this large oceanic region. Consequently, knowledge of the marine species inhabiting this sector remains limited, and most research on benthic invertebrate species there has focused mainly on taxonomic aspects rather than their ecology or entire life cycle. Information on the marine resources of this region is still scarce and, at times, poorly documented, resulting in a limited and incomplete understanding of the marine communities that comprise the surrounding ecosystems. For example, of the Rapa Nui marine lobster species, the only one officially recognized as a fishery is *Panulirus pascuensis*. The overfishing of this palinurid lobster has led to an intensification of catches of another species, the Scyllaridae slipper lobster, *Parribacus perlatus*. However, over time, it has been observed that this species is overfished, as has occurred in the palinurid species already mentioned (Báez & Ruiz, 1985; Boyko, 2003; Navarrete-Taito et al., 2020, 2021, and 2025a). A recently completed scientific project has confirmed the species' high risk of overexploitation and vulnerability (Navarrete-Taito et al., 2025a). However, based on the aforementioned reasons and the limited number of *P. perlatus* (Rarape) specimens collected from the benthic community associated with *Porites lobata*, it has been possible to confirm the taxonomy of *P. perlatus* with accuracy and, more importantly, to clearly distinguish the taxonomy of two additional non-native slipper lobster species that now inhabit the same coral reef environment. In addition to these findings, the analysis of stomach contents has underscored the critical role of the coral *Porites lobata* for *P. perlatus*. This coral provides both food and protection from predators and also serves as a suitable habitat for the two previously mentioned non-native scyllaridean species. Furthermore, *P. lobata*

appears to support key life-history processes in *P. perlatus*, including reproduction, spawning, recruitment, and settlement, thereby providing a secure environment at least until individuals reach sexual maturity. Stomach contents analysis (Table 7) indicates that *P. perlatus* functions as a generalist scavenger and carnivore, primarily feeding on small benthic invertebrates.

Regarding the fecundity of *P. perlatus* (Rarape), the average CL of the ovigerous females analyzed was approximately 6.5 cm. Nearly all individuals were of similar size and were collected from approximately the same location and depth, near Ahu Tongariki (Hanga Nui). All specimens carried eggs at the first stage of embryonic development. Therefore, it is reasonable to hypothesize that these females belong to the same cohort. They were likely retained near the coast, either during their larval stage and/or later as juveniles. Upon reaching the coastal zone and settling on the coral, individuals grow and molt within this protective habitat until the females are fertilized by males, which are also concentrated in the same locality due to the favorable physical and trophic conditions provided by *Porites lobata*. This coral species appears to play a crucial role in the adult life stage of *P. perlatus* in the coastal ecosystem of Rapa Nui, particularly during the early stages of sexual maturity.
The presence of a spermatophore, observed on only one adult female, provides clear evidence of the onset of the reproductive season for this slipper lobster in the region. In terms of fecundity, and for comparison, ovigerous females of *Parribacus caledonicus* with a CL of 70 mm exhibit fecundity levels ranging from 156,000 to 211,000 eggs (Sekiguchi et al., 2007), a range higher than the values recorded for *P. perlatus* to date. The lower fecundity observed in ovigerous females from Rapa Nui is likely associated with their first spawning event upon reaching sexual maturity in the coastal reef environment.

The ovigerous females collected in this study were sampled in mid-December. Notably, the holotype of *P. perlatus* was also a female, collected in Anakena on January 19, 1965, with a CL of 53 mm and a spermatophore covering the entire abdominal sternite. This comparison supports the hypothesis that *P. perlatus* females reach first sexual maturity at the end of spring and the beginning of summer, within the coral reef habitat provided by *Porites lobata*. Likely, our specimens molted earlier, in November, reaching the carapace size associated with the onset of reproductive maturity. Understanding this potential fecundity is essential for estimating the larval contribution of young females to the pelagic ecosystem around Rapa Nui, which is crucial to the sustainability and persistence of *P. perlatus* populations in the region. In general terms, corals constitute one of the most important components of the sublittoral marine ecosystems. Older adult cohorts may inhabit other areas that offer greater protection from predators, particularly around coral colonies. In general terms, because corals are among the most important components of sublittoral marine ecosystems around Rapa Nui, older adult cohorts may inhabit alternative areas that offer greater predator protection, particularly near coral colonies.

Parribacus perlatus and *Arctides regalis* are slipper lobsters from the Rapa Nui coastal ecosystem classified as shallow-water. The ecological role of coral reefs around the island is especially significant for benthic invertebrate species, as their complex structure, characterized by numerous crevices and cavities, provides essential refuges from predation and facilitates key life-history processes such as spawning, recruitment, and settlement (Wieters et al., 2014). Coral reefs, therefore, represent a critical habitat within the Rapa Nui coastal ecosystem, offering optimal conditions for larval settlement (Montano, 2022) and functioning as the most favorable environment during the reproductive season (Ellison, 2019; Soto, 2020).

Essentially, the subtropical waters surrounding Rapa Nui are part of an oligotrophic system characterized by limited input of organic matter (Fernández et al., 2014). Within this environment, the majority of coastal fish species, including slipper lobsters, depend on hard substrates, on which 13 coral species have been documented to settle (Guevara, 2019; based on Glynn et al., 2003 and 2007).

Consequently, it appears reasonable to assume that slipper lobsters settle on corals at the end of their larval stage to obtain both food and protection. Additionally, by inhabiting coral areas, these lobsters play an essential ecological role as prey for fish species that frequent these habitats. In this context, the presence of slipper lobsters has been identified in the stomach contents of a juvenile specimen of the serranid fish *Acanthistius fuscus* (DiSalvo et al., 2007).

Arctides regalis and *Scyllarides haanii* are considered foreign species introduced into the coastal ecosystem of Rapa Nui (Báez et al., 2022). Therefore, it seems advisable and timely to recommend the commercial capture

of both introduced species, which are now more readily recognizable (Navarrete-Taito et al., 2025a). This is a favorable scientific observation and a practical control measure to be considered in future management measures aimed at reducing and avoiding instances of competition, whether for space, food, or another aspect not yet considered, that could be unfavorable for the endemic species of Rapa Nui. Like *P. perlatus*, they require maximum protection because their entire potential has not yet been fully evaluated, and any introduced disequilibrium could directly affect their population and indirectly affect the coastal ecosystem's resilience. An annual study of *P. perlatus* is required to complete the knowledge about its reproduction and to complement the fecundity knowledge of larger females and their distribution around the island. It is necessary to know how many times *P. perlatus* molts per year. The same is needed for all scyllarid species living in the Rapanuinan Province, based on the specimens' sizes and their cohorts' growth. To complete the study of the life cycle of the Scyllaridae species on Rapa Nui, including both adult and larval stages, is a condition noted for other Scyllaridae species, with various nuances and variations (Lavalli & Spanier, 2007).

Parribacus perlatus warrants stringent protection, given that its ecological role and biological potential remain insufficiently characterized. Any perturbation arising from the introduction of non-native species could directly affect its population dynamics and, consequently, undermine the resilience of the coastal ecosystem. It is imperative to conduct an annual comprehensive study of *P. perlatus* to advance understanding of its reproductive biology and to augment current knowledge of the fecundity of larger females and their spatial distribution across the island. Additionally, elucidating the annual molting frequency of *P. perlatus* is essential. This investigative framework should be extended to encompass all scyllarid species in the Rapa Nui Province, with due consideration of specimen size and cohort growth patterns.

A thorough examination of the life cycle of Scyllaridae species inhabiting Rapa Nui, including both adult and larval developmental stages, is an indispensable prerequisite, as previously underscored in studies of other Scyllaridae taxa that reveal significant biological nuances and variations (Lavalli & Spanier, 2007).

Parribacus perlatus is a species of flattened spiny lobster, native and endemic to Rapa Nui (Easter Island) and Motu Motiro Hiva (Salas y Gómez Island). Due to its local gastronomic value and relative ease of capture, the species has been hypothesized to be highly vulnerable to overfishing over time. This hypothesis was supported by recent findings from a scientific project (Navarrete-Taito et al., 2025a), which evaluated the species' current conservation status and classified it as high risk. To fully understand the status of *P. perlatus*, it is essential to consider the broader ecological role of benthic species within the coastal ecosystem of Rapa Nui, particularly their interactions with coral reef habitats. In late August 2025, based on the available scientific evidence and in application of the precautionary principle, *P. perlatus* was officially recognized as a target species in the island's fisheries. This decision, supported by the Rapa Nui Ocean Council and the Chilean Subsecretaría de Pesca y Acuicultura (Undersecretariat of Fisheries and Aquaculture), includes implementing management measures to regulate its harvest in its native coastal habitat. It is expected that these regulatory actions will help prevent further decline of *P. perlatus* populations and contribute to the sustainable management of this ecologically and culturally important species.

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Anexo 1

746 **Table 1.** *Parribacus perlatus*. Capture data of collected specimens (n = 104).

Collection Date	Location	Methods	Sex		Total
			Male	Female	
2019-12-19	Hanga Nui	Scuba diving	5	14 (10)*	19
2020-04-27	Hanga Nui	Scuba diving	35	25	60
2021-12-27	Hanga Nui	Apnea	5	2 (1)*	7
2023-05-13	Hanga Ho'onu	Apnea	11	7	18
		Total	56	48	104

747 * In brackets: ovigerous female.
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750 **Table 2.** *Arctides regalis*. Measurement of specimens collected (n=7) on the coral *Porites lobata.*

Date	Location	Collection method	Sex	CL (cm)	TL (cm)	Wide (cm)	Weight (g)
2019-08-04	Anakena	Scuba diving	Female	5.60	12.10	-	-
2020-01-25	Anakena	Scuba diving	Male	4.55	10.40	3.90	-
2020-04-27	Ana o keke	Apnea	Female	6.43	13.10	4.36	7.20
2020-04-27	Ana o keke	Apnea	Male	5.12	12.02	4.21	5.41
2020-07-17	Poike	Apnea	Male	5.11	12.72	4.44	6.56
2020-07-17	Poike	Apnea	Female	4.52	11.52	4.02	4.96
2021-05-05	Hanga Nui	Apnea	Male	4.10	9.70	3.33	3.58
			Mean	5.06	11.65	4.04	5.54
			SD	0.78	1.22	0.40	1.41

751 SD: standard deviation.
752

753 **Table 3.** *Scyllarides haanii.* Measurement of specimens collected (n=6) on the coral *Porites lobata*.
754

Collection Date	Location	Sex	CL (cm)	TL (cm)	Wide (cm)	Weight (g)
Dic-2019	Hanga Nui	Male	11.00	28.20	10.21	780.00
Jul-23	Hanga Nui	Male	12.23	27.83	9.88	665.00
May-22	Hanga Nui	Female	13.30	31.50	10.70	82000
May-23	Hanga Nui	Female	12.05	29.51	10.95	717.00
May-24	Hanga Ho'onu	Female	14.50	34.93	12.46	889.95
May-24	Hanga Ho'onu	Female	13.00	29.00	1161	675.00
		Mean	12.68	30.16	10.97	757.83
		SD	1.20	2.67	0.94	88.27

755 SD: standard deviation.

756
757

Table 4. *Parribacus perlatus*. PCR primers used to amplify either *COX1* or *16S rDNA* and M13 sequencing primers (underlined).

Name	Cocktail name / Primer sequence 5′–3′
	COX1 (Folmer et al., 1994):
LCO1490/M13	TGTAAAACGACGGCCAGTGGTCAACAAATCATAAAGATATTGG
HCO2198/M13	CAGGAAACAGCTATGACTAAACTTCAGGGTGACCAAAAAATCA
	16S rDNA (Palumbi et al., 2002):
16sar-L/M13	TGTAAAACGACGGCCAGTCGCCTGTTTATCAAAAACAT
16sar-H/M13	CAGGAAACAGCTATGACC CGGTCTGAACTCAGATCACGT
	M13 universal sequencing primers:
M13-FP	TGTAAAACGACGGCCAGT
M13R-pUC	CAGGAAACAGCTATGAC

764 **Table 5**. Scyllaridae material, place or country, voucher number, GenBank Accession numbers of sequences
765 used in this study.

Species	Voucher	Place, Country	GenBank Accession Numbers	
			COX1	*16S rDNA*
Subfamily Ibacinae:				
Evibacus princeps	KC6347	Mexico	JN701658 (1)	JN701693 (1)
Ibacus alticrenatus	KC6080	Australia	JN701659 (1)	JN701694 (1)
Ibacus ciliatus	NTOU M00974	Taiwan	JN701661 (1)	JN701696 (1)
Ibacus chacei	KC6083	Australia	JN701662 (1)	JN701697 (1)
Ibacus peronii	KC6085	Australia	JN701664 (1)	JN701699 (1)
Parribacus antarticus	NTOU M00975	Taiwan	JN701666 (1)	JN701701 (1)
Parribacus perlatus	n.a.	Rapa Nui, Chile	MW699537 (2)	OR230010 (2)
Parribacus japonicus	n.a.	Japan	OK341217 (3)	OK341213 (3)
Subfamily Arctidinae:				
Arctides regalis	n.a	Rapa Nui, Chile	MW699538 (2)	OR230012 (2)
Arctides regalis	MNHN-IU-2009-462	Reunion	JN701651 (1)	JN701685 (1)
Arctides regalis	KC6004	Hawaii, USA	JN701653 (1)	JN701687 (1)
Scyllarides squammosus	NTOU M02303	Hepingdao, Taiwan	OP379522 (4)	OP379972 (4)
Scyllarides squammosus	NTOU M00972	Taiwan	JN701654 (1)	JN701689 (1)
Scyllarides squammosus	n.a.	China	MK783265 (5) *	
Scyllarides squammosus	NSMT-Cr 30950	Ogasawara, Japan	OP379523 (4)	OP379973 (4)
Scyllarides brasiliensis	KC6292	n.a.	KF827966 (6)	KF828186 (6)
Scyllarides haanii	n.a.	n.a.	MN817127 (7) *	
Scyllarides haanii	KC6018	Hawaii, USA	JN701656 (1)	JN701690 (1)
Scyllarides deceptor	CCDB BRA 4190	Brazil	MF490045 (8)	MF490148 (8)
Scyllarides latus	n.a.	n.a.	KC107814 *	
Scyllarides latus	FP0014	n.a.	FJ174947 (10)	FJ174907 (10)
Scyllarides herklotsii	ICMD 2301998	Eastern Atlantic Ocean	FJ174946 (10)	FJ174906 (10)
Scyllarides nodifer	ULLZ7845	Gulf of Mexico, USA	JN701657 (1)	JN701692 (1)

766 n. a.: not available.
767 (1) Yang et al. (2012); (2) This study; (3) Chow S. and Yanagimoto T., unpublished; (4) Hidaka et al. (2022);
768 (5) Liu et al. (2019); (6) Bracken-Grissom et al. (2014); (7) Liu et al., unpublished; (8) Mantelatto et al.
769 (2017);
770 (9) Shen et al. 2013; (10) Palero et al. (2009); * *COX1* and *16S rDNA* partial sequences were extracted from
771 the mitochondrial genome.
772
773

774 **Table 6.** *Parribacus perlatus*. Fecundity of ovigerous females, captured on 17/12/2019 in the southern
775 coastline sector Ana o Keke of Rapa Nui.
776

Ovigerous female	CL (cm)	Ovigerous mass total weigth (g)	Eggs/1 g	Eggs total number
1	5.80	9.78	3756	36734
2	6.30	9.18	2792	25631
3	6.30	12.76	3574	45604
4	6.00	10.60	3760	39856
5	6.80	13.32	2988	39800
6	6.10	9.54	3356	32016
7	6.40	11.26	3544	39905
8	6.60	12.20	3908	47678
9	6.80	8.26	4166	34411
10	6.00	10.52	3786	39829
Mean	6.31	10.74	3563	38146
SD	0.345	1.64	418.57	6396

777 SD: standard deviation.
778

779

780 **Table 7.** Frequencies of the items found in the stomachal contents of *Parribacus perlatus* collected on the
781 coral *Porites lobata* the area near Tongariki, Hanga Nui.

		Stomach content with the ítem found			
Nº	Item	Males	Females	Total	%
1	Sediments (sand)	1	2	3	4,56
2	Organic matter indet.	5	10	15	20,04
3	Calcareous particles	3	6	9	12,32
4	Algae	1	1	2	2,74
5	Foraminifers	2	0	2	2,74
6	Porifera	0	7	7	9,59
7	Cnidarians	0	1	1	1,37
8	Benthic polichaetes	3	2	5	6,05
9	Planctonic polichaetes	1	0	1	1,37
10	Bivalve shells	2	2	4	5,48
11	Polyplacophorans	2	0	2	2,74
12	Gastropods	0	5	5	6,05
13	Gammaridean amphipod indet.	2	0		2,74
14	Decapods	1	9	10	12,10
15	Irregular sea urchin	1	4	5	6,05
Total		24	49	73	**100**
%		32,88	67,12	100	

782

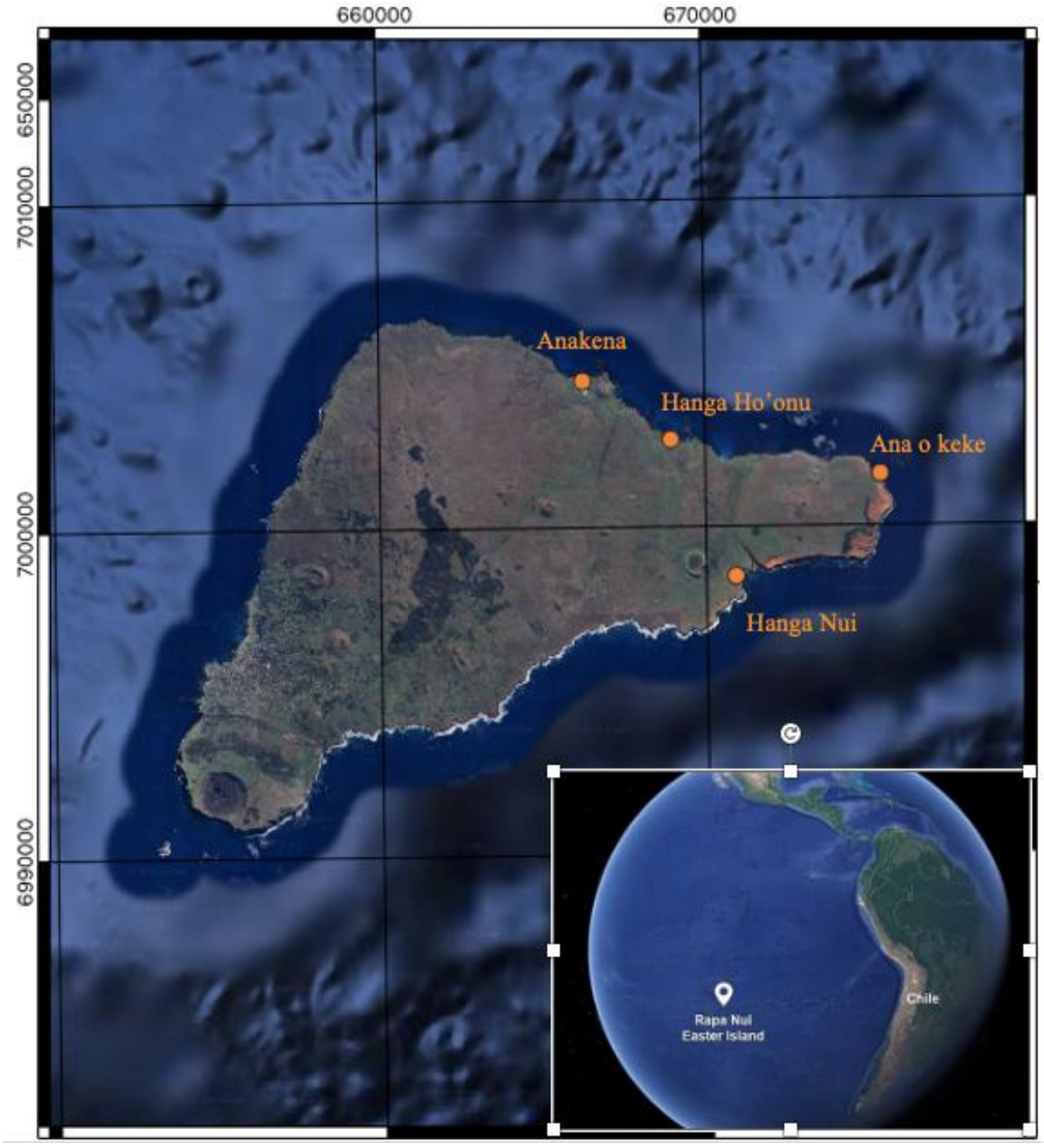


Figure 1. Study area and coastal sampling sites for *Parribacus perlatus* within the Multiple-Use Marine Coastal Protected Area of Easter Island (Rapa Nui).

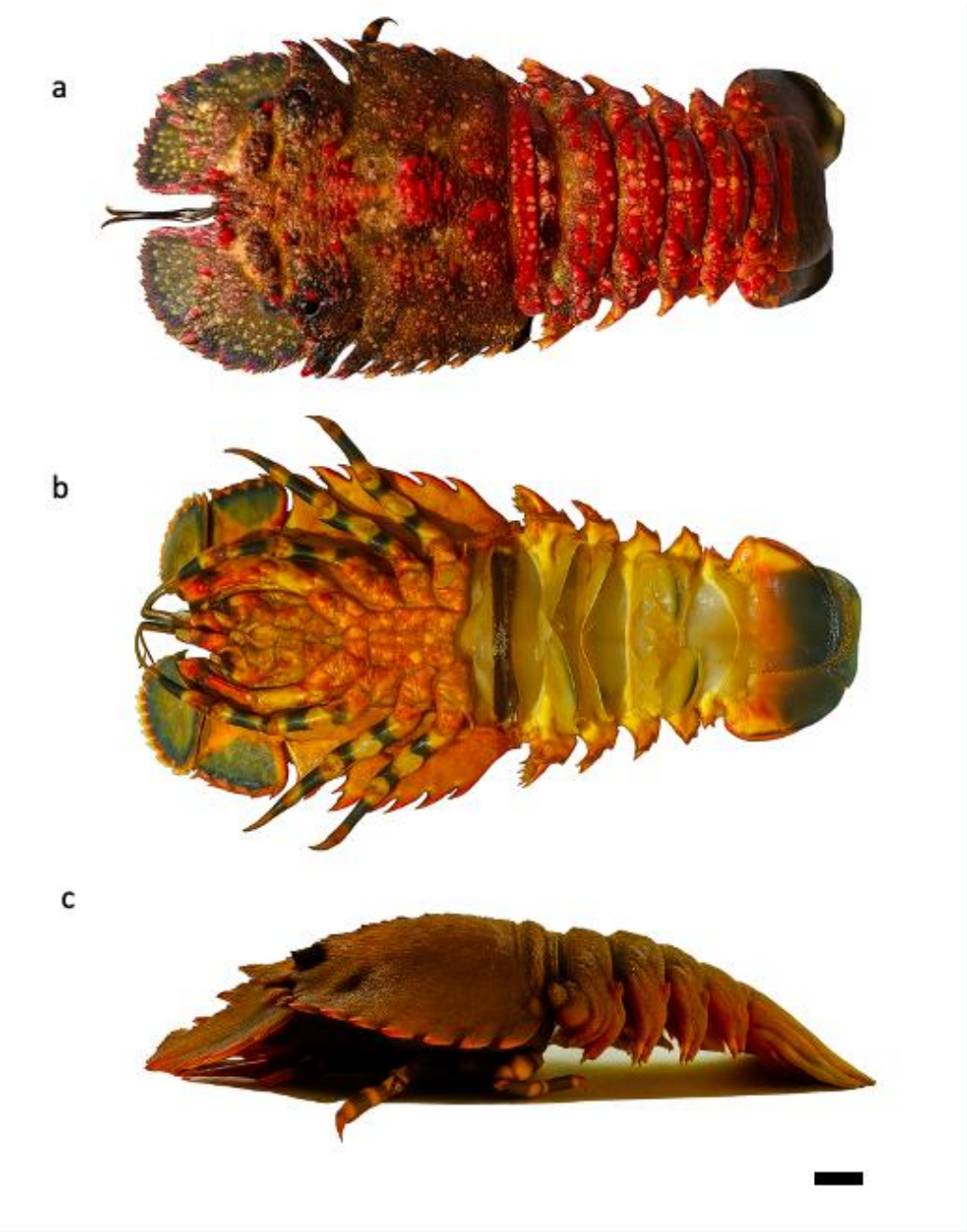


Figure 2. *Parribacus perlatus* living on the coral *Porites lobata* in Rapa Nui (Easter Island): a) Dorsal view of a male specimen, b) ventral view of the same specimen, c) side view. Scale bar: 15 mm



a)



b)

Figure 3. a) and b): *Parribacus perlatus* specimens living on the coral *Porites lobata* Rapa Nui (Easter Island). (LT: 13 cm).

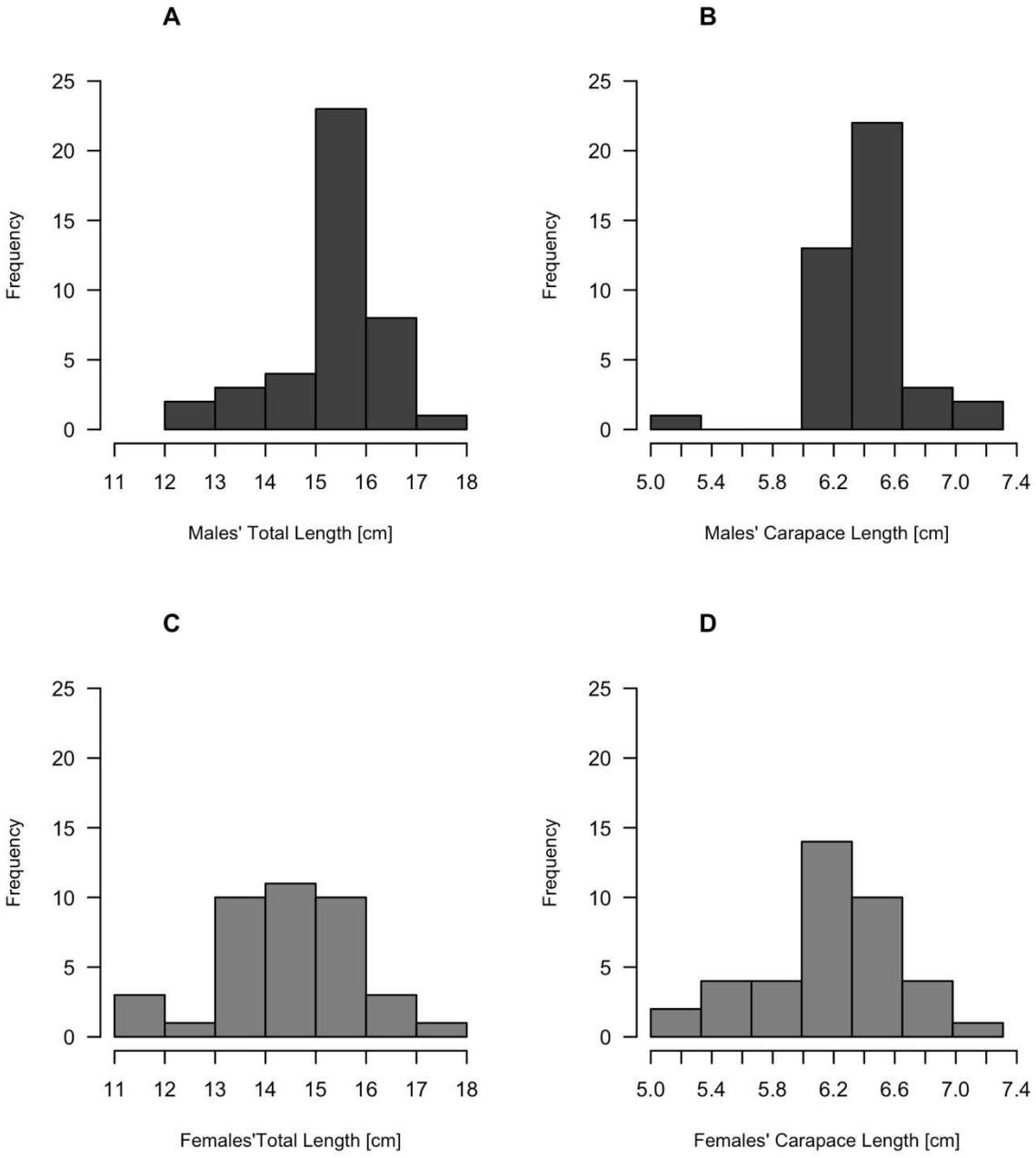


Figure 4. *Parribacus perlatus* size frequency distributions of males (n=41) and females (n=39) from the area between Ana o Keke and Maunga Parehe: A and B males' TL and CL, respectively. C and D females' TL and CL, respectively.

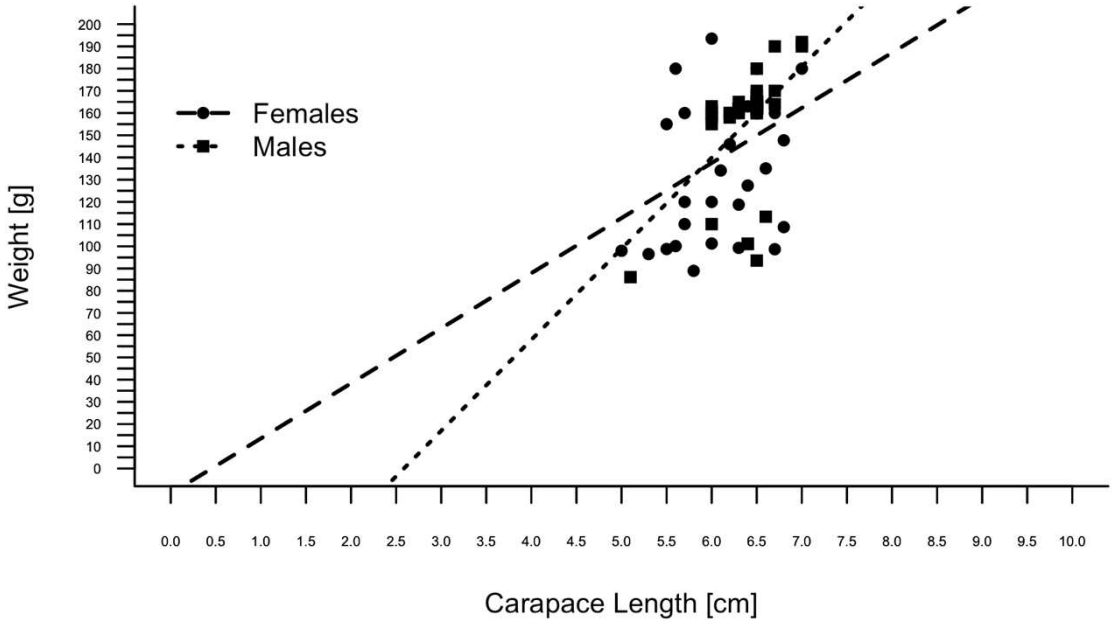


Figure 5. *Parribacus perlatus* Length-weight relationships for females and males. Specimens collected from the area located between Ana o Keke, Rapa Nui

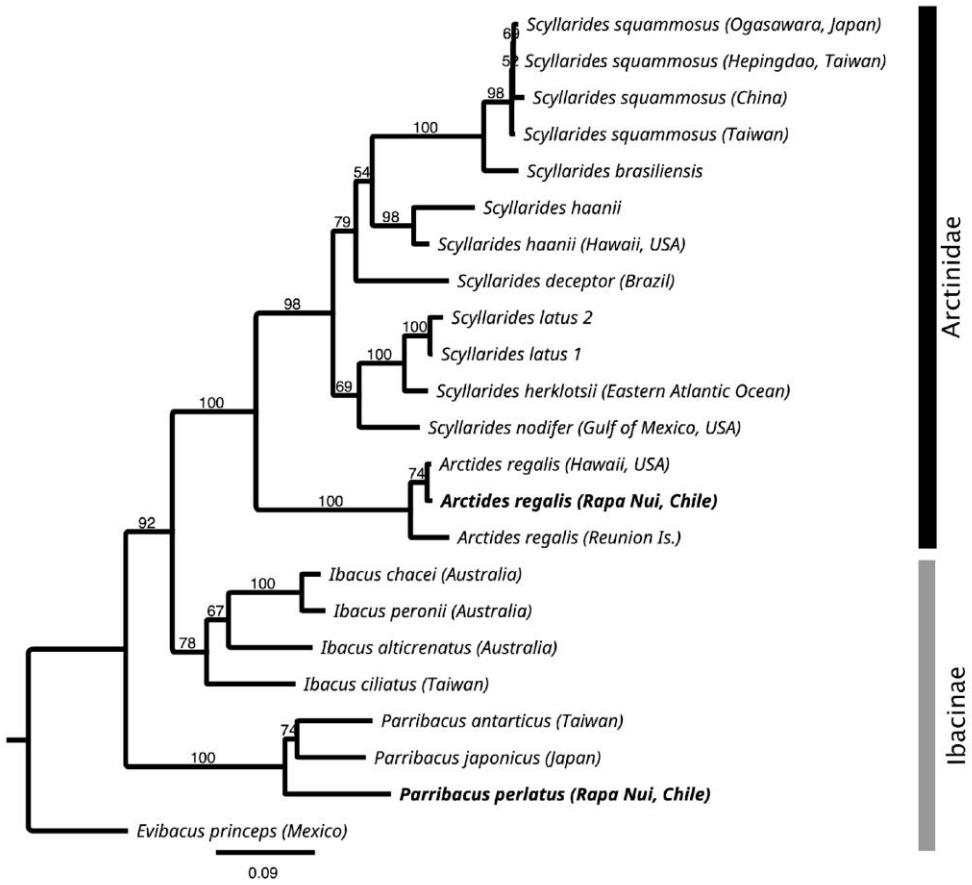


Figure 6 RAxML maximum likelihood tree based on partial sequences of *COX1* and *16S rDNA*. Bootstrap values support are shown in each node (>50). The geographical location of the sample is shown in parentheses. The GenBank Accession numbers of sequences used are shown in Table 5.



Figure 7 *Parribacus perlatus.* Ventral view of an ovígerous female collected on the coral *Porites lobata* near Tongariki,Hanga Nui, Rapa Nui . Scale bar: 10 mm



Figure 8 Cluster of eggs extracted from the ovigerous mass. Scale bar: 1 mm

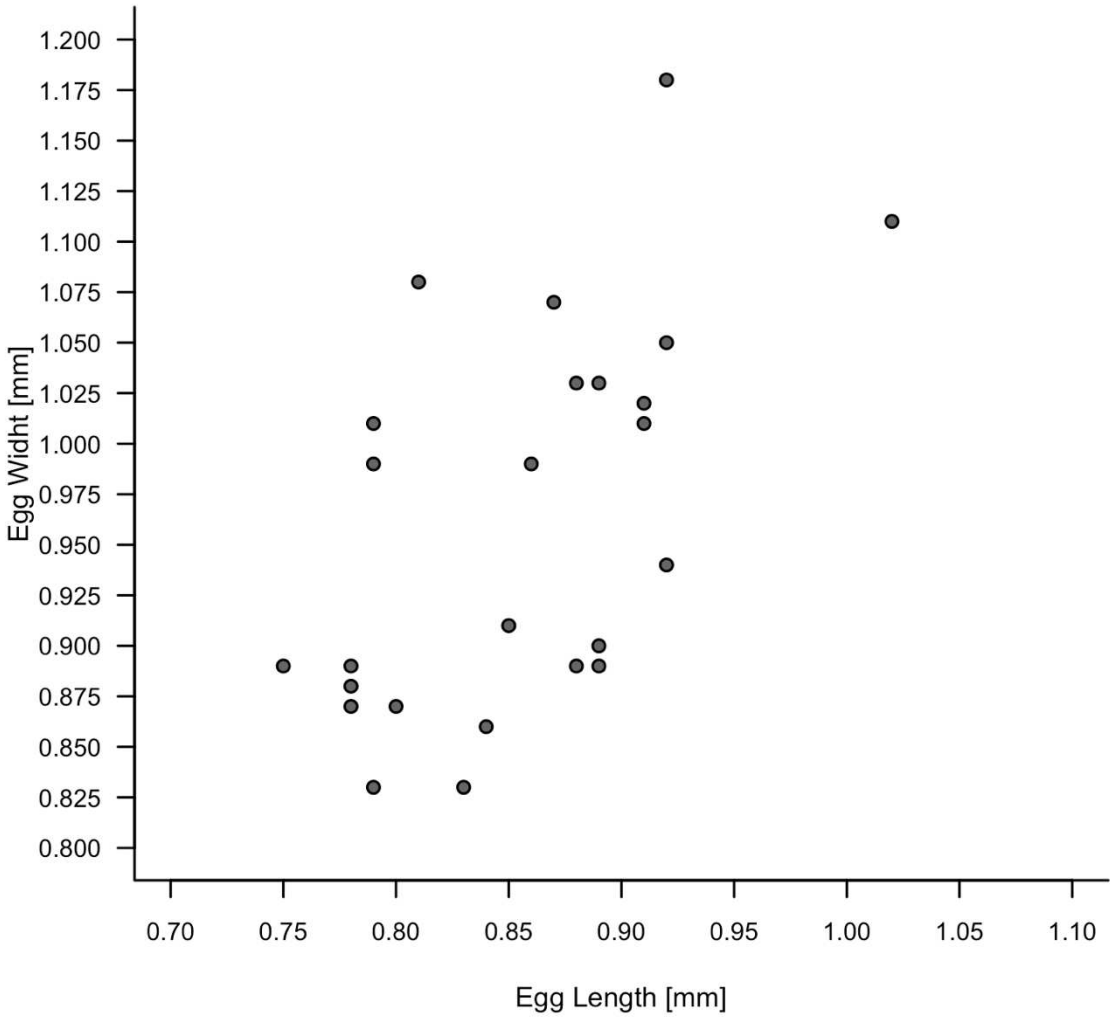


Figure 9. Relationship between egg length and egg width for *P. perlatus* (n = 25).

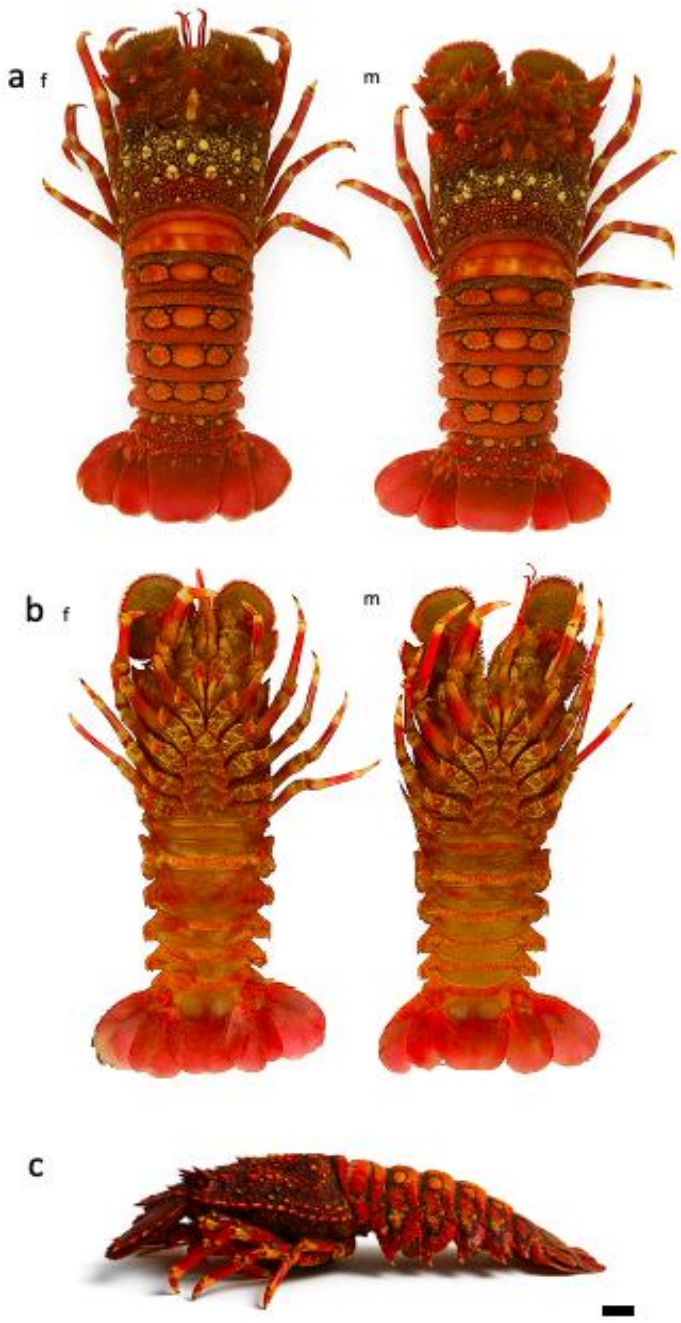


Figure 10. *Arctides regalis* specimens captured living on the coral *Porites lobata* near Tongariki, Hanga Nui, Rapa Nui; a) Dorsal view of female (f) and male (m); b) Ventral view of female (f) and male (m); c) Lateral view of a female. Scale bar: 15 mm



Figure 11 *Arctides regalis*. Specimen on the coral *Porites lobata* in the subtidal Rapa Nui coastal marine ecosystem (LT: 12,5 cm).