

A new species of *Munida* Leach, 1820 (Crustacea: Decapoda: Anomura: Munididae) from seamounts of the Nazca-Desventuradas Marine Park

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ABSTRACT

Munida diritas sp. nov. is described for the seamounts near Desventuradas Islands, in the intersection of the Salas & Gómez and Nazca Ridges, Chile. Specimens of the new species were collected in the summit (~200 m depth) of one seamount and observed by ROV at two nearby ones. This species is characterized by the presence of distinct carinae on the thoracic sternites 6 and 7. Furthermore, it is not related with any species from the continental shelf nor the slope of America, while it is closely related to species of *Munida* from French Polynesia and the West-Pacific Ocean (i.e., *M. ommata*, *M. psylla* and *M. rufiantennulata*). In situ observations indicate that the species lives among the tentacles of ceriantarid anemones and preys on small crustaceans. The discovery of this new species adds to the knowledge of the highly endemic benthic fauna of seamounts of the newly created Nazca-Desventuradas Marine Park, emphasizing the relevance of this area for marine conservation.

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INTRODUCTION

Although recognized by their high levels of diversity and endemism, the seamounts located in the Salas & Gómez (SGR) and Nazca Ridges (NR), in the Southeastern Pacific (SEP), are among the most remote and least explored marine ecosystems (*Parin, Mironov & Nesis, 1997; Poupin, 2003; Poupin, 2008; Gálvez-Larach, 2009; Fernández et al., 2014; Easton et al., 2017*). In order to preserve this ecosystem, a marine protected area was created in 2016, the Nazca-Desventuradas Marine Park (NDMP), covering ~300,000 km² and comprising the intersection of the SGR-NR and the Desventuradas Islands (San Ambrosio and San Felix Islands) within the Chilean exclusive economic zone (EEZ).

The biodiversity information for SGR and NR has been mainly focused outside the Chilean EEZ (mainly west of ~83°W), where 22 seamounts were explored between 1973

and 1987 by research expeditions from the former Soviet Union (*Parin, Mironov & Nesis, 1997*), representing only ~3% of the seamounts that make up both dorsal ranges. Within the Chilean EEZ, the CIMAR 6 cruise (CONA, 2000) and the “Pristine Seas Expedition” (National Geographic OCEANA, 201) multidisciplinary expeditions studied the shallow subtidal zone of Salas & Gómez Island and Desventuradas Islands (DI) and Guyot Stockman (*Gálvez-Larach, 2009; Fernández et al., 2014*). Each new expedition has added new records and/or new species for science, mainly including crustaceans, echinoderms, fishes and mollusks (*Poupin, 2003; Retamal, 2004; Fernández et al., 2014; Easton et al., 2017; Sellanes et al., 2019*).

Decapod crustaceans (mainly brachyurans) are among the taxa that included more new species or range extensions through this area in the last years, as reported by *Zarenkov (1990; URRS expeditions), Retamal (2001), Retamal (2004) and Retamal & Arana (2016)*. It remains curious that only a few species of squat lobsters have been ever reported for this vast area, despite the fact that this group is generally abundant and species-rich in several marine ecosystems, particularly in seamounts (*Schnabel et al., 2011*). *Phylladorhynchus pusillus* (Henderson, 1885) and *P. integrirostris* (Dana, 1852), belonging to the Galatheidae, have been reported for Easter Island, Salas & Gómez Island and the Juan Fernández archipelago, from the subtidal to 80 m depth (*Retamal, 2004; Baba et al., 2008*). Some deep-sea species of Munidopsidae, e.g., *Galacantha bellis* Henderson, 1885, *Munidopsis antonii* (Filhol, 1884) have been cited in the Juan Fernández area (*Andrade, 1985; Macpherson, 2007*), along the East Pacific Rise (*Liu, Li & Lin, 2020*) and southern French Polynesia seamounts (*Macpherson, 2013*).

In the present study we describe a new species of *Munida* for the NDMP, collected during the CIMAR 22 expedition. We also provide genetic data of the new species, assessing its phylogenetic relationships with congeners, as well as insight on its habitat, based in underwater imagery obtained with a remotely operated vehicle (ROV).

METHODOLOGY

The samples were obtained aboard the research vessel AGS-61 “Cabo de Hornos”, between October 22 and November 11, 2016, during the multidisciplinary oceanographic cruise CIMAR 22 “Oceanic Islands”. The aim of the cruise was to study benthic habitats and fauna of unexplored seamounts of the Juan Fernández and Desventuradas Ecoregion (*Fig. 1*) (*Spalding et al., 2007*); ecoregion number 179; *Sellanes et al., 2019*). Eleven visual observations of the study sites were conducted, using an ROV (Commander MK2; Mariscop Meerestechnik, Kiel, Germany) equipped with a HD Camcorder (Panasonic SD 909) and laser pointers (10 cm apart). Collections were performed at 10 sites (150 to 340 m depth) using a modified Agassiz trawl with a mouth of 1.5 m × 0.5 m (width × height) fitted with a net of 12 mm mesh at the cod end, and operated in 10 min hauls (bottom contact) at ~3 knots. The collected material was preserved in 95% ethanol (*Sellanes et al., 2019*). Type material and paratypes specimens were deposited in the MNHNCL, SCBUCN and MNHN. Sample collection was performed under permission Res. Ext N°3685/2016 from SUBPESCA (Chile) to Universidad Católica del Norte.

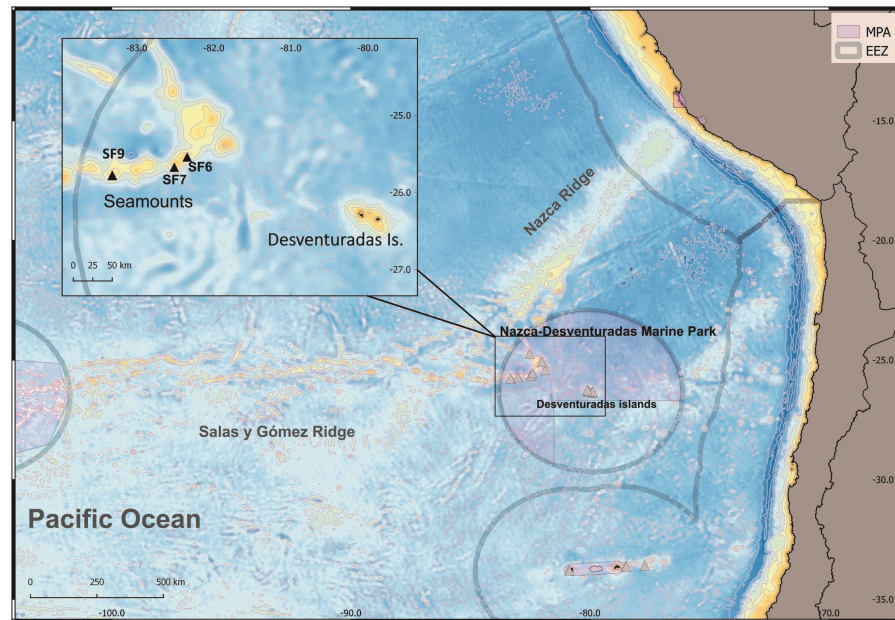


Figure 1 Map of the study area explored during the CIMAR22 cruise, comprising seamounts from Salas & Gómez and Nazca Ridges, Desventuradas Islands and the Juan Fernández Archipelago. Grey lines represent the Chilean exclusive economic zones (EEZ, continental and insular). Grey triangles: sampling points. *Munida diritas* sp. nov. was collected in seamounts SF9 and was observed in situ (ROV, see Video S1) in SF6 and SF7 seamounts. Credits for the map: Ariadna Mecho.

Full-size DOI: 10.7717/peerj.10531/fig-1

The terminology employed in the descriptions largely follows *Baba et al. (2009)* and *Macpherson & Baba (2011)*. The length of the carapace (CL) indicates the postorbital length measured along the dorsal midline from the posterior margin of the orbit to the posterior margin of the carapace. The length of each pereopod article is measured in lateral view along its extensor margin (excluding distal spine), the breadth is measured at its widest portion. Other abbreviations used are: Mxp3 = maxilliped 3; P1, pereopod 1; P2–4, pereopods 2–4.

Molecular analysis

The protocol described by *Macpherson, Rodríguez-Flores & Machordom (2017)* was used for DNA extraction: Tissue of one specimen (MNHN-IU-2014-13931) was isolated from the muscle of the fifth pair of pereopods and homogenized overnight with 20 μ l proteinase K in 180 μ l of buffer ATL (QIAGEN). The extraction was performed using DNeasy Blood and Tissue Kit following manufacturer instructions (QIAGEN). One molecular marker was amplified: a 16S rRNA (16S) fragment, using 16SAR-16SBR from (*Palumbi et al., 1991*) pair of primers.

The pre-mixing of the PCR reagents was built in 25 μ l total volume, which included 2 μ l of DNA extracted, 0,2 mM of each deoxyribonucleotide triphosphate (dNTP), 0,2 μ M

of each primer forward and reverse, 2U of MyTaq polymerase (Bioline), 5 μ l of 5x buffer solution with MgCl₂ and sterilized water. PCR amplification was performed with a thermal cycle including an initial denaturation of 94–95° for 1–4 min and 40 cycles with 95° for 1 min, annealing in 42–45° for 1 min followed by an extension set on 72° for 1 min. A final extension cycle at 72° C was set for 10 min. The amplicons were visualized in agarose 1% gels and purified using ExoSAP-IT™ PCR Product Cleanup Reagent (Thermo Fischer) before sequencing. The purification products were sent to Secugen S.L. (Madrid) for DNA Sanger sequencing (protocol described by [Rodríguez-Flores, Macpherson & Machordom, 2020](#)).

The nucleotide sequences (forward and reverse) were visualized and assembled with Sequencher 4.10.1 software package (Gene Codes Corp.). Manual alignment for the 16S genes was carried out in MAFFT ([Kato et al., 2002](#)) and the revised in AliView ([Larsson, 2014](#)), (protocol described by ([Rodríguez-Flores, Macpherson & Machordom, 2020](#))).

One hundred and fourteen 16S rRNA sequences of *Munida* spp., *Raymunida* spp., *Leiogalthea ascanius*, *Eumunida sternomaculata*, *Cervimunida johni* and *Pleuroncodes monodon* available in NCBI GenBank ([Table S1](#)) were extracted and aligned with the one of *Munida diritas* sp. nov., using default MUSCLE ([Edgar, 2004](#)) parameters. In species where there were more than three sequences of this marker, only three were chosen to consider intraspecific genetic variation in the analysis. The resulting alignment of 556 pb was used to construct the maximum likelihood phylogenetic tree with the PHYML 3.0 software ([Guindon et al., 2010](#)) and the Geneious Prime 2020 1.1 ([Kearse et al., 2012](#)) plugin, using the following settings: bootstrap replicates = 1,000, optimize = Topology/length/rates, Topology search = NNI, nucleotide model substitution = GTR. Significant bootstrap values (>90) are reported at the nodes. *Leiogalthea ascanius*, *Eumunida sternomaculata* and *Raymunida* spp. were used as outgroup. In addition, the locality and biogeographical realm (see [Spalding et al., 2007](#)) where each specimen was collected, was included in [Table S1](#).

Nomenclature

The electronic version of this article in Portable Document Format will represent a published work according to the International Commission on Zoological Nomenclature (ICZN), and hence the new names contained in the electronic version are effectively published under that Code from the electronic edition alone. This published work and the nomenclatural acts it contains have been registered in ZooBank, the online registration system for the ICZN. The ZooBank LSIDs (Life Science Identifiers) can be resolved and the associated information viewed through any standard web browser by appending the LSID to the prefix <http://zoobank.org/>. The LSID for this publication is: LSID: *Munida diritas* sp. nov. urn:lsid:zoobank.org:pub:4F3C623C-0C27-4AEA-B303-E6A86CF4FEA1. The online version of this work is archived and available from the following digital repositories: PeerJ, PubMed Central and CLOCKSS.

RESULTS

Systematic account

Superfamily: Galatheoidea Samouelle, 1819

Family: Munididae Ah Yong, Baba, Macpherson & Poore, 2010

Genus: *Munida* Leach, 1820

Munida diritas sp. nov. Gallardo & Macpherson

(Figs. 2 and 3)

Material examined:

Holotype: MNHNCL DEC-15175 (ex-SCBUCN-7266) (Figs. 2 and 3), CL: 5.0 mm, male, seamount off the coast of Chile, CIMAR 22 cruise, station SF9, 25°46.8'S, 83°9.6'W, 27 October, 2016, ~200 m depth.

Paratypes: ovigerous female, CL: 4.2 mm (MNHN-IU-2014-13931, ex SCBUCN-8677); male, CL: 3.6 mm (MNHNCL DEC-15176); male, CL: 3.9 mm (SCBUCN-7265); female, CL: 3.5 mm (SCBUCN-7991); ovigerous female, CL: 3.8 mm (SCBUCN-7992); all locations same as holotype.

Description: *Carapace:* Slightly longer than wide. Transverse ridges mostly interrupted without secondary ridges between them. Main transverse ridges on posterior part of carapace interrupted in cardiac region. Ridges with dense short, not iridescent setae, and few scattered long iridescent setae. Gastric region with one row of eight epigastric spines, largest pair just behind supraocular spines. One parahepatic, one postcervical and one branchial dorsal spine on each side. Frontal margins slightly oblique. Lateral margins slightly convex. Anterolateral spine well-developed, situated at anterolateral angle, not reaching to level of sinus between rostrum and supraocular spines; second marginal spine before anterior branch of cervical groove smaller than preceding one. Branchial margins with four spines, decreasing in size posteriorly. Rostrum horizontal, slightly sinuous, about 0.5 times length of remaining carapace. Supraocular spines nearly reaching midlength of rostrum and clearly not reaching distal corneal margins, subparallel and slightly directed upwards.

Sternum: Sternite 4 trapezoidal, with few short striae, anterior margin widely contiguous to sternite 3. Distinct short carinae on lateral surfaces of sternites 6 and 7.

Pleon: Pleonites 2 and 3 each with one transverse ridge behind anterior ridge; anterior ridge of somite 2 unarmed; pleonite 4 and 5 smooth; posteromedian margin of pleonite 6 straight.

Eyes: Small, maximum corneal diameter 0.4 distance between bases of anterolateral spines.

Antennule: Article 1 with 2 well-developed subequal distal spines; two spines on lateral margin, proximal one short, located at midlength of article, distal much longer than proximal and reaching end of distal spines.

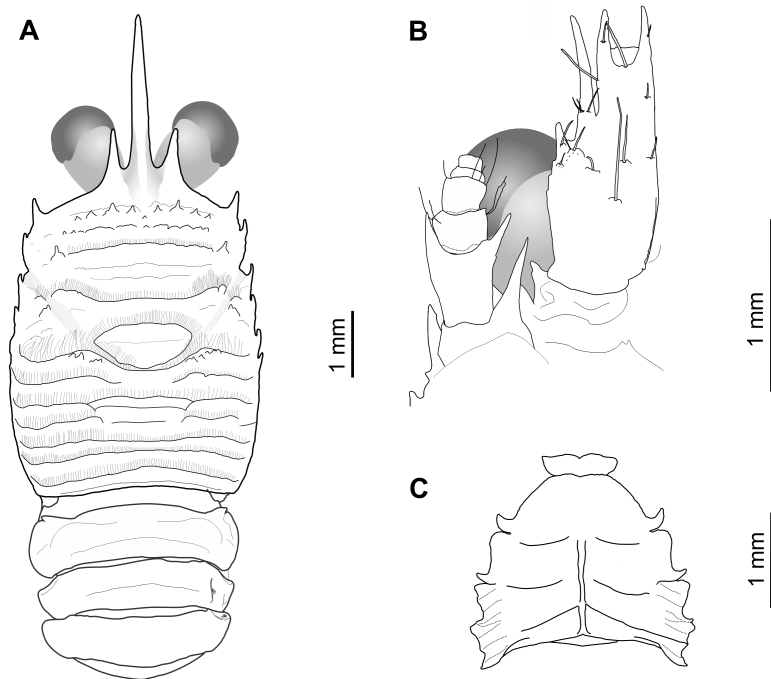


Figure 2 *Munida diritas* sp. nov., holotype, male (CL 4.9 mm), MNHNCL DEC-15175, Seamount SF 9 off Chile; 25°46.8'S, 83°9.6'W; 200 m depth. (A) Carapace, eyes and pleonites 1–4, dorsal view. (B) Left anterolateral part of carapace, eye, first segment of antennular peduncle and antennal peduncle, ventral view. (C) Thoracic sternum, ventral view.

Full-size DOI: [10.7717/peerj.10531/fig-2](https://doi.org/10.7717/peerj.10531/fig-2)

Antenna: Article 1 with 1 strong distal spine on mesial margin, reaching distal margin of article 2. Article 2 with 2 long distal spines on mesial and lateral margins, nearly reaching end of article 3. Penultimate article unarmed.

Mxp3: Ischium with small distal spine on flexor margin. Merus shorter than ischium, measured along extensor margin; bearing 2 well developed spines on flexor margin, proximal spine stronger than distal; extensor margin unarmed. Carpus unarmed.

P1: Squamous, with numerous long iridescent and non-plumose setae, more dense on mesial, lateral and dorsal borders of articles. P1 twice carapace length, merus 0.8 length of carapace, twice as long as carpus, with some strong distal spines, distomesial spine not reaching proximal third of carpus. Carpus 0.9 length of palm, 1.5 times as long as broad, with several spines scattered along mesial and dorsal sides. Palm 1.5 times longer than broad, with row of dorsal spines; lateral margin with row of spines extending onto fixed finger;; mesial margin with row of spines., continuing along mesial margin of movable finger. Fingers slightly longer than palm, dactylus with proximal and subdistal spines on mesial margin and two widely separated spines on dorsal surface adjacent to mesial margin. *P2–4*: Moderately long and slender, furnished with long plumose and iridescent setae along extensor margin of articles. P2 1.3 times carapace length. Meri shorter posteriorly (P3 merus 0.8 length of P2 merus, P4 merus 0.7 length of P3 merus); P2 merus 0.9 length of carapace, 4.5–5.0 times as long as high, 1.2–1.5 times longer than P2 propodus; P3 merus

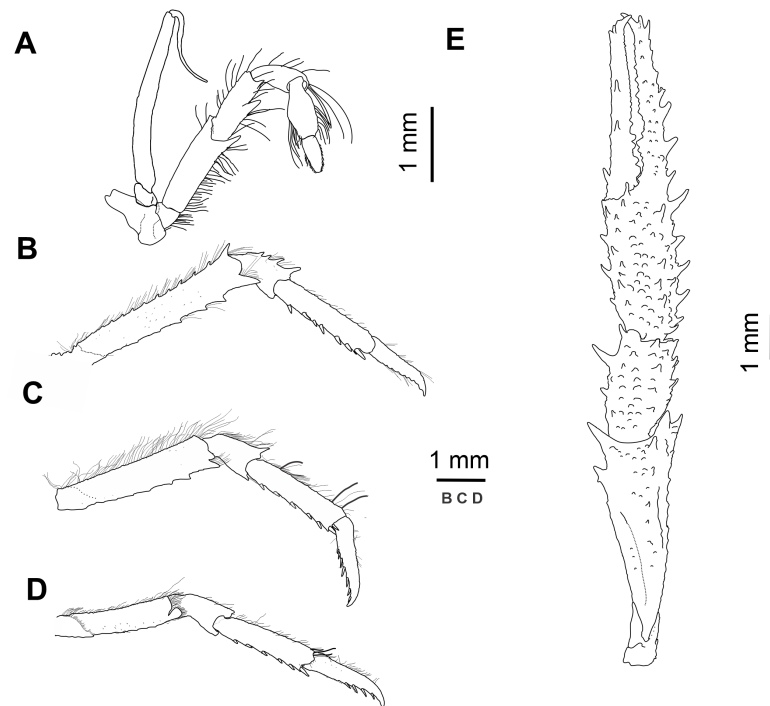


Figure 3 *Munida diritas* sp. nov., holotype, male (CL 4.9 mm), MNHNCL DEC-15175, Seamount SF 9 off Chile; 25°46.8'S, 83°9.6'W; 200 m depth. (A) Right third maxilliped, lateral view. (B) Right second pereopod, lateral view. (C) Right third pereopod, lateral view. (D) Right fourth pereopod, lateral view. (E) Chela and carpus of right cheliped, dorsal view.

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4.0–5.0 times longer than high, 1.2–1.4 times longer than P3 propodus; P4 merus 4.0 times as long as high, as long as P4 propodus. Extensor margins of P2–3 meri with row of proximally diminishing spines, and unarmed on P4, distal spine prominent; flexor margins distally with one prominent spine followed proximally by several eminences; lateral sides unarmed. Carpi with 2–4 spines on extensor margin of P2–3, unarmed on P4; flexor margin with distal spine. Propodi 4.0–4.5 (P2–3)–4.0 (P4) times as long as high; extensor margin unarmed; 6–7 slender movable spines along flexor margin of P2–4. Dactyli slender, extensor border slightly convex on proximal half, slightly curving distally, length 0.8–0.9 that of propodi; flexor margin with 7–8 movable spinules along entire border; P2 dactylus 5 times longer than wide.

Coloration: In fresh condition, body entirely white (see additional material [Video S1](#)).

Genetic data: 16S GENBANK CODE GenBank (accession number: [MT936349](#)).

Remarks: The new species belongs to the group of species with 3–4 branchial spines on the carapace and lateral carinae on the 6–7 thoracic sternites. This group includes only species from the Indian Ocean and Western-Central Pacific waters: *M. cristulata* [Macpherson, Rodríguez-Flores & Machordom, 2017](#), *M. ignea* [Macpherson, 2006](#), *M. lenticularis* [Macpherson & De Saint Laurent, 1991](#), *M. maculata* [Komai, 2012](#), *M. muscae* [Macpherson & De Saint Laurent, 2002](#), *M. ommata* [Macpherson, 2004](#), *M. psylla* [Macpherson, 1996](#), *M. rufiantennulata* [Baba, 1969](#) and *M. vicina* [Komai, 2012](#). From this group of species

the closest relatives are: *M. muscae*, from Madagascar, Reunion Island and Mozambique Channel, *M. psylla*, from Papua-New Guinea, New Caledonia and New Zealand, and *M. vicina*, from Kurose Bank and Izu Islands (Japan), characterized by an unarmed pleon.

Munida psylla is distinct from the new species in having the distomesial spine of the antennal article 2 overreaching the end of the article 4, whereas this spine at most ends at the end of article 3 in the new species. Furthermore, the P1 fixed finger is lacking spines along the lateral margin, other than subterminal spines, in *M. psylla*, whereas there is a row of spines along the lateral margin of the P1 fixed finger in *M. diritas*.

The new species is closely related to *Munida vicina*, but both are distinguished by several characters (see the description and illustration by [Komai \(2012\)](#)):

- The distomesial spine of the antennal article 2 barely reaches the end of the article 3 in the new species, whereas this spine clearly exceeds this article in *M. vicina*.
- The P1 (chelipeds) are more spinose, having also stronger spines, in the new species than in *M. vicina*. The P1 movable and fixed fingers have several spines along the entire mesial and lateral margins, respectively, in the new species, whereas the fingers only have proximal and distal spines in *M. vicina*. Furthermore, the spines along the lateral margin of the palm and fixed finger are clearly larger in the new species than in *M. vicina*.

Munida diritas is distinct from *M. muscae* by the following aspects:

- The distomesial spine of the antennular article 1 is shorter than the distolateral in *M. muscae*, whereas they are subequal in *M. diritas*.
- The movable finger of the P1 (chelipeds) has a row of spines along the mesial margin in *M. diritas*, whereas this finger only has proximal and distal spines in *M. muscae*. Furthermore, as it was observed in *M. vicina*, the spines along the lateral margin of the palm and fixed finger are clearly larger in the new species than in *M. muscae*.

Distribution, habitat and ecological aspects: Apart from the type locality, as suggested by ROV observations, the new species could be present at two other seamounts in the intersection of NR and SGR: Stations SF6 (25°33'S, 82°23'W) and SF7 (25°39'S, 82°28'W) ([Fig. 4](#)), 180 and 176 m depth, respectively. We base our conjecture on the general morphology of the cephalothorax and P1, to identify the new species in the ROV images. The bottom at SF7 and SF9 seamounts was relatively homogeneous, with little relief and dominated by mixed sediment (coarse sand, maërl-rhodoliths: unattached nodules of crustose coralline red algae, sponges, and pteropod shell-beds) ([Fig. 4](#)). In ROV observations, *M. diritas* sp. nov. was found associated to a microhabitat of anemones (*Hormathia* sp. and *Ceriantharia*), hydrozoan colonies, polychaete tubes (*Lanice* sp.) and sea urchin tests (e.g., *Stereocidaris nascaensis*) ([Fig. 4](#)). The new species was observed hunting mysidaceans that foraged around anemones' tentacles. It seems that the white coloring of the new species favors camouflage with sediment, using microtopographic features and resources of microhabitat to block visual recognition of preys in ambush tactics ([Video S1](#)).

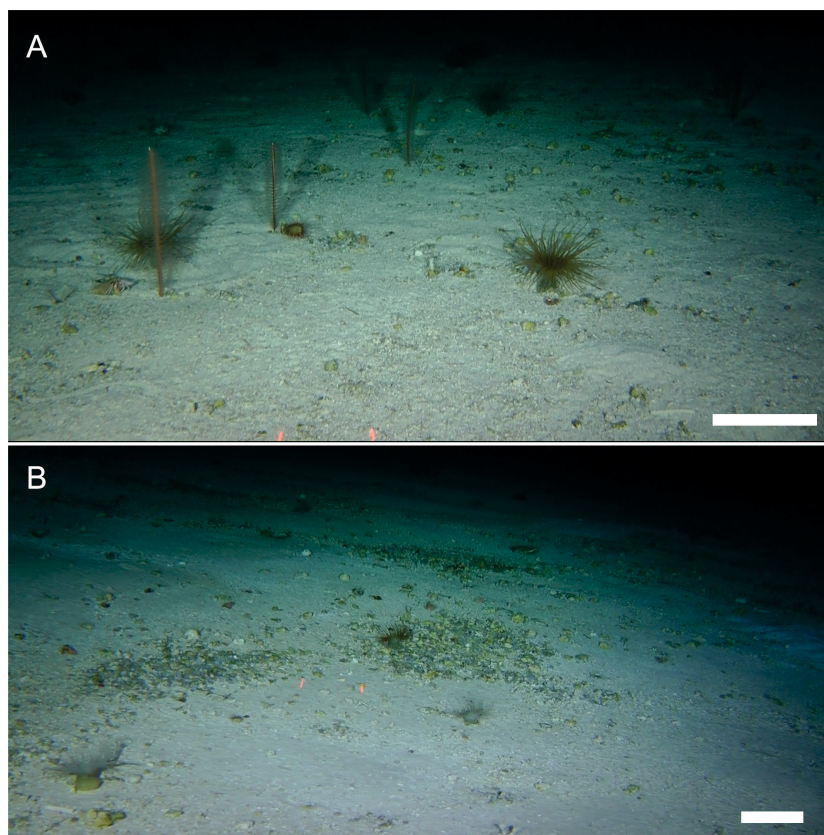


Figure 4 Benthic microhabitats of *Munida diritas* sp. nov. Images taken with an ROV at the sites where *M. diritas* sp. nov. was spotted within the Nazca-Desventuradas Marine Park. (A) Seamount SF7, 176 m depth, regular continuous homogeneous bottom with little relief, coarse sand and some rhodoliths characterized by sea pens (*Protoptilum* sp.), anemones (*Hormathia* sp. and Cerianthids). (B) Seamount SF9, 200 m depth, regular continuous homogeneous bottom with coarse sand and rhodoliths, dominated by sponges and anemones (*Hormathia* sp. and Cerianthids). Scale bar: 10 cm. Image credits for A and B: Matthias Gorny-OCEANA.

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Etymology: From the Latin “*diritas*” (=unfortunate, misfortune), alluding to the type locality at seamounts near Desventuradas Islands (Nazca-Desventuradas Marine Park). “Desventurado” in Spanish means: suffering from misfortune.

Phylogenetic relationships: The 16S rRNA sequence of *Munida diritas* sp. nov. is more similar to *M. ommata* (94.6–94.8%), *M. rufiantennulata* (94.7%) and *M. psylla* (95.3%) than to species in the Southeast Pacific, such *M. gregaria/subrugosa* (89.7–90.0%), *Cervimunida johni* (88.5%) and *Pleuroncodes monodon* (86.4%). Furthermore, the *Munida diritas* sp. nov. sequence appears to form a clade with Central Indian Pacific species (*Munida ommata*, *Munida rufiantennulata* and *Munida psylla*, Fig. 5) while species inhabiting the Southeast Pacific (TSA, Temperate South America) group in another clade, despite belonging to other genera (Fig. 5). The sequences of *Cervimunida johni*, *Pleuroncodes monodon*, and *M. gregaria/subrugosa* differed by 10 to 13.6% from the sequence of *Munida diritas* sp. nov.

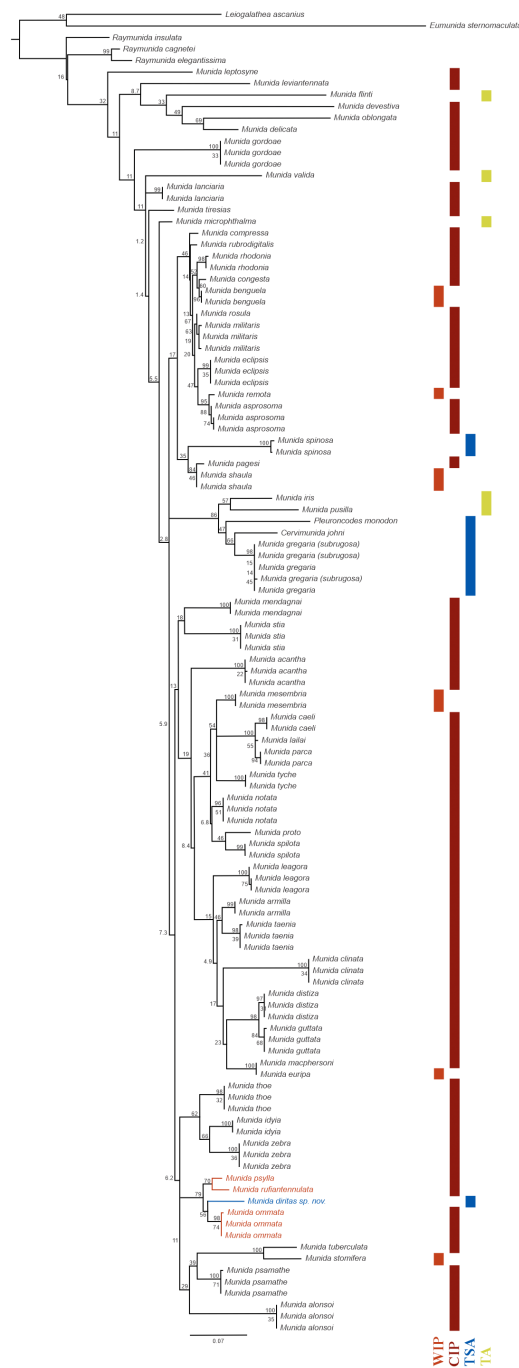


Figure 5 Phylogenetic relationships of *Munida diritas* sp. nov. with other *Munida* spp. based on 16S rRNA. The reconstructed ML phylogram and node bootstrap values are shown. *Leiogalathea ascanius*, *Eumunida sternomaculata*, and *Raymunida* spp. were used as outgroup taxa. Scale bar indicates the number of substitutions/site. The colored bars indicate the origin of the sequenced samples. Biogeographic realms (Spalding et al., 2007): WIP = West Indo-Pacific Ocean, CIP = Central Indo-Pacific Ocean, TA = Tropical Atlantic, TSA = Temperate South America.

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DISCUSSION

The genetic analysis using 16S rRNA sequences suggests that *Munida diritas* sp. nov. is close to *M. ommata*, *M. rufiantennulata* and *M. pusylla*, all are characterized by having lateral carinae on the thoracic sternum. The genetic distances among those four species range from 4.7 to 5.2%. It should be noted that, among the group characterized by the presence of thoracic sternal carinae, these are the three species for which sequence data is available.

The genetic distances observed between the new species and other species of *Munida* occurring along the west coast of America, i.e., *M. gregaria*, *M. quadrispina*, *Pleuroncodes monodon*, were larger than 10% for 16S (Fig. 5). These values imply high levels of genetic divergence, even exceeding the mean divergence reported for other squat lobsters (*Machordom & Macpherson, 2004; Rodríguez-Flores et al., 2019*), and indicating a different phylogenetic origin. The obtained tree supports the existence of a very old common ancestor, with closer relationships with Indo-Pacific species than with American species (Fig. 5).

Munida diritas is the fifth species of the genus *Munida* reported for Chilean waters (*Bahamonde & López, 1962; Hendrickx, 2003; Baba et al., 2008*), and the first for subtropical waters in seamounts of the Juan Fernández and Desventuradas Ecoregion. Other species of *Munida* that occur along the continental shelf and slope off Chile (*Hendrickx, 2003; Baba et al., 2008*) are: *M. curvipes* Benedict 1902, *M. gregaria* (Fabricius 1793), *M. montemaris* *Bahamonde & López, 1962*, and *M. propinqua* Faxon 1893. The new species remarkably differs in morphology from them, while is closer to some species occurring in the Indo West Pacific and French Polynesia. Phylogenetic analysis using 16S clusters the new species with *M. ommata*, *M. psylla* and *M. rufiantennulata*, all characterized by the possession of lateral carinae on the thoracic sternites 6–7. Indeed, the new species is similar also to other species characterized by the possession of four or less branchial spines and the lateral carinae at least on the thoracic sternites 6–7 (*Macpherson, 1994; Machordom & Macpherson, 2004; Baba et al., 2009; Komai, 2012*), this last character probably related to reproductive behaviour (*Machordom & Macpherson, 2004*). Other Munididae species described for French Polynesia, e.g., *Babamunida plexaura* *Macpherson & De Saint Laurent, 1991*, *Munida rubella* *Macpherson & De Saint Laurent, 1991*, *M. rubrovata* *Macpherson & De Saint Laurent, 1991*, have been recently collected around the Salas & Gómez Ridge seamounts (M.A. Gallardo, unpublished data). In addition, up to 40% of the crustaceans of this area (e.g., decapods and stomatopods listed by *Poupin (2008)* are Indo-West Pacific species (subtropical origin). All this evidence indicates that this area is biogeographically very different from the continental margin of the SE Pacific, probably due to the change of environmental conditions observed at ~80–85°W. In this area the influence of the cold and productive Humboldt Current System vanishes and the intrusion of subtropical oligotrophic waters from the West begins (*Fuenzalida et al., 2007; Thiel et al., 2007*). Factors such as temperature, salinity, oxygen and food influence the biogeographic distribution of marine ectotherms (*Pörtner, 2002; Pörtner, 2010*), it is thus expected that species of subtropical origin would limit their distribution in cold waters characteristic of the SE Pacific.

The habitat of *Munida diritas* sp. nov. is shared with anemones, hydrozoan colonies, and other filter-feeding organisms commonly inhabiting the seamounts (Easton *et al.*, 2019; Tapia JM, 2020, unpublished data), forming microhabitat for different taxa (Tapia JM, 2020, unpublished data). These microhabitat can play an important role in the distribution and abundance of the species they host (Buhl-Mortensen & Mortensen, 2004; Cordes *et al.*, 2008), influencing also its feeding behaviour (Becker *et al.*, 2009). The in situ video images show that *Munida diritas* sp. nov. could be an active predator, as it has been observed in other species of *Munida*, e.g., *M. sarsi* (Hudson & Wigham, 2003; Lovrich & Thiel, 2011). These relationships (between microhabitat and associated species) emphasise the role of these seamounts in the maintenance of biodiversity, and the importance of the conservation of this unique biodiversity hotspot.

CONCLUSION

We describe *Munida diritas* sp. nov. from seamounts of Nazca-Desventuradas Marine Park, based on morphological and phylogenetic studies. Molecular and morphological data indicates that the new species remarkably differs from other species from the continental margin of the SE Pacific, and it is closer to some species occurring in the Indo Pacific and French Polynesia.

Abbreviations

MNHN	Muséum National d'Histoire Naturelle, Paris, France
MNHNCL	Museo Nacional de Historia Natural, Chile
NDMP	Nazca Desventuradas Marine Park
ROV	Remotely operated underwater vehicle
SCBUCN	Sala de Colecciones Biológicas de la Universidad Católica del Norte, Chile

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Competing Interests

The authors declare there are no competing interests.

Author Contributions

- María de los Ángeles Gallardo Salamanca conceived and designed the experiments, performed the experiments, analyzed the data, prepared figures and/or tables, authored or reviewed drafts of the paper, and approved the final draft.
- Enrique Macpherson conceived and designed the experiments, performed the experiments, analyzed the data, authored or reviewed drafts of the paper, and approved the final draft.
- Jan M. Tapia Guerra and Cynthia M. Asorey performed the experiments, analyzed the data, prepared figures and/or tables, and approved the final draft.
- Javier Sellanes performed the experiments, analyzed the data, authored or reviewed drafts of the paper, and approved the final draft.

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DNA Deposition

The following information was supplied regarding the deposition of DNA sequences:

The 16S sequence are available in the Supplemental Files and at GenBank: [MT936349](https://www.ncbi.nlm.nih.gov/MT936349) (Munida sp. 1 MDLAGS-2020)

<https://www.ncbi.nlm.nih.gov/nuccore/1896876245>.

<https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=2767541&lvl=3&lin=f&keep=1&srchmode=1&unlock>.

Data Availability

The following information was supplied regarding data availability:

The specimens for study are deposited in the following collections:

- Museo Nacional de Historia Natural (MNHNCL), Chile. Holotype MNHNCL DEC-15175, Paratype 2 MNHNCL DEC-15176.

- Muséum National d'Histoire Naturelle, Paris, France. Paratype 1 MNHN-IU-2014-13931.

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Munida diritas sp. nov.: urn:lsid:zoobank.org:act:0EC498DE-46D1-42B8-95D3-E6CDD4FBA20F.

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REFERENCES

- Andrade H. 1985.** Crustáceos decápodos marinos del archipiélago de Juan Fernández. In: Arana P, ed. *Investigaciones Marinas en el Archipiélago de Juan Fernández, Chile*. Valparaíso: Universidad Católica de Valparaíso, 109–116.
- Baba K. 1969.** Four new genera with their representatives and six new species of Galatheidae in the collection of the Zoological Laboratory, Kyushu University, with redefinition of the genus *Galathea*. *Ohmu* 2:1–32.
- Baba K, Macpherson E, Lin CW, Chan T-Y. 2009.** *Crustacean Fauna of Taiwan. Squat lobsters (Chirostylidae and Galatheidae)*. Keelung: National Taiwan Ocean University.
- Baba K, Macpherson E, Poore GCB, Shane T, Bermudez A, Cabezas P, Lin C, Nizinski M, Rodrigues C, Schnabel KE, Lin C, Nizinski M, Rodrigues C, Schnabel KE. 2008.** Catalogue of squat lobsters of the world (Crustacea: Decapoda: Anomura—families Chirostylidae, Galatheidae and Kiwaidae). *Zootaxa* 1905:1–220.
- Bahamonde N, López MT. 1962.** Un galatheido nuevo para Chile, *Munida montemaris* n. sp. Crustacea Decapoda, Anomura). *Revista Chilena de Historia Natural* 55:85–91.
- Becker EL, Cordes EE, Macko SA, Fisher CR. 2009.** Importance of seep primary production to *Lophelia pertusa* and associated fauna in the Gulf of Mexico. *Deep-Sea Research Part I: Oceanographic Research Papers* 56:786–800 DOI 10.1016/j.dsr.2008.12.006.
- Buhl-Mortensen L, Mortensen PB. 2004.** Crustaceans associated with the deep-water gorgonian corals *Paragorgia arborea* (L., 1758) and *Primnoa resedaeformis* (Gunn. 1763). *Journal of Natural History* 38:1233–1247 DOI 10.1080/0022293031000155205.
- Cordes EE, Mcginley MP, Podowski EL, Becker EL, Lessard-Pilon S, Viada ST, Fisher CR. 2008.** Deep-Sea Research I Coral communities of the deep Gulf of Mexico. *Deep Sea Research Part I: Oceanographic Research Papers* 55:777–787 DOI 10.1016/j.dsr.2008.03.005.

- Easton EE, Gorny M, Mecho A, Sellanes J, Gaymer CF, Spalding HL. 2019.** Chile and the Salas y Gómez Ridge. In: Loya Y, Puglise KA, Bridge TCL, eds. *Mesophotic coral ecosystems, coral reefs of the world 12*. 2019. New York: Springer Nature, 477–490 DOI [10.1007/978-3-319-92735-0](https://doi.org/10.1007/978-3-319-92735-0).
- Easton EE, Sellanes J, Gaymer CF, Morales N, Gorny M. 2017.** Diversity of deep-sea fishes of the Easter Island Ecoregion. *Deep-Sea Research Part II: Topical Studies in Oceanography* **137**:78–88 DOI [10.1016/j.dsr2.2016.12.006](https://doi.org/10.1016/j.dsr2.2016.12.006).
- Edgar RC. 2004.** MUSCLE: multiple sequence alignment with high accuracy and high throughput. *Nucleic Acids Research* **32**:1792–1797 DOI [10.1093/nar/gkh340](https://doi.org/10.1093/nar/gkh340).
- Fernández M, Pappalardo P, Rodríguez-Ruiz M, Castilla JC. 2014.** Synthesis of the state of knowledge about species richness of macroalgae, macroinvertebrates and fishes in coastal and oceanic waters of Easter and Salas y Gómez islands. *Latin American Journal of Aquatic Research* **42**:760–802 DOI [10.3856/vol42-issue4-fulltext-7](https://doi.org/10.3856/vol42-issue4-fulltext-7).
- Fuenzalida R, Schneider W, Blanco JL, Garces-Vargas J, Bravo L. 2007.** Sistema de corrientes Chile-Perú y masas de agua entre Caldera e Isla de Pascua. *Revista Ciencia y Tecnología del Mar* **30**:5–16.
- Gálvez-Larach M. 2009.** Montes submarinos de Nazca y Salas y Gómez: una revisión para el manejo y conservación. *Latin American Journal of Aquatic Research* **37**:479–500 DOI [10.3856/vol37-issue3-fulltext-16](https://doi.org/10.3856/vol37-issue3-fulltext-16).
- Guindon S, Dufayard J-F, Lefort V, Anisimova M, Hordijk W, Gascuel O. 2010.** New algorithms and methods to estimate Maximum-Likelihood Phylogenies: assessing the performance of PhyML 3.0. *Systematic Biology* **59**:307–321 DOI [10.1093/sysbio/syq010](https://doi.org/10.1093/sysbio/syq010).
- Hendrickx ME. 2003.** The temperate species of the genus *Munida* Leach (Crustacea, Decapoda, Galatheidae) in the east Pacific, with the description of a new species and additional records for tropical-subtropical species. *Bulletin De L' Institut Royal des Sciences Naturelles De Belgique* **73**:115–136.
- Hudson IR, Wigham BD. 2003.** In situ observations of predatory feeding behaviour of the galatheid squat lobster *Munida sarsi* using a remotely operated vehicle. *Journal of Marine Biological Association of the United Kingdom* **83**:463–464 DOI [10.1017/S0025315403007343](https://doi.org/10.1017/S0025315403007343).
- Katoh K, Misawa K, Kuma K, Miyata T. 2002.** MAFFT: a novel method for rapid multiple sequence alignment based on fast Fourier transform. *Nucleic Acids Research* **30**:3059–3066 DOI [10.1093/nar/gkf436](https://doi.org/10.1093/nar/gkf436).
- Kearse M, Moir R, Wilson A, Stones-Havas S, Cheung M, Sturrock S, Buxton S, Cooper A, Markowitz S, Duran C, Thierer T, Ashton B, Meintjes P, Drummond A. 2012.** Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. *Bioinformatics* **28**:1647–1659 DOI [10.1093/bioinformatics/bts199](https://doi.org/10.1093/bioinformatics/bts199).
- Komai T. 2012.** Squat Lobsters of the Genus *Munida* Leach, 1820 (Crustacea: Decapoda: Anomura: Munididae) from the Sagami Sea and Izu Islands, Central Japan, with descriptions of 10 new species. *Natural History Research* **12**:1–69.

- Larsson A. 2014.** AliView: a fast and lightweight alignment viewer and editor for large datasets. *Bioinformatics* **30**:3276–3278 DOI [10.1093/bioinformatics/btu531](https://doi.org/10.1093/bioinformatics/btu531).
- Liu X, Li X, Lin R. 2020.** A new squat lobster species of the genus *Munida* Leach, 1820 (Crustacea: Anomura: Galatheoidea: Munididae) from hydrothermal vents on the Eastern Pacific Rise. *Zootaxa* **4743**:131–136 DOI [10.11646/zootaxa.4743.1.12](https://doi.org/10.11646/zootaxa.4743.1.12).
- Lovrich GA, Thiel M. 2011.** Ecology, physiology, feeding and trophic role of squat lobsters. In: Poore G, Ah Yong ST, Taylor J, eds. *The biology of squat lobsters*. Australia: CSIRO Publishing, 183–222.
- Machordom A, Macpherson E. 2004.** Rapid radiation and cryptic speciation in squat lobsters of the genus *Munida* (Crustacea, Decapoda) and related genera in the South West Pacific: molecular and morphological evidence. *Molecular Phylogenetics and Evolution* **33**:259–279 DOI [10.1016/j.ympev.2004.06.001](https://doi.org/10.1016/j.ympev.2004.06.001).
- Macpherson E. 1994.** Crustacea Decapoda: studies on the genus *Munida* Leach, 1820 (Galatheidae) in New Caledonian and adjacent waters with descriptions of 56 new species. In: Crosnier A, ed. *Résultats des Campagnes MUSORSTOM, Volume 12*. Paris: Mémoires du Muséum National d'Histoire Naturelle, 421–569.
- Macpherson E. 2004.** Species of the genus *Munida* Leach, 1820 and related genera from Fiji and Tonga (Crustacea: Decapoda: Galatheidae). In: Marshall B, Richer de Forges B, eds. *Tropical Deep-Sea Benthos, Volume 23*. Paris: Mémoires du Muséum National d'Histoire Naturelle, 231–292.
- Macpherson E. 2006.** Galatheidae (Crustacea, Decapoda) from the Austral Islands, Central Pacific. In: Richer De Forges B, Justine J, eds. *Tropical Deep-Sea Benthos, volume 24*. Paris: Mémoires du Muséum National d'Histoire Naturelle, 285–333.
- Macpherson E. 2007.** Species of the genus *Munidopsis* Whiteaves, 1784 from the Indian and Pacific Oceans and reestablishment of the genus *Galacantha* A. Milne-Edwards, 1880 (Crustacea, Decapoda, Galatheidae). *Zootaxa* **1417**:1–135.
- Macpherson E. 2013.** New species and new occurrences of squat lobsters (Crustacea, Decapoda, Munididae, Eumunididae) from French Polynesia. In: Ah Yong ST, Chan T-Y, Corbari L, Ng PKL, eds. *Tropical Deep-Sea Benthos 27, Mémoires du Muséum national d'Histoire naturelle (1993)*. 27. Paris: Publications Scientifiques du Muséum, 287–239.
- Macpherson E, Baba K. 2011.** Chapter 2, Taxonomy of squat lobsters. In: Poore G, Ah Yong ST, Taylor J, eds. *The biology of squat lobsters*. Boca Raton: CSIRO Publishing: Melbourne and CRC Press, 39–71 DOI [10.13140/2.1.1394.8480](https://doi.org/10.13140/2.1.1394.8480).
- Macpherson E, De Saint Laurent M. 1991.** Galatheid crustaceans of the genus *Munida* from French Polynesia. *Bulletin du Muséum National d'Histoire Naturelle, Paris* **4(13)**:373–422.
- Macpherson E, De Saint Laurent M. 2002.** On the Genus *Munida* Leach, 1820 (Decapoda, Galatheidae) from the Western and Southern Indian Ocean, with the Description of Four New Species. *Crustaceana* **75**:465–484.
- Macpherson E, Rodríguez-Flores PC, Machordom A. 2017.** New sibling species and new occurrences of squat lobsters (Crustacea, Decapoda) from the western Indian Ocean. *European Journal of Taxonomy* **343**:1–61.

- Palumbi SR, Martin AP, Romano S, McMillan WO, Stice L, Grabowski G. 1991.** *The simple fool's guide to PCR*. Honolulu, Dept. of Zoology and Kewalo Marine Laboratory, University of Hawaii at Manoa 23 DOI [10.1186/s13620-015-0060-3](https://doi.org/10.1186/s13620-015-0060-3).
- Parin NV, Mironov AN, Nesis KM. 1997.** Biology of the Nazca and Sala y Gómez submarine ridges, an outpost of the Indo-West Pacific fauna in the Eastern Pacific ocean: composition and distribution of the fauna, its communities and history. *Advances in Marine Biology* **32**:145–242 DOI [10.1016/s0065-2881\(08\)60017-6](https://doi.org/10.1016/s0065-2881(08)60017-6).
- Pörtner HO. 2002.** Climate variations and the physiological basis of temperature dependent biogeography: systemic to molecular hierarchy of thermal tolerance in animals. *Comparative Biochemistry and Physiology - A Molecular and Integrative Physiology* **132**:739–761 DOI [10.1016/S1095-6433\(02\)00045-4](https://doi.org/10.1016/S1095-6433(02)00045-4).
- Pörtner HO. 2010.** Oxygen- and capacity-limitation of thermal tolerance: a matrix for integrating climate-related stressor effects in marine ecosystems. *The Journal of Experimental Biology* **213**:881–893 DOI [10.1242/jeb.037523](https://doi.org/10.1242/jeb.037523).
- Poupin J. 2003.** Crustacea Decapoda and Stomatopoda of Easter Island and surrounding areas, A documented checklist with historical overview and biogeographic comments. *Atoll Research Bulletin* **500**:1–50.
- Poupin J. 2008.** Biogeography of the decapod and stomatopod Crustacea of the tropical Pacific: issues and prospects. *Pacific Science* **62**:377–383 DOI [10.2984/1534-6188\(2008\)62\[377:BOTDAS\]2.0.CO;2](https://doi.org/10.2984/1534-6188(2008)62[377:BOTDAS]2.0.CO;2).
- Retamal MA. 2001.** *Huenia pacifica* Miers, 1879, first record of the genus and species in the Southeast Pacific. *Gayana (Concepcion)* **65**:211–214 DOI [10.4067/S0717-65382001000200012](https://doi.org/10.4067/S0717-65382001000200012).
- Retamal MA. 2004.** Decápodos de las islas oceánicas chilenas: Pascua y Salas y Gómez. *Ciencia y Tecnología del Mar* **27**:55–68.
- Retamal MA, Arana PM. 2016.** Record of stomatopods and decapods, including descriptions of the species of commercial interest from the submarine rises and surrounding waters of the Chilean oceanic islands (southeastern Pacific Ocean). *Latin American Journal of Aquatic Research* **44**:16–33 DOI [10.3856/vol44-issue1-fulltext-2](https://doi.org/10.3856/vol44-issue1-fulltext-2).
- Rodríguez-Flores PC, Machordom A, Abelló P, Cuesta JA, Macpherson E. 2019.** Species delimitation and multi-locus species tree solve an old taxonomic problem for European squat lobsters of the genus *Munida* Leach, 1820. *Marine Biodiversity* **49**:1751–1773 DOI [10.1007/s12526-019-00941-3](https://doi.org/10.1007/s12526-019-00941-3).
- Rodríguez-Flores PC, Macpherson E, Machordom A. 2020.** A new species of squat lobster of the genus *Hendersonida* (Crustacea, Decapoda, Munididae) from Papua New Guinea. *ZooKeys* **935**:25–35 DOI [10.3897/zookeys.935.51931](https://doi.org/10.3897/zookeys.935.51931).
- Schnabel K, Cabezas P, Mccallum A, Macpherson E, Ah Yong ST, Baba K. 2011.** World-wide distribution patterns of squat lobsters. In: Poore G, Anyong ST, Taylor J, eds. *Squat Lobster Biology*. Canberra: CSIRO Publishing, 149–182 DOI [10.13140/2.1.1394.8480](https://doi.org/10.13140/2.1.1394.8480).
- Sellanes J, Salisbury RA, Tapia JM, Asorey CM. 2019.** A new species of *Atrimitra* Dall, 1918 (Gastropoda: Mitridae) from seamounts of the recently created Nazca-Desventuradas Marine Park, Chile. *PeerJ* **7**:e8279 DOI [10.7717/peerj.8279](https://doi.org/10.7717/peerj.8279).

- Spalding MD, Fox HE, Allen GR, Davidson N, Ferdaña ZA, Finlayson M, Halpern BS, Jorge MA, Lombana A, Lourie SA, Martin KD, McManus E, Molnar J, Recchia CA, Robertson J. 2007.** Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. *BioScience* 57:573–583 DOI [10.1641/B570707](https://doi.org/10.1641/B570707).
- Thiel M, Macaya EC, Acuña E, Arntz WE, Bastias H, Brokordt K, Camus PA, Castilla JC, Castro LR, Córtes M, Dumont CP, Escribano R, Fernández M, Gajardo JA, Gaymer CF, Gómez I, González AE, González HE, Haye PA, Illanes J-E, Iriarte JL, Lancellotti DA, Luna-Jorquera G, Luxoro C, Manriquez PH, Marín VH, Muñoz P, Navarrete SA, Pérez E, Poulin E, Sellanes J, Sepúlveda HH, Stotz W, Tala F, Thomas A, Vargas CA, Vasquez JA, Vega JMA. 2007.** The Humboldt Current System of northern and central Chile: oceanographic processes, ecological interactions and socioeconomic feedback. *Oceanography and Marine Biology: An Annual Review* 45:195–344.
- Zarenkov NA. 1990.** Decapods (Stenopodidea, Decapods (Stenopodidea, Brachyura, Anomura) of the underwater Nazca and Salas y Gómez Ridges Ridges. *Trudy Instituta Okeanologii AN USSR* 124:218–244.