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1 Diversity of deep-sea fishes of the Easter Island Ecoregion

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12 Abstract

13 The Easter Island Ecoregion is in the center of the South Pacific gyre and experiences
14 ultra-oligotrophic conditions that could make it highly susceptible to global change and
15 anthropogenic activities, so it is imperative that these regions are characterized and studied so
16 that conservation and sustainable management strategies can be developed. From the few
17 studies from the region, we know that the coastal areas are relatively depauperate and have
18 relatively high rates of endemism. Here, we present a brief report from the first video
19 observations from this region of the deep fish fauna from ROV exploration of benthic
20 communities from 157 to 281 m and baited drop-camera videos from 150 to 1850 m. We
21 observed a total of 55 fish species from the ROV and Drop-Cam surveys; nine could not be
22 assigned family level or lower, 26 were observed in the ROV surveys, 29 were observed in the
23 Drop-Cam surveys, nine were observed with both survey methods, at least six species are
24 potentially new to science, and nine species were observed at deeper depths than previously
25 reported. These new reports may be indicative of the unique oceanographic conditions in the
26 area and the relative isolation of the communities that have provided opportunity for the
27 evolution of new species and favorable conditions for range expansion. In contrast, these new
28 reports may be indicative of the severe undersampling in the south Pacific at mesopelagic depths.
29 The prevalence of potentially new species suggests that the region likely harbors a wealth of
30 undiscovered biodiversity.

31 1. Introduction

32 The Easter Island Ecoregion (EIE) consists of Easter Island, Salas y Gómez, and the
33 nearby seamounts. These islands and seamounts are part of a ~4,000–km chain of seamounts
34 (Salas y Gómez and Nazca Ridges) that formed from the movement of the Nazca plate over the
35 Easter Island hotspot, currently located somewhere between Easter Island and Salas y Gómez
36 (Ray et al., 2012; Vezzoli and Acocella, 2009). Easter Island (27°09' S, 109°22'W) is
37 considered the most-isolated inhabited island on Earth (Loret and Tanacredi, 2003; Mieth and
38 Bork, 2005; Santelices and Abbott, 1987), located ~2,000 km east of the nearest inhabited island,
39 Pitcairn, and ~3,700 km west of continental Chile. Because of its remoteness, relative isolation,
40 and limited resources to support scientific studies, knowledge on the diversity of fishes was
41 limited prior to the mid-1980s. Studies at Salas y Gómez, which lies 400 km to the east, are even
42 more limited. The waters surrounding Salas y Gómez are part of the Motu Motiro Hiva Marine
43 Park, established by the Chilean government in October 2010. The area experiences ultra-
44 oligotrophic conditions, but with increased nutrients at Salas y Gómez relative to Easter Island
45 (Andrade et al., 2014). Since the 1980s, the known diversity of Easter Island shore and
46 epipelagic fishes expanded from less than 30 species to 171 species; however, these fauna are
47 considered depauperate in comparison to other islands, which have ~10-fold more fish species
48 (Randall and Cea, 2010).

49 Of the 171 species known from the island (Randall and Cea, 2010), 141 occur at depths
50 less than 200 m. Of these fishes, ~26.3% are locally endemic and an additional ~14% are
51 regionally endemic (Friedlander et al., 2013; Randall and Cea, 2010). Of those species reported
52 from depths to 200 m, their reports primarily come from scuba surveys and observations to ~40
53 m and catches by artisanal fisherman in the coastal and offshore waters (DiSalvo et al., 1988;

54 Hubbard and Garcia, 2003; Randall and Cea, 2010; Zyllich et al., 2014). Because offshore
55 artisanal fisheries focus on top predators (e.g., tunas and jacks) and use a traditional line method
56 instead of trawls, relatively few species are known from depths greater than 40 m.

57 The only studies in the area of deep-dwelling fishes were a series of expeditions by
58 Russian scientists in the 1970s and 1980s to explore the seamount communities of the Nazca
59 Ridge and eastern Salas y Gómez Ridge (Parin, 1991; Parin et al., 1997). From the resulting
60 data, the authors made several preliminary conclusions that require further studies for
61 verification. (1) An apparent biogeographic discontinuity occurs at ~83° W and may be
62 maintained by the Humboldt Current serving as a barrier. (2) As observed for shallow-water
63 fishes, a high percentage (~44%) of deep-sea fishes appear to be locally or regionally endemic.
64 (3) The EIE should be considered a separate ecoregion from the surrounding ones, including the
65 Nazca and eastern Salas y Gómez Ridges. (4) The benthopelagic communities studied are more
66 similar to the west Pacific than to the continental east Pacific despite their relative proximity to
67 continental Chile.

68 Because the EIE is near the center of the South Pacific Gyre and is surrounded by ultra-
69 oligotrophic waters that could limit the available energy to support biomass at depth, the region
70 is more susceptible to climatic and anthropogenic disturbances and likely has a slow recovery
71 time after disturbances (Andrade et al., 2014). Susceptibility to disturbances and productivity
72 may vary at various time scales due to oceanographic and other environmental conditions that
73 can vary, in turn, intra-annually in association with season and eddies and inter-annually in
74 association with El Niño Southern Oscillation (ENSO) (Andrade et al., 2014; Mucciarone and
75 Dunbar, 2003).

76 The diversity and abundance of coastal fishes has declined since the 1980s, with some
77 fishes, including endemics, being rare or not observed in more recent surveys (Friedlander et al.,
78 2013; Randall and Cea, 2010; Wieters et al., 2014). This decline potentially could be due to
79 changes in environmental conditions and benthic community structure and the effects of
80 increased fishing pressure due to increasing tourism and consequent demand for fish (DiSalvo et
81 al., 1988; Zyllich et al., 2014). Similarly, catch of commercially important fishes has begun to
82 level off or decline over the last 20 years (Zyllich et al., 2014). Under these changing conditions,
83 it is important to catalogue the diversity and distribution of species of Easter Island to inform
84 local and national communities for planning management and conservation strategies. In
85 addition, Parin et al. (1997) could not investigate the seamounts and islands within the Chilean
86 EEZ, so they were unable to determine whether the pattern of apparent trends of longitudinal
87 transitions in community composition and high levels of endemism continued along the Salas y
88 Gómez Ridge into the EIE. To help begin to fill the knowledge gap for the EIE, we report the
89 biodiversity of benthopelagic fishes observed in videos from a remotely-operated vehicle (ROV)
90 deployed at 155-280 m of the southwest coast of Easter Island at an ancestral fishing ground,
91 locally called “Apolo,” as well as those fishes observed in videos from baited drop cameras
92 deployed in 2011 at 150-1850 m off the coasts of Salas y Gómez and Easter Island and at two
93 seamounts between these islands. We then compare our observations to the available literature
94 on the distributions and depth ranges of the identified species.

95 2. Methods

96 2.1. Study site

97 Easter Island is a triangular-shaped island consisting of three volcanoes, Rano Kau,
98 Terevaka, and Poike, with one located at each of the three corners of the island. Rano Kau forms

99 the southwest corner of the island and has a subsurface peak ~ 13 km offshore at ~ 150-m depth,
100 where the local rapanui fishermen have a historic fishing ground called Apolo (Fig. 1). Three
101 exploratory surveys were performed at Apolo on 1 October 2014 with a ROV Comander MK2
102 (Mariscope Meerestechnik, Kiel, Germany) equipped with a HD Camcorder (Panasonic SD 909).
103 Bottom time for each survey varied from 12 to 32 minutes and depths ranged from 157 to 281 m
104 (Table 1). The distance between the HD camera and the seafloor varied between several
105 centimeters and about 1 meter, and the camera was positioned in front of the ROV with a fixed
106 angle of 15 degrees towards the bottom, with two laser pointers fixed to indicate a distance of 10
107 cm.

108 Up to three baited, deep-ocean Drop-Cams (Turchik et al., 2015), developed by the
109 National Geographic Society, were simultaneously deployed at a total of 20 stations along the
110 island slopes of Salas y Gómez and Easter Island or the slopes of two seamounts west of Salas y
111 Gómez at 150 – 1850 m (Table 2, Fig. 2). These Drop-Cams have a 12-megapixel Sony
112 Handycam HDR-XR520V encased in a borosilicate glass sphere rated to 12,000 m. Depending
113 on the angle of the substrate, the viewing area per frame was 3-6 m². Each camera was baited
114 with frozen fish and deployed for ~5 hours. For some deployments, the lights, a high-intensity
115 LED array directed using external reflectors, were not turned on until up to ~4 hours after
116 deployment. Depth was measured with an external pressure sensor, and communication with the
117 sealed cameras was through a waterproof bulkhead connector. The Drop-Cams were positively
118 buoyant, resulting in an ascent rate of 0.5 ms⁻¹ and weighted with a 22-kg external weight,
119 resulting in a descent rate of 1.5 ms⁻¹. The weight was released by burn wire, activated using
120 onboard battery voltage, and the Drop-Cams were located for recovery by communication of an

121 onboard VHF transmitter and locating antennae, with backup location via communication with
122 the ARGOS satellite system.

123 2.2. Video analyses

124 ROV videos were first analyzed frame-by-frame with Adobe Premiere Pro CS5 (Adobe
125 Systems Incorporated, San Jose, CA) by a single observer and then by the same observer at 0.2 x
126 speed with GOM Player 2.2 (GOMlab, Gretech Corporated, Seoul, Korea) to quantify the
127 maximum number (NMax) of individuals of each species per frame for each 3-minute segment
128 of video, starting when the seafloor became visible. ROV videos were watched a third time by a
129 2-person team of observers to confirm species identifications and counts of individuals. Drop-
130 Cam videos were watched by a two-person team at normal speed with GOM Player 2.2 to
131 quantify the maximum number (NMax) of individuals of each species per frame for each 3-
132 minute segment of video. Frame grabs of representatives of each species were taken with Adobe
133 Premiere and GOM Player for archival and identification purposes. Individuals were identified
134 to the lowest possible taxonomic level using the Hawaii Underwater Research Laboratory
135 (HURL) database (HURL, 2013), FishBase (Froese and Pauly, 2011), and regional guides and
136 reports of trawl data from Salas y Gómez and Nazca Ridge (Dyer and Westneat, 2010; Parin,
137 1991; Parin et al., 1997; Randall and Cea, 2010).

138 2.3. Nomenclature and species assignment

139 We acknowledge the inherent difficulties in identifying individuals to species level from
140 video footage and therefore all species assignments are made to the lowest possible taxon in
141 which we had reasonable confidence. For this reason, we likely underestimated the number of
142 species, especially for those morphologically similar taxa that often have overlapping geographic

143 ranges (e.g., Macrouridae). We used information on the known ranges, the original descriptions,
144 and reports of revisions to aid us in assigning individuals to species and discuss potentially
145 conflicting data, including differences in color, among reports in Supplementary Material to help
146 fill gaps in primary literature on biogeographic ranges and color variation within species. In this
147 study, we used nomenclature accepted by FishBase (Froese and Pauly, 2011) and accepted
148 species names were verified using WoRMS (WoRMS Editorial Board, 2016); however, lack of
149 clarity in several species names warrants discussion.

150 The following species were reported in Randall and Cea (2010) under synonymous
151 names: *Cheilodactylus plessisi* (as *Goniistius plessisi*), *Pseudocaranx dentex* (as *P. cheilio*), and
152 *Etelis carbunculus* (as *E. marshi*). In the case of *Goniistius plessisi*, Randall and Cea (2010)
153 recognized generic-level morphological and genetic differences that have yet to be officially
154 revised (Burrige and White, 2000; Randall, 1983). *Pseudocaranx cheilio* has conflicting
155 reports on its validity due to differences in gill raker counts of Easter Island specimens relative to
156 Hawaiian specimens (Randall and Cea, 2007). The Catalogue of Fishes (Eschmeyer, 2015)
157 considers it a valid species; however, it is a synonym of *P. dentex* in WoRMS and Fishbase. See
158 Supplemental Material for additional discussion of nomenclature issues for *E. marshi* and
159 morphological differences between *Antigonia capros*, *Pristilepis oligolepis*, and *Priacanthus*
160 *nasca* and morphologically similar species in the area.

161 A preliminary report of 21 species from these Drop-Cam videos were reported in
162 Friedlander et al. (2013); however, many of their preliminary identifications differ from this
163 report, including *Squalus mitsukurii*, Congridae, *Glossanodon* cf. sp., *Synodus isolatus*,
164 *Coelorinchus* sp., *Plectranthias parini*, *Priacanthus nasca*, *Amphichaetodon melbae* (see Table
165 4a in Friedlander et al. 2013). Here, we report the list of species observed during this study with

166 notes on the differences between the preliminary reports and this brief report. For *S. mitsukurii*,
167 recent work suggests that the species present in our study area is part of the *S. mitsukurii* species
168 group, but we have insufficient data to assign it to species or to determine whether it is
169 potentially a new species (see 3.3.1.). For *Glossanodon* cf. sp. (our unidentified species 7, Table
170 3), we did not assign it to a specific taxon due to the small size of the specimen and poor image
171 quality. For *Coelorinchus* sp., individuals were not sufficiently close to the camera to assign
172 individuals below the level of family, Macrouridae. For *Plectranthias parini*, *Priacanthus*
173 *nasca*, and *Amphichaetodon melbae*, we assigned them respectively to *Tosanoides* sp.,
174 *Cookeolous japonicus*, and *Prognathodes* sp. on the basis of their morphology. For example, the
175 *Tosanoides* sp. is distinct from *P. parini* in several aspects, including color pattern, size, and fin
176 shape. Finally, it appears that individuals of Halosauridae and Synphobranchidae were assigned
177 to either Congridae or Nettastomatidae in the preliminary reports; one unidentified fish at 1099
178 m could be a Congridae but video quality was insufficient to assign that individual definitively to
179 family.

180 3. Results and discussion

181 3.1. Species assignments

182 We observed a total of 55 fish species from the ROV and Drop-Cam surveys. Of these
183 species, nine could not be assigned family level or lower; however, color patterns and general
184 shape allowed us to determine that they are morphologically distinct from the other 46. Due to
185 the uncertainty in assigning those individuals to taxon, we only considered the 46 species we
186 could assign to family level or lower for the remaining results. From ~64 minutes of total
187 bottom recording time from the ROV videos, we assigned individuals to 26 putative taxa. In ~42
188 hours (2517 min) of total video time from the Drop-Cams, we assigned individuals to 29 putative

189 taxa. Of the 46 putative taxa, nine were observed with both survey methods, ROV and Drop-
190 Cam (Table 3). In addition, *Beryx splendens* and *B. cf. splendens* were observed respectively in
191 the Drop-Cam and ROV surveys, and the both taxa could be *B. splendens*.

192 At least one species of *Rexea* was observed from 552-847 m at Salas y Gómez and a
193 neighboring seamount (Table 3, Fig. 3F). Species known from the area are *R. brevilineata* and
194 *R. antefurcata*. Distinguishing characters between these species include the length of the upper
195 lateral line, squamation patterns, maximum size, and differences in fin coloration patterns
196 (Nakamura and Parin, 1993). These features were not sufficiently clear in the videos to
197 confidently assign individuals to one of these two species; however, the known geographic
198 range, the apparent size of individuals, and the depth at which they were observed is more
199 consistent with *R. antefurcata* (Froese and Pauly, 2011; Nakamura and Parin, 1993; Parin et al.,
200 1997). For example, the smaller *R. brevilineata* has only been reported from 81°W to 90°W
201 (more than 15° east of Salas y Gómez) at depths of 180-440 m, whereas, the generally larger *R.*
202 *antefurcata* has been reported from 83°W to 143°E at depths of 160-920 m.

203 Individuals of cf. *Synaphobranchus affinis* (Fig. 3G) could not be assigned confidently to
204 species, and even to a genus, as most of their diagnostic characteristics were not visible from
205 videos and they were notoriously difficult to identify even with specimens in hand (Sulak and
206 Shcherbachev, 1997). For those individuals that were close enough to the camera to observe the
207 morphology of the head, the morphology was consistent with *Synaphobranchus* (Sulak and
208 Shcherbachev, 1997). Therefore, we tentatively assigned all individuals to cf. *Synaphobranchus*
209 *affinis*, which is known from 290-2400 m, with most observations at 500-1500 m (Froese and
210 Pauly, 2011; Sulak and Shcherbachev, 1997); however, we only observed individuals at depths
211 greater than 1000 m despite its apparent abundance at 250-750 m at the seamounts to the east

212 (Parin et al., 1997). It is possible that some of the individuals may belong to one of the other two
213 species of Synphobranchidae, *Ilyphis blachei* and *Simenchelys parasiticus*, which were reported
214 from the area by Parin et al. (1997).

215 Due to the small size of individuals and their generally large distance from the cameras,
216 we could not assign Macrouridae individuals to any of the known species from the area. In one
217 video, we did observe one individual with a different body shape, so at least two species of
218 Macrouridae were present. Similarly, we were unable to assign the individuals of
219 Nettastomatidae and Halosauridae (Fig. 3I) to species due to lack of visible diagnostic
220 characters. Other species in these families known from similar depths along the Salas y Gómez
221 Ridge are *Nettastoma falcinaris*, *Aldrovandia affinis*, and *A. phalacra* (Froese and Pauly, 2011;
222 Parin et al., 1997).

223 3.2. Biodiversity and abundance

224 The ~10-fold lower diversity of fishes at Easter Island compared to other oceanic islands
225 (Randall and Cea, 2010) may be due to its relatively young age (<2 my), its distance from source
226 populations, and the ultra-oligotrophic conditions. These same factors may also contribute to the
227 relatively high percentage of local and regional endemics, which is among the largest
228 percentages in the world. With such high rates of endemics, Easter Island harbors unique
229 biodiversity and may have a limited ability to recover from disturbances due to ultra-oligotrophic
230 conditions and the limited number of populations and ranges of each species.

231 This report expands the total number of known shorefishes (found at depths <200 m)
232 from 141 to 145 and the total number of known species from Easter Island by at least seven,
233 from 171 to 178, including five deep-sea species observed at depths >200 m. Therefore, this
234 report increased the known species for the island by ~4%; which we believe is an underestimate

235 as we observed several individuals that we were unable to identify but that were distinct from
236 species known from the island. On the basis of these observations, we suggest that Easter Island
237 and the surrounding seamounts harbor many undiscovered species, especially at depths > 60 m.
238 Further, with high rates of apparent endemism and, therefore, potentially high rates of speciation,
239 this area may provide researchers with an ideal environment to study speciation and connectivity
240 patterns among seamounts that are not strongly influenced by coastal inputs and coastal and
241 boundary currents.

242 Most species observed in the ROV videos had relatively low abundances and were often
243 observed in a single transect. Several species were observed in relatively high abundance
244 (NMax > 10): *Seriola lalandi*, *Chromis* sp. nov., *Antigonia capros*, and the new species of
245 *Tosanoides*. Of these, only *S. lalandi* is commercially important (Zylich et al., 2014). Due to the
246 noise and lights of the ROV, some species may have been attracted to or frightened away from
247 the ROV. Jacks, such as *S. lalandi*, and *A. capros* appear to be attracted by the noise or lights of
248 the ROV, whereas *Parapercis* sp., *Tosanoides* sp., and some unidentified fishes would swim
249 away and hide as the ROV approached. Therefore, relative abundances could differ by the
250 sampling location and due to behavioral differences in response to the ROV.

251 The diversity and abundance of fishes we observed during only ~64 min of video
252 recording on bottom at “Apolo” were relatively high considering the declining diversity and
253 abundance of fishes at dive depths over the last 50 years (DiSalvo et al., 1988; Friedlander et al.,
254 2013; Hubbard and Garcia, 2003). During surveys at 10 stations around Easter Island in the
255 austral summer of 2011, only 41 species of fishes were recorded in four days of diving (~12
256 hours of total bottom time) (Friedlander et al. 2013). Mesophotic reefs have been found to have
257 higher percentages of endemism (Kane et al., 2014) and relatively few fish species in common

258 with adjacent shallow-water communities; however, the prevalence of new depth reports
259 suggests at least some species dominant in shallow waters also live at mesophotic depths, so
260 additional studies are necessary to better understand depth patterns (Kahng et al., 2014; Kahng et
261 al., 2010). The general trend from the few studies at mesophotic depths is that fish richness and
262 abundance declines with depth, especially for herbivores, and that higher abundance and richness
263 are correlated with greater structure associated with steep topography and greater abundance of
264 crevices and corals (see Kahng et al., 2014; Kahng et al., 2010). The relatively high diversity
265 and abundance we observed may, likewise, be associated with structure and abundance of whip
266 corals, crevices, and rocky structures present. Further studies are necessary to uncover depth
267 patterns in the mesophotic waters of Easter Island and how these habitats compare to other
268 mesophotic habitats.

269 Compared to the known diversity (>170 species) of the deep, benthopelagic fishes from
270 22 seamounts of the Nazca and Salas y Gómez Ridges (Parin, 1991; Parin et al., 1997), relatively
271 few species were identified from the baited Drop-Cams. The relatively low percentage of
272 species we identified is not surprising considering the limits of this technology relative to
273 trawling. With the exception of six potentially new species (see 3.3), all of the taxa we identified
274 have been reported from the South Pacific, including from the EIE and the adjacent Salas y
275 Gómez and Nazca Ridges (see, e.g., Parin, 1991; Parin et al., 1997).

276 Like Parin et al. (1997), we found apparent breaks in fish compositions (Table 3). These
277 breaks are between 150 m and 550 m and between 850 to 1100 m (Table 3), which are
278 comparable to those reported in Parin et al. (200-300 m, 500-600 m, and 700-800 m). In
279 addition, species-composition changes with longitude led Parin et al. to conclude that the EIE
280 was separate from that of the surrounding area, including the Nazca Ridge and eastern extent of

281 the Salas y Gómez Ridge. To determine whether these breaks are real or an artifact of limited
282 sampling and the difference in depth among stations, we will need future studies as we could not
283 statistically compare communities among islands or with depth because of differences in depth
284 among survey locations, a lack of replication among similar depths and locations, and
285 differences in survey methods and the associated biases. For example, Drop-Cams were baited
286 and therefore were biased towards scavengers and species associated with structure provided by
287 the rocky outcrops in some videos, and ROV surveys were biased towards the peak of an area
288 known to have high productivity.

289 Of 171 species identified by Parin et al. (1997), 44.4% were new to science and the
290 largest percentage (42.8%) were related to Indo-Pacific species instead of to eastern Pacific
291 species. In comparison, we determined $\geq 15\%$ of the 46 species observed in the ROV and Drop-
292 Cam videos were new reports for the southeast Pacific and potentially new to science. As we
293 identified several potentially new species from our relatively limited video footage, we suspect
294 that the EIE and the Salas y Gómez and Nazca Ridges harbor a substantial amount of
295 undiscovered biodiversity and therefore future studies should be done in these regions and
296 adjacent areas in the south Pacific so that we can have a better understanding of the biodiversity
297 and connectivity among the seamounts in this area.

298 3.3. New records

299 3.3.1. Potentially new species

300 At least six species are potentially new to science or, at least, have unique color and/or fin
301 patterns in comparison to the closely related species known from adjacent areas (Fig. 4).

302 Potentially new species were assigned to the following taxa *Tosanoides*, *Chromis*,

303 *Grammatonotus*, *Parapercis*, *Suezichthys*, and *Prognathodes*. In addition, *S. cf. mitsukurii* and
304 *Hydrolagus cf. trolli* may be new species (Table 3, Fig. 3J-L).

305 Although we assigned individuals to potentially new species on consensus of expert
306 opinions, we acknowledge the difficulty in assigning individuals to a genus or subfamily from
307 video alone and emphasize that these identifications are tentative until specimens can be
308 collected to confirm identifications. Further, determining whether species are truly endemic to
309 Easter Island or the region requires more extensive sampling. Due to a lack of sampling in this
310 area, it is premature to hypothesize whether these potentially new species are endemic or
311 whether they reflect an overall lack of sampling at mesopelagic and greater depths, especially in
312 the South Pacific.

313 The potentially new species of *Tosanoides* has a distinct color pattern in comparison to
314 known *Tosanoides* species. We observed two distinct patterns for this species (Fig. 4A and 4B).
315 The less abundant and larger individuals (likely males) are light pink or purple with bright
316 yellow fins and two broad, bright yellow strips separated by a thin purple stripe on the dorsal
317 portion of the head, with the lower yellow stripe extending down towards the pectoral fin. The
318 smaller individuals (probably females) are pale pink or purple with pale yellow fins and two
319 broad orangish bands extending from the midline up into the dorsal fin. Some individuals with
320 the orange bands had a yellow and purple banding pattern on the front-dorsal region of their
321 head, possibly indicating that these individuals are in the process of changing from female to
322 male as is common in Anthiinae. Individuals were also observed at Salas y Gómez at 150 m and
323 were observed hiding in holes at 277-281 m and swimming among whip corals in groups as large
324 as ~100 individuals at 157-175 m at Easter Island. Other Anthiines are known to aggregate in

325 large numbers, live at similar depths, be sexually dichromatic and dimorphic, and be
326 protogynous hermaphrodites.

327 The potential new species of *Chromis* was also observed at Salas y Gómez Island in
328 National Geographic Drop-Cam videos at 150 m (Friedlander et al., 2013). Therefore, this
329 species has a depth range of at least 150-175 m, which is comparable to several *Chromis* spp.
330 with depth maxima of 150-210 m (Froese and Pauly, 2011). This species has a bright yellow
331 body and caudal fin and the other fins are lighter yellow to bluish grey (Fig. 4D). They have one
332 or two white spots, one bright spot dorsally at the base of the caudal fin and another lighter spot
333 medially at the base of the dorsal fin. They were observed in large groups of several dozens,
334 generally swimming a meter or more above the seafloor. Along with the potentially new
335 *Tosanoides*, this *Chromis* species is one of the most abundant species observed at ~150 m at
336 Easter Island and Salas y Gómez (Table 3).

337 The potential new species of *Grammatonotus* was observed at 277-281 m, where the
338 habitat was rocky with an abundance of crevices in which the individuals would hide when the
339 ROV approached. This habitat and depth range, the overall body and fin shape, and the relative
340 size of the eyes are consistent with other species in this genus; however, genus-level diagnostic
341 characters require specimens to be collected and this genus is believed to need taxonomic
342 revision (Mundy and Parrish, 2004). Due to the scarcity of specimens and observations of
343 species in this genus, living color of many species are unknown and new species reports have
344 been made from comparisons of video observations to published descriptions and images
345 (Mundy and Parrish, 2004; Prokofiev, 2006, 2015). Other species are known to have yellowish
346 bodies and pink, blue, and /or lavender fins or markings; however, none of the reported color
347 patterns are consistent with the individuals we observed (Katayama et al., 1982; Mundy and

348 Parrish, 2004; Prokofiev, 2006, 2015). This species has a bright yellow body and bright purple
349 fins, with outer rays of the caudal fin produced into filaments.

350 The potential new species of *Parapercis* species was observed at 277-281 m on a rocky
351 bottom, which is within the known range of congeners. Due to differences in coloration (Fig.
352 4F), we could not confidently assign this individual to a known species. The only known species
353 from the area is *P. dockinsi*, which is considered endemic to the Juan Fernandez Archipelago
354 (Dyer and Westneat, 2010; Froese and Pauly, 2011; Rosa and Rosa, 1997) despite Parin et al.
355 (1997) reporting specimens from 180-290 m at two seamounts of the Salas y Gómez and Nazca
356 Ridges. The specimens we observed have distinct coloration patterns in comparison to *P.*
357 *dockinsi*, and it is unclear whether the specimens from the seamounts explored by Parin et al.
358 (1997) differed in coloration as well. Although minor variation in color pattern within species
359 has been observed (Ho and Causse, 2012; Randall, 2008), this genus is not known to have
360 substantial within-species color variation, excluding sexual dimorphism (Imamura and Yoshino,
361 2007), and morphological revision of populations with distinct color patterns has revealed
362 additional morphometric and meristic differences resulting in revisions of species (Randall,
363 2008). Further, two morphotypes of *P. sexfasciata* were found to be genetically distinct with
364 variation among morphotypes being consistent with inter-species differences (Kai et al., 2004).
365 Specimens are necessary to resolve whether coloration differs along the geographic range of this
366 species and whether observed color patterns are indicative of species-level differences.

367 The potential new species of *Suezichthys* was observed at 157-281 m (Fig. 4E), which is
368 consistent with the depth range of some congeners (Froese and Pauly, 2011). This genus has not
369 been reported for Easter Island and the first-ever report of this genus in the eastern Pacific is of
370 *S. rosenblatti*, which was found at 10-33 m at Juan Fernandez Archipelago and San Felix Island

371 (Russell and Westneat, 2013). The individuals in this report have a distinct color pattern in
372 comparison to *S. rosenblatti*; however, the pattern is similar to the Indo-Pacific coastal species *S.*
373 *devisi*. The species in this report and *S. devisi* have two orange lateral stripes in the same
374 location and a black spot dorsally on the caudal peduncle; however, the spot on the caudal
375 peduncle is considerably smaller on *S. devisi*. The species in this report, unlike *S. devisi*, has a
376 small, black spot ventrally on the dorsal fin and a much larger spot posteriorly on the bright
377 yellow, dorsal fin.

378 Finally, a potential new species of *Prognathodes* was observed at 157-175 m (Fig. 4C),
379 which is within the known range of congeners. It is similar but distinct from that of the
380 undescribed *Prognathodes* sp. “basabei” found along the Hawaiian archipelago. It is the first
381 report of this genus at Easter Island.

382 Recent revisions of *Squalus* spp., especially those formally considered *S. mitsukurii*, have
383 led to the conclusion that *S. mitsukurii* is likely restricted to the western North Pacific and is not
384 a circumglobal species with a patchy distribution as previously thought (see Froese and Pauly,
385 2011; White and Iglésias, 2011). Further, geographic variability in reproductive and growth
386 parameters and recent taxonomic work suggest that *S. mitsukurii* is a species complex and
387 several populations currently reported as *S. mitsukurii* are likely new and probably endemic
388 species in their respective regions (Cotton et al., 2011; Graham, 2005; Last et al., 2007).

389 Additional taxonomic work is needed to identify the number of species in this complex as well as
390 their geographic and depth ranges and whether the individuals in this study were the same as the
391 two individuals of an undescribed new species of *Squalus* collected 8 mi SW of Easter Island at
392 200-400 m (Randall and Cea, 2010). Individuals in this study were observed at 552-644 m,
393 which is consistent with *Squalus* cf. *mitsukurii* species (Graham, 2005).

394 *Hydrolagus* cf. *trolli* may be a new species as reported by Friedlander et al. (2013);
395 however, we were unable to eliminate or confirm the identification of the observed individuals as
396 *H. trolli*. Few species of *Hydrolagus* are known from the eastern South Pacific and only three,
397 *H. macrophthalmus*, *H. melanophasma*, and *H. trolli*, are known from Chile (Bustamante et al.,
398 2014). The individuals we observed were distinct in color pattern, lateral line pattern, and fin
399 shape from the first two species. The individuals we observed were more similar to *H. trolli*;
400 however, we chose not to assign the individuals as we could not see sufficient diagnostic features
401 and the report of *H. trolli* was not determined from analysis of a specimen but from reported
402 morphometrics of a specimen originally assigned to a different species (Bustamante et al., 2012).

403 3.3.2. New depth reports

404 Nine species were observed at deeper depths than previously reported. Two species with
405 notably deeper ranges than previously reported are *Etelis carbunculus* and *Polymixia*
406 *salagomeziensis*. *Etelis carbunculus* was observed at 638 m, which is deeper than the reported
407 range of 90-400 m (Froese and Pauly, 2011). *Polymixia salagomeziensis* (Fig. 3C), which differs
408 in several morphological characters, including distinct color patterns from the only other known
409 species of the genus from the area, *P. yuri* (Kotlyar, 1982, 1991, 1993), was observed at 644 and
410 776 m, which is considerably deeper than the previous report of 330 m (Parin et al., 1997) but
411 similar to maximum depths (550-770 m) for other species in this genus (Froese and Pauly, 2011).
412 See Supplementary Material for discussion of the depth range expansions for the other seven
413 species: *Aulostomus chinensis*, *Cheilodactylus plessisi*, *Lactoria diaphana*, *Plectranthias parini*,
414 *Bodianus unimaculatus*, *Sargocentron wilhelmi*, and *Scorpaena orgila*. In addition to these nine
415 new depth reports, *Evistias acutirostris* was recently registered for Easter Island (Hernández et
416 al., 2015), with this study being one of two documented observations for the island.

417 Some of these new depth reports are indicative of the limited sampling efforts below 40
418 m at Easter Island and general undersampling at mesopelagic depths, especially in the south
419 Pacific (Kahng et al., 2010). The prevalence of new depth reports could also be indicative of the
420 unique oceanographic conditions of the area and depauperate faunal assemblages that allow
421 species to expand their ranges to take advantage of open niches as well as deeper chlorophyll
422 maxima and deeper aphotic and disphotic conditions associated with ultra-oligotrophic waters
423 and local oceanographic regimes (e.g., central-gyre downwelling, eddies, and island- and
424 seamount-influenced currents).

425 4. Conclusion

426 These surveys of the deep-dwelling fishes of the EIE revealed apparent breaks in fish
427 communities between 150 m and 550 m and between 850 to 1100, which are comparable to
428 breaks in fish communities observed by Parin et al. (1997) for seamounts of the Nazca and
429 eastern Salas y Gómez Ridges. Our surveys expanded the known depth ranges of nine species
430 and the known species for the region by ~4%. Many of the previously unrecorded fishes,
431 including six potential new species, were observed at mesopelagic depths (150-280 m). The
432 abundance of new reports from this study emphasizes the lack of knowledge available for deep-
433 dwelling fish species, especially for the southeast Pacific, including the EIE. In addition, these
434 new reports may be indicative of the relative isolation of the island and/or unique oceanographic
435 conditions that may have provided favorable conditions for range expansion and the evolution of
436 new species. The data obtained from these surveys is the first step in establishing a baseline for
437 conservation and sustainable management planning, for understanding the effects of natural and
438 anthropogenic disturbances on these communities, and for testing biogeographical hypotheses,

439 including whether latitudinal or longitudinal breaks in species' ranges exist among similar
440 communities in the Pacific and the extent and pathway of connectivity among them.

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576 Island, a recent history (1950-2010). Latin American Journal of Aquatic Research 42,
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578 Table 1. Location and duration information for the three exploratory ROV transects done at the
 579 Apolo fishing ground on 1 October 2014.

Transect name	Depth (m)	Bottom time (min)	Starting latitude	Starting longitude	Ending latitude	Ending longitude
Apolo-1	171-175	~ 12 min	27°13'59.9"S	109°29'01.7"W	27°14'05.5"S	109°29'02.0"W
Apolo-2	277-281	~ 32 min	27°14'17.0"S	109°29'09.9"W	27°14'17.0"S	109°29'09.9"W
Apolo-3	157-167	~20 min	27°14'4.1"S	109°29'02.3"W	27°14'17.6"S	109°28'54.6"W

580

581 Table 2. Station information for the Drop-Cam deployments. SyG = deployments on the island
582 slope of Salas y Gómez. nSyG = deployments along the slope of seamounts near Salas y Gómez.
583 RN = deployments on the slope of Easter Island (also known as Rapa Nui). Camera number
584 indicates which of the three Drop-Cams was used.

Station	Location	Depth (m)	Latitude	Longitude	Video time (min)	Date (2011)	Camera number
SyG150	SyG	150	26°28.66' S	105°24.301' W	300	22-Feb	1
SyG552	SyG	552	26°31.197' S	105°18.947' W	135	26-Feb	3
SyG638	SyG	638	26°28.653' S	105°24.71' W	300	22-Feb	3
SyG640	SyG	640	26°28.772' S	105°24.859' W	300	22-Feb	2
nSyG644	nSyG	644	26°21.98' S	106°35.48' W	105	28-Feb	2
SyG776	SyG	776	26°23.4' S	105°19.5' W	105	25-Feb	2
SyG847	SyG	847	26°25.52' S	105°22.8' W	35	24-Feb	1
SyG1097	SyG	1097	26°31.912' S	105°18.302' W	35	27-Feb	1
SyG1099	SyG	1099	26°23.9' S	105°18.75' W	105	25-Feb	3
RN1113	RN	1113	27°6.799' S	109°27.469' W	76	2-Mar	3
RN1242	RN	1242	27°8' S	109°28.8' W	105	3-Mar	1
SyG1312	SyG	1312	26°24.5' S	105°22.94' W	35	24-Feb	2
SyG1323	SyG	1323	26°32.393' S	105°17.716' W	35	27-Feb	2
RN1331	RN	1331	27°7.369' S	109°28.402' W	76	2-Mar	2
SyG1348	SyG	1348	26°31.783' S	105°22.122' W	65	23-Feb	3
SyG1395	SyG	1395	26°23.15' S	105°20.1' W	105	25-Feb	1
RN1550	RN	1550	27°6.2' S	109°28.2' W	195	4-Mar	3
RN1577	RN	1577	27°7' S	109°28.1' W	105	3-Mar	3
RN1610	RN	1610	27°5.5' S	109°28.1' W	195	4-Mar	2
nSyg1849	nSyG	1849	26°43.831' S	106°16.87' W	105	28-Feb	1

585 Table 3. Maximum number per frame (Nmax) of each species of fish per ROV transect and DropCam deployment, with transects and
 586 deployments ordered from the shallowest to the deepest. Station names include the location and depth of the deployment. SyG1097 is
 587 excluded from this table because no fishes were observed. A-1, A-2, and A-3 are ROV transects 1-3 at Apolo. Easter Island endemics
 588 are indicated respectively by (E) after the species name. See Tables 1 and 2 for station localities and deployment information.

Family	Species	SyG	A-3	A-1	A-2	SyG	SyG	SyG	nSyG	SyG	SyG	SyG	RN	RN	SyG	SyG	RN	SyG	SyG	RN	RN	RN	nSyG
Hexanchidae	<i>Hexanchus griseus</i> ^a									2													
Squalidae	<i>Squalus cf. mitsukurii</i>					1	1		2														
Chimaeridae	<i>Hydrolagus cf.</i> <i>trolli</i> ^{a,b}																2					1	
Halosauridae	Halosauridae sp.												1	1			1	1	2	2	1		
Muraenidae	<i>Gymnothorax</i> <i>bathophilus</i>	2																					
Synphobranchidae	<i>cf. Synphobranchus</i> <i>affinis</i>													1		2				1		1	2
Nettastomatidae	Nettastomatidae sp.															1							
Sternoptychidae	<i>Argyripnus</i> sp.					1	1																
Synodontidae	<i>Synodus cf. isolatus</i>	2	1																				
Polymixiidae	<i>Polymixia</i> <i>salagomeziensis</i>								1	2													
Moridae	<i>Laemonema</i>					1																	

Moridae	<i>Antimora rostrata</i>						1		1	1							2	
Macrouridae	Macrouridae sp. 1						4		1			1	2	1				
Macrouridae	Macrouridae sp. 2									1								
Holocentridae	<i>Pristilepis oligolepis</i>																	1
Holocentridae	<i>Sargocentron wilhelmi</i> (E)																	1 ^d
Berycidae	<i>Beryx splendens</i> ^d							1										
Berycidae	cf. <i>Beryx splendens</i> ^d																	1
Caproidae	<i>Antigonia capros</i>																	11
Aulostomidae	<i>Aulostomus chinensis</i>																	1 ^d
Scorpaenidae	<i>Scorpaenoides engleri</i> (E)																	1 ^d
Scorpaenidae	<i>Scorpaena orgila</i>																	1 ^d
Serranidae	<i>Caprodon longimanus</i>	1	2	8	1													
Serranidae	<i>Plectranthias parini</i>																	3 ^d
Serranidae	<i>Tosanooides</i> sp. ^{a,b}	8	56 ^e	32 ^e	2													
Callanthiidae	cf. <i>Grammatonotus</i> sp. ^{a,b}																	4
Priacanthidae	<i>Cookeolus japonicus</i>	1																
Priacanthidae	<i>Priacanthus nasca</i> (E)		1	2														
Emmelichthyidae	Emmelichthyidae sp.	2																
Lutjanidae	<i>Parapristipomoides squamimaxillaris</i>	8																
Lutjanidae	<i>Etelis carbunculus</i>	2						1			1 ^d							

Chaetodontidae	<i>Prognathodes</i> sp. ^{a,b}	1	1	1					
Pentacerotidae	<i>Evistias acutirostris</i>		7						
Carangidae	<i>Pseudocaranx dentex</i>	1		1					
Carangidae	<i>Seriola lalandi</i>	4	1	12	1				
Cheilodactylidae	<i>Cheilodactylus plessisi</i>		1 ^d						
Pomacentridae	<i>Chromis</i> sp. ^{a,b}	2	15	11					
Labridae	<i>Bodianus</i>								
	<i>unimaculatus</i>	2	1	3 ^d					
Labridae	<i>Pseudolabrus semifasciatus</i> (E)		1						
Labridae	<i>Suezichthys</i> sp. ^{a,b}		1		2				
Labridae	Unidentified <i>Suezichthys</i> sp. ^{a,c}		1						
Pinguipedidae	<i>Parapercis</i> sp. ^{a,b}				2				
Gempylidae	<i>Rexea</i> sp.					1	1	2	2
									1
Gempylidae	<i>Ruvettus pretiosus</i>								1
Gempylidae	cf. <i>Rexea</i>								1
Ostraciidae	<i>Lactoria diaphana</i>			1 ^d					
Unidentified 1	Unidentified 1		1						
Unidentified 2	Unidentified 2			1					
Unidentified 3	Unidentified 3			1					
Unidentified 4	Unidentified 4				1				
Unidentified 5	Unidentified 5				1				
Unidentified 6	Unidentified 6	1							
Unidentified 7	Unidentified 7					1			

Unidentified 8

Unidentified 8

1

Unidentified 9

Unidentified 9

1

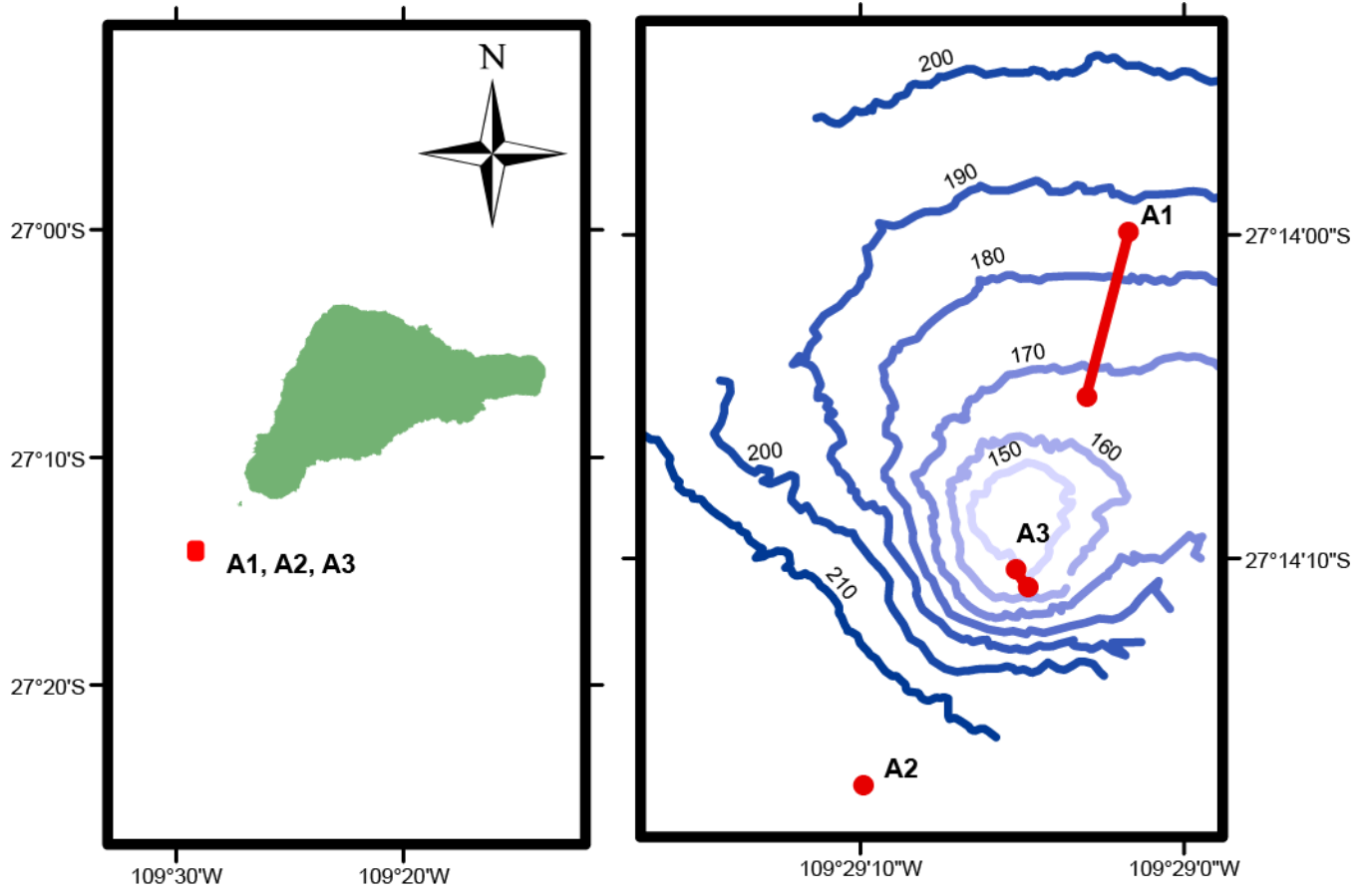
589 ^aFirst confirmed report from the Easter Island Ecoregion.

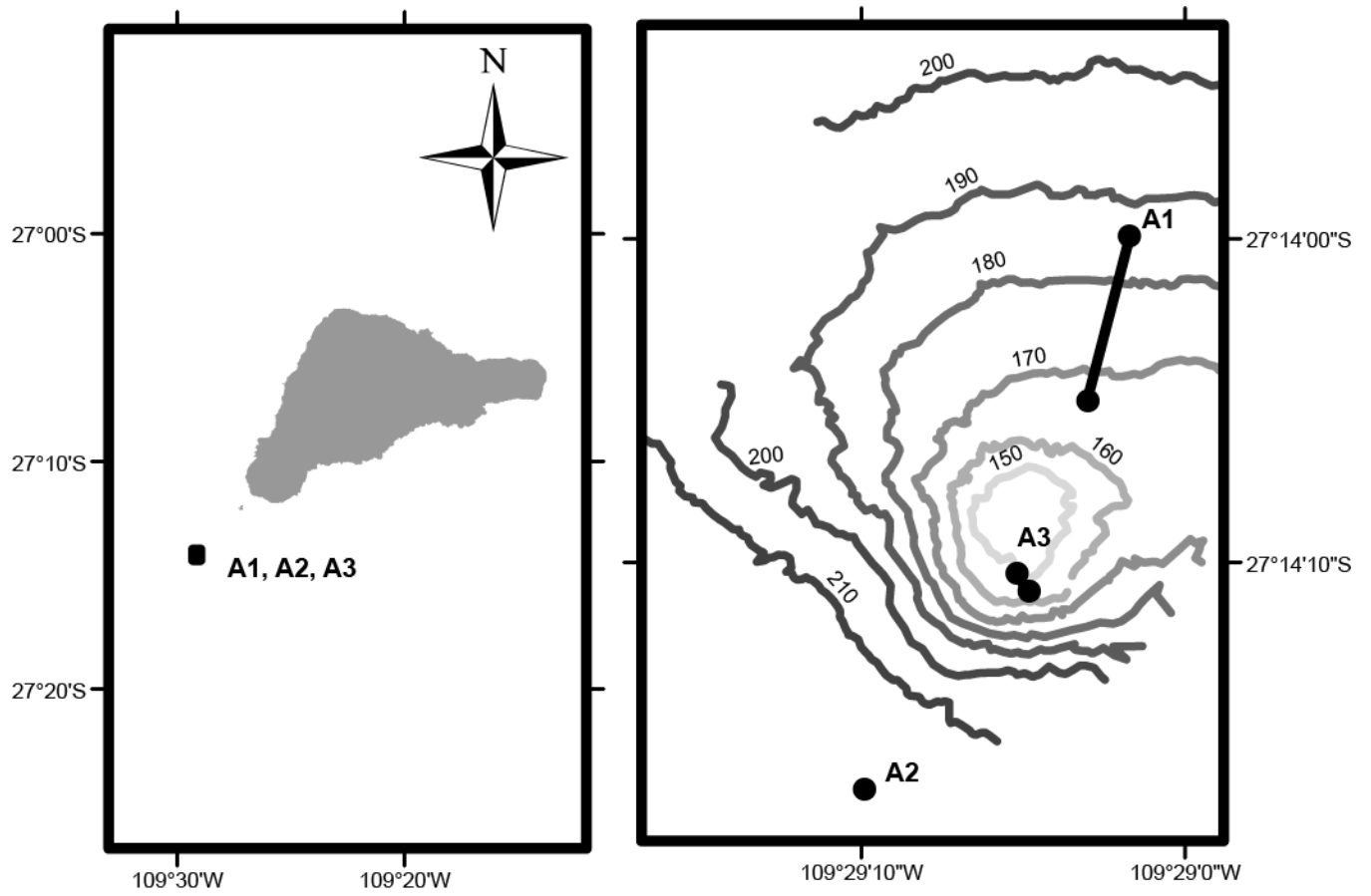
590 ^bPotentially a new species on the basis of distinct coloration and, in some cases, fin shape in comparison to known species.

591 ^cThis potential species could be either the female or male of the above *Suezichthys* sp. nov. or a separate new species of *Suezichthys*.

592 ^dThis report is a new maximum depth for this species.

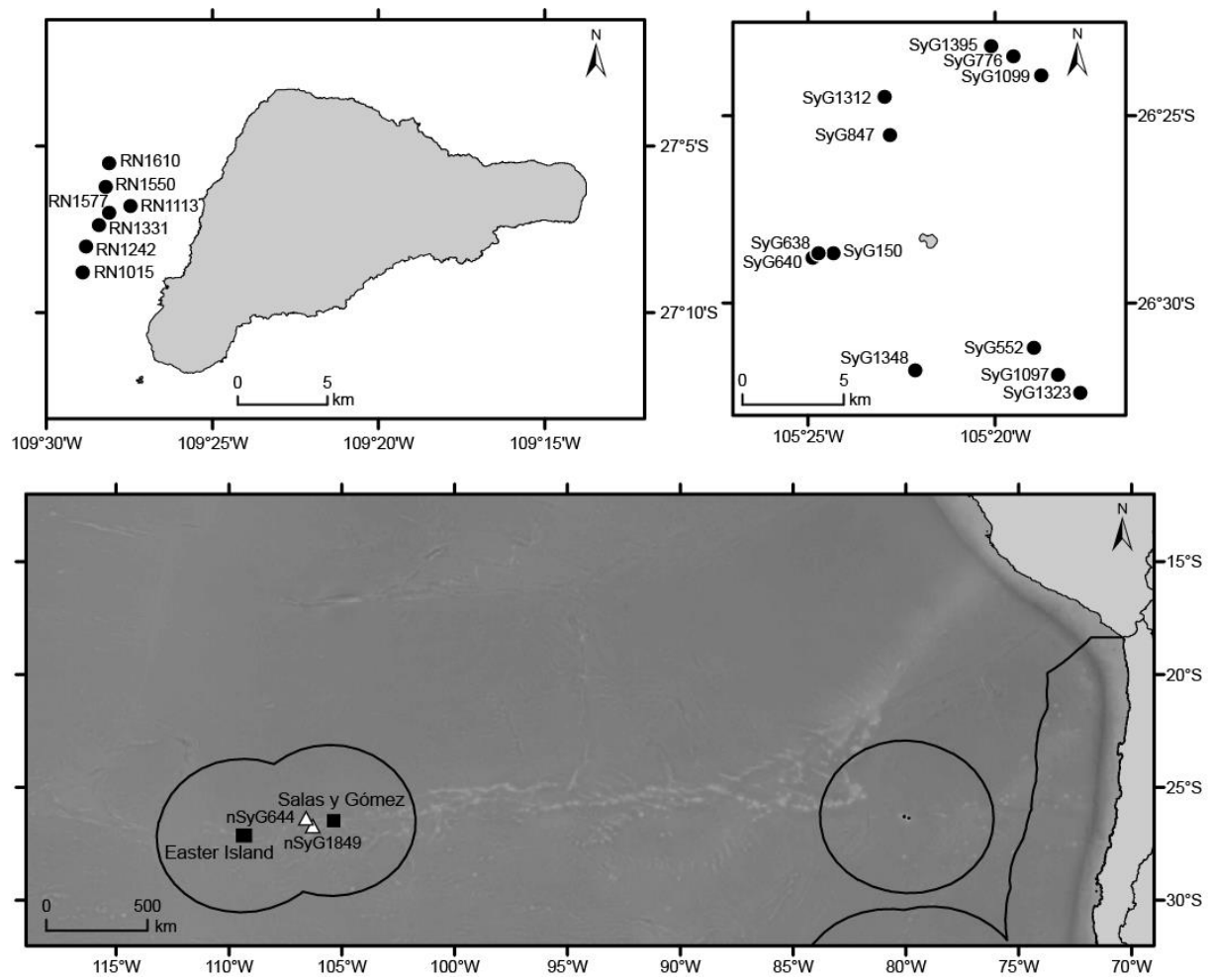
593 ^eCount may include juveniles of the *Chromis* species.





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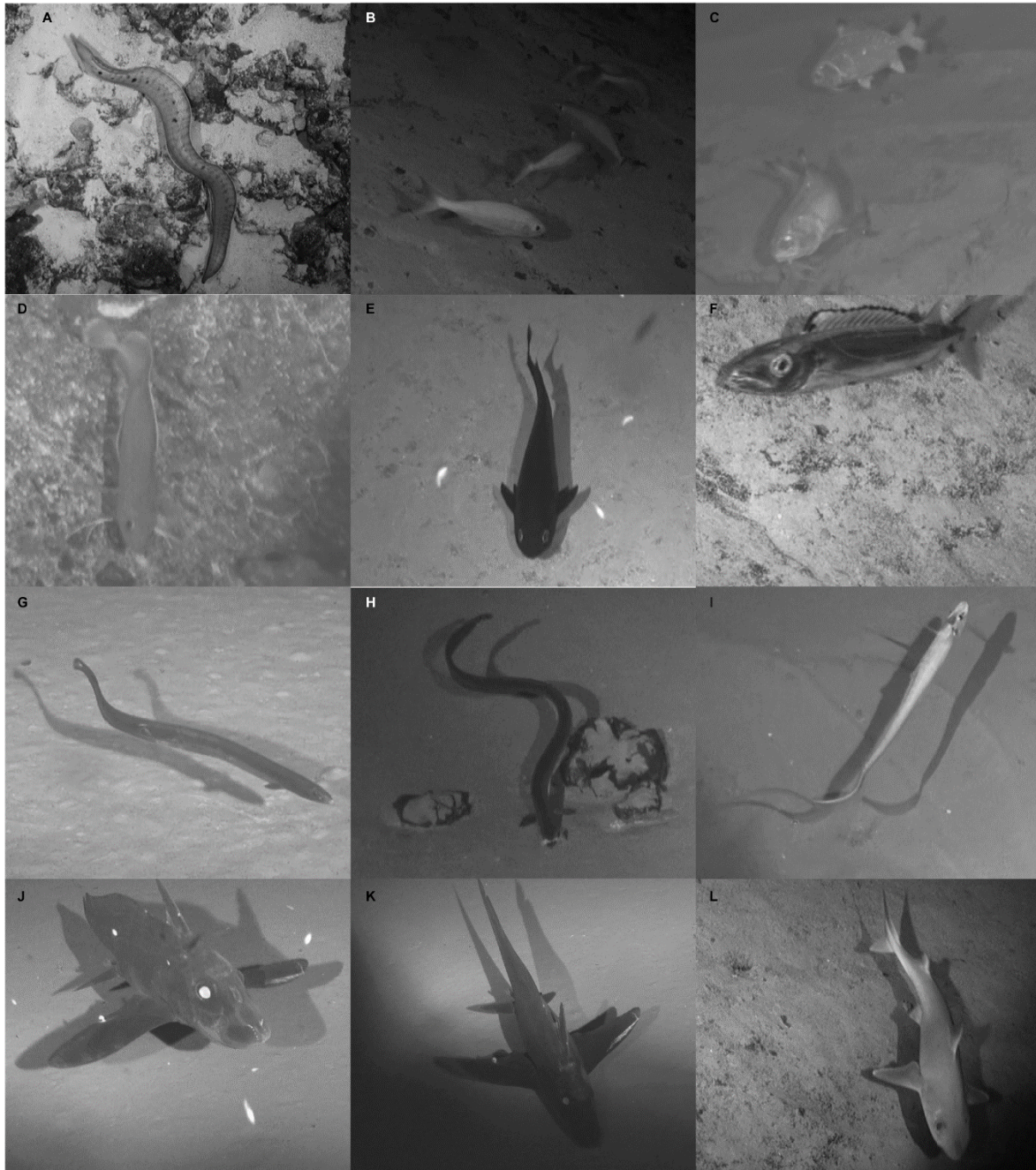
597 Fig. 1. Location of the three ROV transects at Apolo, the subsurface peak off the southwest
 598 coast of Easter Island.



599

600 Fig. 2. Location of the Drop-Cam deployments near Salas y Gómez and Easter Island (black
 601 circles) and the seamounts (white triangles) between the islands. See Table 1 for station
 602 information and deployment details. 'File 1 here'





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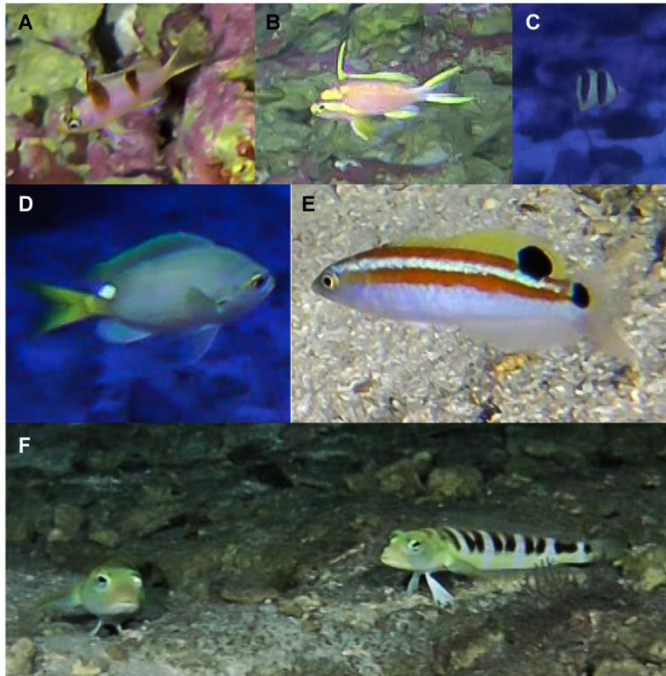
605 Fig. 3. Representative images of select fishes from the Drop-Cam videos deployed in the Easter

606 Island Ecoregion. (A) *Gymnothorax bathyphilus*. (B) *Parapristipomoides squamimaxillaris*.

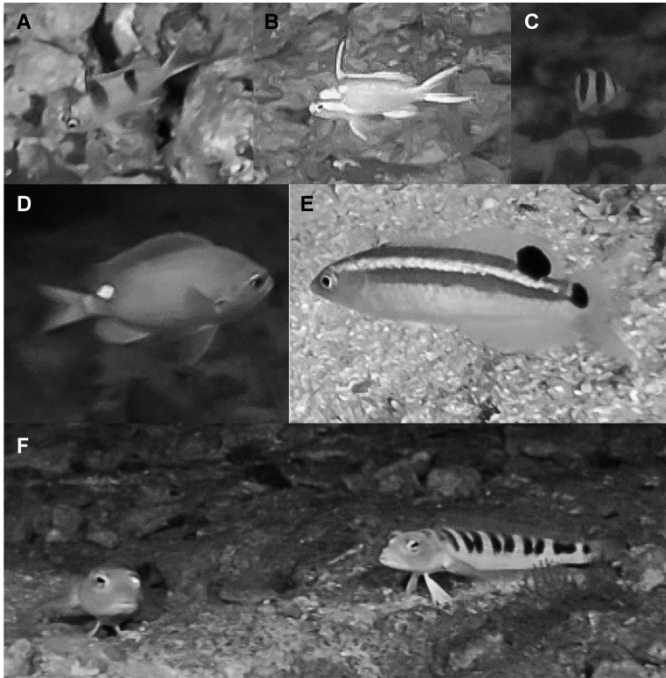
607 (C) *Polymixia salagomeziensis*. (D) *Laemonema* sp. (E) *Antimora rostrata*. (F) *Rexea* sp. (G)

608 cf. *Synaphobranchus affinis*. (H) cf. *Synaphobranchus affinis* consuming loose bait. (I)

- 609 Halosauridae sp. (J and K) *Hydrolagus* cf. *trolli*. (L) *Squalus* cf. *mitsukurii*. Photo credit: Eric
610 Berkenpas, National Geographic.



611



612

613 Fig. 4. Images of potentially new species of fishes observed in the ROV videos from Apolo. (A)
 614 Female of *Tosanoides* sp. (B) Male of *Tosanoides* sp. (C) *Prognathodes* sp. (D) *Chromis* sp. (E)
 615 *Suezichthys* sp. (F) *Parapercis* sp. Photo credit: Matthias Gorny, Oceana Chile.