

THE ENDEMIC SHORE FISHES OF THE HAWAIIAN ISLANDS, LORD HOWE ISLAND AND EASTER ISLAND

par

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INTRODUCTION

The author has been privileged to collect and observe fishes at the three insular localities in Oceania which have the highest percentage of endemic fishes : Hawaiian Islands, Easter Island (27° S ; 109° W) and Lord Howe Island (31° 30' S ; 159° W) (1). At all of these islands the most abundant shore fishes, in general, are the species unique to the islands. Before discussing these fishes, the question of what constitutes an endemic species must be considered.

The islands mentioned above are all isolated peripherally in the subtropical Pacific. Because of limited gene flow with other insular populations, many species of fishes at these islands exhibit differences. For some populations the differences are slight, and few systematists would be tempted to assign specific rank to them. Other populations have differentiated so markedly (or are relics) that nearly all workers would agree to call them species. In between these two groupings, for which there is a clear consensus, there are populations which some systematists would classify as species and others at best as subspecies. GOSLINE and BROCK (1960), for example, regard the Hawaiian variant of the convict surgeonfish *Acanthurus triostegus* (Linnaeus) as a species, *Acanthurus sandvicensis* Streets, whereas RANDALL (1956) labelled it *Acanthurus triostegus sandvicensis*. GOSLINE and BROCK can point out that they are able to separate 100 percent of the Hawaiian variant by a sickle-shaped dark mark at the pectoral base. RANDALL, on the other hand, feels that this slight color difference and broadly overlapping fin-ray count do not constitute specific-level differentiation — that the Hawaiian form would freely interbreed with *triostegus* elsewhere in its range if it had the opportunity to do so. Since natural

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populations of these two forms have no such opportunity, and acanthurid fishes would not be good subjects for experimental work on breeding in aquaria (RANDALL, 1961a ; 1961b), it is not likely that the problem of whether to regard the Hawaiian form a species or a subspecies can ever be solved. It may be argued that it does not matter how one names a variant so long as the differences are clearly shown. The reader could then come to his own opinion. However, it does matter in discussions on endemism. In this report insular variants which have been named as subspecies will be regarded as endemics.

Equally perplexing is the problem of whether to regard a species as an endemic at an island if it turns up at another island. There is always the possibility that it is only a transient at the extra-limital locality, *i.e.*, a waif from the sole breeding population at the primordial island. This seems to be no problem with the Hawaiian Islands and outlying Johnston Island because of the vast distance which separates the Hawaiian Province from the rest of the Indo-West-Pacific. But the determination of the percentage of endemism for Lord Howe Island is difficult. Norfolk Island, which lies about 560 miles ENE, should probably be included with Lord Howe as a single endemic region, but what about the Great Barrier Reef, northern New Zealand, and New Caledonia ? Some fishes thought to be native only at Lord Howe Island have been subsequently found at these other localities.

For the purpose of computing percentage endemism in the present paper, pelagic fishes are omitted. The Hawaiian record of *Seriola rivoliana* Cuvier and Valenciennes by GOODING and MAGNUSON (1967), for example, will not be included because this carangid fish is primarily pelagic. Also, species introduced by man to the Hawaiian Islands (BROCK, 1952 ; RANDALL, 1960a ; RANDALL and KATAYAMA, 1972), are not considered.

HAWAIIAN ISLANDS

In their "Handbook of Hawaiian Fishes", GOSLINE and BROCK (1960) stated that 34 % of the reef fishes recognized in the book have not been taken outside of the Hawaiian chain and Johnston Island. Collections that were made since the book was written and recent systematic work, however, require a modification of this figure (which, even without the updating, seems too high).

A chronological summary of literature pertinent to the recomputation of the number of species of Hawaiian fishes and the percentage endemism is presented below.

GOSLINE and BROCK provisionally recognized *Gregoryina gygis* Fowler and Ball, known from a single specimen from a tern's nest at Laysan Island, Leeward Hawaiian Islands as a valid species in the monotypic family Gregoryinidae. Evidently, they overlooked the placement of *Gregoryina* as a junior synonym of the cheilodactylid genus *Goniistius* by NORMAN (1957) ; thus *gygis* is a synonym of *Goniistius vittatus* (Garrett).

SCHULTZ in SCHULTZ and collaborators (1960) showed that the labrid fish *Hemipteronotus bifer* (Lay and Bennett) is the young of *H. taeniourus* (Lacépède), a species often placed in *Novaculichthys* or *Xyrichtys* (*Xyrichtys* of most authors). He differed further from GOSLINE and BROCK in recognizing *Hemipteronotus jenkinsi* Snyder as a valid species and in placing *H. baldwini* Jordan and Evermann in the synonymy of *H. melanopus* (Bleeker), described from Indonesia. More study of the Indo-Pacific fishes of this genus is needed, however.

GOSLINE (1960) described the pseudogrammid fish *Suttonia lineata* from the Hawaiian Islands. He stated that it is obviously close to *S. suttoni* Smith from East Africa.

STRASBURG (1960) described the engraulid fish *Stolephorus buccaneeri* from Hawaii.

RANDALL (1960b) reported *Ctenochaetus hawaiiensis* Randall from the Tuamotu Archipelago, thus this surgeonfish is not endemic to Hawaii as first presumed.

RANDALL (1961c) described a new butterflyfish, *Forcipiger inornatus*, from Hawaii; however, in a later paper (RANDALL and CALDWELL, 1970), it was shown to be a color form of the true *F. longirostris* (Broussonet). The most common species of the genus, *F. flavissimus* (Jordan and McGregor), has been called *longirostris* by most authors. Both species of the genus are wide-ranging in the Indo-Pacific, including Hawaii.

RANDALL (1963) gave Pearl Harbor, Oahu, as the type locality for his *Cirrhitichthys serratus*; however, the type specimens were collected from a drydock that had been towed from Guam. Since this hawkfish has not been taken since in Hawaii, it probably should not be regarded as a Hawaiian species. RANDALL also mentioned two specimens of the wide-ranging longnose hawkfish *Oxycirrhites typus* Bleeker as a new Hawaiian record; these were reported on fully by MORRIS and MORRIS (1967).

RANDALL (1964) has shown that there are three, not four, species of filefish of the genus *Cantherhines* (*Cantherines* of JORDAN and EVERMANN, 1905, and *Amanes* of GOSLINE and BROCK) in the Hawaiian Islands: *dumerili* (Hollard), *sandwichiensis* (Quoy and Gaimard), and *verecundus* E.K. Jordan; the latter two are endemics.

The flatfish *Engyprosopon arenicola* Jordan and Evermann was mistakenly placed in the synonymy of *E. hawaiiensis* Jordan and Evermann by GOSLINE and BROCK (1960). GOSLINE (1965) corrected this error.

STRASBURG (1966) added two new Hawaiian fish records, *Pikea maculata* Döderlein and Steindachner, described from Japan, and *Hime japonicus* (Günther). According to Paul STRUHSAKER (personal communication), who is studying the genus *Aulopus* in Hawaii with Carl L. HUBBS and Douglass F. HOESE (they regard *Hime* as a subgenus of *Aulopus*), STRASBURG's specimen

represents an undescribed species. Also there is another new species of *Aulopus* in Hawaii which is more abundant. Both are endemic to the Hawaiian Islands at the present time.

In his revision of the blenny genus *Entomacrodus*, V. SPRINGER (1967) described *E. strasburgi* from Oahu, Hawaiian Islands.

TYLER (1968) described *Hollardia goslinei* in his monograph of triacanthoid fishes. It is presently known only from the Hawaiian Islands.

The butterflyfish *Megaprotodon trifascialis* (Quoy and Gaimard) was collected for the first time in the Hawaiian Islands by Lester ZUKERAN (recorded by AXELROD and EMMENS, 1969).

The photograph of a specimen of *Centropyge loriculus* (Günther) from Oahu by RANDALL which appears in AXELROD and EMMENS (1969) represents the first record of this species from Hawaii. The author has previously determined that *C. flammeus* Schultz is a junior synonym.

ESCHMEYER (1969) recorded the odd scorpaenid fish *Ectreposebastes imus* Garman for the first time from the Hawaiian Islands from specimens collected in 325 to 350 fathoms by Paul STRUHSAKER and commented on the probable circumtropical distribution of this species.

COHEN (1970) described the argentinid fish *Glossanodon struhsakeri* from specimens collected by STRUHSAKER in 183 to 296 meters in the Hawaiian Islands.

W.D. ANDERSON (1970) showed that there are two species of the lutjanid genus *Symphysanodon* in the Hawaiian Islands : *S. typus* Bleeker, which is recorded also from New Guinea, Kai Islands and the Philippines, and *S. maunaloae* Anderson, which is confined to the Hawaiian Islands.

RANDALL and STRUHSAKER (1971) recorded the surgeonfish *Nasolopezi* Herre from the Hawaiian Islands ; it is also known from the Philippines and Japan.

RANDALL (1971) showed that the Hawaiian triggerfish *Balistes nycteris* (Jordan and Evermann) is the transforming stage of the Indo-Pacific *Melichthys vidua* (Solander).

V. SPRINGER (1971) relegated the blennioid fish *Ecsenius hawaiiensi* Chapman and Schultz to the synonymy of *E. bicolor* (Day). He regarded it as a possible inadvertent introduction from Guam (it was also collected in Pearl Harbor from the drydock hauled from Guam).

BALDWIN (1972) described *Psilogobius mainlandi* as a new genus and species of gobioid fish from the Hawaiian Islands.

CLARKE (1972) collected six fishes not previously known for Hawaii : *Odontaspis ferox* (Risso), *Centrophorus tessellatus* Garman, *Urotrygon daviesi* Wallace, *Muraenichthys macropterus* Bleeker, *Hoplostethus mediterraneus* Cuvier and Valenciennes, and *Epinnula magistralis* Poey. He also obtained *Paratrachichthys* sp., *Gymnothorax* sp., and *Ostichthys* sp., which are believed to be undescribed and confined to the Hawaiian Islands. The specimens identified as *Ostichthys japonicus* (Cuvier and Valenciennes) by GOSLINE AND BROCK (1960) are *O. pilwaxii* (Steindachner). This species has recently been collected by RANDALL and associates at Easter Island, Lord Howe Island, and Réunion (RANDALL and GUEZE, MS).

HEEMSTRA (1972) has distinguished the Hawaiian emmelichthyid fish *Erythrocles scintillans* (Jordan and Thompson) from *E. schlegeli* (Richardson) from Japan.

RANDALL and SWERDLOFF (1972) reviewed the species of *Chromis* from the Hawaiian Islands. The two "color forms" of the *leucurus* of GOSLINE and BROCK (1960) and WOODS in SCHULTZ and collaborators (1960) were shown to be species, neither of which is *leucurus* Gilbert. One was identified as *C. agilis* Smith and the other described as new (*hanui*). The true *Chromis leucurus* Gilbert was reported from the Marquesas and *C. vanderbilti* (Fowler) from a number of Pacific localities. Another species, *C. struhsakeri*, was described as new from deeper waters. Thus, there are seven species of *Chromis* from Hawaii, four of which are native to the islands.

HERALD and RANDALL (1972) described the pipefish *Dunckerocampus baldwini* from the Hawaiian Islands.

RANDALL (1972a) reported *Ostracion whitleyi* Fowler from Hawaii (recorded previously from Johnston Island as *soloensis* by FOWLER and BALL, 1925, and others) as well as *O. cubicus*, a record of FOWLER (1923) based on a single specimen (not compiled by GOSLINE and BROCK). RANDALL cast doubt on this record ; however, a recent underwater observation of the unmistakable bright yellow, black-spotted juvenile of this species by E.H. CHAVE (personal communication) in Hawaii confirms the earlier record of this Indo-Pacific species. The Hawaiian form of *Ostracion meleagris* Shaw and Nodder (*lentiginosus* Bloch and Schneider is a junior synonym) was classified as the subspecies *camurum* Jenkins.

COHEN and NIELSEN (1972) described the ophidiid fish *Saccogaster hawaii* from specimens collected by Paul STRUHSAKER in 234 meters off Maui.

RANDALL (1972b) demonstrated that the labrid fish *Anampses godeffroyi* Günther is the male of *A. cuvier* (Quoy and Gaimard) and *A. chrysocephalus* Randall the male of *A. rubrocaudatus* Randall (the names *cuvier* and *chrysocephalus* have priority). Both species are native to Hawaii.

STRUHSAKER (1973a) described a new stomiatoid fish, *Argyripnus brocki*, from the Hawaiian Islands. He identified a postlarval form from the Indian Ocean as this species.

RANDAL (1973a) recorded the wrasse *Pseudojuloides cerasinus* (Synder) (erroneously placed in *Leptojulis* by RANDALL) from the Society Islands, thus indicating that this species is not a Hawaiian endemic. He mentioned that *Thalassoma umbryostygma* (Rüppell) is a primary color phase of *T. purpureum* (Forsskal). The doubtful Hawaiian records in GOSLINE and BROCK (1960) of *T. lunare* (Linnaeus) and *T. melanochir* (Bleeker) [= *T. amblycephalus* (Bleeker)] are even more doubtful in view of the continued lack of new material from the Hawaiian area to verify these records. On the other hand, *T. quinquevittata* (Lay and Bennett) listed by GOSLINE and BROCK as "Not known north of Johnston" was recorded from French Frigate Shoals in the Leeward Hawaiian Islands by FOWLER and BALL (1925) and has been collected at the island of Hawaii by Edmund S. HOBSON.

TOMINAGA and YASUDA (1973) have determined that the angelfish *Centropyge interruptus* (Tanaka) from Japan is not a junior synonym of *C. fisheri* (Snyder) as TANAKA (1931) had later decided. Therefore, *C. fisheri*'s range is again restricted to the Hawaiian chain.

RANDALL and KAY (1974) have united the native Hawaiian wrasses *Stethojulis axillaris* (Quoy and Gaimard) and *S. balteata* (Quoy and Gaimard) as sexual color phases of one species. *S. balteata*, the name for the terminal male phase, has page priority. Most authors have mistakenly called this form *S. albavittata* (Bonnaterre), however, this is the name for an Indian Ocean species described before any fishes were collected in the Hawaiian Islands.

RANDALL and McCOSKER (1975) determined that the snake eel *Caecula platyrhyncha* Gosline from Hawaii is a synonym of *Ichthyapus vulturis* Weber and de Beaufort, described from Indonesia. Also they listed *Anarchias seychellensis* Smith from Hawaii and distinguish it from the closely related *A. leucurus* (Snyder). The supposed Hawaiian endemic moray *Gymnothorax eurostus* (Abbott) was recorded from a number of Indo-Pacific localities between 16° and 32° N. and S.

In their revision of the sharpnose puffer genus *Canthigaster*, ALLEN and RANDALL (in press) resurrected *C. epilamprus* from synonymy and recorded it from several non-Hawaiian localities in the Pacific, added the wide-ranging *solandri* to the fauna, and described a deep-dwelling species collected by STRUHSAKER as new. Two of the eight Hawaiian species are endemics.

STRUHSAKER and MONCRIEF (1974) ascertained that *Bothus thompsoni* Fowler, previously considered a synonym of *B. bleekeri* Steindachner, is a valid species native to the Hawaiian Islands.

In addition to the above, the author has in preparation 18 manuscripts (12 with co-authors) concerning Hawaiian fishes which will describe 23 new species (three of these not endemic), add eight new records, recover six species from synonymy (three not endemic) and show that six others believed to be

unique to Hawaii occur elsewhere. There are also two records of fishes (one endemic) which were overlooked by GOSLINE and BROCK.

Specimens of six other species of Hawaiian fishes believed to be undescribed and one new record have been loaned to colleagues for their study. Two new Hawaiian fishes from other sources are also being described.

During the period 1967 to 1972, Paul STRUHSAKER and associates of the National Marine Fisheries Service in Hawaii conducted a survey of the deeper water off the islands (63 to 704 meters), primarily with a 12.5-meter otter trawl from the "Townsend Cromwell", for shrimps and fishes. During the first four cruises alone, 182 bottom fishes were taken of which 29 were new to the islands (STRUHSAKER 1973b). The only previous survey of comparable magnitude was that carried out in 1902 from the U.S. Fish Commission steamer "Albatross" and reported by Charles H. GILBERT (1905). GILBERT obtained 44 fishes that were not collected during the recent trawling, mostly because the "Albatross" sampled deeper water and often rougher bottom. In the subsequent benthic survey cruises of the "Townsend Cromwell" more unique bottom fishes were taken. As discussed above, certain publications have already dealt with some of these fishes. Of STRUHSAKER's remaining unreported material there are two new genera, eight new species, ten new records, and nine other fishes which are either new species or new records from the Hawaiian Islands.

The small meso and bathypelagic fishes are the most poorly known of the Hawaiian fish fauna, but a current program to collect and identify these fishes is doing much to obviate this deficiency. Thomas A. CLARKE has collected these fishes during the period 1969 to 1973, mainly with a 10-foot Izaacs-Kidd midwater trawl from the University of Hawaii's R/V "Teritu" from the surface to 1 000 meters. He estimates that he has taken between 225 and 250 species of these fishes in 54 different families, the most important of which are the Myctophidae and the Melanostomiidae. It is expected that approximately half of these fishes will be new to the Hawaiian region when the studies of CLARKE and his colleagues are completed.

GOSLINE and BROCK (1960) recorded 584 species of fishes from the Hawaiian Islands, excluding introductions, but including pelagic species. Recent collecting and the studies outlined above (but not CLARKE's which is too preliminary at this time to permit such analysis) have added and will add 111 fishes to the fauna as new species, new or overlooked records, and resurrections from synonymy. As a result of synonyms and old records that seem invalid, there are 14 deletions from the Hawaiian fish fauna. The new total of naturally occurring species of fishes in Hawaiian waters is 681.

GOSLINE and BROCK wisely confined their comments on endemism for the inshore fishes which they defined as "those on the shore side of the maximum depth fished by trap and hand-line fishermen ; this depth lies well within the 100-fathom boundary". This was purposely vague because, as these authors pointed out, no sharp dividing line between inshore and deeper water forms can be drawn. If the deeper water fishes were included, many would be considered

endemics that will eventually be shown to occur elsewhere. The benthic fish fauna of Hawaii below 100 fathoms is among the best known in the world (though certainly some forms remain to be discovered). In addition to the extensive trawling and dredging surveys mentioned above, Hawaii has had the unique deep collecting opportunity provided by lava flows entering the sea (JORDAN, 1921 ; GOSLINE *et al.*, 1954). Also the alert state Division of Fish and Game and a number of local fishermen have brought unusual fishes to the attention of ichthyologists. In sharp contrast lie the other islands of Oceania where very few fishes have been reported from depths greater than 100 fathoms.

The author follows GOSLINE and BROCK in restricting the discussion of island endemism to the shore fishes. Because these authors have generally not given the distribution of fishes in the species accounts of their book, it is not possible to know which fishes they treated as endemics. Since an adjustment of endemism of the Hawaiian fish fauna is necessary due to developments since 1960, a total reassessment has been made by the author. The percentage of endemism of the inshore Hawaiian fish fauna, based on the 442 species regarded herein as reef and shore fishes, is 29.

GOSLINE and BROCK (1960) made the important observation that many of the abundant Hawaiian fishes are endemics. Their examples were *Thalassoma duperrey* (Quoy and Gaimard), *Gymnothorax eurostus*, *Muraenichthys cookei* Fowler, *Caecula platyrhyncha*, *Scarus perspicillatus* Steindachner, *Acanthurus sandvicensis*, *Kuhlia sandvicensis* Steindachner, and *Istiblennius zebra* Vaillant and Sauvage. As has been indicated above, two of these species, *G. eurostus* and *C. platyrhyncha*, are not endemics. Nevertheless, the principle is true of most groups. A noteworthy example is the endemic *Chaetodon miliaris* Quoy and Gaimard, the most abundant of the butterflyfishes in Hawaii. Two other chaetodontids, *C. fremblii* Bennett and *C. multicinctus* Garrett, are among those in a second level of abundance, and both are found only in Hawaii. Much the most common of the angelfishes is the endemic *Centropyge potteri* (Jordan and Metz), though five of the seven pomacanthids in Hawaii are unique to Hawaii.

The largest family of fishes in Hawaii is the Labridae, with 40 species. The most common of these, as noted by GOSLINE and BROCK, is *Thalassoma duperrey*. Indeed, it is probably the most abundant of all shore fishes in the islands. *Stethojulis balteata*, *Anampses cuvier*, and *Thalassoma ballieui* (Vaillant et Sauvage) rank with the most common labrids after *T. duperrey*, and all are endemics. In the reef and inshore rocky habitat only *Halichoeres ornatissimus* (Garrett) and *Thalassoma fuscum* (Lacépède) rival these three labrids in numbers ; more study is needed to determine if the former is subspecifically distinct in Hawaii.

For a fish of its size, the labrid currently identified as *Bodianus bilunulatus* (Lacépède) is unusually common in the Hawaiian Islands, especially if one compares its relative abundance with the genus elsewhere in the Indo-Pacific. The author and Martin F. GOMON determined that the population of this fish in Hawaii seems sufficiently distinct to be regarded as the subspecies *albotaeniatus* Cuvier and Valenciennes.

Among the squirrelfishes the wide-ranging *Adioryx lacteoguttatus* (Cuvier and Valenciennes) is the most common in the inshore environment subjected to wave action ; however, in water deeper than about 15 meters, the endemic *A. xantherythrus* (Jordan and Evermann) is obviously the dominant holocentrid.

The picture for the damselfishes is also not clear because of differences in relative abundance with habitat. Of the 14 pomacentrids in Hawaii, nine could be classified as very common : *Eupomacentrus fasciolatus* Ogilby [Gerald R. ALLEN, personal communication, has found this earlier name for *E. jenkinsi* (Jordan and Evermann)], *Plectroglyphidodon imparipennis* (Sauvage), *Chromis vanderbilti*, *C. agilis*, *C. hamui*, *C. verater* Jordan and Metz, *C. ovalis* (Steindachner), *Abudefduf abdominalis* (Quoy and Gaimard), and *Dascyllus albisella* Gill. The latter five are endemics.

The endemic *Anthias thompsoni* (Fowler) (formerly classified in *Caesioperca*) seems to be the most abundant of the 14 serranid fishes in the Hawaiian Islands (four of which are undescribed) ; however, nine are confined to the Hawaiian chain and most occur in deeper water than diving depths where knowledge of their relative abundance is limited.

The most common of the goatfishes of the largest genus, *Parupeneus*, is *P. multifasciatus* (Quoy and Gaimard) which is known only from Hawaii.

The two most common of the seven filefishes in the islands are *Pervagor spilosoma* (Lay and Bennett) and *Cantherhines sandwichiensis* Jordan and Evermann ; both are endemics. *Ostracion meleagris camurum* is the most common of five trunkfishes. *Canthigaster janthinopterus jactator* (Jenkins) is the most abundant of the 13 puffers known in the Hawaiian area.

Of the deeper-dwelling fishes in Hawaii which can be caught in trawls, the endemic species are overwhelmingly dominant numerically (Paul STRUHSACKER, personal communication).

EASTER ISLAND

The first collection of fishes to be reported from Easter Island was one of 23 fishes made from the U.S. Fish Commission steamer "Albatross" during an eastern Pacific cruise of 1905-1905 (KENDALL and RADCLIFFE, 1912). Two species were described as new, *Kuhlia nutabunda* and *Girella nebulosa*. The two *Thalassoma* listed (*purpureum* and *umbrotygma*), however, are color phases of a single species.

A collection of 11 species of fishes made in 1911 by Professor FUENTES was studied by REGAN (1913). Nine of these 11 species had been taken by the "Albatross". REGAN described the remaining two as new, *Anampses pulcher* (a synonym of *caeruleopunctatus* Rüppell, as indicated by FOWLER, 1928) and *Pseudomonacanthus paschalis* (now placed in *Navodon*). He created a new genus,

Girellops, for Kendall and Radcliffe's *nebulosa*, and described as new *Acanthis-tius fuscus*, *Labrichthys fuentesi* (now classified in *Pseudolabrus*), and *Bathyste-thus orientale* [these species had been reported as *Acanthis-tius cinctus* (Günther), *Pseudolabrus inscriptus* (Richardson), and *Platystethus cultratus* (Bloch and Schneider) by KENDALL and RADCLIFFE]. FUENTES (1914) reported on the same collection, improving on REGAN only by adding some illustrations.

The Swedish Pacific Expedition of 1916-17, under the direction of C. SKOTTSBERG, made a collection of 15 fishes (REND AHL, 1921). Six of these had not been taken before, three of which were described as new : *Gymnothorax obscurirostris*, *Labrichthys semifasciatus*, (now *Pseudolabrus*), and *Ostracion pas-chae* (now *Lactoria*).

FOWLER (1928) showed that the *Teuthis umbra* (Jenkins) listed from Easter Island by KENDALL and RADCLIFFE is in reality *Acanthurus leucopa-reius* (Jenkins), described from Hawaii. He also noted that this surgeonfish has been reported (as *Teuthis bishopi* Bryan and Herre) from Marcus Island. FOWLER (1933) described *Pseudupeneus orientalis* as new from the material of KENDALL and RADCLIFFE.

ADAM (1945) reported on a collection of 20 species of fishes from Easter Island made during the Mission Franco-Belge in 1934, and transmitted to the Muséum National d'Histoire Naturelle in Paris by M. R.Ph. DOLLFUS. Only the species tentatively identified as *Cheilodactylus vittatus* Garrett was not cited in earlier papers.

WILHELM and HULOT (1957) prepared a provisional list of the fishes of Easter Island which included eight species not previously recorded, five of which were listed by genus only : *Engraulis*, *Scombresox*, *Cirrhités*, *Chelmo* and *Aulos-toma* (sic) .

DE BUEN (1959) recorded *Mola ramsayi* (Giglioli) from Easter Island. In 1962 he described two new morays from the island : *G. dentex* [the *G. dovii* (Günther) of KENDALL and RADCLIFFE] and *G. nasuta*.

DE BUEN (1963) reviewed the 40 species of fishes known from Easter Island at that time, including three which he described as new, *Holocentrum wil-helmi*, *Amanes rapanui*, and *Xanthichthys surcatus*, and a new subspecies, *Cirri-pectes variolosus patuki*. The holocentrid is a valid species of *Adioryx* ; it is the same as the one identified as *Holocentrum bleekeri* Weber by ADAM (1945), but it is not the squirrelfish KENDALL and RADCLIFFE identified as *Holocen-trus punctatissimus* [= *Adioryx lacteoguttatus* (Cuvier and Valenciennes)] *Aman-es rapanui* (better placed in *Cantherhines*) is the species misidentified as *Mon-a-canthus cirrhifer* Temminck and Schlegel by KENDALL and RADCLIFFE. The blenny subspecies *patuki* was elevated to specific rank by SPRINGER (1970). DE BUEN showed that the *Priacanthus arenatus* of WILHELM and HULOT is *P. cru-entatus* (Lacépède) ; also that their *Chelmo* is *Forcipiger* (the species, however, is *flavissimus* Jordan and McGregor and not *longirostris* Broussonet).

SPRINGER (1967) described *Entomacrodus chapmani*, the only member of the genus at Easter Island. Previous authors had called this blenny *striatus* (Quoy and Gaimard), *arenatus* (Bleeker), or *marmoratus* (Bennett).

In recent years, three major collections have substantially increased the number of fishes known at Easter Island. The first of these was a single large rotenone station made at Anakena Cove by Ramsey Parks and crew of the yacht "Chiriqui" in 1958. These fishes are now at the Natural History Museum, Los Angeles County. A series of collections was made by Ian E. EFFORD, Jack A. MATHIAS and associates during the Canadian Medical Expedition in 1964-65 ; these specimens were deposited at the University of British Colombia. A month of intensive collecting was carried out by the author, Gerald R. ALLEN and Bruce A. BAKER in early 1969 ; most of these fishes are at the Bishop Museum. A semi-popular account of the latter expedition was written by RANDALL, 1970. It was pointed out that the total fish fauna of the island has been raised to 109. Also the extraordinary high percentage of endemic fishes was mentioned. As had been observed by other authors, a segment of the fish fauna of Easter Island is allied to that of Norfolk Island and other islands of the SW Pacific. Suspecting that some of these fishes or close relatives would occur at islands of the Pitcairn Group and Rapa, which lie to the west of Easter at about the same latitude as Easter and Norfolk, an expedition was organized to these intermediate islands with the support of the National Geographic Society RANDALL, 1973b. More than twice the number of species was collected at these islands as Easter. Included were eight species previously thought to be confined to Easter Island, such as *Gymnothorax nasuta*, *Pseudolabrus fuentesi*, and the species which ADAM (1945) identified as *Cheilodactylus vittatus* (which is actually an undescribed species of *Goniistius*).

Nine recent papers have described new species of fishes from Easter, principally as a result of these large collections. ALLEN (1970) named two new frogfishes (*Antennarius*). GREENFIELD and HENSLEY (1970) reviewed the three damselfishes of the island, describing two of them as new, *Chromis randalli* and *Abudefduf rapanui* (with the division of *Abudefduf* proposed by G.R. ALLEN, the latter species belongs in *Glyphidodontops*). ESCHMEYER and ALLEN (1971) named three new scorpionfishes (two in *Scorpaena*, one in *Scorpaenodes*). HERALD and RANDALL (1972) described the pipefish *Syngnathus caldwelli* from specimens from Easter Island and Pitcairn. Evidently unaware of the recent collections, LAVENBERG and YAÑEZ (1972) described the hawkfish *Cirrhitus wilhelmi* from a single fish collected by Ottmar WILHELM in 1956 ; the placement in *Cirrhitus*, however, is incorrect. RANDALL (1972b) reviewed the labrid fishes of the genus *Anampses* ; among them was a colorful species, *A. femininus*, which was described as new from Easter Island and other southern localities. KAMI (1973) described a new species and subgenus of lutjanid fish, *Pristipomoides (Parapristipomoides) squamimaxillaris* from Easter Island and Rapa. RANDALL and CALDWELL (1973) named a new butterflyfish (*Chaetodon litus*) and a new angelfish (*Centropyge hotumatua*) from the island (the latter also occurs at the Pitcairn Group, Rapa, and the Austral Islands). In his revision of the squirrelfish genus *Myripristis*, GREENFIELD (1974) described a new species from Easter,

the Pitcairn Group, and Rapa. McALLISTER and RANDALL (1975) named a new centrolophid fish of the genus *Schedophilus* from Easter Island and Rapa. RANDALL and McCOSKER (1975) have reviewed the 11 eels that occur at Easter Island, seven of which are new records and one a new species of *Gymnothorax*. *G. obscurirostris* Rendahl was referred to the synonymy of *G. porphyreus* (Guichenot), and *G. dentex* De Buen to *G. eurostus* (Abbott).

Ninety-nine fishes of the 109 presently known from Easter Island are reef and shore fishes. Of these, 27 appear to be restricted to the island (though studies are not completed on several species) ; thus, the percentage of endemism is 27.3.

During the author's stay at Easter Island the most abundant fishes appeared to be *Eupomacentrus fasciolatus*, *Pseudolabrus fuentesi*, *Adioryx lacteoguttatus*, *Trachypoma macracanthus* Günther, *Gymnothorax panamensis* (Steindachner), *Kyphosus vaigiensis* (Quoy and Gaimard), *Myripristis tiki*, *Cirripectes patuki*, *Coris* sp., *Cirrhitus wilhelmi*, *Chromis randalli*, *Glyphidodontops rapanui*, and *Chaetodon litus*. The last six mentioned are endemics, and *Myripristis tiki*, and *Pseudolabrus fuentesi* range only to the Pitcairn Group and Rapa (also one individual of the latter was sighted and speared at Raivavae, Austral Islands).

LORD HOWE ISLAND

Investigations of the fish fauna of Lord Howe Island have been almost exclusively carried out by ichthyologists of the Australian Museum, and the great majority of specimens are deposited at this museum. The first of many papers concerning the island's fishes by Australian ichthyologists was that of Edward P. RAMSAY (1883) in which *Coris semicineta* was described. Unfortunately, this proved to be a junior synonym of *Coris picta* (Bloch and Schneider). Later, the scorpionfish *Sebastopis scaber* (= *Scorpaenodes scaber*) was named from the island and New South Wales (RAMSAY and OGILBY, 1885).

OGILBY (1889) published an account of the fish fauna of Lord Howe Island in an Australian Museum memoir devoted to the zoology and geology of the island. His fishes came from eight sources, the first a single specimen of a serranid of dubious authenticity, that was collected in 1788, the year that the island was discovered. The most important of the collections were those of R. ETHERIDGE and party of the Australian Museum in 1887 and ones obtained shortly thereafter by E.H.SAUNDERS. OGILBY listed 88 fishes from Lord Howe, of which five were in such poor condition that they were identified only to genus. He described 14 new species. His *Chaetodon aphrodite*, however, is the young of *C. flavirostris* Günther (GOLDMAN, 1967), and his *Anampses variolatus* is a junior synonym of *A. elegans* Ogilby (WAITE, 1904a). On the other hand, a few of his specimens were not recognized by him as representing new species. WHITLEY (1929), for example, described the anemonefish OGILBY listed as *Amphiprion melanopus* Bleeker as *A. mccullochi*. The labrid fish identified as *Coris aygula* Lacépède, which the islanders call "doubleheader", is still undescri-

bed. A number of other name changes have or will take place such as *Salarias marmoratus* Bennett being altered to *Entomacrodus striatus* (Quoy and Gaimard) (SPRINGER, 1967), and *Stethojulis axillaris* (Quoy and Gaimard) to *S. bandanensis* (Bleeker) (RANDALL and KAY, 1974).

OGILBY (1891) described a new puffer from Lord Howe Island as *Tetrodon atipinnis*. In his "Edible Fishes of New South Wales" (1893) he recorded two more fishes from the island.

OGILBY (1899) reported on two small collections from Lord Howe from which he named five new species (three of these as new genera) and listed seven new records (two of which had been reported before by genus only). Two of his new species are now recognized as invalid: *Salarias insulae* = *Istiblennius edentulus* (Bloch and Schneider) and *Monacanthus alternans* = *Pervagor melanocephalus* (Bleeker).

Edgar R. WAITE of the Australian Museum visited Lord Howe Island in 1898 and again in 1904 with Allan R. McCULLOCH as his assistant. His fish collections, plus those of islanders and other visitors, resulted in a series of papers in which four new genera and 19 new species were described and a total of 83 fishes added to the fauna (WAITE, 1900; 1901; 1903; and 1904a). Six of his new species are synonyms, including *Gymnothorax chalazius* [= *G. eurostus* (Abbott)] (RANDALL and McCOSKER, 1975) and *Iniistius cacatua* [= *Hemipteronotus pavo* (Cuvier and Valenciennes)]. His "Catalogue of the fishes of Lord Howe Island" (1904b) contains 180 species.

McCULLOCH and WAITE (1916) described seven new fishes from specimens sent by residents of the island and added some significant notes on other species.

In their revision of the Atherinidae, JORDAN and HUBBS (1919) described *Atherion maccullochi* from Lord Howe Island.

McCULLOCH (1923a; 1923 b) added six new records of fishes and described *Cubiceps baxteri*.

In 16 publications between 1927 and 1964 inclusive, Gilbert P. WHITLEY (see Literature Cited) named 10 new species of fishes from Lord Howe Island (five of which are currently recognized) and added several new records.

FRASER-BRUNNER (1941) described *Cantherhines longipinnis* from Lord Howe, the only known locality for this filefish.

Lord Howe Island was among the localities from which the wrasse *Anampses femininus* Randall (1972b) was described.

By the end of 1972 the total number of fishes known for Lord Howe Island was 208.

A month of intensive fish collecting was carried out at Lord Howe Island in February, 1973, by the author and the following ten ichthyologists : Gerald R. ALLEN, Walter DEAS, Wade DOAK, Barry GOLDMAN, Douglass F.HOESE, John R. PAXTON, Barry C. RUSSELL, Walter A. STARCK, II, Frank H. TALBOT, and Gilbert P. WHITLEY. It was Mr. WHITLEY's third visit to the island. The objective was to collect and photograph as many Lord Howe fishes as possible, with emphasis on those that had not been taken before. Over 6,000 specimens belonging to 105 families and 278 species were procured. In addition, 24 species were recorded from reliable underwater observations. The primary series of fishes from this collection was deposited at the Australian Museum ; a second series is at the Bishop Museum. During the course of study of Lord Howe fishes at the Australian Museum, 35 other records were obtained from specimens not previously reported. An annotated checklist of the fishes of Lord Howe Island has been prepared by eight authors (ALLEN *et al.*, MS). It totals 423 fishes. Forty-eight of these are pelagic species and thus do not enter into discussions of endemism of benthic shoal-water forms.

Of the remaining 375 reef and shore fishes of Lord Howe Island (which includes a few species that occur as adults in freshwater at the island), 12 are confined to the island and another six range to Norfolk Island. Twenty-eight other species, which at present are represented only by specimens from Lord Howe, are not yet identified ; nearly all of these appear to be undescribed. The percentage of endemism of the fishes of Lord Howe Island, if we may include the species believed to be new and those which occur otherwise only at nearby Middleton and Elizabeth Reefs (WHITLEY, 1937) and Norfolk Island is about 12.

If we consider as endemics those fishes known from Lord Howe Island which are also found off the coast of eastern Australia, northern New Zealand, or in a few cases, New Caledonia, the percentage of endemism would be about 30.

During the 1973 expedition to Lord Howe the author and other divers were struck by the abundance of the endemic fishes. In the outer reef areas at depths of about 8 to 15 meters the most common fishes as seen by a diver were *Chromis hypsilepis* (Günther), *Apogon norfolcensis* Ogilby, *Pseudolabrus luculentus* (Richardson), *Eupomacentrus fasciolatus* (Ogilby), *Glyphidodontops* sp., *Trachypoma macracantha* Günther, *Apogon* sp., *Plagiotremus tapeinosoma* (Bleeker), *Eupomacentrus gascoynei* (Whitley), *Paraglyphidodon polyacanthus* (Ogilby), *Parma polylepis* Günther, and *Goniistius ephippium* (McCulloch and Waite). A second level of abundance was represented by *Chatedon tricinctus* Waite, *Apogon* sp., *Anampses elegans* Ogilby, *Thalassoma lunare* (Linnaeus), *T. lutescens* (Lay and Bennett), *T. amblycephalus* (Bleeker), *Coris* sp., *Cirripectes alboapicalis* (Ogilby), *Plesiops* sp., and *Stethojulis bandanensis* (Bleeker). *Spratelloides gracilis* Temminck and Schlegel, *Kyphosus vaigiensis* (Quoy and Gaimard), *Prionurus maculatus* Ogilby, and *Girella cyanea* Ogilby were at times locally abundant.

In coral-sand areas of the lagoon the most common fishes of a size readily observed were *Pseudolabrus luculentus*, *Apogon norfolcensis*, *Paraglyphidodon*

polyacanthus, *Trachypoma macracanthus*, *Anampses elegans*, *Parma polylepis*, and *Goniistius ephippium*. Those in a second level of abundance were *Amphiprion mccullochi* Whitley, *Eupomacentrus gascoynei*, *Chaetodon tricinctus*, *C. flaviventris* Günther, *Thalassoma lunare*, *Coris* sp., *Belonepterygion fasciolatum* (Ogilby), and *Parupeneus signatus* (Günther).

Twenty-one of these 31 common fishes are endemic to Lord Howe Island and environ (*i.e.*, in the broader geographical area mentioned above, to which about 30 % of the species are restricted).

Conversely, many of the wide-ranging Indo-Pacific fishes which are usually common in more tropical localities were rare at Lord Howe Island. In fact, 25 of the 1973 expedition's new records of such fishes were based on observation and/or collection of three or fewer individuals.

DISCUSSION

Of the many islands and island groups that comprise the vast area of the Pacific known as Oceania, three stand well above the others in possessing a unique marine fauna and flora : Hawaiian Islands, Easter Island, and Lord Howe Island (and Norfolk Island). In terms of shore fishes, the percentage endemism is about 29, 27, and 12, respectively. The latter figure can be raised to about 30 if Lord Howe fishes are considered as endemics even though they range to other islands and reefs within a radius of about 800 miles. This might not seem unreasonable when one considers that the Hawaiian Islands stretch nearly 2,000 miles ; however, shoal areas within the chain are separated by more than 160 miles. On the other hand, Johnston Island, which has primarily a Hawaiian marine fauna (GOSLINE, 1955) lies 450 miles from the nearest of the Hawaiian Islands.

As has been mentioned, Hawaii, Easter and Lord Howe are all geographically and hydrographically well isolated from other shallow-water parts of the Pacific. Also of significance is their peripheral subtropical location within Oceania.

The endemic fishes at these islands fall into two categories. There are those which have close relatives that are often common elsewhere in the Indo-Pacific. Indeed, some are so closely related to the endemics that it is difficult for systematists to decide whether to recognize the island forms at the specific or subspecific level. It seems evident that these related species or their immediate ancestors represented the progenitor stock that gave rise through isolation to the island endemics. The second group are relics. Once they or their immediate ancestors may have been more broadly distributed but now they survive only at their respective island outposts.

One striking aspect common to all three insular locations is the abundance, in general, of endemic species of fishes. There are two explanations for this. The endemics have either differentiated in their island environment over a long

span of time, or if relics, they may also have existed in the area for a long period. During this time they should have had ample opportunity to become fully adapted to the environment. One manifestation of their success in adaptation would be their abundance.

The second explanation concerns the subtropical location of these islands. Indo-Pacific species which are common on tropical reefs may not do well in the higher latitudes because of marginal temperature conditions or an indirect effect of the lower temperature on coral development or food supply. In the case of Lord Howe Island, some of the Indo-Pacific species are so rare that it is doubtful that all are offsprings of local breeding populations. Surely some must be individuals that have drifted as larvae from the Great Barrier Reef or New Caledonia. The most successful species, then, would be those adapted to the cooler temperature regime. They may be species of tropical genera, or they may be temperate derivatives.

Evidence for the apparent importance of temperature comes from two species which are abundant both in Hawaii and southern latitudes but absent in the tropical zone. These fishes are *Gymnothorax eurostus* and *Acanthurus leucopareus*. At one time when seas were cooler these species were probably in continuous distribution across the central Pacific region. In Hawaii, Easter, and Lord Howe Islands, they are more common than nearly all the species of their respective genera at the islands.

LITERATURE CITED

ADAM Geneviève (1945).—

La faune ichthyologique de l'Île de Pâques. Bull.Mus. Natl. Hist. Nat., ser.2, 17 (5) : 385-394.

ALLEN Gerald R. (1970).—

Two new species of frogfishes (Antennariidae) from Easter Island. Pacific Sci. 24 (4) : 517-522, 3 figs.

ALLEN Gerald R. and John E. RANDALL (in press).—

Review of the sharpnose pufferfishes (subfamily Canthigasterinae) of the Indo-Pacific. Rec. Austral. Mus., 78 ms pp. 7 col. pls., 9 text figs.

ANDERSON William D., Jr. (1970).—

Revision of the genus *Symphysanodon* (Pisces : Lutjanidae) with descriptions of four new species. Fishery Bull. 68 (2) : 325-346, 5 figs.

AXELROD Herbert R. and Cliff W. EMMENS (1969). —

Exotic Marine Fishes. 607 pp., col. illustr. TFH Publ. Jersey City.

- BALDWIN Wayne J. (1972).—
A new genus and new species of Hawaiian gobiid fish. *Pacific Sci.* 26 (1) : 125-128, 4 figs.
- BROCK Vernon E. (1952).—
A history of the introductions of certain aquatic animals to Hawaii. *Bien. Rep. Bd. Comm. Agric. Fores. Terr. Hawaii* : 114-123.
- CLARKE Thomas A. (1972).—
Collections and submarine observations of deep benthic fishes and decapod Crustacea in Hawaii. *Pacific Sci.* 26 (3) : 310-317.
- COHEN Daniel M. (1970).—
A new argentiniid fish from Hawaii. *Pacific Sci.* 24 (3) : 377-378, 1 fig.
- COHEN Daniel M. and Jørgen G. NIELSEN (1972).—
A review of the viviparous ophidioid fishes of the genus *Saccogaster*. *Proc. Biol. Soc. Washington* 85 (39) : 445-468, 8 figs.
- DE BUEN Fernando (1959).—
El pez luna (*Mola ramsayi*) en aguas de la Isla de Pascua. *Inv. Zool. Chilenas* 5 : 89-92, 1 fig.
- DE BUEN Fernando (1962).—
Peces Chilenos. Familias Alepocephalidae, Muraenidae, Sciaenidae, Scorpaenidae, Liparidae y Bothidae. *Montemar* 1 : 1-52, 11 figs.
- DE BUEN Fernando (1963).—
Los peces de la Isla des Pascua. *Bol. Soc. Biol. Concepcion (Chile)* 25-26 : 3-80, 33 figs.
- ESCHMEYER William N. (1969).—
A systematic review of the scorpionfishes of the Atlantic Ocean (Pisces : Scorpaenidae). *Occ. Pap. Calif. Acad. Sci.* 79 : 130 pp., 13 figs.
- ESCHMEYER William N. and Gerald R. ALLEN (1971).—
Three new scorpionfishes (Family Scorpaenidae) from Easter Island. *Proc. Calif. Acad. Sci., ser. 4*, 37 (19) : 515-527, 4 figs.
- FOWLER Henry W. (1923).—
New or little-known Hawaiian fishes. *Occ. Pap. B. P. Bishop Mus.* 8 (7) : 375-392.
- FOWLER Henry W. (1928).—
The fishes of Oceania. *Mem. B. P. Bishop Mus.* 10 : iii + 540 pp., 49 pls., 82 text figs.

FOWLER Henry W. (1933).—

Contributions to the biology of the Philippine Archipelago and adjacent regions. The fishes of the families Banjosidae, Lethrinidae,... Bull. U.S. Natl. Mus. 200, vol. 12 : vi + 465 pp., 32 figs.

FOWLER Henry W. and Stanley C. BALL (1925).—

Fishes of Hawaii, Johnston Island, and Wake Island. Bull. B.P. Bishop Mus. 26 : 31 pp.

FRASER-BRUNNER A (1941).—

Notes on the plectognath fishes. — VI. A synopsis of the genera of the family Aluteridae, and descriptions of seven new species. Ann. & Mag. Nat. Hist., ser. 11, 8 : 176-199, 9 figs.

FUENTES G. (1914).—

Contribucion al estudio de la fauna de la Isla de Pascua. Pisces. Bol. Mus. Nac. Hist. Nat. (Chile), no. 7 : 295-312, 8 pls.

GILBERT Charles H. (1905).—

The aquatic resources of the Hawaiian Islands. Part II. The deep-sea fishes. Bull. U.S. Fish Comm. 23 : viii + 577-713 pp. 45 pls., 46 figs.

GOLDMAN Barry (1967).—

Chaetodon aphorodite, the juvenile of *Chaetodon flavirostris* (Teleostei, Chaetodontidae). Proc. Roy. Zool. Soc. N.S.W. : 45-51, 2 pls.

GOODING Reginald M. and John J. MAGNUSON (1967).—

Ecological significance of a drifting object to pelagic fishes. Pacific Sci. 21 (4) : 486-497, 6 figs.

GOSLINE William A. (1955).—

The inshore fish fauna of Johnston Island, a central Pacific atoll. Pacific Sci. 9 (4) : 442-480, 4 figs.

GOSLINE William A. (1960).—

A new Hawaiian percoid fish, *Suttonia lineata*, with a discussion of its relationships and a definition of the family Grammistidae. Pacific Sci 14 (1) : 28-38, 7 figs.

GOSLINE William A. (1965).—

Vertical zonation of inshore fishes in the upper water layers of the Hawaiian Islands. Ecology 46 : 823-831.

GOSLINE William A. and Vernon E. BROCK (1960).—

Handbook of Hawaiian Fishes. 372 pp., 277 figs. Univ. Hawaii Press, Honolulu.

- GOSLINE W. A., V.E. BROCK, H.L. MOORE, and Y. YAMAGUCHI (1954).—
Fishes killed by the 1950 eruption of Mauna Loa. I. The origin and nature
of the collections. *Pacific Sci.* 8 (1) : 23-27, 3 figs.
- GREENFIELD David W. (1974). —
A revision of the squirrelfish genus *Myripristis* Cuvier (Pisces : Holocentridae).
Nat. Hist. Mus. Los Angeles County, Sci. Bull. 19 : 1-54, 27 figs. (4 col.).
- GREENFIELD David W. and Dannie A. HENSLEY (1970).—
Damsel-fishes (Pomacentridae) of Easter Island, with descriptions of two
new species. *Copeia*, no. 4 : 689-695, 3 figs.
- HEEMSTRA Phillip C. (1972).—
Erythrocles monodi (Perciformes : Emmelichthyidae) in the Western At-
lantic, with notes on two related species. *Copeia*, no. 4 : 875-878, 2 figs.
- HERALD Earl S. and John E. RANDALL (1972).—
Five new Indo-Pacific pipefishes. *Proc. Calif. Acad. Sci.* 39 (11) : 121-140,
6 figs.
- JORDAN David S. (1921).—
Description of deep-sea fishes from the coast of Hawaii, killed by a lava
flow from Mauna Loa. *Proc. U. S. Natl. Mus.* 59 (2392) : 643-656, 8 figs.
- JORDAN David S. and Barton W. EVERMANN (1905).—
The aquatic resources of the Hawaiian Islands. Part I. — The shore fishes.
Bull. U.S. Fish Comm. 23 : xxviii + 574 pp., 73 col. pls., 65 pls., 229 text-
figs.
- JORDAN David S. and Carl L. HUBBS (1919).—
A monographic review of the family of Atherinidae or silversides. 87 pp.,
12 pls. Stanford Univ. Press, Stanford.
- KAMI Harry T. (1973).—
A new subgenus and species of *Pristipomoides* (Family Lutjanidae) from
Easter Island and Rapa. *Copeia*, no. 3 : 557-559, 1 fig.
- KENDALL William C. and Lewis RADCLIFFE (1912).—
Reports on the scientific results of the expedition to the eastern tropical
Pacific, ... XXV. The shore fishes. *Mem. Mus. Comp. Zool.* 25 (3) : 77-
170 8 pls.
- LAVERBERG Robert J. and L. Alejandro YAÑEZ A. (1972).—
A new species of *Cirrhitus* from Easter Island. *Gayana, Zool.*, no. 21 : 10
pp., 1 fig.
- McALLISTER Don E. and John E. RANDALL (1975).—
A new species of centrolophid fish from Easter Island and Rapa Iti Island
in the South Pacific. *Natl. Mus. Canada. Natl. Mus. Nat. Sci. Publ. Biol.*
Oceanog., no. 8 : 7 pp., 3 figs.

McCULLOCH Allan R. (1923 a).—

Notes on fishes from Australia and Lord Howe Island. Rec. Austral. Mus. 14 (1) : 1-17, 3 pls.

McCULLOCH Allan R. (1923b).—

Fishes from Australia and Lord Howe Island, No. 2 Rec. Austral. Mus. 14 (2) : 113-125, 3 pls.

McCULLOCH Allan R. and Edgar R. WAITE (1916).—

Additions to the fish-fauna of Lord Howe Island. No. 5. Trans. Proc. Roy. Soc. S. Austral. 40 : 437-451, 4 pls.

MORRIS Robert A. and Donald E. MORRIS (1967).—

A rare hawkfish *Oxycirrhites typus* Bleeker found in Hawaii. Ichthyologica 39 (2) : 71-72, 1 col. fig.

NORMAN J.R. (1957).—

A draft synopsis of the orders, families and genera of recent fishes and fish-like vertebrates. 649 pp. British Mus. (Nat. Hist.), London.

OGILBY J. Douglas (1889).—

The reptiles and fishes of Lord Howe Island. Mem. Austral. Mus. Sydney 3 : 51-74, 2 pls.

OGILBY J. Douglas (1891).—

Description of a new fish from Lord Howe Island. Rec. Austral. Mus. 1 (6) : 110.

OGILBY J. Douglas (1893).—

Edible fishes and crustaceans of New South Wales. 212 pp., 50 pls. World's Columbian Exposition, Chicago.

OGILBY J. Douglas (1899).—

Additions to the fauna of Lord Howe Island. Proc. Linn. Soc. N.S.W., pt 4 : 730-745.

RAMSAY E.P. (1883).—

Description of a new species of *Coris* from Lord Howe's Island and New South Wales. Proc. Lin. Soc. N.S.W. 7 (2) : 301-302.

RAMSAY Edward Pierson and J. D. OGILBY (1885).—

Descriptions of new or rare Australian fishes. Proc. Linn. Soc. New South Wales 10 : 575-579.

RANDALL John E. (1956).—

A revision of the surgeon fish genus *Acanthurus*. Pacific Sci. 10 (2) : 159-235, 3 col. pls., 23 text figs.

RANDALL John E. (1960a).—

New fishes for Hawaii. Sea Frontiers 6 (1) : 33-43, 7 figs.

- RANDALL John E. (1960b).—
A new species of *Acanthurus* from the Caroline Islands, with notes on the systematics of other Indo-Pacific surgeonfishes. *Pacific Sci.* 14 (3) : 267-279, 7 figs.
- RANDALL John E. (1961a).—
A contribution to the biology of the convict surgeonfish of the Hawaiian Islands, *Acanthurus triostegus sandvicensis*. *Pacific Sci.* 15 (2) : 215-272, 25 figs.
- RANDALL John E. (1961b).—
Observations on the spawning of surgeonfishes (Acanthuridae) in the Society Islands. *Copeia*, no.2 : 237-238.
- RANDALL John E. (1961c).—
Two new butterflyfishes of the Indo-Pacific genus *Forcipiger*. *Copeia*, no.1 : 53-62, 6 figs.
- RANDALL John E. (1963).—
Review of the hawkfishes (Family Cirrhitidae). *Proc. U.S. Natl. Mus.* 114 (3472) : 389-451, 16 pls.
- RANDALL John E. (1964).—
A revision of the filefish genera *Amaneses* and *Cantherhines*. *Copeia*, no.2 : 331-361, 18 figs.
- RANDALL John E. (1970).—
Easter Island, an ichthyological expedition. *Oceans* 3 (3) : 48-59, 9 figs.
- RANDALL John E. (1971).—
The nominal triggerfishes (Balistidae) *Puchynathus nycteris* and *Oncobalistes erythropterus*, junior synonyms of *Melichthys vidua*. *Copeia*, no. 3 : 462-469, 5 figs.
- RANDALL John E. (1972a).—
The Hawaiian trunkfishes of the genus *Ostracion*. *Copeia*, no. 4 : 756-768, 10 figs.
- RANDALL John E. (1972b).—
A revision of the labrid fish genus *Anampses*. *Micronesica* 8 (1 and 2) : 151-195, 3 col. pls., 10 text figs.
- RANDALL John E. (1973a).—
Tahitian fish names and a preliminary checklist of the fishes of the Society Islands. *Occ. Pap. B.P. Bishop Mus.* 24 (11) : 167-214.
- RANDALL John E. (1973b).—
Expedition to Pitcairn. *Oceans* 6 (2) : 12-21, 7 figs.

- RANDALL John E. and David K. CALDWELL (1970).—
Clarification of the species of the butterflyfish genus *Forcipiger*. Copeia, no. 4 : 727-731, 3 figs.
- RANDALL John E. and David K. CALDWELL (1973).—
A new butterflyfish of the genus *Chaetodon* and a new angelfish of the genus *Centropyge* from Easter Island. Contr. Sci. Nat. Hist. Mus. Los Angeles County, no. 237 : 11 pp., 4 figs. (2 col.).
- RANDALL John E. and Richard K. KANAYAMA (1972).—
Hawaiian fish immigrants. Sea Frontiers 18 (3) : 144-153, 7 figs.
- RANDALL John E. and Hohn C. KAY (1974).—
Stethojulis axillaris, a junior synonym of the Hawaiian labrid fish *S. balteata*, with a key to the species of the genus. Pacific Sci., 28 (2) : 101-107, 1 col. pl., 1 text fig.
- RANDALL John E. and John E. McCOSKER (1975).—
The eels of Easter Island, with description of a new moray. Contrib. Sci. Nat. Hist. Mus. Los Angeles County, no. 264 : 32 pp., 15 figs.
- RANDALL John E. and Paul STRUHSACKER (1971).—
The acanthurid fish *Naso lopezi* Herre from the Hawaiian Islands. Copeia, no. 2 : 320-322.
- RANDALL John E. and Stanley N. SWERDLOFF (1973).—
A review of the damselfish genus *Chromis* from the Hawaiian Islands, with descriptions of three new species. Pacific Sci. 27 (4) : 327-349, 12 figs.
- REGAN C. Tate (1913).—
A collection of fishes made by Professor Francisco Fuentes at Easter Island. Proc. Zool. Soc. London : 368-374, 6 pls.
- RENDahl Hjalmar (1921).—
The fishes of Easter Island : 59-68. In the Natural History of Juan Fernandez and Easter Island, edited by C. SKOTTSBERG, Uppsala.
- SCHULTZ Leonard P. and collaborators (1960).—
Fishes of the Marshall and Marianas Islands. Bull. U.S. Natl. Mus. 202, vol. 2 : ix + 438 pp.
- SPRINGER Victor G. (1967).—
Revision of the circumtropical shorefish genus *Entomacrodus* (Blenniidae : Salariaeinae). Proc. U.S. Natl. Mus. 122 (3582) : 1-150, 30 pls., 10 text figs.
- SPRINGER Victor G. (1970).—
The Blennies. Tropical Fish Hobbyist 19 (176) : 54-55, 57-63, 65-66, 11 col. figs.

SPRINGER Victor G. (1971).—

Revision of the fish genus *Ecsenius* (Blenniidae, Blenniinae, Salariini).
Smithsonian Contr. Zool. 72 : 74 pp., 36 figs.

STRASBURG Donald W. (1960).—

A new Hawaiian engraulid fish. Pacific Sci. 14 (4) : 395-399, 2 figs.

STRASBURG Donald W. (1966).—

New fish records from Hawaii : *Hime*, *Pikea*, and *Omobranchus*. Pacific Sci. 20 (1) : 91-94, 2 figs.

STRUHSAKER Paul (1973a).—

Argyripnus brocki, a new species of stomatioid fish from Hawaii, with observations on *A. ephippiatus* and *A. iridescens*. Fishery Bull. 71 (3) : 827-836, 3 figs.

STRUHSAKER Paul (1973b).—

A contribution to the systematics and ecology of Hawaiian bathyal fishes. 497 pp., PhD thesis, University of Hawaii.

STRUHSAKER Paul and Robert M. MONCRIEF (1974).—

Bothus thompsoni (Fowler) 1923, a valid species of flatfish (Pisces : Bothidae) from the Hawaiian Islands. Fishery Bull. 72 (1) : 237-246, 7 figs.

TANAKA Shigeo (1931).—

On the distribution of fishes in Japanese waters. Jour. Fac. Sci. Imp. Univ. Tokyo, sec. 4, 3 (1) : 1-90, 3 pls. (2 in col.).

TOMINAGA Yoshiaki and Fujio YASUDA (1973).—

Holacanthus interruptus, a valid pomacanthid species, distinct from *Centropyge fisheri*. Japan. Jour. Ichthyol. 20 (3) : 157-162, 1 fig.

TYLER James C. (1968).—

A monograph on plectognath fishes of the superfamily Triacanthoidea. Monogr. Acad. Nat. Sci. Phila. 16 : 364 pp., 209 figs.

WAITE Edgar R. (1900).—

Additions to the fish-fauna of Lord Howe Island. Rec. Austral. Mus. 3 (7) : 193-216, 4 pls. 2 text-figs.

WAITE Edgar R. (1901).—

Additions to the fish-fauna of Lord Howe Island, No. 2. Rec. Austral. Mus. 4 (1) : 28-47, 4 pls., 1 text-fig.

WAITE Edgar R. (1903).—

Additions to the fish-fauna of Lord Howe Island, No. 3. Rec. Austral. Mus. 5 (1) : 20-45, 3 pls., 2 text-figs.

- WAITE Edgar R. (1904a).—
Additions to the fish-fauna of Lord Howe Island, No. 4. Rec. Austral. Mus. 5 (3) : 135-186, 8 pls., 1 text-fig.
- WAITE Edgar R. (1904b).—
Catalogue of the fishes of Lord Howe Island. Rec. Austral. Mus. 5 (3) : 187-230.
- WHITLEY Gilbert P. (1927a).—
A check-list of fishes recorded from Fijian waters. Jour. Pan-Pac. Res. Inst. 2 (1) : 3-8.
- WHITLEY Gilbert P. (1927b).—
Studies in ichthyology, No. 1. Rec. Austral. Mus. 15 (5) : 289-304, 2 pls., 1 text-fig.
- WHITLEY Gilbert P. (1929).—
Some fishes of the order Amphiprioniformes. Mem. Queensl. Mus. 9 (3) : 207-246, 2 pls., 4 text-figs.
- WHITLEY Gilbert P. (1931).—
Studies in ichthyology. No. 4. Rec. Austral. Mus. 18 (3) : 96-113, 6 pls., 2 text-figs.
- WHITLEY Gilbert P. (1932).—
Studies in ichthyology. No. 6. Rec. Austral. Mus. 18 (6) : 321-348, 4 pls., 3 text-figs.
- WHITLEY Gilbert P. (1937).—
The Middleton and Elizabeth Reefs, South Pacific Ocean. Austral. Zool. 8 (4) : 199-231, 2 pls., 3 maps.
- WHITLEY Gilbert P. (1940).—
Illustrations of some Australian fishes. Austral. Zool. 9 (4) : 397-428, 2 pls., 45 text-figs.
- WHITLEY Gilbert P. (1941).—
Ichthyological notes and illustrations. Austral. Zool. 10 (1) : 1-50, 2 pls., 32 text-figs.
- WHITLEY Gilbert P. (1943).—
Ichthyological notes and illustrations. (Part 2). Austral. Zool. 10 (2) : 167-187, 10 figs.
- WHITLEY Gilbert P. (1948).—
Studies in ichthyology. No. 13. Rec. Austral. Mus. 22 (1) : 70-94, 11 figs.
- WHITLEY Gilbert P. (1949).—
Sucking fishes. Austral. Mus. Mag. 10 : 17-23, 8 text-figs.

- WHITLEY Gilbert P. (1951).—
Studies in ichthyology. No. 15. Rec. Austral. Mus. 22 (3) : 389-408, 14
figs.
- WHITLEY Gilbert P. (1953).—
Studies in ichthyology. No. 16. Rec. Austral. Mus. 23 (3) : 133-138, 3
text-figs.
- WHITLEY Gilbert P. (1964a).—
Scombroid fishes of Australia and New Zealand, Proc. Sympos. Scombroid
Fish. (Mandapam Camp, India) 1 : 221-254, 4 pls., 6 text-figs.
- WHITLEY Gilbert P. (1964b).—
Fishes from the Coral Sea and the Swain Reefs. Rec. Austral. Mus. 26 (5) :
145-195, 3 pls., 15 text-figs.
- WHITLEY Gilbert P. And Joyce ALLAN (1958).—
The Sea-horse and its Relatives. x + 84 pp., 1 col. pl., 24 text-figs. Geor-
gian House, Melbourne.
- WILHELM Ottmar E. and André L. HULOT (1957).—
Pesca y peces de la Isla de Pascua. Bol. Soc. Biol. Concepcion (Chile)
32 : 139-152, 3 figs.