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INDO-WEST PACIFIC FISHES
FROM THE GULF OF CHIRIQUI, PANAMA

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CONTRIBUTIONS IN SCIENCE



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INDO-WEST PACIFIC FISHES FROM THE GULF OF CHIRIQUI, PANAMA¹

By RICHARD H. ROSENBLATT², JOHN E. MCCOSKER², and IRA RUBINOFF³

ABSTRACT: Recent collections indicate the presence of a number of Indo-west Pacific fishes in the Gulf of Chiriqui. The Gulf of Chiriqui is not subject to seasonal upwelling as is the adjacent Gulf of Panama, and supports a relatively rich development of hermatypic corals. Twenty-four percent (40) of the reef fish species collected there also occur in the Indo-west Pacific, and of them, nine were previously unrecorded at or near the American mainland: *Myripristis murdjan*, *Ctenochaetus cyano-guttatus*, *Gymnothorax flavimarginatus*, *G. buroensis*, *G. undulatus*, *Enchelynassa canina*, *Uropterygius tigrinus*, *Malacanthus hoedti*, and *Hemipteronotus taeniourus*. The last six are heretofore unreported from the eastern Pacific, although none is restricted to the Gulf of Chiriqui.

Eastern Pacific records of the following Indo-west Pacific species are regarded as invalid, being based either on misidentification or mislabelings: *Brachysomophis crocodilinus*, *Gymnothorax chilospilus*, *Callechelys marmoratus*, *Myrichthys maculosus*, *Myripristis berndti*, *Lutjanus kasmira*, *Runula tapeinosoma*, *Abudefduf saxatilis vaigiensis*, and *Antennatus bigibbus*.

The ranges of the eastern Pacific endemic species *Gymnothorax castaneus*, *Petrotyx hopkinsi*, and *Paraclinus altivelis* are extended to Panama. *Xyrichthys panamensis* Fowler 1944, is synonymized with *Hemipteronotus pavoninus* (Valenciennes, 1839).

Many of the transpacific migrants are localized and limited in their eastern Pacific distributions. Some are seemingly closely associated with the development of hermatypic corals. There is no evidence that any are displacing eastern Pacific endemic species.

The number of new records in the Gulf of Chiriqui collections reflects the inadequacy of current knowledge of the distribution of the fishes of the eastern tropical Pacific.

INTRODUCTION

Recent collecting efforts by the Scripps Institution of Oceanography and the Smithsonian Tropical Research Institute in the Gulf of Chiriqui, western Panama, have disclosed the presence of a large number of Indo-west Pacific species adjacent to or along the continental coastline in the eastern tropical

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Pacific. Our results are interesting in that many fishes of Indo-west Pacific origin which have previously been reported only from the oceanic Galapagos, Revillagigedo, Cocos, and Clipperton islands are maintaining populations in the coral reef communities in the Gulf of Chiriqui.

The Gulf of Chiriqui lies west of the Gulf of Panama and is not subject to the seasonal upwelling conditions which profoundly affect the fauna of Panama Bay and the Perlas Islands (Schaefer et al., 1958; Forsbergh, 1969). Pacific coastal waters west of the Azuero Peninsula, therefore, present a warmer and more stable thermal regime (Renner, 1963) which facilitates extensive development of certain hermatypic corals (Glynn, in press). The presence of extensive *Pocillopora* bank reefs (Fig. 1) to depths of 10-15 meters provides a habitat similar, but not identical, to that of the islands of the central Pacific. These reefs, in contrast to well-developed Caribbean or Indo-Pacific formations, comprise relatively few species of *Pocillopora*, possibly three or four. Associated with them, however, are several species of *Porites*, *Pavona*, and the hydrocoral *Millepora* which contribute to the habitat diversity, to which the increased Indo-west Pacific components in the vertebrate and invertebrate fauna may be related. The structure and extent of coral reef development in the Gulf of Chiriqui is discussed in Glynn et al. (in press). Notable Indo-west Pacific invertebrates in the Gulf of Chiriqui include the crown of thorns starfish, *Acanthaster* cf. *planci*, the painted shrimp *Hymenocera picta*, and the fire corals *Millepora intricata* and *M. platyphylla* (Glynn, in press). Eastern Pacific records for *Hymenocera* and *Millepora* are based on specimens from the Gulf of Chiriqui, these forms being as yet unreported from Clipperton, Galapagos, and the Revillagigedo islands. A similar restricted distribution pattern also exists for certain fishes.

COLLECTIONS

The eastern Gulf of Chiriqui contains seven major island groups. The largest is Coiba which is ca. 30 km in length. The outermost island, Montuosa, is 60 km from the mainland and separated by a channel 80 m deep. We have either collected at or made observations using SCUBA at each island group and several mainland localities (Fig. 2) on three separate occasions, during March and September of 1970 and April of 1971. More than 30 days were spent in the field while aboard the vessels R/V *Alpha Helix*, R/V *Tethys*, and USN LST *Traverse County*. A collection of fishes made by C. H. Birkeland and T. Spight at Isla Viradores Sur, Costa Rica (10° 34' 50" N, 85° 43' 30" W), is included in this study. Accessory material from other Pacific island and Gulf of California localities was provided through the extensive collecting efforts of the Scripps Institute of Oceanography (SIO), and the University of California at Los Angeles (UCLA). Fishes discussed in this paper are presently housed at SIO, UCLA, the Smithsonian Tropical Research Institute (STRI), the University of Miami Marine Laboratory (UMML), the Harvard Museum of Comparative Zoology (MCZ), the Universidad de Costa Rica (UCR), and the California Academy of Sciences (CAS). In this study we refer to the offshore

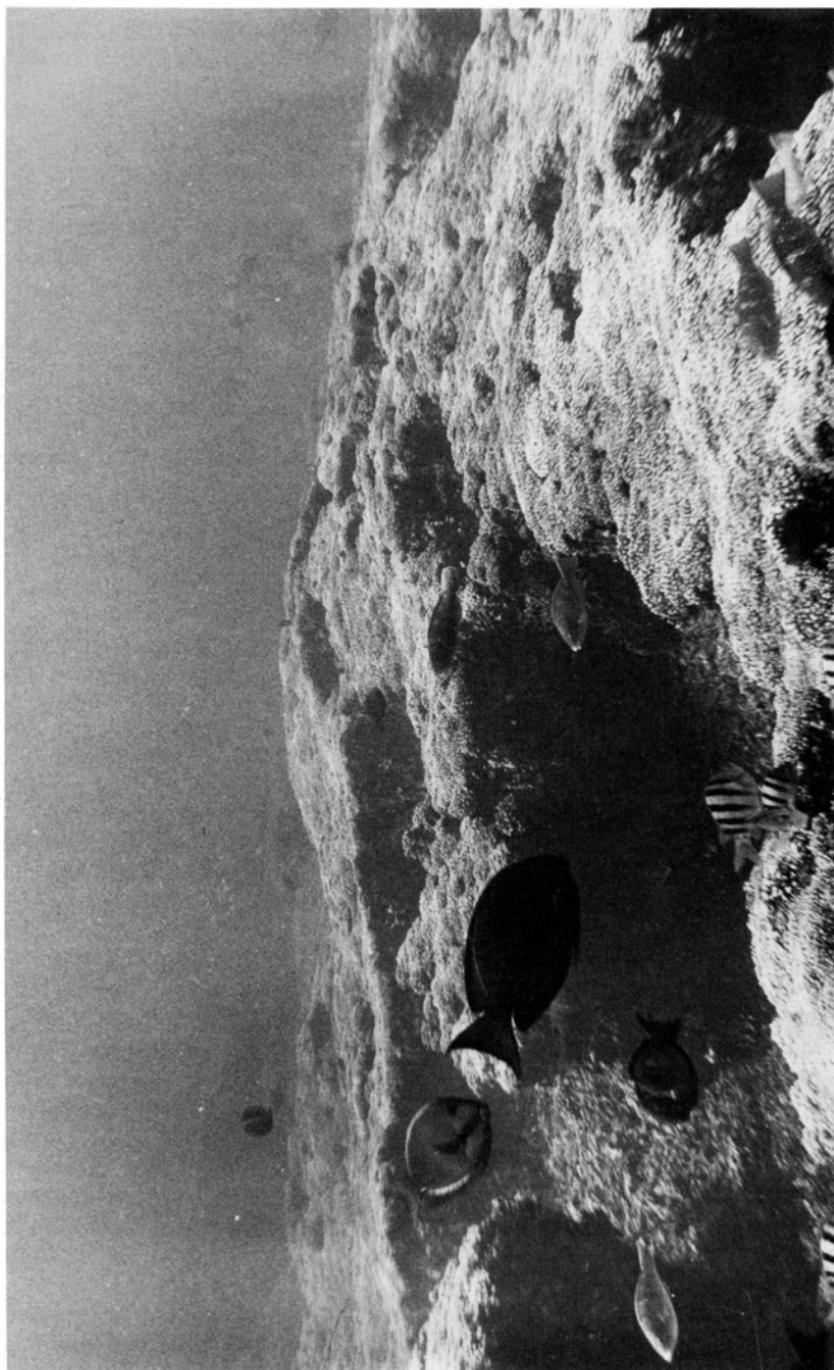


FIGURE 1. Shallow water (ca. 7 m) *Pocillopora* bank reef at a small island SE of Isla Cavada, Islas Secas, *Ctenochaetus cyanoguttatus*, *Scarus ghobban*, and *Abudefduf troschetii* in foreground. Photo by Peter W. Glynn, 24 March, 1971.

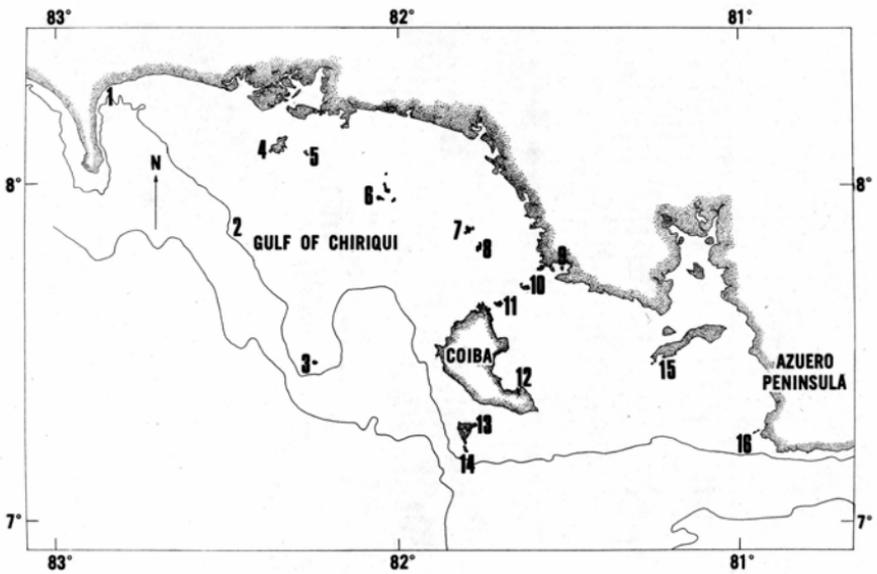


FIGURE 2. Major collection localities in the Gulf of Chiriquí, Panamá. 100 and 1000 fathom contours taken from hydrographic chart H.O. 1018 (1968 edition). 1, Puerto Armuelles; 2, Islas Ladrones; 3, Isla Montuosa; 4, Isla Parida; 5, Isla Balaños and Isla Berraco; 6, Islas Secas; 7, Isla Brincanco and 8, Isla Uva, Islas Contreras; 9, Bahía Honda; 10, Isla Canal de Afuera; 11, Isla Ranchería; 12, Isla Coiba, Bahía de Las Damas; 13, Isla Jicarón; 14, Isla Jicarita; 15, Isla Cebaco; 16, Islas Naranjas.

islands of the eastern Pacific ocean. These include: Isla del Coco, Clipperton Island, Islas de Revillagigedo, and Islas Galapagos.

GULF OF CHIRIQUI FISHES

We have discovered nine Indo-west Pacific fish species previously unrecorded at or near the American mainland. Six species are first reported from the eastern Pacific in this paper. The Indo-west Pacific fishes of the Gulf of Chiriquí can be placed in two categories (Table 1) based on their distribution, and most likely, their dependence upon the coral reef habitat. These categories are arbitrary in some cases, but for the most part the distinction is rather clear cut.

The fishes that are part of the coral reef community of the gulf island groups include 165 species; of these we find that 40 (24 percent) also occur in the Indo-west Pacific region. This high percentage is comparable only to the Clipperton fish fauna, and is probably associated with the extensive coral development at both localities.

Other fishes collected in the Gulf of Chiriquí represent range extensions for the eastern tropical Pacific. A single specimen of *Paraclinus altivelis*

TABLE 1

Eastern Pacific distributions of Indo-west Pacific and circumtropical shorefish species. * Indicates species found in the Gulf of Chiriqui.

† Indicates circumtropical species.

I. Broadly distributed in eastern tropical Pacific

†* <i>Aetobatus narinari</i> (Euphrasen)	* <i>Oxycirrhites typus</i> Bleeker
<i>Chanos chanos</i> (Forsskål)	* <i>Cirrhitichthys oxycephalus</i> (Bleeker)
† <i>Albula vulpes</i> (Linnaeus)	* <i>Doryrhamplus melanopleura</i> (Bleeker)
* <i>Euleptorhamphus viridis</i> (Van Hasselt)	* <i>Acanthurus xanthopterus</i> (Valenciennes)
† <i>Ablennes hians</i> (Valenciennes)	* <i>Fistularia petimba</i> Lacépède
* <i>Kuhlia taeniura</i> (Cuvier)	† <i>Canthidermis maculatus</i> (Bloch)
†* <i>Priacanthus cruentatus</i> (Lacépède)	<i>Chilomycterus affinis</i> (Günther)
†* <i>Mugil cephalus</i> Linnaeus	†* <i>Diodon holacanthus</i> Linnaeus
* <i>Alectis ciliaris</i> (Bloch)	†* <i>D. hystrix</i> Linnaeus
* <i>Gnathanodon speciosus</i> (Forsskål)	* <i>Arothron hispidus</i> (Linnaeus)
* <i>Scarus ghobban</i> Forsskål	* <i>A. meleagris</i> (Bloch and Schneider)
* <i>S. rubroviolaceus</i> Bleeker	* <i>Ostracion meleagris</i> Shaw
* <i>Sectator ocyurus</i> (Jordan and Gilbert)	

II. Limited to offshore islands and/or certain mainland localities

* <i>Triaenodon obesus</i> (Rüppell)	* <i>H. taeniourus</i> (Lacépède)
* <i>Echidna nebulosa</i> (Ahl)	* <i>Thalassoma lutescens</i> (Lay and Bennett)
* <i>E. zebra</i> (Shaw)	<i>Calotomus spinidens</i> (Quoy and Gaimard)
* <i>Gymnothorax buroensis</i> (Bleeker)	* <i>Aulostomus chinensis</i> (Linnaeus)
* <i>G. flavimarginatus</i> (Rüppell)	* <i>A. triostegus</i> Linnaeus
<i>G. pictus</i> (Ahl)	* <i>A. glaucopareius</i> Cuvier
* <i>G. undulatus</i> (Lacépède)	* <i>Ctenochaetus cyanoguttatus</i> Randall
* <i>Enchelynassa canina</i> (Quoy and Gaimard)	* <i>Zanclus canescens</i> (Linnaeus)
* <i>Uropterygius tigrinus</i> (Lesson)	<i>Antennarius drombus</i> Jordan and Evermann
<i>Holotrachys lima</i> (Valenciennes)	† <i>Xanthichthys ringens</i> (Linnaeus)
* <i>Myripristis murdjan</i> (Forsskål)	†* <i>Melichthys niger</i> (Bloch)
<i>Aphareus furcatus</i> (Lacépède)	†* <i>Alutera scripta</i> (Osbeck)
* <i>Malacanthus hoedti</i> Bleeker	<i>Canthigaster amboinensis</i> (Bleeker)
* <i>Caranx melampygus</i> Cuvier	
<i>Forcipiger flavissimus</i> (Jordan and McGregor)	
* <i>Hemipteronotus pavoninus</i> (Valenciennes)	

(Lockington), previously known only from deep water in the Gulf of California (Rosenblatt and Parr, 1969), was collected in ten m at Isla Canal de Afuera (SIO 71-52). Numerous specimens of *Gymnothorax castaneus* Jordan and Gilbert (which we regard as distinct from *G. dovii* Günther) were collected at several Gulf of Chiriqui and Panama Bay locations and represent a southern extension from the previously known range in Mexico. A single specimen of the brotulid *Petrotyx hopkinsi* Heller and Snodgrass from Isla Uva (SIO 70-135) extends the recorded range of the species from the Galapagos Islands, although it has also been taken between Cape San Lucas and Espiritu Santo Island, Lower California (SIO material). The collections also include a new species of chaenopsid (Stephens and Rosenblatt, MS) and a new species of dactyloscopid, both of which are distinctively different from known genera.

TRANSPACIFIC SHORE FISHES

Briggs (1961, 1964) has listed 62 transpacific shore fishes. His list includes certain records that our studies indicate are invalid for various reasons. These are discussed below:

Brachysomophis crocodilinus (Bennett). The eastern Pacific occurrence of this species rests on a report by Günther (1870) of a single specimen listed as "Galapagos Islands. From the Haslar Collection." Incorrect provenances of Haslar Hospital collection material has already led to several zoogeographic improbabilities (Kresja, 1960). In light of this, and lacking other records, we remove *B. crocodilinus* from the fauna of the eastern Pacific.

Gymnothorax chilospilus Bleeker. Herre's (1936) record of this species from Eden Island Galapagos, was based on a small specimen of *Muraena lentiginosa* Jenyns. We have examined Herre's specimen (SU 24399, now at CAS) and compared it with other material of *M. lentiginosa*. Herre's record of *Gymnothorax undulatus* (Lacépède), also based on *M. lentiginosa*, is discussed later in this paper.

Callechelys marmoratus (Bleeker). Fowler's (1932) record of this species from Charles Island, Galapagos, pertains to the recently described eastern Pacific species *C. galapagensis* McCosker and Rosenblatt, 1972.

Myrichthys maculosus (Cuvier). Fowler's (1938) record of *M. maculosus* from Narborough Island, Galapagos is referable to *M. tigrinus* Girard, an eastern Pacific endemic. The two nominal species are identical in external appearance. However, eastern Pacific populations have a significantly lower number of vertebrae than central and western Pacific material (McCosker, in preparation).

Myripristis berndti Jordan and Evermann. Although Greenfield (1965) did not place Briggs' (1964) record of *M. berndti* in the synonymy of *M. murdjan* (Forsskål) he does include the three Cocos Island specimens recorded by Briggs in his material of *M. murdjan*.

Lutjanus kasmira (Forsskål). The eastern Pacific endemic *L. viridis* Valenciennes is very similar to the Indo-west Pacific *L. kasmira*. Seale (1940)

regarded the two as synonymous in recording *L. kasmira* from the Galapagos and Cocos islands. However, Jordan and Evermann (1898) had noted morphological differences between *L. kasmira* and *L. viridis* and regarded the latter as distinct. Our material indicates differences in color pattern between the two species. In *L. viridis* there are five distinct blue stripes, the lowest behind the pectoral base; in *L. kasmira* this band is absent. The upper three stripes in *L. viridis* are almost horizontal, contacting the dorsal profile at the base of the ninth dorsal spine, between the ninth and tenth dorsal soft rays, and the anterior one-third of the caudal peduncle respectively. In *L. kasmira* the corresponding points are the sixth dorsal spine, the fifth or sixth dorsal soft ray, and the end of the soft dorsal. Also in *L. viridis* the fourth stripe runs forward below the eye to the upper lip, rather than ending at the preopercular margin. Seale's (1940) record then should be considered a misidentification of *L. viridis*, and *L. kasmira* removed from the eastern Pacific list.

Runula tapeinosoma (Bleeker). Clark's (1936) Galapagos record of *Petroscirtes tapeinosoma* was without doubt based on a specimen of the wide ranging eastern Pacific *Plagiotremus azaleus* (Jordan and Bollman).

Abudefduf saxatilis vaigiensis (Quoy and Gaimard). The taxonomy of the *Abudefduf saxatilis* species complex is confused. The Atlantic, Indo-west Pacific, and eastern Pacific populations have been considered to represent distinct species or subspecies (*A. saxatilis* (Linnaeus), *A. vaigiensis* and *A. troschellii* (Gill) respectively) or sometimes united under the oldest name, *A. saxatilis*. Herre's listing of Galapagos material with specimens from the western Pacific under the name *A. saxatilis* is insufficient reason to establish the presence of the Indo-west Pacific form at that locality.

Scarops jordani (Jenkins) and *Scarus rubroviolaceus* Bleeker. These nominal species have recently (Rosenblatt and Hobson, 1969) been shown to be synonymous. The older name is *S. rubroviolaceus*.

Amanses carolae (Jordan and McGregor). This species has been shown by Randall (1964) to be synonymous with *Cantherines dumerilii* (Hollard), known from east Africa, the Seychelles, Lord Howe Island, the central Pacific and Hawaii.

Antennatus bigibbus (Lacépède). The specimen on which the Revillagigedo Island record was based (BC 57-160) was included by Rosenblatt (1963) in his material of the eastern Pacific endemic *Antennatus strigatus* (Gill). *A. bigibbus* has not yet been taken in the eastern Pacific.

Our findings, in general, agree with the concept of the eastern Pacific barrier to shorefish distribution as proposed by Ekman (1953) and amplified by Briggs (1961, 1964). Most of the Indo-Pacific elements in western Panama possess larval stages adapted to long distance pelagic transport, or juveniles and adults which may be able to accompany floating debris across the equatorial Pacific using the north equatorial current system (Hubbs and Rosenblatt, 1961).

The often mentioned but poorly understood phenomenon of offshore

insular confinement in the eastern Pacific (Snodgrass and Heller 1905; Briggs, 1961, 1967; McCosker, 1971; Rosenblatt and Walker, 1963) deserves further mention. It is important to note that Indo-west Pacific migrants are not only confined to the offshore islands, but are also usually less abundant than the congeneric species of the indigenous fauna. An example is the sympatric association of the squirrelfishes *Myripristis murdjan* and *M. leiognathus* Valenciennes. The former, an Indo-Pacific emigrant, is, in the Gulf of Chiriqui, always found with, but less abundant than, the latter, a widespread eastern Pacific species. The same situation seems to pertain at Clipperton Island, except that the abundant eastern Pacific endemic there is *M. clarionensis*. A similar picture is also found in the Indo-Pacific morays in the eastern Pacific, except at Clipperton Island.

The evidence that the direction of movement across the Pacific has been from west to east has been presented by Briggs (1961) and Hubbs and Rosenblatt (1961). More recent findings have done little to alter their conclusions. It is, however, difficult to argue a west Pacific origin for *Sectator ocyurus*. The species has been recorded only from Hawaii and the Marquesas, on the fringes of the area, and might have crossed from east to west.

Briggs (1961, 1967, 1969, 1970) has in part ascribed the greater success of the Indo-west Pacific species in crossing the eastern Pacific barrier to their status as "dominant species." He (1967: 575) has stated that "It seems clear that the unusually stable ecosystems and high level of competition (in the Indo-west Pacific region) provide the proper environment for the evolution of dominant species that can successfully invade the other regions."

Inherent in this argument is the concept that competition between species leads to an increase in general "fitness" and the ability to compete in a new habitat with different competitors. This might be true if competition (overlap of requirement(s) for resource(s) in short supply) inevitably led to the extinction of all competitors but one, leaving a generalist occupying a broad niche. However, the widespread phenomenon of character displacement (Brown and Wilson, 1956) indicates that a more common result of competitive interaction is coexistence, with competition reduced by narrowing of niche breadth. Competition thus is more likely to produce specialists than generalists. The richness of the Indo-west Pacific fauna, especially in sympatric congeneric species, indicates that competitive interactions have had the latter result. For example Chave (in press) has carefully studied partitioning of the environment by six species of *Apogon* in Hawaii. Although all six occur together, there are differences in substrate preference, time of feeding, position in the water column while feeding, and food organisms taken. Her observations indicate that resources are partitioned in such a way as to reduce competition. Hobson's (1968) observations on *Apogon retrosella*, an eastern Pacific endemic which overlaps in part of its range with a single congener, *A. parri*, indicate much less restriction in several of these parameters. It is found over rocks as well as over sand patches at night, and feeds benthically as well as in midwater. Although it

is difficult to predict the results of invasions (MacArthur and Wilson, 1967, Chap. 5), there is no a priori reason to suppose that any one of the Hawaiian species of *Apogon*, each with a narrow range of substrate and food preferences, would be able to replace *A. retrosella* if introduced into the habitat of that species.

The data indeed indicate that eastward migrants have not displaced eastern Pacific endemics. As our previous discussion has shown, a large number of eastward migrants are limited in their eastern Pacific distributions. The Muraenidae are instructive in this regard. There are 15 endemic species of muraenids, distributed among six genera, in the eastern tropical Pacific. As might be expected from their pelagic larval stage, the muraenids are represented by more species of migrants than any other family. Seven species distributed among four genera have crossed the east Pacific barrier. However, none of these is widespread and abundant along the mainland coast.

The success of Indo-west Pacific forms in colonizing the eastern Pacific seems to be related to several factors, among them the ability to survive in the coral-poor, more variable environment of the eastern Pacific, as well as to the presence of endemic competitors. The idea that these species are behaving as "competitively dominant species" is unwarranted, and not supported by evidence.

The paradox that the major equatorial currents flow from east to west but the major faunal movements have been from west to east is more apparent than real. The North Equatorial Current is relatively weak to the east. Movement of water from the mainland of Central America is not strongly unidirectional and more a drift than a current for much of the year (Wyrski, 1965). In addition a considerable part of the north equatorial current is derived from the California Current, which would not be carrying tropical elements. The South Equatorial Current, which is strong and consistent near its eastern source, originates from the cold Peru Current which flows along the South American coast, where the fauna is essentially temperate (Myers, 1941; Ekman, 1953; Morrow, 1957). It is not surprising that these currents have not been major highways for tropical shore-fish dispersal.

The present impoverishment of the coral reef habitat in the eastern tropical Pacific appears to be limiting the diversity of corallophilic fishes and other in-shore faunal elements (as Emerson, 1967, has suggested for the Panamic molluscan fauna). The presence of a suitable reef habitat may be a key to the success of Indo-west Pacific elements in the Gulf of Chiriqui. A similar association of Indo-west Pacific fishes with notable coral development has been described for Isla Jaltimba, Nayarit, Mexico by Greenfield et al. (1970), and an association between coral and certain eastern Pacific scarids has been demonstrated by Rosenblatt and Hobson (1969: 438). As was pointed out in the latter paper, the causative factors in this relationship are not clear. It may be that hermatypic corals and the associated fishes have similar requirements with respect to the physical environment. For example, *Myripristis murdjan*

would seem by its distribution to be a strongly corallophilic form. However, it is a nocturnal planktivore which seemingly utilizes coral only as a shelter during the day. Additionally, Indo-west Pacific species form a conspicuous component of the fish fauna at the region of Cape San Lucas, lower California, an area of much poorer coral development than the Gulf of Chiriqui. The interrelationships between the biotic and physical factors in determining these associations clearly can only be elucidated by detailed studies.

In conclusion, we suggest that our findings of this large number of Indo-west Pacific species in western Panama is representative of the poor state of knowledge of fish distribution throughout western Central America, (Rosenblatt and Rubinoff, 1972), and may require reevaluation of the role of distance in maintaining the geographic isolation of many species of shore fishes with vagile embryonic or larval stages.

ANNOTATED LIST OF INDO-WEST PACIFIC REEF-ASSOCIATED FISHES IN THE GULF OF CHIRIQUI

Hemirhamphidae

1. *Euleptorhamphus viridis* (Van Hasselt) — Indo-Pacific, widespread in the eastern Pacific.

Muraenidae

2. *Echidna zebra* (Shaw) — known from the Indo-west Pacific and Hawaii; in the eastern Pacific, from Isla del Carmen to Cabo San Lucas, Isla Jaltemba Mexico, Clipperton Island, nearshore island localities from Costa Rica (UCR 14-38), the Gulf of Chiriqui, and the Perlas Archipelago.

3. *Echidna nebulosa* (Ahl) — known from the Indo-west Pacific and Hawaii; and the eastern Pacific from Bahia Muertos (SIO 61-253), Bahia San Lucas (SIO 67-136), and Manzanillo (UCLA 56-232), Mexico, Cocos Island, the Gulf of Chiriqui, and the Gulf of Panama.

4. *Gymnothorax buroensis* (Bleeker) — known from the Indo-west Pacific and Hawaii. In the eastern Pacific, from Clipperton Island (UCLA 58-289), Cocos Island, Isla del Caño and Isla Murciélago, Costa Rica (UCR 423-58 and 382-29), and a single specimen (SIO 71-48) collected in 10 meters in a *Pocillopora* bank reef at Islas Secas, Gulf of Chiriqui. New record for the eastern Pacific.

5. *Gymnothorax flavimarginatus* (Rüppell) — abundant in Indo-west Pacific and Hawaii, and offshore eastern Pacific islands of Clipperton, Cocos, and Isla del Caño, Costa Rica (UCR 423-125). Observed and photographed, but not collected at Islas Secas and Islas Contreras, Gulf of Chiriqui.

6. *Gymnothorax undulatus* (Lacépède) — Indo-west Pacific and Hawaii. In the eastern Pacific, known only from Isla del Caño, Costa Rica (UCR 423-59) and the Gulf of Chiriqui. We have collected and/or observed this species

at Islas Naranjas, Islas Contreras (SIO 70-135, SIO 71-40), Islas Secas (SIO 70-136, SIO 70-140), and Isla Coiba (MCZ 44103). New record for the eastern Pacific. Galapagos listings for this species are based on Herre's misidentification of a juvenile *Muraena lentiginosa* (SU 24382).

7. *Enchelynassa canina* (Quoy and Gaimard) — Indo-west Pacific and Hawaii. In the eastern Pacific known from Clipperton Island (SIO 59-12, UCLA 56-240) and Isla Montuosa, Gulf of Chiriqui (SIO 70-358). New record for the eastern Pacific.

8. *Uropterygius tigrinus* (Lesson) — Hawaii, Johnston, and the Society Islands. In the eastern Pacific, from Isla Espiritu Santo, Gulf of California (SIO 61-276), Isla Clarion, Islas de Revillagigedo (UCLA 55-131), and Islas Contreras, Gulf of Chiriqui (SIO 70-135, SIO 71-40). New record for the eastern Pacific.

Holocentridae

9. *Myripristis murdjan* (Forsskål) — Red Sea and Indo-west Pacific; eastern Pacific from the major islands groups, nearshore island localities from Costa Rica, and the Gulf of Chiriqui.

Kuhliidae

10. *Kuhlia taeniura* (Cuvier) — Indian Ocean to central Pacific. In the eastern Pacific, from Cape San Lucas to Colombia. Observed at Isla Montuosa and other localities in the Gulf of Chiriqui. The name *K. arge* Jordan and Bollman is available for the eastern Pacific population. In the absence of a critical study we tentatively regard it as conspecific with the western Pacific form.

Priacanthidae

11. *Priacanthus cruentatus* (Lacépède) — Pantropical; in the eastern Pacific, from Cabo San Lucas, Isla Jaltemba, and Islas Tres Marias, Mexico, the major offshore islands, Panama Bay, and the Gulf of Chiriqui.

Mugilidae

12. *Mugil cephalus* Linnaeus — Cosmopolitan in warm seas; in the eastern Pacific from Monterey, California, to Chile.

Branchiostegidae

13. *Malacanthus hoedti* Bleeker — Indian and tropical Pacific Oceans. This species, a new record for the eastern Pacific, was observed and collected at numerous localities in the Gulf of Chiriqui (SIO 70-138, SIO 71-42, SIO 71-53) where it is a common associate of the sand bottom and contiguous reef community at depths of 10-25 meters. The finding of *Malacanthus* initiated a search for additional material in existing collections; as a result of this inspection we now know that *M. hoedti* in the eastern Pacific ranges from Costa Rica



FIGURE 3. *Malacanthus hoedti*. A 244 mm individual from Isla Cavada, Islas Secas (SIO 70-138).

(Isla Viradores Sur, sight record) to Gorgona Island, Colombia (Argosy 27, now at UMML). In the Gulf of Chiriqui we have observed *M. hoedti* at numerous stations, both near the mainland (Bahia Honda) and at several island groups (Islas Naranjas, Brincanco, Uva, and Canal de Afuera). *M. hoedti* was encountered in pairs (not known to be male-female pairs in that the sexes are not externally distinguishable) at all localities. When approached by a diver, the fish would retreat into a burrow head-first. The burrow entrances were at the edges of large rocks, and the shallow burrows run beneath the rocks and terminate in an enlargement. We have compared our material with a series from Hawaii (CAS 24823) and a single specimen from the Caroline Islands (CAS 24824). All agree in morphology, number of vertebrae, and coloration, especially in the distinctively banded caudal (compare Fig. 3 with Berry, 1958, Fig. 7). There are, however, differences in the mean numbers of dorsal and anal rays (Table 2). The differences are significant at the $P \leq .05$ level but not at $P \leq .01$. Differences of this magnitude could indicate separation of the

TABLE 2

Total dorsal and anal rays in *Malacanthus hoedti*. Data for Central Pacific material include counts from Berry (1958).

Total dorsal rays

	54	55	56	57	58	59	60	61	62	\bar{X}	95% Conf. interval
E. Pacific	1	1	2	1	3					56.5	± 1.3
Cent. Pacific			1	1	2	-	4	2	1	59.4	± 1.2

Total anal rays

	48	49	50	51	52	53	54	\bar{X}	95% Conf. interval
E. Pacific	2	-	3	3				49.9	± 1.0
Cent. Pacific			2	2	3	3	1	51.9	± 0.9

populations at the specific or subspecific level. However, there is broad overlap of the ranges of the dorsal and anal counts. More importantly, our concept of *M. hoedti* (sensu stricto) is based on the Hawaiian population (10 of 11 specimens). Until adequate samples from throughout the entire range of the species are available, it would be premature to give formal taxonomic recognition to differences between the Hawaiian and eastern Pacific populations.

Carangidae

14. *Alectis ciliaris* (Bloch) — Indo-west Pacific and Hawaii, widespread in eastern Pacific. Observed and taken at several localities in the Gulf of Chiriqui.

15. *Caranx melampyngus* Cuvier — Indo-west Pacific and Hawaii; in the eastern Pacific, from the major offshore islands and the Cape San Lucas region of Baja California. Observed and photographed over the reefs at several localities in the Gulf of Chiriqui.

16. *Gnathanodon speciosus* (Forsskål) — Indo-west Pacific and Hawaii, and widespread in the eastern tropical Pacific. Observed and collected at numerous localities in the Gulf of Chiriqui (SIO 70-136).

Labridae

17. *Hemipteronotus pavoninus* (Valenciennes) — Indo-west Pacific and Hawaii; in the eastern Pacific, known from Cabo San Lucas, Baja California, several island localities in the Gulf of Chiriqui, and Isla Pedro Gonzalez, Archipelago de las Perlas (as *Xyrichthys panamensis* Fowler, 1944). We follow Randall (1965) in placing *Iniistius* and *Xyrichthys* in the synonymy of *Hemipteronotus*.

18. *Hemipteronotus taeniourus* (Lacépède) — Indo-west Pacific and Hawaii; in the eastern Pacific, from Punta Pescadero, Gulf of California (SIO 59-225, SIO 61-252), the Gulf of Chiriqui, and the Archipelago de las Perlas. New record for the eastern Pacific.

19. *Thalassoma lutescens* (Lay and Bennett) — Indo-west Pacific; in the eastern Pacific from San Jose del Cabo (SIO 61-237), the Gulf of Chiriqui, and the major offshore island groups.

Scaridae

20. *Scarus ghobban* Forsskål — Red Sea and Indian Ocean to eastern Pacific. In Panama, common in the Gulf of Chiriqui and the Archipelago de las Perlas.

21. *Scarus rubroviolaceus* Bleeker — East Africa to central Pacific and Hawaii; in eastern Pacific, at the major offshore island groups, Cabo San Lucas, and in Panama, in the Gulf of Chiriqui and the Archipelago de las Perlas.

Kyphosidae

22. *Sectator ocyurus* (Jordan and Gilbert) — Randall (1961) notes that this

species is a senior synonym of *S. azureus* Jordan and Evermann from Hawaii. Known from Hawaii and the Society Islands in the Indo-west Pacific, and in the eastern Pacific, from Cabo San Lucas to Costa Rica, the Gulfs of Chiriqui and Panama, and Isla La Plata, Ecuador.

Cirrhitidae

23. *Cirrhitichthys oxycephalus* Bleeker — Red Sea and Indo-west Pacific; in the eastern Pacific it extends from the Gulf of California to Colombia, and the major offshore islands.

24. *Oxycirrhites typus* Bleeker — Randall (1963) and Morris and Morris (1967) have discussed the range and synonymy of this species, now known from the Indo-west Pacific and Hawaii, and in the eastern Pacific from Los Frailes, Baja California to Isla Gorgona, Colombia. We have observed it in relatively shallow water (15-20 m) associated with the gorgonian *Lophogorgia* cf. *alba*, at Isla Coiba in the Gulf of Chiriqui, Isla Taboguilla in Panama Bay, and Isla Viradores Sur, Costa Rica.

Syngnathidae

25. *Doryrhamphus melanopleura* (Bleeker) — Indo-west Pacific; widespread and common in the eastern Pacific from the Gulf of California to Panama.

Fistulariidae

26. *Fistularia petimba* Lacépède — Indo-west Pacific; in the eastern Pacific from the Gulf of California to Panama.

Aulostomatidae

27. *Aulostomus chinensis* Smith and Swain — Indo-west Pacific; in the eastern Pacific from Clipperton, Revillagigedo, and Cocos Islands, and Islas Contreras in the Gulf of Chiriqui.

Acanthuridae

28. *Acanthurus triostegus* (Linnaeus) — Indo-west Pacific and Hawaii; in the eastern Pacific from Cabo San Lucas, Isla Jaltemba, and Islas Tres Marias, Mexico, to the Gulf of Chiriqui and the offshore island groups.

29. *Acanthurus glaucopareius* Cuvier — Indo-west Pacific and Hawaii; in the eastern Pacific from the major offshore islands (except the Galapagos), Isla Jaltemba, Isla Viradores, and the Gulf of Chiriqui.

30. *Acanthurus xanthopterus* Valenciennes — Indo-west Pacific and Hawaii; in the eastern Pacific, from the Gulf of California to Panama. This is the only surgeonfish species observed at the Perlas Archipelago.

31. *Ctenochaetus cyanoguttatus* Randall/Briggs (1961:554) lists the distribution as "Cocos Island. Line Islands to the Marquesas and west to Aldabra in the western Indian Ocean." This species has been collected in the Gulf of Chiriqui (SIO 71-40), at Isla del Caño, Costa Rica (UCR 423), and photographed at Isla Viradores, Costa Rica.

32. *Zanclus canescens* (Linnaeus) — Widespread in the Indo-west Pacific; in the eastern Pacific from Las Frailes, Gulf of California (SIO 61-243), Isla Jaltemba, Islas Tres Marias, the Gulf of Chiriqui, and the offshore islands.

Diodontidae

33. *Diodon holacanthus* Linnaeus — Circumtropical; widespread in the eastern tropical Pacific.

34. *Diodon hystrix* Linnaeus — Circumtropical; widespread in the eastern tropical Pacific.

Tetraodontidae

35. *Arothron hispidus* (Linnaeus) — Indo-west Pacific and Hawaii; in eastern Pacific from Cabo San Lucas to Panama and the offshore islands.

36. *Arothron meleagris* (Bloch and Schneider) — Indo-west Pacific and Hawaii; in the eastern Pacific it ranges from Cabo San Lucas to Ecuador and the offshore islands. Recent evidence (Tyler, Randall, and McCosker, in preparation) indicates that the polychromatic *A. setosus* (Smith) is conspecific with the wide ranging Indo-Pacific species *A. meleagris*.

Balistidae

37. *Melichthys niger* (Bloch) — A circumtropical species usually associated with oceanic islands (Berry and Baldwin, 1968). This species is present at the offshore islands within the Gulf of Chiriqui (Isla Ladrones and Isla Montuosa) where it replaces *Sufflamen verres* (Gilbert and Starks) on the reef.

38. *Alutera scripta* (Osbeck) — A circumtropical species. In the eastern Pacific, at the offshore islands and Cabo San Lucas. In Panama, it is infrequently seen in the Gulf of Chiriqui and the Archipeilago de las Perlas.

Ostraciontidae

39. *Ostracion meleagris* Shaw — Indo-west Pacific and Hawaii; in the eastern Pacific from Cabo San Lucas, Bahia Banderas, Isla Jaltemba, the offshore islands, and the Gulf of Chiriqui.

RESUMEN

Las colecciones recientes nos indican la presencia de un número de especies de peces del Indo Pacífico Occidental en el Golfo de Chiriquí. El veinticuatro por ciento (40) de las especies de peces de arrecifes también se encuentran en el mar Indo Pacífico Occidental. El Golfo de Chiriquí está fuera del efecto de afloramiento, como si lo está el Golfo de Panamá; siendo así relativamente más rico en el desarrollo de corales hermatípicos.

Nueve de las especies del Indo Pacífico Occidental que no han sido registrado en o cerca del continente Americano fueron colectadas: *Myripristis murdjan*, *Ctenochaetus cyanoguttatus*, *Gymnothorax flavimarginatus*, *G. buroensis*, *G. undulatus*, *Enchelynassa canina*, *Uropterygius tigrinus*, *Malacanthus hoedti*, y *Hemipteronotus taeniourus*. Las últimas seis de las especies

mencionadas no han sido reportadas como del Pacífico Oriental; aunque ninguna se encuentra confinada al Golfo de Chiriquí.

Los datos de las siguientes especies del Pacífico Oriental son clasificados como nulos, basándose en el hecho de que no han sido correctamente identificados o erróneamente registrados: *Brachysomophis crocodilinus*, *Gymnothorax chilospilus*, *Callechelys marmoratus*, *Myrichthys maculosus*, *Myripristis berndti*, *Lutjanus kasmira*, *Runula tapeinosoma*, *Abudefduf saxatilis vaigiensis* y *Antennatus bigibbus*.

La distribución de las siguientes especies endémicas del Pacífico Oriental *Gymnothorax castaneus*, *Petrotyx hopkinsi*, y *Paraclinus altivelis* se ha extendido hasta Panamá. *Xyrichthys panamensis* Fowler, 1944, es sinónimo con *Hemipteronotus pavoninus* (Valenciennes, 1839).

Muchos de los migratorios transpacífico están restringidos y limitados en su distribución Pacífico Oriental. Algunos se encuentran aparentemente en estrecha relación asociados con el desarrollo de corales hermatípicos. No existe evidencia que nos indique que dichas especies estén desplazando especies endémicas del Pacífico Oriental.

El número de especies encontradas por primera vez en el Golfo de Chiriquí refleja el poco conocimiento en lo que se refiere a la distribución de los peces del Pacífico trópico oriental.

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