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THE VERTEBRATES OF ROTUMA AND SURROUNDING WATERS

BY

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ABSTRACT

The vertebrate fauna of Rotuma consists of over 425 fish species, no amphibians, 11 terrestrial reptiles, 15 land birds and two native mammals. The zoogeographic affinity of the Rotuman fish fauna is with the Pacific plate fauna; in contrast, the affinity of the reptile fauna is with the Fijian fauna. A species list of Rotuman occurrence is provided for each of the four vertebrate groups as well as brief descriptions of the marine and terrestrial habitats.

INTRODUCTION

Rotuma is a small cluster of islands lying near the margin of the Pacific lithospheric plate at 12°30'S 177°E. Politically, these islands are part of Fiji, although they are separated from the Fiji islands by a water gap of over 450 km. They are distant from all other island groups, the closest being Niulakita, Tuvalu, approximately 350 km to the northeast. The Rotuman group consists of a large island, called Rotuma (ca. 43 km^2), and nearly a dozen islets (<1 km^2) sitting on a submarine reef/limestone bank (ca. 200 km^2) whose outer edge forms a narrow fringing reef. Several of the islets lie close (<1 km) to the northeastern and southeastern coasts of the main island. A small chain of islets and submerged reefs extends along the northwestern edge of the submarine bank, approximately 3-5 km from the main island.

All the islands are volcanic in origin (Woodhall, in press). Rotuma, the largest island, is a shield volcano of alkali-olivine basalt and hawaiite with over a dozen cones projecting above 100 m, but only six extending slightly over 200 m. The surface of Rotuma is composed largely of an admixture of lava flows, scoria and tuffs of Recent and late Pleistocene age. Weathering and erosion have been

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slight in a geological sense, but enough to produce a thin mantle of soil (even on the slopes of the cones), drainage systems without permanent streams, and narrow coastal plains of beach and outwash materials.

The climate of Rotuma is wet and warm. Records for the past 20 years show no months without rain and an average annual rainfall of 335 cm (Gill, 1977, in Woodhall, op. cit.). Rare dry periods of up to three months have occurred, however. Rainfall varys from light, misty showers to torrential downpours. In general, the daily temperature regime goes from early morning lows of 24-25°C to midafternoon highs of 31-32°C.

Our purpose for visiting Rotuma centered on its isolated position on what we thought then was the common margin of the India-Australia and Pacific lithospheric plates. The margin, however, is a fossil one, now replaced with an area of more recently formed ocean bottom and island chains that geologists have grouped into a region, which they call the Melanesian Borderlands. Springer (1982) demonstrated that the biota, particularly the shorefishes, of the Pacific plate was recognizably different from that of the continental plates to the west. We wished to determine whether the relationships of the Rotuman biota, particularly fishes and reptiles, were with the continental or Pacific plates.

Prior to our collecting, only slightly more than 100 species of shorefishes were known from Rotuma (Boulenger, 1897a) , or less than 15% of the total fish fauna that could be expected to occur there, based on our knowledge of the fish faunas of other Pacific plate island groups. All of Boulenger's species have wide distributions and are, therefore, biogeographically uninformative. We needed more representative collections, which could be made using modern collecting techniques. Similarly, the reptilian fauna was last surveyed in 1892 (Boulenger, 1897b). Not surprisingly, this fauna also consisted predominantly of widespread Southwest Pacific species, with three exceptions, two skinks otherwise restricted to the Fijian islands and an endemic gecko. The gecko was represented only by a single poorly preserved specimen. Was it actually a unique population and, if so, what is its closest relative? In addition to confirming the composition of the Rotuman herpetofauna, we wished to determine if a unique gecko species did exist on Rotuma and, if it did, to investigate aspects of its biology.

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Hernan, Atta, Emilia, Lili) provided exceptional support for our field work while on Rotuma. We were also most ably assisted by Sesewa (Fijian Marine Fisheries Laboratory) and Joe Libby (Smithsonian diving officer) during the fish surveys. The Rotuma survey would have been impossible without the logistic and moral support of Dr. A.E. Lewis and the Marine Fisheries Laboratory of the Fijian Ministry of Primary Industries. The entire survey was funded by a grant from the Max & Victoria Dreyfus Foundation. We wish to thank all of these individuals and organizations for making the survey successful.

Numerous colleagues generously provided assistance with identifications of the Rotuman fishes. We greatly appreciate their aid (all the species in a listed taxon may not have been identified by the individual listed): G.R. Allen (Pomacentridae); W.D. Anderson, Jr. (Lutjanidae); K. Carpenter (Caesionidae); J. Clayton (Acanthuridae); D.M. Cohen (Bythitidae, Ophidiidae); B.B. Collette (Hemiramphidae, Scombridae); R. Cressey (Synodontidae); W.N. Eschmeyer (Caracanthidae, Scorpaenidae); A. Gerberich (Chaetodontidae, Lethrinidae, Lutjanidae); A.C. Gill (Pseudochromidae); S. Jewett (Gobiidae); L. Knapp (Platycephalidae); J.E. McCosker (Muraenidae, Ophichthidae); E. Murdy (Gobiidae); T.W. Pietsch (Antennariidae); J.E. Randall (Apogonidae, Cirrhitidae, Holocentridae, Labridae, Serranidae); W.F. Smith-Vaniz (Carangidae); W. Starnes (Priacanthidae); K. Tighe (Xenocongridae); R.P. Vari (Teraponidae); R. Winterbottom (Gobiidae). L.W. Kroenke critically reviewed the geotectonic discussion

MARINE HABITATS

We made only a cursory survey of Rotuman marine habitats. Because of interdistrict political strife, our collecting was almost entirely restricted to areas outside the barrier reef and to the lagoon adjacent to the Malha'a District. During most of our visit, much of the lagoon was subject to strong currents, which precluded the successful use of ichthyocides, our primary means of sampling near-shore and reef fishes.

Rotuma is almost completely surrounded by a barrier reef, which is less than 400 m offshore for most of the coast. We saw no mangroves or permanent freshwater streams, although Fijian Fisheries personnel (1983) reported the presence of mangroves and a small permanent stream. The shore includes extensive stretches of beach rock, lava boulders and rubble, and/or limestone interspersed with patches of sand. There are few small, white-sand beaches and extensive muddy-sand bays, the

latter with marine spermatophytes and spotty dead and live coral. In many areas, low masses of dead and live coral fill the lagoon, which frequently dries during low tides. Large areas of living coral appeared to be restricted to some of the satellite islets lying outside the barrier reef of Rotuma Island proper.

FISHES

Except for a few hook-and-line caught specimens, collections of fishes were made exclusively with the use of rotenone, from the shoreline to depths of 41-42 m. A complete list of species obtained is not possible, because some groups of fishes have not been sorted by specialists and some specimens represent undescribed species.

Boulenger (1897a) published the only listing of Rotuman shore fishes; he listed 108 species, about a fourth of the number listed below. Without examining Boulenger's specimens (deposited at the British Museum), it is not possible to determine the degree to which our lists of species overlap. Undoubtedly, a large majority of Boulenger's species are included among those listed herein; however, several definitely are not; for instances: Monacanthus scopas (=Amanses scopas), Fierasfer homei, F. gracilis, F. parvipinnis, Coris greenoughii (=C. gaimardi), Naseus unicornis (=Naso unicornis), Hemigymnus fasciatus, Synancia verrucosa (=Synanceia verrucosa). All of these species are widely distributed and would be expected to occur at Rotuma, although our survey did not record their presence.

In 1983, the Fisheries Division of the Ministry of Primary Industries (then Ministry of Agriculture and Fisheries) prepared a limited number of photocopies[1] of the results of a fisheries survey of Rotuma. The report mentioned about 85 species, most from deep water well offshore and not collected or seen by us or reported by Boulenger). The number of species of fishes known from Rotuman waters is about 425. We make no prediction as to the total number that occurs there, except that it may well approach the 999 species reported for Samoa (Wass, 1984).

Although the following list is incomplete, it still offers insights into the composition and biogeographic affinities of the Rotuman fish fauna. In addition to fish captured during our survey, we have included the food fish species found by the Fiji Fisheries survey (1983), but not

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1) The report, The Fishery Resources of Rotuma, is available in the library, Division of Fishes (Natl. Museum of Natural History).

collected or observed during our survey; these species are identified (F). Species observed or collected are identified as: collected (C); observed (O); discarded (D). Species not reported from Samoa (Wass, 1984) are noted with an asterisk.

Sharks & Rays

Carcharhinidae
- Carcharhinus albimarginatus (F)
- Carcharhinus melanopterus (O)
- Triaenodon obesus (O)

Dasyatididae
- Dasyatis kuhlii or Taeniura lymna* (O)

Hexanchidae
- Heptranchias* (F) (and/or?) Hexanchus (F)

Mobulidae
- Manta birostris (F)

Orectolobidae
- Nebrius sp. (F)

Sphyrnidae
- Sphyrna sp. (F)

Squalidae
- Etmopterus* (F) (and/or?) Centrophorus* (F) (and/or?) Squalus (F)

Bony Fishes

Acanthuridae
- Acanthurus glaucopareius (C)
- Acanthurus guttatus (C)
- Acanthurus lineatus (C)
- Acanthurus nigricauda (C)
- Acanthurus nigrofuscus (C)
- Acanthurus olivaceus (C)
- Acanthurus pyroferus (F)
- Acanthurus triostegus (C)
- Ctenochaetus binotatus (C)
- Ctenochaetus striatus (C)
- Naso lituratus (C)
- Zebrasoma veliferum (C)

Albulidae
- Albula sp. (F)

Ammodytidae
- Ammodytes sp.* (C)

Antennariidae
Antennarius coccineus (C)

Aploactinidae
Paraploactis sp.* (C)
Apogonidae
Apogon angustatus (C)
Apogon bandanensis (C)
Apogon coccineus (C)
Apogon doryssa* (C)
Apogon erythrinus* (C)
Apogon exostigma (C)
Apogon fraenatus (C)
Apogon gracilis* (C)
Apogon kallopterus (C)
Apogon nigrofasciatus (C)
Apogon novemfasciatus (C)
Apogon nubilis* (C)
Apogon savayensis (C)
Apogon sp. (C)
Apogon unicolor* (C)
Apogonichthys perdix* (C)
Archamia fucata (C)
Cheilodipterus macrodon (C)
Cheilodipterus quinquilineatus (C)
Foa brachygramma* (C; as F. vaiulae in Wass?)
Fowleria isostigma (C)
Gymnapogon urospilotus (C)
Gymnapogon spp.* (C; at least two species)
Pseudamia gelatinosa (C; as P. polystigma in Wass)

Atherinidae
Genus and species unidentified (C)

Aulostomidae
Aulostomus chinensis (C)

Balistidae
Balistapus undulatus (C)
Melichthys vidua (C)
Pseudobalistes sp. (F)
Rhinecanthus aculeatus (C)
Rhinecanthus rectangulus (O)
Sufflamen chrysopterus (C)

Belonidae
Ablennes hians (F)

Blenniidae
Alticus sp. (C)
Aspidontus taeniatus (C)
Cirripectes fuscoguttatus (C)
Cirripectes polyzona (C; as C. sebae in Wass)

Cirripectes stigmaticus (C)
Cirripectes variolosus (C)
Ecsenius portenoyi (C; as E. oculus in Wass)
Ecsenius opsifrontalis (C)
Enchelyurus ater (C)
Entomacrodus caudofasciatus (C)
Entomacrodus decussatus (C)
Entomacrodus sealei (C)
Entomacrodus striatus (C)
Entomacrodus thalassinus (C)
Glyptoparus delicatulus* (C)
Istiblennius andamensis (C; as I. interruptus in Wass)
Istiblennius chrysospilos (C; as I. coronatus in Wass)
Istiblennius edentulus (C)
Istiblennius periophthalmus (C; as I. cyanostigma and I. paulus in Wass)
Meiacanthus atrodorsalis (C)
Nannosalarias nativitatus (C)
Plagiotremus rhinorhynchos (C)
Plagiotremus tapeinosoma (C)
Praealticus sp. (C)
Stanulus seychellensis (C)

Bothidae
Genus and species unidentified (C)

Bythitidae
Brosmophyciops pautskei (C)
Dinematichthys sp. (C)
?Dinematichthys sp. (C)

Caesionidae
Caesio teres* (C)
Pterocaesio marri* (C)
Pterocaesio tile (C)

Callionymidae
Diplogrammus goramensis (C)
Synchiropus laddi* (C)

Caracanthidae
Caracanthus maculatus (C)
Caracanthus unipinna (C)

Carangidae
Carangoides ferdau (F)
Caranx ignobilis (F)
Caranx lugubris (F)
Caranx melampygus (C)
Caranx sexfasciatus (F)
Elegatis bipinnulatus (F)
Seriola rivoliana (D)

Chaetodontidae
- Chaetodon auriga (C)
- Chaetodon citrinellus (C)
- Chaetodon ephippium (C)
- Chaetodon lunula (C)
- Chaetodon mertensii (C)
- Chaetodon ornatissimus (C)
- Chaetodon pelewensis (C)
- Chaetodon reticulatus (C)
- Chaetodon trifascialis (C)
- Chaetodon trifasciatus (C)
- Chaetodon ulietensis (O)
- Chaetodon vagabundus (O)
- Forcipiger flavissimus (C)
- Heniochus chrysostomus (C)

Cirrhitidae
- Amblycirrhites bimacula (C)
- Cirrhitichthys falco (C)
- Cirrhitus pinnulatus (C)
- Paracirrhites arcatus (C)
- Paracirrhites forsteri (C)

Congridae
- Conger cinereus (C)

Coryphaenidae
- Coryphaena hippurus (F)

Creediidae
- Chalixodytes tauensis (C)
- Limnichthys donaldsoni (C)

Diodontidae
- Diodon hystrix (C)

Ephippididae
- Platax orbicularis (C)

Gempylidae
- Promethichthys prometheus (F)
- Ruvettus pretiosus (F)
- Thyrsitoides marleyi* (F)

Gerreidae
- Gerres oyena (C)

Gobiesocidae
- Genus and species unidentified (C)

Gobiidae
- Amblygobius bimaculatus (C)
- Amblygobius nocturnus (C)

Amblygobius phalaena (C)
Asterropteryx semipunctatus (C)
Bryaninops ridens* (C)
Callogobius sp. A (C)
Callogobius sp. B (C)
Callogobius sp. C (C)
Eviota albolineata* (C)
Eviota disrupta (C)
Eviota distigma (C)
Eviota melasma (C)
Eviota nebulosa* (C)
Eviota prasina* (C)
Eviota pseudostigma (C)
Eviota punctulata* (C)
Eviota zonura (C)
Eviota sp. a (C)
Eviota sp. b (C)
Fusigobius neophytus (C)
Fusigobius sp. (C)
Gnatholepis sp. (C)
Gobiodon rivulatus (C)
Gobiodon sp. A (C; brown, chin grooves deflected anteriorly)
Gobiodon sp. B* (C; brown, 2 bars below eye, straight chin grooves)
Gobiodon sp. C(*?) (C; pale, 5-6 bars on head, no chin grooves)
Istigobius decoratus (C)
Istigobius rigilius (C)
Lotelia sp.* (O)
Nemateleotris magnifica (O)
Paragobiodon echinocephalus (C)
Paragobiodon lacunicolus (C)
Paragobiodon melanosomus* (C)
Paragobiodon xanthosomus (C)
Priolepis semidoliatus (C)
Ptereleotris evides (C)
Ptereleotris heteroptera (C)
Rotuma lewisi*
Trimma caesiura (C)
Trimma emeryi (C)
Trimma eviotops (C)
Trimma okinawae* (C)
Trimma (C; two undescribed species)
Valenciennea sp. (C)
Xenisthmus clara (C)
Xenisthmus cf. clara (C)
several unidentified genera and species (C)

Hemiramphidae
Hyporhamphus dussumieri (C)

Holocentridae
- Myripristis adustus (C)
- Myripristis berndti (C)
- Myripristis kuntee (C)
- Myripristis murdjan (C)
- Myripristis pralinus (C)
- Myripristis violaceus (C)
- Neoniphon sammara (C)
- Plectrypops lima (C)
- Sargocentron caudimaculatum (C)
- Sargocentron diadema (C)
- Sargocentron lepros* (C)
- Sargocentron microstoma (C)
- Sargocentron punctatissimum (C; as S. lacteoguttatum in Wass)
- Sargocentron spiniferum (C)
- Sargocentron tiere (C)
- Sargocentron tiereoides (C)
- Sargocentron violaceum (C)

Kuhliidae
- Kuhlia mugil (C)

Kraemeriidae
- Kraemeria sp. (C)

Kyphosidae
- Kyphosus sp.(O)

Labridae
- Anampses twistii (C)
- Bodianus axillaris (O)
- Cheilinus diagramma (C)
- Cheilinus oxycephalus (C)
- Cheilinus undulatus (C)
- Cheilinus unifasciatus (C)
- Choerodon jordani (C)
- Cirrhilabrus sp. (C)
- Epibulus insidiator (C)
- Gomphosus varius (C)
- Halichoeres biocellatus (C)
- Halichoeres hortulanus (C)
- Halichoeres margaritaceus (C)
- Halichoeres marginatus (C)
- Halichoeres trimaculatus (C)
- Labroides bicolor (C)
- Labroides dimidiatus (C)
- Labropsis australis (C)
- Macropharyngodon meleagris (C)
- Pseudocheilinus evanidus (C)
- Pseudocheilinus hexataenia (C)
- Pseudodax moluccanus (C)
- Stethojulis bandanensis (C)

Thalassoma hardwicke (C)
Thalassoma purpureum (C)
Thalassoma quinquevittatum (C)
Thalassoma trilobatum* (C)
Wetmorella nigropinnata (C)

Lethrinidae
Gnathodentex aurolineatus (C)
Gymnocranius griseus* (F)
Gymnocranius lethrinoides (F)
Gymnocranius robinsoni* (F)
Lethrinus amboinensis? (F)
Lethrinus elongatus (F)
Lethrinus harak (C)
Lethrinus mahsena (C)
Lethrinus rubrioperculatus (C)
Monotaxis grandoculis (C)
Wattsia mossambica (F, as Gnathodentex mossambicus)

Lutjanidae
Aphareus furca (C; formerly A. furcatus, W.D. Anderson, Jr., pers. comm.)
Aphareus rutilans (F)
Aprion virescens (F)
Etelis carbunculus (F)
Etelis coruscans (F)
Etelis radiosus (F)
Lutjanus bohar (F)
Lutjanus fulvus (C)
Lutjanus gibbus (C)
Lutjanus kasmira (C)
Lutjanus malabaricus* (F)
Paracaesio caeruleus* (F)
Paracaesio gonzalesi* (F)
Paracaesio kusakarii (F)
Paracaesio stonei (F)
Pristipomoides argyrogramminicus* (F)
Pristipomoides auricilla (F)
Pristipomoides filamentosus (F)
Pristipomoides flavipinnis (D)
Pristipomoides multidens (F)
Pristipomoides typus* (F)
Pristipomoides zonatus (D)

Malacanthidae
Malacanthus brevirostris (C)

Monacanthidae
Cantherhines pardalis (C)
Oxymonacanthus longirostris (O)
Pervagor janthinosoma* (C)

Moringuidae
Moringua sp. (C)

Mugilidae
Crenimugil crenilabis (F)
Liza vaigiensis (C)
Valamugil engeli (C)
Valamugil seheli (F)

Mugiloididae
Parapercis cephalopunctata (C)
Parapercis clathrata (C)

Mullidae
Mulloides flavolineatus (C)
Mulloides vanicolensis (C)
Parupeneus barberinus (C)
Parupeneus moana (C; as trifasciatus in Wass)
Parupeneus cyclostomus (C; as chryserydros in Wass)
Parupeneus pleurostigma (C)
Upeneus taeniopterus (F; as U. arge)

Muraenidae
Gymnomuraena zebra (C)
Gymnothorax buroensis (C)
Gymnothorax fimbriatus (C)
Gymnothorax margaritophorus (C)
Gymnothorax rueppelliae (C)
Gymnothorax undulatus (C)
Gymnothorax zonipectis (C)
Uropterygius macrocephalus* (C)

Ophichthidae
Callechelys marmorata (C)
Callechelys melanotaenia (C)
Leiuranus semicinctus (C)
Muraenichthys sp.* (C)
Myrichthys colubrinus (C)

Ophidiidae
Brotula multibarbata (C)
Brotula townsendi (C)

Ostraciidae
Ostracion meleagris (C)

Pempheridídae
Parapriacanthus guentheri* (C)
Pempheris oualensis (C)

Platycephalidae
Thysanophrys chiltonae (C)
Thysanophrys otaitensis (C)

Plesiopidae
Plesiops coeruleolineatus (C)

Pleuronectidae
Samariscus triocellatus (C)

Pomacanthidae
Centropyge bispinosus (C)
Centropyge flavissimus (C)
Pygoplites diacanthus (C)

Pomacentridae
Amphiprion chrysopterus (C)
Amphiprion melanopus (O)
Amphiprion perideraion (C)
Chromis acares (C)
Chromis agilis (C)
Chromis iomelas (C)
Chromis margaritifer (C)
Chromis viridis (C; as *C. caerulea* in Wass)
Chromis weberi (C)
Chromis xanthura (C)
Chrysiptera biocellata (C)
Chrysiptera cyanea (C)
Chrysiptera glauca (C)
Chrysiptera leucopoma (C)
Dascyllus aruanus (C)
Dascyllus reticulatus (C)
Dascyllus trimaculatus (C)
Neopomacentrus metallicus (C)
Plectroglyphidodon dickii (C)
Plectroglyphidodon johnstonianus (C)
Plectroglyphidodon lacrymatus (C)
Plectroglyphidodon leucozona (C)
*Pomacentrus bankanensis** (C)
Pomacentrus coelestis (C)
*Pomacentrus philippinus** (C)
Pomacentrus vaiuli (C)
Stegastes albifasciatus (C)
Stegastes fasciolatus (C)
Stegastes lividus (C)
Stegastes nigricans (C)

Priacanthidae
Heteropriacanthus cruentatus (C)

Pseudochromidae
Pseudoplesiops multisquammata (C; as *Chlidichthys* sp. in Wass)
Pseudoplesiops rosae (C)
Pseudoplesiops sp. (C)

Scaridae
- Scarus ghobban (C)
- Scarus gibbus (D; photographed)
- Scarus sordidus (C)

Scombridae
- Acanthocybium solandri (F)
- Auxis thazard (F)
- Grammatorcynus bilineatus (C)
- Gymnosarda unicolor (D)
- Katsuwonus pelamis (F)
- Scomberomorus commerson* (F, verification desired)
- Thunnus albacares (F)

Scorpaenidae
- Pterois radiata (C)
- Scorpaenodes hirsutus (C)
- Scorpaenodes kelloggi* (C)
- Scorpaenodes parvipinnis (C)
- Scorpaenodes scaber* (C)
- Scorpaenopsis sp. (C)
- Scorpaenopsis diabolus (C)
- Scorpaenopsis fowleri (C)
- Sebastapistes tinkhami* (C)
- Taenianotus triacanthus (C)

Serranidae
- Aethaloperca rogaa* (C)
- Cephalopholis argus (C)
- Cephalopholis igarashiensis (F)
- Cephalopholis leopardus (C)
- Cephalopholis spiloparaea (C) (as C. sp. in Wass?)
- Cephalopholis sonnerati (F)
- Cephalopholis urodeta (C; formerly C. urodelus)
- Epinephelus chlorostigma* (F)
- Epinephelus cylindricus* (F)
- Epinephelus fuscoguttatus (F)
- Epinephelus maculatus (F)
- Epinephelus magniscuttis* (F)
- Epinephelus microdon (F)
- Epinephelus morrhua (F)
- Epinephelus septemfasciatus* (F)
- Epinephelus spilotoceps* (C)
- Grammistes sexlineatus (C)
- Liopropoma susumi (C)
- Plectranthias longimanus* (C)
- Pseudogramma bilinearis (C)
- Pseudogramma polyacantha (C)
- Variola albomarginata* (F)
- Variola louti (C)

Siganidae
- Siganus punctatus (C)

Soleidae
Genus and species unidentified (C)

Sphyraenidae
Sphyraena barracuda (D)

Symphysanodontidae
Symphysanodon typus* (C)

Syngnathidae
Choerichthys brachysoma* (C)
Corythoichthys flavofasciatus (C)
Corythoichthys intestinalis (C)
Cosmocampus banneri* (C)
Doryrhamphus dactyliophorus (C)
Doryrhamphus excisus (C)
Doryrhamphus melanopleura (C)
Micrognathus andersonii* (C)
Phoxocampus diacanthus (C)

Synodontidae
Saurida gracilis (C)
Synodus binotatus (C)
Synodus englemani (C)
Synodus variegatus (C)

Teraponidae
Terapon theraps* (C)

Tetraodontidae
Arothron hispidus (C)
Canthigaster amboinensis (C)
Canthigaster janthinoptera (C)
Canthigaster solandri (C)
Canthigaster valentini (C)

Tripterygiidae
Enneapterygius sp. (C)
Helcogramma chica (C)
Helcogramma ellioti (C)
Helcogramma fuscopinna* (C)
Helcogramma hudsoni (C)

Xenocongridae
Kaupichthys atronasus (C)
Kaupichthys brachychirus (C)
Kaupichthys hyoproroides (C)
Kaupichthys sp. A (C)
Kaupichthys sp. B (C)

Zanclidae
Zanclus cornutus (O)

TERRESTRIAL HABITATS AND VEGETATION

The flora of Rotuma was not formally surveyed or identified by any member of the expedition. Nonetheless, the impressions and observations of the flora and its zonation by a zoologist (G.R.Z.) may be useful to inform the reader of the types of habitats currently available to terrestrial vertebrates and to serve as a historical record.

Topographically, the island consists of a series of three terraces: the first is littoral and partially underwater at low tide and completely submerged at high tide. The second is the coastal terrace and extends from the supralittoral zone to the beginning of the hill slopes. The third terrace is at mid elevation along the slopes of the hills and forms a central plateau of gentle undulations from which the hill tops (remanent volcano cones) arise abruptly and steeply. Although this is an overgeneralization, it does convey an impression of the landscape better than the narrow contour lines on a topographic map; it also identifies the different soil and vegetation zones.

The coastal terrace is narrow, typically 100-150 m or narrower throughout most of the island, except for the eastern and northeastern ends of the island, where it may be 1 km in extent. The soil is predominantly sandy. This terrace is the area of human habitation, mixed with small garden plots, small coconut grooves, and patches of secondary forest. The latter exist in areas of heavy lava rubble or areas simply not needed presently for gardening. The central plateau occupies the entire center of the island (eastern portion) at an approximate elevation of 30-60 m. The soil is predominantly a reddish brown "clay". The plateau is an area of intense agriculture; coconut plantations predominate, cocoa groves are a recent agricultural introduction, taro, cassava and yam gardens, and infrequent small patches of bush (secondary growth forest) are also present.

The boundary between the littoral and the coastal terrace is an abrupt and usually vertical bank, the base of which is awash at high tide. Most beaches exist only at low tide and are predominantly of lava rubble or flows interspersed with patches of sand. The coastal terrace and the central plateau are separated by a slope of variable length and inclination, typically less than 30^{o} slope and 1 km in width. The soil ranges from dark-brown humus or clay mixed with small lava rubble to jumbled lava blocks. Secondary growth forest covers the majority of the slope area, although small coconut groves or small gardens are scattered throughout. The forest is in various stages of

growth with fairly open canopied forest of 5-10 m to more closed canopied forests of 15-20 m. Understory vegetation occurs throughout, but is nowhere so dense as to be impenetrable. Not surprising for such a small island with long human occupation, there is no area of undisturbed forest, although some trees may be centuries old; we measured one tree with a 9 m dbh on the top of Mt. Suelhof. Within the older secondary forest, trees with buttresses were not uncommon although few had dbh >1 m, and in the older forest, most trees were >40 cm dbh, and coconut palms were a common species in all stages of forest regrowth. The slopes of the higher peaks also bore secondary growth forests, most in early stages of regeneration, and often one side was cleared to the top for gardening or coconut plantations. Slopes are steep, often >30^{o} inclination with clay soil.

Rainfall is heavy and frequent in Rotuma, thus the interior of the forest is quite moist with numerous epiphytes; ferns are probably the dominant epiphytic plant. Moss is also common on trees and rocks.

MAMMALS

Aside from the assorted domestic mammals (cattle, horses, pigs, goats, dogs and cats), only two wild species were observed, a rat and a bat.

The bat (presumably Emballonura) was observed infrequently and only singly in or adjacent to the forest; it had a weak fluttering flight pattern. No fruit bats presently occur on the islands; Rotumans declared their absence.

The rat, Rattus exulans, is widespread from the houses of the coast to the gardens and plantations of the central plateau. Only a single rat was captured and tentatively identified; it is likely that R. rattus and/or R. norvegicus are also present.

BIRDS

The following list of land birds derives from Clunie's (1984) excellent handbook and follows the order of his presentation. Miscellaneous observations are appended.

Egretta sacra (reef heron). Although this is a common bird of the shoreside in the Fiji Islands, we saw none in Rotuma.

Anas superciliosa (black duck). Not observed. Gallus gallus (jungle fowl). Feral chickens were regularly

seen in the secondary growth forest or along its margin. The few roosters seen as they fled possessed the jungle fowl color pattern; however, their morning calls remain like their domestic brethren and not the higher pitch, rougher-sounding call of their Asian ancestors.

Gallirallus philippensis (banded rails). This species is common. Typically 6-8 would be seen for every kilometer of road in the morning. They occur singly or in pairs, feeding on the road. They seldom flew.

Porphyrio porphyrio (purple swamphen). Not observed.

Columbia vitiensis (white-throated pigeon). Not observed.

Ptilinopus porphyraceus (crimison-crown fruit pigeon). This species may have been observed once, but the fleeting observation of a small pigeon was too brief for adequate confirmation of its identity.

Ducula pacifica (Pacific pigeon). This large pigeon was seen and heard daily. They feed in the treetops singly or in small groups (2-3). From a distance, the head, neck and chest are grey, and back and wings a dark metallic blue.

Eudynamis taitensis (long-tailed cuckoo). Not observed.

Tyto alba (barn owl). A single individual was seen at noon (sunny day), in flight, in a large coconut plantation on the island's central plateau.

Collocalia spodiopygia (white rumped swiftlet). Not observed.

Halcyan chloris (white-collared kingfisher). Not observed.

Lalage maculosa (Polynesian triller). A common species observed most frequently in gardens and along the edge of secondary growth forest.

Myiagra vanikorensis (Vanikoro broadbill). Not observed.

Myzomela cardinalis (cardinal honey eater). The honey eater is the most abundant of Rotuma's birds. It occurs everywhere, feeding as a gleaner on outer branches in the forest or dangling from seed heads of weeds in open areas. Young fledglings were seen during our mid May visit.

Aplonis tabuensis (Polynesian starling). This species is also extremely abundant and occurs in all habitats, although my impression is that it prefers the more open habitats. Its diet includes overripe papayas and chili peppers, of the latter it selects only the ripe red ones and swallows them whole.

Clytorhynchus vitiensis (lesser shrikebill). The shrikebill is a forest species, feeding primarily among the tree branches, but occasionally descending to the forest floor to catch an insect. Large insects are subdued by repeatedly and rapidly striking them against the perch branch.

Only a few shore- and sea birds were observed, several inadequately for positive identification.

Arenaria interpres (ruddy turnstone). Small flocks (3-6) were seen several times, usually feeding among the rocks of the littoral area and once on the airstrip.

Pluvialis dominica (lesser golden plover). This plover was seen everyday, as often in the grassy areas within the villages as in the littoral areas; they usually occurred in small groups of 2-3.

Fregata (frigate-bird). Frigate-birds were common around Uea and its adjacent islets, but were rarely seen near the main island. They were not observed sufficiently close to identify them as lesser or greater frigates.

Gygis alba (white tern). This was the commonest tern near-shore and over the island.

Phaethon lepturus (white-tailed tropic bird). These birds were seen regularly (every other day) gliding high over the central plateau. They generally occurred singly, but six were observed in one flock.

cf. Sterna A small dark tern was often seen flying close to water outside the reef. It appeared to be slightly smaller than the white tern and had a light or white patch on its head.

Sula leucogaster (brown booby). This species was also commonly seen outside of the reef.

REPTILES

Eight species of lizards were observed and collected in Rotuma. The Pacific boa (Candoia bibronii) was reported from the island by Boulenger (1897b) and persists according to the Rotumans; however, they see it rarely. The lizards are:

Emoia concolor (green tree skink). Not observed. The specimen reported by Boulenger is present in the British Museum, and examination confirms its identification.

Emoia cyanura (copper-striped skink). This terrestrial skink is the most abundant lizard. It occurs in all habitats from human dwellings to the forest.

Emoia nigra (black skink). The black skink is the largest Rotuman lizard and is fairly common. In habits, it is terrestrial to semi-arboreal, feeding and seeking shelter in rock or wood piles as well as climbing high in trees.

Emoia trossula (barred skink). Although this skink may also feed on the ground, it appears to be the most arboreal of the observed Rotuman skinks. The skink is commonly seen clinging head down on the side of trees in open areas, such as coconut plantation and fence

rows, but it also occurs in secondary growth forest. It is abundant.

Gehyra mutilata (stump-toed gecko). This gecko appears to be restricted to buildings.

Gehyra oceanica (oceanic gecko). This is the largest gecko in Rotuma. Although it occurs on buildings, it is predominantly a forest inhabitant, living in upright dead trees and holes of living ones.

Lepidodactylus gardineri (Rotuman forest gecko). This gecko is the only endemic Rotuman reptile. It lives in termite galleries in dead tree branches and trunks.

Lepidodactylus lugubris (mourning gecko). This gecko is nearly always associated with human habitation. Only one series of specimens was collected away from dwellings in an erect rotten tree trunk adjacent to a pasture.

Lipinia noctua (moth skink). In Rotuma, this skink was found only in forested and arboreal situations, e.g., palm axils, beneath bark or in termite galleries of dead trees.

Nactus pelagicus (Pacific slender-toed gecko). This gecko was also observed only in forested situations, during the day beneath surface detritus and at night on the sides of trees.

DISCUSSION

The geographical position and geotectonic history of Rotuma place this small cluster of islands at a faunistic boundary and lead to the question of whether the affinities of the Rotuman fish fauna are with the fauna of the Pacific plate, India-Australia plate, or with the main islands of Fiji. The main Fijian islands harbor a considerable number of endemic fish species. Rotuma, however, lies about 450 km north of the nearest reefs of these islands. Rotuma is also moderately isolated from the nearest neighboring island, Niulakita, Tuvalu (about 350 km to the northeast) on the Pacific lithospheric plate. There are numerous shallow, submarine banks that decrease the isolation of the island and provide stepping stones for dispersal: eastward to the Samoa Islands, westward to the Santa Cruz Islands; and southward to Fiji. These stepping stones were more closely connected during periods of glacial sea level lowering; Gibbons (1985:113) shows the distribution of land masses in the southwest Pacific during the last ice age, 18,000 years ago.

The geotectonic history of Rotuma is important for an understanding of its biota. Beginning in the middle Eocene (ca. 45 million years ago - MYBP), the convergence boundary where island arc volcanism was occurring between the India-Australia and Pacific plates included stretches along the

coast of New Guinea and along the then combined New Caledonia-Norfolk Ridge (Kroenke, 1984). In late Eocene-early Oligocene (ca. 38 MYBP), there was an extensive northeastern shift in position of the convergence boundary and the beginning of island-arc volcanism along the new boundary. Volcanic islands formed along the new boundary, and from late Eocene-early Oligocene to early Miocene (ca. 21 MYBP), the various linear island chains ranging from New Britain and New Ireland east to Fiji were established. The formation of these island chains trapped a large area of the Pacific plate between them and the margin of the India-Australia plate (Kroenke, 1984), effectively adding this portion of the Pacific plate to the India-Australia plate. The volcanic structure on which Rotuma rests appears to have formed initially in the Tertiary on the margin of the India-Australia lithospheric plate bordering the old Vitiaz Trench (Woodhall, in press, and references cited therein). Possibly this structure was formed along with the linear island chains between New Britain and Fiji.

In mid-Miocene, about 13.5 MYBP, the Samoan Islands began to form (Natland and Turner, 1985) on the Pacific Plate just east of Fiji. Stepping-stone islands quite possibly existed between Fiji and Samoa at this time. About 10 MYBP, the ocean floor (i.e., the trapped portion of the Pacific plate) behind the convergence zone began subducting the island arcs that had formed along the zone in the late Eocene-early Oligocene (Kroenke, 1984). Consequently, the contiguous, linear chains of island arcs (and Rotuma?) that were once well out on the Pacific plate (at least surrounded by Pacific plate) moved west and/or south, overriding the northeastern margin of the India-Australia plate.

About 8 to 6 MYBP the New Hebrides Arc began a clockwise rotation and the Fiji Arc began a counterclockwise rotation associated with ocean-floor spreading that formed the North Fiji Basin (Kroenke, 1984). The effects of these rotations were to: separate Fiji from the New Hebrides and increase the distance between the two; increase the distance between Fiji and the Samoa Islands; and increase the distance of both the New Hebrides and Fiji islands from Rotuma, which essentially remained in place, near the forearc side of the old Vitiaz Trench. From the late Pliocene to Pleistocene, renewed volcanism (probably a result of plate reorganization in the area) capped the original, older edifice of Rotuma with younger volcanics (Woodhall, in press).

A reasonably complete modern listing of the fishes of Fiji (excluding Rotuma) has not been published. Fowler's (1959) compilation is too incomplete and inaccurate for an analysis of faunistic affinities. Our knowledge of the

Fijian fish fauna derives from a large Fijian collection made in 1982 by VGS and associates and several other large Fijian collections made recently by others (e.g., Royal Ontario Museum). The number of fish families (and species) present at Fiji (Springer, 1982) is greater than is found at either Rotuma or Samoa. Many species of fishes were believed to be endemic to Fiji prior to our trip to Rotuma, and none of these were taken subsequently at Rotuma. Among these endemics are several species of blenniids (Smith-Vaniz, 1976; Springer, 1988a), all of which are replaced at Rotuma and Samoa by different, but closely related species; for example: Ecsenius fijiensis at Fiji, E. opsifrontalis at Rotuma, Samoa, and other Pacific plate localities; Ecsenius pardus at Fiji, E. portenoyi endemic to Rotuma and Samoa; Plagiotremus flavus at Fiji, P. laudandus at Rotuma, Samoa, and many other localities in the western and central Pacific; Meiacanthus ovalauensis at Fiji, M. atrodorsalis at Rotuma, Samoa, and many other localities in the western and central Pacific; Alticus sp. "A" at Fiji, Alticus sp. at Rotuma and Samoa.

The fishes of Samoa are reasonably well known. Wass (1984) reported 999 species from Samoa, approximately 40 of which were undescribed or unknown elsewhere. Wass believed that most of these 40 species probably occurred outside the Samoa area, and we concur. About 60 species (noted with an asterisk in Table 1) that we report from Rotuma, were not included in Wass' list. Perhaps one of these, Rotuma lewisi Springer (1988b), a gobioid, may prove to be a Rotuman endemic, but we believe that all but a few of these Rotuman species also occur at Samoa. The gobioid is a tiny, cryptic species, easily overlooked.

Of the species in our Rotuma list, most appear to be widely distributed and, therefore, provide little information on the biogeographic relationships of Rotuma. Those species that we consider informative for biogeographic purposes are: Alticus sp., Cirripectes variolosus*, Cirripectes fuscoguttatus*, Ecsenius opsifrontalis*, Ecsenius portenoyi**, Entomacrodus sealei*, Chalixodytes tauensis*, Paraploactis sp.**. Terapon theraps**, Amphiprion chrysopterus*. Of these ten species, six (marked with *) are widely distributed Pacific Plate endemics (Springer, 1982), three (**) are representative of higher taxonomic groups that are widely distributed in the Indo-west Pacific but absent from the Pacific plate except marginally, and the tenth, Alticus sp., was discussed above. Several, non-Pacific plate families are known marginally on the plate at Samoa, and at Fiji, but are unknown at Rotuma: Opistognathidae, Plotosidae, Triodontidae, and Uranoscopidae (a single species of each at Samoa). Only one family, Aploactinidae (represented by Paraploactis), is known from both Rotuma and Fiji, but

unknown at Samoa. The Rotuma fish fauna, therefore, shows its closest biogeographic relationships with Pacific Plate localities, and especially Samoa.

The terrestrial fauna of Rotuma show four biogeographic patterns. The first is the Polynesian gateway pattern (Robinson, 1975) with Rotuma lying in the string of islands between the Solomons and Samoa and serving as one of the stepping stones in species dispersal from northern Melanesia to western Polynesia. Among the reptiles, Emoia nigra best represents this pattern, occurring abundantly in the Solomons, Rotuma and Samoa, also occurring to the south in Fiji. A number of birds (e.g., Gallirallus philippensis, Lalage maculosa, Apolonis tabuensis) also show the Polynesian gateway pattern. A Polynesian distribution is shown by a few birds (e.g., Myzomela cardinalis) extending westward from Polynesia to Rotuma but not beyond. There are no reptiles with this pattern, and to the contrary, two species (Emoia concolor, Emoia trossula) link Rotuma more closely to Fiji than to Samoa. This linkage is reinforced by the absence of Emoia adspersus from Rotuma but its presence in Samoa, Futuna and Tuvalu, and the occurrence of Emoia murphyi and E. samoensis (sister species to the two aforementioned Rotuman-Fijian Emoia). The distribution of E. trossula is unlike that of any other Pacific reptile, occurring on Rotuma, widely in the Fiji islands, on some of the Tonga islands and on Rarotonga in the Cook islands. The final pattern is the existence of a Rotuman endemic, Lepidodactylus gardineri. The interspecific relationships of this gecko genus are not known. L. gardineri is clearly not related to the widespread parthenogenetic L. lugubris and is not especially similar to the endemic bisexual species of Tonga and Fiji. Bisexual Lepidodactylus are unknown for Tuvalu, Wallis/Futuna or Samoa.

Overall the geographic affinties of the Rotuman lizard fauna are with the Fijian fauna. The bird fauna combines elements of both the Samoan and Fijian faunas. The mammal fauna is too small and of widespread species to be useful in a biogeographic sense.

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