

Original Article

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Author for correspondence:

Lynne R. Parenti, E-mail: parentil@si.edu

Fishes collected during the 2017 MarineGEO assessment of Kāneʻohe Bay, Oʻahu, Hawaiʻi

Lynne R. Parenti¹ , Diane E. Pitassy¹ , Zeehan Jaafar^{1,2} ,
Kirill Vinnikov^{3,4,5} , Niamh E. Redmond⁶  and Kathleen S. Cole^{1,3} 

¹Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, PO Box 37012, MRC 159, Washington, DC 20013-7012, USA; ²Department of Biological Sciences, National University of Singapore, Singapore 117543, 14 Science Drive 4, Singapore; ³School of Life Sciences, University of Hawaiʻi at Mānoa, 2538 McCarthy Mall, Edmondson Hall 216, Honolulu, HI 96822, USA; ⁴Laboratory of Ecology and Evolutionary Biology of Aquatic Organisms, Far Eastern Federal University, 8 Sukhanova St., Vladivostok 690091, Russia; ⁵Laboratory of Genetics, National Scientific Center of Marine Biology, Vladivostok 690041, Russia and ⁶National Museum of Natural History, Smithsonian Institution DNA Barcode Network, Smithsonian Institution, PO Box 37012, MRC 183, Washington, DC 20013-7012, USA

Abstract

We report the results of a survey of the fishes of Kāneʻohe Bay, Oʻahu, conducted in 2017 as part of the Smithsonian Institution MarineGEO Hawaii bioassessment. We recorded 109 species in 43 families. The most speciose families were Acanthuridae (11 species), Gobiidae (11 species), Pomacentridae (10) and Chaetodontidae (9 species). Nine of the species that we collected are known or suspected to be introduced to the Hawaiian Islands. Specimens were identified, measured and photographed. All specimen vouchers were fixed in formalin and ultimately transferred to 75% ethanol for long-term storage. For nearly all species, we took multiple tissue samples from specimen vouchers prior to formalin-fixation; we preserved tissues in 95% ethanol and then stored them at -80°C . The 5'-end of the mitochondrial cytochrome oxidase I gene (mtCOI) was sequenced for 94 species to confirm their taxonomic identification. Using these barcode sequences, we also measured genetic distances between collected individuals and their conspecifics from other localities outside Hawaii to verify the hypothesis that Hawaiian populations of species broadly distributed throughout the Indo-Pacific may be genetically distinct. We present select case studies to demonstrate the potential for undiscovered endemism in the Hawaiian fish biota.

Introduction

Our knowledge of the fishes of the Hawaiian Islands is broad compared with that of many other subtropical and tropical islands of the central Pacific. Bruce Mundy's (2005) masterful *Checklist of the Fishes of the Hawaiian Archipelago* compiles taxonomic data and records for 1250 species of fishes, native and introduced, within the 200-nautical mile Exclusive Economic Zone. Modern illustrated taxonomic summaries of the ichthyofauna are led by Jack Randall's (2007) *Reef and Shore Fishes of the Hawaiian Islands* and his 2010 *Shore Fishes of Hawaii*. The well-illustrated guide of Hoover (2016) provides information on the fishes most commonly encountered by snorkellers and divers, and those of interest to aquarists throughout the Hawaiian Islands.

Even with these comprehensive treatments of the fishes of Hawaii, there have been few attempts at a thorough systematic inventory and assessment of the fish species of Kāneʻohe Bay, Oʻahu, illustrated in Figure 1, the largest sheltered body of water in the Hawaiian Islands (Jokiel, 1991). Since the late 1940s, Kāneʻohe Bay has been the site of the University of Hawaii's marine field station, now known as the Hawaiʻi Institute of Marine Biology (HIMB), on Moku o Loʻe, or Coconut Island, in the south-east portion of the Bay (Gordon & Helfrich, 1970). Then HIMB ichthyologist Wayne J. Baldwin compiled 'a list of 71 families and 211 species found in the waters of Kaneohe Bay and its tributaries from October 5, 1967 to the summer of 1970. A continuing study ...' as it was described by Gordon & Helfrich (1970: 12) and known by the working title 'Tentative List of Fishes of Kaneohe Bay and Tributaries Field Notes and Work List. unpubl[ished]'. When Baldwin (now deceased) 'left Hawaiʻi he discarded the list and there are no copies. Thus, there is no information on the species known to occur in the bay' (Greenfield, 2003: 47).

Two detailed technical reports provided baseline data on marine species occurrence and relative abundance in the Bay. Watson & Leis (1974) summarized data from a one-year study of fish eggs and larvae collected from two localities, the Sampan Channel, seen in Figure 1, and the south-east Bay. Coles *et al.* (2002) reported on a survey of the non-native marine biota and summarized literature records for native and non-native species reported from throughout the Bay including museum catalogue numbers of voucher specimens for many, but not all, species. The most recent comprehensive systematic study of fishes in Kāneʻohe Bay is that of Greenfield (2003) who surveyed small reef fishes from 1990 to 1995 using the ichthyocide rotenone. We compare the results of these studies with ours, below.

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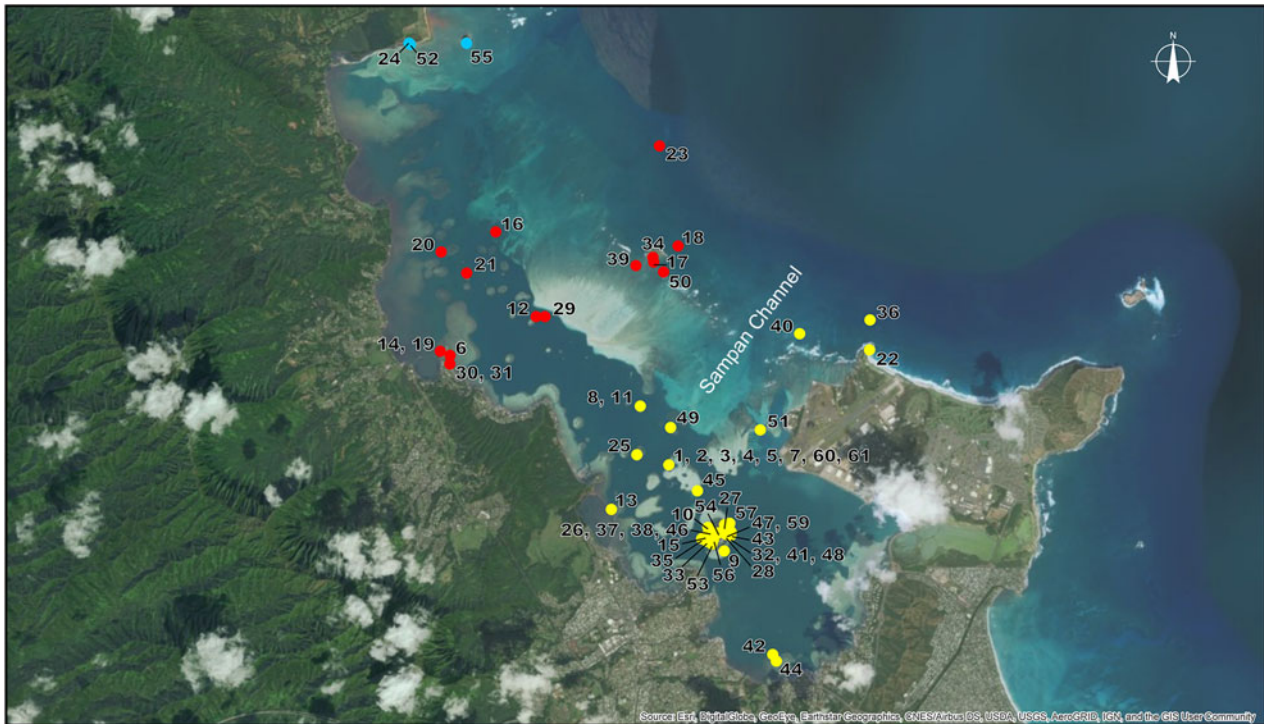


Fig. 1. Map of Kāneʻohe Bay with the 2017 MarineGEO fish collecting localities numbered 1 to 61, as described in text. Blue dots = North-west bay; Red dots = Central bay; Yellow dots = South-east bay.

In 2017, we conducted a survey of the fishes of Kāneʻohe Bay as part of a broader Smithsonian Institution MarineGEO Hawaiʻi bioassessment: *Ola I Ke Kai*, or Life Comes from the Sea. The Marine Global Earth Observatory (MarineGEO), directed by the Smithsonian's Tennenbaum Marine Observatories Network (TMON), is a global network dedicated to describing marine ecosystems and understanding how they function. Kāneʻohe Bay was chosen for intensive study because of the long history (~800 years) of use by Hawaiʻi's peoples living around the Bay (Devaney *et al.*, 1982; Bahr *et al.*, 2015). The Bay has a total surface area of about 41.4 km² at mean surface levels; it is ~4.3 km wide and 12.8 km long, in a south-west to south-east axis (Jokiel, 1991; Bahr *et al.*, 2015). Its average depth is 10 m, with its deepest point about 19 m (Bahr *et al.*, 2015). Native Hawaiians divided its surrounding lands into nine *ahupuaʻa* each of which spans the area from the uplands to the sea. They built walled fishponds throughout the Bay as a reliable source of food. Many of these have been filled in, but the fishpond of the Heʻeia *ahupuaʻa*, has been restored and is maintained by the Paepae o Heʻeia, a non-profit cultural and educational organization. The Heʻeia National Estuarine Research Reserve comprising 1385 acres from upland forests to coral reefs, was designated in 2017 to aid in restoration and recovery of natural habitat as well as historic and cultural sites. HIMB is the site of vigorous research and educational activities focused on the natural history of the Bay and its biota. Despite hundreds of years of stress from human activity, the fringing and patch coral reefs of the Bay remain among the most resilient in the world (Bahr *et al.*, 2015).

The Hawaiian shorefish fauna is notable for its high level of endemism, estimated at 25% (Randall, 2007). Systematists have recognized the uniqueness of this fish biota by describing populations as new species or subspecies. Here we use DNA barcode sequences from the 5'-end of the mitochondrial cytochrome oxidase I gene (mtCOI) to measure genetic distances between conspecifics from remote regions to verify the hypothesis that

Hawaiian populations of species broadly distributed throughout the Indo-Pacific may be genetically distinct from other populations throughout the species' range. We present case studies to demonstrate the potential for undiscovered endemism in the Hawaiian fish biota.

The objectives of this report are to: (1) compile an annotated systematic inventory of the fish species collected during the 2017 survey and document the occurrence of each species with an archived voucher specimen or a verified field observation, ethanol-preserved tissue sample, and a colour photograph of a freshly dead specimen; (2) to sequence the mitochondrial DNA barcode region (see below; Hebert *et al.*, 2003; Ward *et al.*, 2005) of as many species as possible to confirm their taxonomic identification; (3) to compare the barcode sequences of select species with those previously reported for other specimen vouchered collections from the Pacific; and (4) to develop a working list of the fish species that live in Kāneʻohe Bay.

Materials and methods

Fish specimen collection

We collected fish specimens using methods approved by the Hawaii Department of Land and Natural Resources (DLNR) under Special Activity Permit 2018–35. Ichthyocides such as rotenone or quinaldine were not approved for use, which limited our collection of cryptobenthic species. Sampling gear included dip nets, hand nets, cast nets, spears, and hook and line, on a pole or by hand, while wading, snorkelling or on scuba. We also collected by hand specimens stranded on the beach or in the mud during ebb tide. Other teams that were collecting algae and invertebrates during the 2017 MarineGEO survey also contributed fish specimens that they took incidentally. Specimens were collected and transported back to the laboratory at HIMB; a few were processed in the field. Live specimens were euthanized in buffered MS-222 (Argent Chemical Laboratories, Inc., Redmond, WA)

until gill movements ceased. A representative of nearly every species was photographed and one or more tissue samples (dorsal muscle, fin clip and/or eyeball) were dissected from the right side of the specimen and fixed in 95% ethanol overnight. The ethanol was changed the next day and the samples were frozen in cryovials and held at -80°C . The vials were placed in liquid nitrogen-charged dry shippers, transferred to and subsequently deposited in the Smithsonian's National Museum of Natural History (NMNH) Biorepository. Voucher specimens were fixed in 10% formalin following dissection and transported to the NMNH where they were transferred to 75% ethanol for long-term storage. Randall's (2007, 2010) volumes served as general guides for the morphological identification of specimens. Specimens we identified only to genus were too small to identify morphologically to species with confidence and the mtCOI barcode sequences were insufficient to resolve their identification further (see below). Additional publications used for identification are cited in the Remarks sections for each family or species. Data for all specimens are available from the online catalogue of the Division of Fishes: <http://collections.mnh.si.edu/search/fishes/>. Catalogue numbers for the Kāneʻohe Bay specimens are preceded by the abbreviation USNM (former United States National Museum). Catalogue numbers for comparative material from French Polynesia are preceded by the abbreviation MNHN (Muséum national d'Histoire naturelle, Paris). Higher classification follows Mundy (2005) and/or Fricke *et al.* (2019). Family-group names follow van der Laan *et al.* (2014).

DNA barcode

DNA extraction, amplification and sequencing were performed in the Laboratories of Analytical Biology (LAB), NMNH. Total genomic DNA was extracted from ethanol-fixed tissue samples using the AutoGenPrep 965 high-throughput DNA extractor (AutoGen) using the manufacturer's instructions for animal tissue extraction. This included two ethanol wash steps and final elution in 100 μl of AutoGen R9 reagent solution. A 655 bp region at the 5'-end of cytochrome oxidase-*c* subunit I (mtCOI) was amplified using the Fish-BCL/Fish-HCL primer set (Baldwin *et al.*, 2009). Polymerase chain reaction (PCR) was carried out in 10 μl reactions for each sample. Two PCR approaches were employed, utilizing different *Taq* polymerases and thermocycling conditions. Method #1 used a GoTaq[®] Mastermix (2X; Promega, Madison, WI), and each 10 μl sample reaction comprised the following: 5 μl of GoTaq[®] Mastermix, 3.15 μl of sterile water, 0.3 μl each of forward and reverse primers (10 mM concentration), 0.25 μl BSA (New England Biolabs, 20 mg ml⁻¹) and 1 μl of template DNA. The PCR thermocycling protocol consisted of the following steps: initial denaturation at 95°C for 5 min; 34 cycles of 45 s at 95°C, 45 s at 50°C and 60 s at 72°C; and the final extension at 72°C for 5 min. Method #2 used BIOLASE DNA polymerase (Bioline USA Inc., Taunton, MA) and each 10 μl sample reaction comprised the following: 0.1 μl BIOLASE polymerase (5 units μl^{-1}), 6.4 μl of sterile water, 1 μl of 10 \times reaction buffer (Bioline), 0.3 μl of each forward and reverse primers (10 mM concentration), 0.5 μl of dNTPs (10 mM, Bioline), 0.4 μl magnesium chloride (50 mM, Bioline) and 1 μl of template DNA. The PCR thermocycling protocol consisted of the following steps: initial denaturation at 95°C for 5 min; 35 cycles of 30 s at 95°C, 30 s at 52°C and 45 s at 72°C; and the final extension at 72°C for 7 min. PCR products were visualized using 1.5% agarose gel electrophoresis and purified with USB ExoSAP-IT following the manufacturer's protocol (Affymetrix, Santa Clara, CA). Purified PCR products were sequenced using a 3730xl DNA analyser (Applied Biosystems, Inc., Waltham, MA). Geneious v9 and v11 (Biomatters Ltd, Auckland, New Zealand) were used for sequence

management and quality control. Forward and reverse raw traces were assembled into contigs using the 'De Novo Assemble' function in the software, where primers and poor quality 3'- and 5'-ends were automatically trimmed. Barcode sequences of selected species with widespread distribution were aligned in MAFFT v7.4 (Katoh & Standley, 2013) using the default parameters against the mtCOI datasets obtained from the NCBI GenBank (Benson *et al.*, 2017). Using the BLASTn search algorithm (Altschul *et al.*, 1990), we revealed sequences of conspecific individuals collected at different localities outside Hawaii and measured their uncorrected genetic distances (p-distances) from our samples representing Hawaiian populations with the *dist.seqs* module in mothur v1.43 (Schloss *et al.*, 2009). All mtCOI sequences produced in the current study were uploaded to the NCBI GenBank (Supplementary material T1) and may be found in the NCBI BioProject PRJNA437657. All data are also included in the public BOLD project KANB. We also compared sequences with those in BOLD (The Barcode of Life Data System; Ratnasingham & Hebert, 2007) to confirm species identification.

Collecting localities

Here we report our collecting localities in one of three general sectors that correspond to the divisions of Kāneʻohe Bay based on circulation patterns in the lagoon and the relative degree of oceanic influence: south-east, central and north-west (Bahr *et al.*, 2015). We surveyed a variety of habitats throughout the Bay with a concentration in the south-east sector near our laboratory facilities at HIMB, as illustrated in Figure 2. Each locality is mapped in Figure 1. Time of collection was not recorded for specimens received from other field teams.

South-east Kāneʻohe Bay

Station LRP 17-1

Coconut Is., sandflat fore reef beach, 21°26'38.5"N 157°47'47.2"W. Collection depth 0.3–1 m. Coarse sand, coral bommies, reef front. 1 May 2017. 1015–1115 h. Method: dip nets. Collectors: L.R. Parenti, C. Lager and V. Carter.

Station LRP 17-2

Coconut Is., sandflat fore reef beach, 21°26'38.5"N 157°47'47.2"W. Collection depth 0.3–1 m. Coarse sand, coral bommies, reef front. 2 May 2017. 1015–1115 h. Method: dip nets. Collectors: L.R. Parenti, C. Lager and M. Henley.

Station LRP 17-3

Coconut Is., sandflat fore reef beach, 21°26'38.5"N 157°47'47.2"W. Collection depth 0.3–1 m. Coarse sand, coral bommies, reef front. 4 May 2017. 1015–1115 h. Method: dip nets. Collectors: C. Lager, M. Henley and L.R. Parenti.

Station LRP 17-4

Coconut Is., sandflat fore reef beach, 21°26'38.5"N 157°47'47.2"W. Collection depth 0.3–1 m. Coarse sand, coral bommies, reef front. 10 May 2017. 1015–1115 h. Method: dip nets. Collectors: M. Henley and L.R. Parenti.

Station LRP 17-5

Coconut Is., sandflat fore reef beach, 21°26'38.5"N 157°47'47.2"W. Collection depth 0.3–1 m. Coarse sand, coral bommies, reef front. 15 May 2017. 1015–1115 h. Method: dip nets. Collectors: M. Henley and L. R. Parenti.

Station LRP 17-7

Coconut Is., sandflat fore reef beach. 21°26'38.5"N 157°47'47.2"W. Collection depth: 0–5 m. Coarse sand, coral bommies, reef front. 22 May 2017. 1230–1400 h. Method: dip nets and hand spear. Collectors: L.R. Parenti, K. Cole, Z. Jaafar and D.E. Pitassy.

Station LRP 17-8



Fig. 2. Select localities throughout Kane'ohe Bay. (A) View of the bay looking north from Laenani Beach. The small island to the right of the Ko'olau mountain range is Mokoli'i (Chinaman's Hat). Photo by L.R. Parenti. (B) Exposed lava rock tidepools on Kapapa Island. Photo by D.E. Pitassy. (C) Laenani Beach looking north. Photo by L.R. Parenti. (D) Wall of the He'eia fishpond; enclosed fishpond waters are to the left of the wall, open bay to the right. Photo by Z. Jaafar. (E) Moku o Lo'e, or Coconut Island, home of the Hawai'i Institute of Marine Biology. Photo by L.R. Parenti. (F) The Ko'olau mountain range looking north at Kaha'u'u. Photo by L.R. Parenti.

Patch reef 14. $21^{\circ}27'11''\text{N}$ $157^{\circ}48'4''\text{W}$. Collection depth: 1–2 m. Coral rubble. 22 May 2017. Method: by hand. Collector: G. Pauley. Station LRP 17–9

Coconut Is., fringing reef off southern portion of island. $21^{\circ}25'51''\text{N}$ $157^{\circ}47'14.7''\text{W}$. Collection depth: 0–1 m. Inner fringing reef flat with coarse sand and rubble. 23 May 2017. 0815–1115 h. Method: dip nets while snorkelling. Collectors: Z. Jaafar, D.E. Pitassy, J.P. Daly and K. Vinnikov. Station LRP 17–10

Coconut Is., west side, coral community near mangroves. $21^{\circ}26'41''\text{N}$ $157^{\circ}47'24.3''\text{W}$. Collection depth: 0–5 m. Coral, silty bottom. 23 May 2017. 1045–1115 h. Method: dip nets while snorkelling. Collector: M. Henley. Station LRP 17–11

Patch reef 14, windward side. $21^{\circ}27'11''\text{N}$ $157^{\circ}48'4''\text{W}$. Collection depth: 1–12 m. 22 May 2017. Method: scuba diving. Collector: G. Pauley. Station LRP 17–13

He'eia fishpond. $21^{\circ}26'14.0''\text{N}$ $157^{\circ}48'21.1''\text{W}$. Fishpond, mud bottom with emergent vegetation. 23 May 2017. 1000–1500 h.

Methods: hook and line, cast net, dip nets. Collectors: H. Kawelo, L.K.C. Morgan, K. Kotubetey, K. Bishop, K. Piiohia, K. Pizarro, T.S. Ramoy, L.R. Parenti, J.P. Daly, K. Vinnikov, Z. Jaafar, K. Cole and D.E. Pitassy. Station LRP 17–15

Coconut Is., lagoon in front of Lanai suites (HIMB visiting scientist quarters). $21^{\circ}25'59.0''\text{N}$ $157^{\circ}47'25.8''\text{W}$. Collection depth: 0–0.3 m. 25 May 2017. Method: dip net. Collector: D. Gross. Station LRP 17–22

Marine Corps Base Hawaii, Pyramid Beach near pyramid at the water line at low tide. $21^{\circ}27'41.5''\text{N}$ $157^{\circ}45'49.0''\text{W}$. Collection depth: 0–0.3 m. Intertidal sediment. 26 May 2017. 0855 h. Method: sediment scooped into one-gallon, resealable plastic bag. Collector: J.L. Norenburg. Station LRP 17–25

Patch reef 9. $21^{\circ}26'44.2''\text{N}$ $157^{\circ}48'6''\text{W}$. Coral. Collection depth: 3 m. 27 May 2017. Method: Autonomous Reef Monitoring Structure. Collector: A. Anand. Station LRP 17–26

Coconut Is., leeward side. 21°26'1.64"N 157°47'23"W. Collection depth: 1–4 m. 28 May 2017. 1200–1330 h. Method: hand spear while snorkelling. Collectors: J. Zill and F. Carvalho. Station LRP 17–27

Coconut Is., windward side. 21°26'4.40"N 157°47'14.51"W. Collection depth: 1–4 m. 28 May 2017. 1400–1800 h. Method: hand spear while snorkelling. Collectors: J. Zill and F. Carvalho. Station LRP 17–28

Coconut Is., near shark pen. 21°25'59.0"N 157°47'13.6"W. Collection depth: 0–1.5 m. 28 May 2017. 2130 h. Method: hand spear while snorkelling. Collector: D. Gross. Station LRP 17–32

Coconut Is., southern end, off Point Lab. 21°25'58.4"N 157°47'10.8"W. Collection depth: 0–5 m. 29 May 2017. 0950–1245 h. Method: hand spear while scuba diving. Collector: D. Gross. Station LRP 17–33

Coconut Is., off Point Lab and Lighthouse. 21°25'56.4"N -157°47'25"W. Collection depth: 0–3 m. 29 May 2017. 1000–1600 h. Method: hand spear while scuba diving. Collector: L. Weaver. Station LRP 17–35

Patch reef 1. 21°25'57.8"N 157°47'28"W. Collection depth: 3 m. Coral. 30 May 2017. Method: Autonomous Reef Monitoring Structure. Collector: M. Henley. Station LRP 17–36

Black Rock Point near Marine Corps Base Hawaii. 21°27'58"N 157°45'48.7"W. Collection depth: 12–14 m. 30 May 2017. 1445 h. Method: hand spear while scuba diving. Collectors: L. Weaver and D. Uyeno. Station LRP 17–37

Coconut Is., leeward side, sand flat in front of Lanai suites (HIMB visiting scientist quarters). 21°26'2"N 157°47'23"W. Collection depth: 0–1 m. Sandy silt flat. 30 May 2017. Method: sand sieve. Collector: G. Pauley. Station LRP 17–38

Coconut Is., leeward side, sand flat in front of Lanai suites (HIMB visiting scientist quarters). 21°26'2"N 157°47'23"W. Collection depth: 0–1 m. Sandy silt flat. 30 May 2017. Method: yabby pump (used to extract crayfish or shrimp from burrows within the substrate). Collector: G. Pauley. Station LRP 17–40

Kekepa Is., off windward side. 21°27'49.8"N 157°46'30.5"W. Collection depth: 15–25 m. Coral reef and sand. 31 May 2017. 1030–1130 h. Method: hand spear while scuba diving. Collectors: D. Gross and L. Weaver. Station LRP 17–41

Coconut Is., southern end, off Point Lab. 21°25'58.4"N 157°47'10.8"W. Collection depth: 0–5 m. 31 May 2017. 0800–0900 h. Method: hook and line. Collector: D. Gross. Station LRP 17–42

South-east bay fringing reef. 21°24'53.9"N 157°46'46.3"W. Coral. Collection depth: 3 m. 31 May 2017. Method: Autonomous Reef Monitoring Structure. Collector: M. Henley. Station LRP 17–43

Coconut Is., windward side near Point Lab. 21°26'0.38"N 157°47'10.64"W. Collection depth: 1–4 m. 29 May 2017. 1100–1230 h. Method: hand spear while snorkelling. Collectors: J. Zill and F. Carvalho. Station LRP 17–44

South-east bay fringing reef. 21°24'50.3"N 157°46'44.2"W. Collection depth: 0.5–1 m. 29 May 2017. 1330–1430 h. Method: hand spear while snorkelling. Collectors: J. Zill and F. Carvalho. Station LRP 17–45

Near the Sunken City. 21°26'24.25"N 157°47'30.39"W. Collection depth: 1–4 m. 29 May 2017. 1500–1700 h. Method: hand spear while snorkelling. Collectors: J. Zill and F. Carvalho. Station LRP 17–46

Coconut Is., leeward side, sand flat in front of Lanai suites (HIMB visiting scientist quarters). 21°26'2.0"N 157°47'23.0"W. Collection depth: 0–1 m. 31 May 2017. Method: yabby pump (used to extract crayfish or shrimp from burrows within the substrate). Collectors: G. Pauley and macroinvertebrates team. Station LRP 17–47

Coconut Is. 21°25'59.8"N 157°47'13.1"W. Collection depth: 0–3 m. 30 May 2017. Method: hand spear. Collector: L. Weaver. Station LRP 17–48

Coconut Is., southern end, off Point Lab. 21°25'58.4"N 157°47'10.8"W. Collection depth: 0–5 m. 31 May 2017. 1815–1845 h. Method: hook and line. Collector: D. Gross. Station LRP 17–49

Patch reef 11. 21°26'59.2"N 157°47'46.2"W. 29 May 2017. Collection depth: 3 m. Method: Autonomous Reef Monitoring Structure. Collector: M. Henley. Station LRP 17–51

Near Marine Corps Base Hawaii. 21°26'57.8"N 157°46'53.4"W. 30 May 2017. Collection depth: 5 m. Method: by hand while scuba diving. Collector: B. Brooks. Station LRP 17–53

Coconut Is., shuttle boat lagoon. 21°25'54.9"N 157°47'21.9"W. Collection depth: 0–5 m. 31 May 2017. 1740 h. Method: handline. Collector: D. Gross. Station LRP 17–54

Coconut Is. (no coordinates reported). 31 May 2017. Method: hand spear while snorkelling. Collector: D. Gross. Station LRP 17–56

Coconut Is., leeward side, mangrove channel and sandflat near boat launch. 21°25'57.3"N 157°47'21"W. Collection depth: 0–2 m. 31 May 2017. Method: hand spear and dip net while snorkelling. Collector: L. Weaver. Station LRP 17–57

Coconut Is., windward side, off edge of fringing reef. 21°26'6.3"N 157°47'11.4"W. Collection depth: 0–3 m. 1 June 2017. Method: hand spear while snorkelling. Collector: L. Weaver. Station LRP 17–58

South-east Kāne'ohe Bay. 31 May 2017. Collector: Miscellaneous material from the macroinvertebrates team or Autonomous Reef Monitoring System team. Station LRP 17–59

Near Coconut Is. 21°25'59.8"N 157°47'13.1"W. April 2017. Collector: HIMB Shark Lab. Station LRP 17–60

Coconut Is., windward side, sandflat, fore reef beach. 21°26'38.5"N 157°47'47.2"W. Collection depth: 0.3–1 m. Sandy beach with coral bommies. 19 June 2017. 0830–1030 h. Method: dip nets while snorkelling. Collectors: M. Henley and C. Lager. Station LRP 17–61

Coconut Is., windward side, sandflat, fore reef beach. 21°26'38.5"N 157°47'47.2"W. Collection depth: 0.3–1 m. Sandy beach with coral bommies. 22 June 2017. 0845–0930 h. Method: dip nets while snorkelling. Collectors: C. Lager and N. Zuchowicz. Central Kāne'ohe Bay. Station LRP 17–62

Kahalu'u, Laenani Beach. 21°27'38.7"N 157°49'55.9"W. Collection depth 0 m. Sandy beach with debris. 17 May 2017. 1130 h. Method: by hand (freshly dead specimen on beach). Collectors: L.R. Parenti and T.S. Ramoy. Station LRP 17–12

Patch reef 26. 21°28'0.0"N 157°49'5.2"W. Collection depth: 4–5 m. Patch reef. 22 May 2017. Methods: by hand while scuba diving. Collector: D. Gross. Station LRP 17–14

Kahalu'u, Lihikai Dock at the end of Lihikai Drive. 21°27'41.0"N 157°50'1.6"W. Collection depth: at surface, 0 m.

24 May 2017. 0615–0715 h. Method: dip nets. Collector: L.R. Parenti.

Station LRP 17–16

Sandbar near patch reef 14. 21°28′46.8″N 157°49′28.9″W. Collection depth: 4–7 m. 23 May 2017. 0842–0958 h. Method: By hand while scuba diving. Collector: D. Gross.

Station LRP 17–17

South of Kapapa Is. 21°28′30.0″N 157°47′56.0″W. Collection depth: 1–2 m. Limestone bench, patchy coral and rubble. 25 May 2017. Method: dip nets while snorkelling. Collectors: G. Pauley and macroinvertebrates team.

Station LRP 17–18

Kapapa Is., north-east side. 21°28′38.9″N 157°47′41.6″W. Collection depth: 4–6 m. Fore reef. 25 May 2017. Method: dip-nets on scuba. Collectors: G. Pauley and macroinvertebrates team.

Station LRP 17–19

Kahalu‘u, Lihikai Dock at the end of Lihikai Drive. 21°27′41.0″N 157°50′1.6″W. Collection depth: 0–1 m. Inlet with mangroves and sponge-encrusted pontoon. 26 May 2017. 1000–1230 h. Method: dip nets, hand net, and by hand. Collectors: L.R. Parenti, Z. Jaafar, D.E. Pitassy, and H. Bashaw.

Station LRP 17–20

Patch reef 44. 21°28′35.8″N 157°50′1.0″W. 26 May 2017. Collection depth: 3 m. Method: Autonomous Reef Monitoring Structure. Collector: M. Timmers.

Station LRP 17–21

Patch reef 38. 21°28′24.1″N 157°49′46.0″W. Collection depth: 2–4 m. 27 May 2017. 1030–1200 h. Method: hand spear while scuba diving. Collectors: Z. Jaafar and E. Nalley.

Station LRP 17–23

Outer reef slope. 21°29′34.2″N 157°47′52.5″W. Collection depth: 10.7 m. Outer reef slope, subtidal sand. 28 May 2017. 1100 h. Method: collection bag while scuba diving. Collectors: F. Goetz and K. Jorger.

Station LRP 17–29

Patch Reef 29, south-west side. 21°28′00.0″N 157°49′00.0″W. Collection depth: 1–2 m. 27 May 2017. Method: by hand. Collector: G. Pauley.

Station LRP 17–30

Kahalu‘u, just north of Laenani Beach park. 21°27′34″N 157°49′56″W. Collection depth: 0–0.3 m. Tidal pools in exposed basalt, smooth lava rock formation and sandy shore. 28 May 2017. 1200 h. Method: by hand. Collector: T.S. Ramoy.

Station LRP 17–31

Kahalu‘u, just north of Laenani Beach park. 21°27′34″N 157°49′56″W. Collection depth: 0–0.3 m. Tidal pools in exposed basalt, smooth lava rock formation and sandy shore. 29 May 2017. 1010–1130 h. Methods: dip nets and by hand. Collectors: L. R. Parenti and T. S. Ramoy.

Station LRP 17–34

Kapapa Is., leeward rocky reef flat. 21°28′32.7″N 157°47′56.4″W. Collection depth: 0–1.5 m. Rocky reef flat, windward tidal surge area and tide pools. 30 May 2017. 0930–1115 h. Methods: Spear, dip nets and by hand. Collectors: L.R. Parenti, Z. Jaafar, D.E. Pitassy and D. Gross.

Station LRP 17–39

Kapapa Is., leeward side 21°28′28.1″N 157°48′6.4″W. Collection depth: 2–2.5 m. 31 May 2017. Method: by hand. Collector: G. Pauley.

Station LRP 17–50

Kapapa Is., leeward side. 21°28′24.6″N 157°47′50.2″W. Rubble field of barrier reef. 29 May 2017. Method: hand spear while scuba diving. Collector: D. Uyeno.

North-west Kāne‘ohe Bay

Station LRP 17–24

Kualoa Regional Park. 21°30′31″N 157°50′19.8″W. Collection depth: 0–0.3 m. Rocky intertidal area off sandy beach. 28 May 2017. 1000–1200 h. Method: dip nets. Collectors: L.R. Parenti, Z. Jaafar and D.E. Pitassy.

Station LRP 17–52

Kualoa Regional Park. 21°30′30.3″N 157°50′19.0″W. Sandy shoreline and rocky intertidal. Collection depth: 0–0.5 m. 1 June 2017. Method: dip nets while snorkelling. Collectors: L.R. Parenti, Z. Jaafar and D.E. Pitassy.

Station LRP 17–55

South of Mokoli‘i Is. (Chinaman’s Hat). 21°30′31″N 157°49′46″W. Collection depth: 0–4 m. 31 May 2017. Method: hand spear while scuba diving. Collector: L. Weaver.

Results

We recorded 109 species in 43 families from Kāne‘ohe Bay (Table 1). The most speciose families were Acanthuridae (11 species), Gobiidae (11 species), Pomacentridae (10 species) and Chaetodontidae (9 species). Nine of the species that we collected are known or suspected to be introduced to the Hawaiian Islands: *Herklotsichthys quadrimaculatus*, *Osteomugil engeli*, *Gambusia affinis*, *Poecilia* sp., *Omobranchus obliquus*, *Parablennius thysanurus*, *Sarotherodon melanothron*, *Tilapia* sp. and *Lutjanus fulvus*. Two species, *Bathytoshia lata* and *Novaculichthys taeniourus*, were seen but not taken. Sequences of mtCOI gene were successfully produced for a total of 151 samples, representing 94 species. The sequence length ranged from 547 to 658 bp, with an average length of 650 bp.

Systematics

Class Chondrichthyes Huxley, 1880

Order Carcharhiniformes Compagno, 1977

Family Sphyrnidae Bonaparte, 1840

Sphyrna lewini (Griffith & Smith, 1834)

Remarks

Kāne‘ohe Bay is well documented as a breeding ground of the scalloped hammerhead (Clarke, 1971). We obtained one juvenile specimen as part of the 2017 survey. It was collected alive in April 2017 by the HIMB Shark Lab and frozen following its death in the lab’s shark tank. We received the frozen specimen on 2 June 2017 and thawed it sufficiently to take several tissue samples which we fixed in 95% ethanol and ultimately froze in liquid nitrogen. We fixed the specimen in formalin and transferred it to 75% ethanol.

Material

South-east bay: USNM 442494 (1).

Order Myliobatiformes Compagno, 1973

Family Dasyatidae Jordan & Gilbert, 1879

Bathytoshia lata (Garman, 1880)

Remarks

One adult was seen, but not taken, in the He‘eia fishpond on 24 May 2017. Classification of this species in the genus *Bathytoshia* follows Last *et al.* (2016a, 2016b).

Class Actinopterygii Klein, 1885

Division Teleostei Müller, 1845

Order Anguilliformes Berg, 1943

Family Congridae Kaup, 1856

Ariosoma bowersi (Jenkins, 1903)

Table 1. List of species collected in a classification

CLASS CHONDRICHTHYES
Order Carcharhiniformes
Family Sphyrnidae
<i>Sphyrna lewini</i> (Griffith & Smith, 1834)
Order Myliobatiformes
Family Dasyatidae
<i>Bathytoshia lata</i> (Garman, 1880)
CLASS ACTINOPTERYGII
Division Teleostei
Order Anguilliformes
Family Congridae
<i>Ariosoma bowersi</i> (Jenkins, 1903)
Family Muraenidae
<i>Echidna nebulosa</i> (Ahl, 1789)
<i>Gymnothorax eurostus</i> (Abbott, 1860)
<i>Gymnothorax undulatus</i> (Lacépède, 1803)
Order Clupeiformes
Family Clupeidae
* <i>Herklotsichthys quadrimaculatus</i> (Rüppell, 1837)
Order Aulopiformes
Family Synodontidae
<i>Saurida gracilis</i> (Quoy & Gaimard, 1824)
<i>Saurida nebulosa</i> Valenciennes in Cuvier & Valenciennes, 1850
Order Mugiliformes
Family Mugilidae
<i>Mugil cephalus</i> Linnaeus, 1758
* <i>Osteomugil engeli</i> (Bleeker, 1858)
Order Atheriniformes
Family Atherinidae
<i>Atherinomorus insularum</i> (Jordan & Evermann, 1903)
Order Beloniformes
Family Belonidae
<i>Tylosurus crocodilus</i> (Péron & Lesueur, 1821)
Order Cyprinodontiformes
Family Poeciliidae
* <i>Gambusia affinis</i> (Baird & Girard, 1853)
* <i>Poecilia</i> sp.
Order Holocentriformes
Family Holocentridae
<i>Neoniphon sammara</i> (Forsskål, 1775)
Order Syngnathiformes
Family Aulostomidae
<i>Aulostomus chinensis</i> (Linnaeus, 1766)
Family Fistulariidae
<i>Fistularia commersonii</i> Rüppell, 1838
Family Syngnathidae

(Continued)

Table 1. (Continued.)

<i>Hippocampus kuda</i> Bleeker, 1852
Order Scorpaeniformes
Family Scorpaenidae
<i>Dendrochirus barberi</i> (Steindachner, 1900)
<i>Sebastapistes coniota</i> Jenkins, 1903
<i>Sebastapistes fowleri</i> (Pietschmann, 1934)
<i>Scorpaenopsis cacopsis</i> Jenkins, 1901
<i>Taenianotus triacanthus</i> Lacépède, 1802
Order Gobiiformes
Family Gobiidae
<i>Asterropteryx semipunctata</i> Rüppell, 1830
<i>Bathygobius</i> sp.
<i>Bathygobius coalitus</i> (Bennett, 1832)
<i>Bathygobius cocosensis</i> (Bleeker, 1854)
<i>Eviota epiphanes</i> Jenkins, 1903
<i>Eviota susanae</i> Greenfield & Randall, 1999
<i>Gnatholepis anjerensis</i> (Bleeker, 1851)
<i>Pleurosicya</i> sp.
<i>Priolepis eugenius</i> (Jordan & Evermann, 1903)
<i>Priolepis farcimen</i> (Jordan & Evermann, 1903)
<i>Psilogobius mainlandi</i> Baldwin, 1972
Family Kraemeriidae
<i>Kraemia bryani</i> Schultz, 1941
Order Blenniiformes
Family Blenniidae
<i>Blenniella gibbifrons</i> (Quoy & Gaimard, 1824)
<i>Entomacrodus strasburgi</i> Springer, 1967
* <i>Omobranchus obliquus</i> (Garman, 1903)
* <i>Parablennius thysanius</i> (Jordan & Seale, 1907)
Order Perciformes
Family Acanthuridae
<i>Acanthurus</i> sp.
<i>Acanthurus blochii</i> Valenciennes, 1835
<i>Acanthurus guttatus</i> Forster in Bloch & Schneider, 1801
<i>Acanthurus leucopareius</i> (Jenkins, 1903)
<i>Acanthurus triostegus</i> (Linnaeus, 1758)
<i>Acanthurus xanthopterus</i> Valenciennes in Cuvier & Valenciennes, 1835
<i>Ctenochaetus strigosus</i> (Bennett, 1828)
<i>Naso lituratus</i> (Forster in Bloch & Schneider, 1801)
<i>Naso unicornis</i> (Forsskål, 1775)
<i>Zebrasoma flavescens</i> (Bennett, 1828)
<i>Zebrasoma veliferum</i> (Bloch, 1795)
Family Apogonidae
<i>Foa brachygramma</i> (Jenkins, 1903)
Family Carangidae
<i>Caranx ignobilis</i> (Forsskål, 1775)

(Continued)

Table 1. (Continued.)

<i>Caranx melampygus</i> Cuvier, 1833
<i>Gnathanodon speciosus</i> (Forsskål, 1775)
<i>Scomberoides lysan</i> (Forsskål, 1775)
Family Chaetodontidae
<i>Chaetodon</i> sp.
<i>Chaetodon auriga</i> Forsskål, 1775
<i>Chaetodon lunula</i> (Lacépède, 1802)
<i>Chaetodon lunulatus</i> Quoy & Gaimard, 1825
<i>Chaetodon multicinctus</i> Garrett, 1863
<i>Chaetodon ornatissimus</i> Cuvier in Cuvier & Valenciennes, 1831
<i>Chaetodon quadrimaculatus</i> Gray, 1831
<i>Chaetodon unimaculatus</i> Bloch, 1787
<i>Forcipiger flavissimus</i> Jordan & McGregor in Jordan & Evermann, 1898
Family Cichlidae
* <i>Sarotherodon melanotheron</i> Rüppell, 1852
* <i>Tilapia</i> sp.
Family Cirrhitidae
<i>Cirrhitus pinnulatus</i> (Forster in Bloch & Schneider, 1801)
Family Creediidae
<i>Crystallodytes cookei</i> Fowler, 1923
Family Kuhliidae
<i>Kuhlia xenura</i> (Jordan & Gilbert, 1882)
Family Kyphosidae
<i>Kyphosus hawaiiensis</i> Sakai & Nakabo, 2004
<i>Kyphosus vaigiensis</i> (Quoy & Gaimard, 1825)
Family Microcanthidae
<i>Microcanthus strigatus</i> (Cuvier, 1831)
Family Labridae
<i>Bodianus albotaeniatus</i> (Valenciennes in Cuvier & Valenciennes, 1839)
<i>Gomphosus varius</i> Lacépède, 1801
<i>Halichoeres ornatissimus</i> (Garrett, 1863)
<i>Novaculichthys taeniourus</i> (Lacépède, 1801)
<i>Oxycheilinus unifasciatus</i> (Streets, 1877)
<i>Thalassoma ballieui</i> (Vaillant & Sauvage, 1875)
<i>Thalassoma duperrey</i> (Quoy & Gaimard, 1824)
Family Lutjanidae
* <i>Lutjanus fulvus</i> (Bloch & Schneider, 1801)
Family Mullidae
<i>Mulloidichthys flavolineatus</i> (Lacépède, 1801)
<i>Parupeneus multifasciatus</i> (Quoy & Gaimard, 1825)
<i>Parupeneus porphyreus</i> (Jenkins, 1903)
Family Polynemidae
<i>Polydactylus sexfilis</i> (Valenciennes, 1831)
Family Pomacanthidae
<i>Centropyge potteri</i> (Jordan & Metz, 1912)
Family Pomacentridae

(Continued)

Table 1. (Continued.)

<i>Abudefduf</i> sp.
<i>Abudefduf abdominalis</i> (Quoy & Gaimard, 1825)
<i>Abudefduf sordidus</i> (Forsskål, 1775)
<i>Abudefduf vaigiensis</i> (Quoy & Gaimard, 1825)
<i>Chromis</i> sp.
<i>Chromis agilis</i> Smith, 1960
<i>Chromis hanui</i> Randall & Swerdloff, 1973
<i>Dascyllus albisella</i> Gill, 1862
<i>Plectroglyphidodon imparipennis</i> (Vaillant & Sauvage, 1875)
<i>Stegastes marginatus</i> (Jenkins, 1901)
Family Priacanthidae
<i>Heteropriacanthus carolinus</i> (Cuvier, 1829)
Family Scaridae
<i>Chlorurus spilurus</i> (Valenciennes, 1840)
<i>Scarus psittacus</i> Forsskål, 1775
Family Sphyrnidae
<i>Sphyrna barracuda</i> (Edwards, 1771)
Family Zanclidae
<i>Zanclus cornutus</i> (Linnaeus, 1758)
Order Tetraodontiformes
Family Balistidae
<i>Rhinecanthus rectangulus</i> (Bloch & Schneider, 1801)
<i>Sufflamen bursa</i> (Bloch & Schneider, 1801)
Family Diodontidae
<i>Diodon hystrix</i> Linnaeus, 1758
Family Monacanthidae
<i>Cantherhines sandwichiensis</i> (Quoy & Gaimard, 1824)
Family Ostraciidae
<i>Ostracion meleagris</i> Shaw in Shaw & Nodder, 1796
Family Tetraodontidae
<i>Arothron hispidus</i> (Linnaeus, 1758)
<i>Canthigaster amboinensis</i> (Bleeker, 1864)
<i>Canthigaster jactator</i> (Jenkins, 1901)

*Known or suspected introduced species.

Remarks

We collected one of our two specimens by hand; it was a larva stranded in the mud at low tide near the wall of the Kahalu'u fishpond. Mundy (2005: 139) lists this species as *Ariosoma marginatum* (Vaillant & Sauvage, 1875), a Hawaiian endemic. That name was pre-occupied by *Leptocephalus marginatus* Kaup, 1856 when it was placed in *Ariosoma* by Bertin (1935). *Leptocephalus marginatus* Kaup, 1856 is a synonym of *Ariosoma balearicum* (Delaroche, 1809), an Atlantic species. Therefore, the next available name for the Hawaiian species is *Ariosoma bowersi* (Jenkins, 1903) (DG Smith personal communication).

Material

Central bay: USNM 442311 (1); USNM 442312 (1).



Fig. 3. *Gymnothorax eurostus* (Abbott, 1860), family Muraenidae. USNM 442426. Photo by L.R. Parenti.

Family Muraenidae Rafinesque, 1815
Echidna nebulosa (Ahl, 1789)

Material

Central bay: USNM 442412 (1).

Gymnothorax eurostus (Abbott, 1860)

Figure 3

Remarks

We collected one individual, by hand, stranded on the beach at low tide.

Material

Central bay: USNM 442426 (1).

Gymnothorax undulatus (Lacépède, 1803)

Remarks

We collected one individual of this common moray eel. A second individual was seen and photographed outside the Kahalu'u fishpond in the central portion of the Bay on 5 April 2017, but not collected.

Material

Central bay: USNM 442319 (1).

Order Clupeiformes Goodrich, 1909

Family Clupeidae Cuvier, 1816

Herklotsichthys quadrimaculatus (Rüppell, 1837)

Remarks

The natural distribution of this species of herring is broadly throughout the Indo-Pacific from South Africa and the Red Sea to Japan, Australia and Samoa (Mundy, 2005: 149). It was introduced unintentionally to the Hawaiian Islands in 1972 (Mundy, 2005). We collected two specimens in the He'eia fishpond.

Material

South-east bay: USNM 442242 (1); USNM 442243 (1).

Order Aulopiformes Rosen, 1973

Family Synodontidae Gill, 1861

Note: Randall (2007) recognized three species in the genus *Saurida* from Hawaii: *S. flamma*, *S. gracilis* and *S. nebulosa*. Our specimens of *Saurida* lack the distinctive orange colouration on the mouth that is diagnostic of *S. flamma* and keyed out to *S. gracilis* and *S. nebulosa*. *Saurida gracilis* differs from *S. nebulosa* by having relatively long pectoral-fin rays that extend past the point of insertion of the pelvic fins as opposed to reaching the point of insertion of the pelvic fins, teeth on the vomer as opposed to no vomerine teeth, and three as opposed to two rows of palatine teeth, among other characters. We sequenced the mtCOI DNA barcode (see below) of our specimens to confirm

these species identifications.

Saurida gracilis (Quoy & Gaimard, 1824)

Material

South-east bay: USNM 442221 (1); USNM 442397 (1); USNM 442485 (1); USNM 442475 (1).

Saurida nebulosa Valenciennes in Cuvier & Valenciennes, 1850

Material

Central bay: USNM 442308 (1); USNM 442427 (1). North-west bay: USNM 442473 (1), USNM 442471 (1).

Order Mugiliformes Berg, 1940

Family Mugilidae Jarocki, 1822

Mugil cephalus Linnaeus, 1758

Material

South-east bay: USNM 442273 (1); USNM 442275 (1); USNM 442277 (1); USNM 442279 (1); USNM 442281 (1); USNM 441983 (2); USNM 442163 (5).

Osteomugil engeli (Bleeker, 1858)

Remarks

This species of mullet was introduced from the Marquesas Islands to O'ahu in 1955 where it is now well established (Mundy, 2005). It has also been classified as *Moolgarda engeli* and *Valamugil engeli*; we follow the recent classifications of Durand *et al.* (2012), Schemmel *et al.* (2019) and Fricke *et al.* (2019).

Material

South-east bay: USNM 442245 (1); USNM 442247 (1); USNM 442249 (1); USNM 442282 (1); USNM 442284 (1); USNM 442286 (1); USNM 442288 (1).

Order Atheriniformes Rosen, 1964

Family Atherinidae Risso, 1827

Atherinomorus insularum (Jordan & Evermann, 1903)

Material

South-east bay: USNM 442290 (1); USNM 442292 (1); USNM 442162 (5); USNM 442482 (1). Central bay: USNM 442309 (1).

Order Beloniformes Berg, 1937

Family Belontiidae Bonaparte, 1835

Tylosurus crocodilus (Péron & Lesueur, 1821)

Material

North-west bay: USNM 442362 (1). Unspecified locality in Kane'ohe Bay: USNM 442493 (1).

Order Cyprinodontiformes Berg, 1940

Family Poeciliidae Bonaparte, 1831

Note: All species of poeciliids in the Hawaiian Islands are introduced. Our specimens are from the brackish He'eia fishpond.

Gambusia affinis (Baird & Girard, 1853)

Material

South-east bay: USNM 441930 (1).

Poecilia sp.



Fig. 4. *Hippocampus kuda* Bleeker, 1852, family Syngnathidae. USNM 442322. Photo by D.E. Pitassy.

Remarks

Our specimen is morphologically comparable to species in the closely related *Poecilia sphenops* and *Poecilia mexicana* complexes (see Alda *et al.*, 2013), but we cannot identify it to species with confidence. Mundy (2005) concluded that Hawaii has an exotic hybrid poeciliid of unknown origin. Our specimen may be a hybrid. It is a female that clusters with other specimens identified as *Poecilia mexicana* Steindachner, 1863, along with *Poecilia gillii* (Kner, 1863) and *Poecilia orri* Fowler, 1943, in a Neighbour-joining tree obtained from a general BLAST against the BOLD database. These are all members of the *Poecilia mexicana* complex of Alda *et al.* (2013). Additional specimens of this taxon are needed to confirm its identification to species.

Material

South-east bay: USNM 442278 (1).

Order Holocentriformes Betancur-R. *et al.* 2014
Family Holocentridae Bonaparte, 1833
Neoniphon sammara (Forsskål, 1775)

Material

South-east bay: USNM 442370 (1); USNM 442478 (1); USNM 442483 (1).

Order Syngnathiformes Berg, 1940
Family Aulostomidae Rafinesque, 1815
Aulostomus chinensis (Linnaeus, 1766)

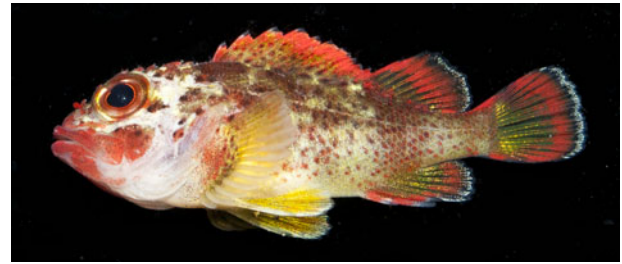


Fig. 5. *Sebastapistes coniora* Jenkins, 1903, family Scorpaenidae. USNM 442298. Photo by D.E. Pitassy.

Material

South-east bay: USNM 442387 (1); USNM 442439 (1).

Family Fistulariidae Stark, 1828
Fistularia commersonii Rüppell, 1838

Material

South-east bay: USNM 442207 (1).

Family Syngnathidae Bonaparte, 1831
Hippocampus kuda Bleeker, 1852

Figure 4

Remarks

Our single specimen of *H. kuda* in Figure 4 was collected by hand from among algae on exposed pilings at low tide outside the Kahalu'u fishpond.

Material

Central bay: USNM 442322 (1).

Order Scorpaeniformes Greenwood, Rosen Weitzman & Myers,
1966

Family Scorpaenidae Risso, 1827
Dendrochirus barberi (Steindachner, 1900)

Material

South-east bay: USNM 442423 (1); USNM 442266 (1). Central bay: USNM 442280 (1).

Sebastapistes coniora Jenkins, 1903
Figure 5

Remarks

Once reported as a Hawaiian Islands and Johnston Atoll endemic (Randall, 2007), this species is now known also from the Wake Atoll and New Caledonia (Fricke *et al.*, 2011). We report on its mtCOI DNA barcode, below. Our single specimen is illustrated in Figure 5.

Material

Central bay: USNM 442298 (1).

Sebastapistes fowleri (Pietschmann, 1934)

Material

Central bay: USNM 442383 (1).

Scorpaenopsis cacopsis Jenkins, 1901



Fig. 6. *Asterropteryx semipunctata* Rüppell, 1830, family Gobiidae. USNM 421677. Photo by Z. Jaafar.

Material

South-east bay: USNM 442452 (1).

Taenianotus triacanthus Lacépède, 1802

Material

Central bay: USNM 442240 (1).

Order Gobiiformes Günther, 1880

Family Gobiidae Cuvier, 1816

Note: Greenfield & Randall (2004) summarized the taxonomy of the marine gobies of Hawaii.

Asterropteryx semipunctata Rüppell, 1830

Figure 6

Remarks

This species was targeted for research on cryopreservation of fish spermatogonial cells because it is one of the most common species living in varied marine microhabitats around Coconut Island (Hagedorn *et al.*, 2018). We collected specimens for these studies beginning in 2013; here we report just those collected in 2017. We report on the mtCOI DNA barcode of this species, below. A representative adult male is illustrated in Figure 6.

Material

South-east bay: USNM 441795–441809 (15); USNM 441931 (1); USNM 441978 (6); USNM 441979 (6); USNM 441980 (5); USNM 441933 (1); USNM 442149 (12); USNM 442227–442232 (6); USNM 442151 (1); USNM 442153 (1); USNM 442158–442161 (4); USNM 442175–442205 (31). Central bay: USNM 442152 (1).

Bathygobius sp.

Material

South-east bay: USNM 441974 (1). Central bay: USNM 442156 (2).

Bathygobius coalitus (Bennett, 1832)

Material

South-east bay: USNM 442350 (1); Central bay: USNM 442419 (1); North-west bay: USNM 442363 (1).

Bathygobius cocosensis (Bleeker, 1854)

Material

South-east bay: USNM 441972 (1); USNM 441973 (1); USNM 442236 (1); USNM 442238 (1); USNM 442467 (1). Central bay: USNM 442146 (3); USNM 442170 (3); USNM 442350 (1); USNM 442351 (1); USNM 442352 (1); USNM 442353 (1);

USNM 442433 (1); USNM 442434 (1); USNM 442435 (1). Unspecified locality in Kane'ohē Bay: USNM 442492 (1).

Eviota epiphanes Jenkins, 1903

Material

South-east bay: USNM 441971 (1); USNM 442166 (1); USNM 442171 (1); USNM 442224 (1); USNM 442225 (1); USNM 442226 (1); USNM 442239 (1). Central bay: USNM 442173 (3).

Eviota susanae Greenfield & Randall, 1999

Remarks

This species was described from Kane'ohē Bay (Greenfield & Randall, 1999: 439).

Material

South-east bay: USNM 442165 (1).

Gnatholepis anjerensis (Bleeker, 1851)

Material

South-east bay: USNM 442233 (1); USNM 442235 (1); USNM 442237 (1); USNM 442174 (1); USNM 442235 (1).

Central bay: USNM 442172 (1).

Remarks

We classify this species following Greenfield & Randall (2004) and Randall & Greenfield (2007). In contrast, Larson & Buckle (2012) use *G. knighti* for the Hawaiian taxon. In the mtCOI DNA barcode analysis, our specimens cluster with those identified as *G. anjerensis* (USNM 402522) and *G. knighti* (USNM 435610). Larson & Buckle (2012: 12) commented on the state of this taxonomic confusion: 'Four species (*G. anjerensis*, *G. thompsoni*, *G. cauerensis* and *G. knighti*) remain problematic for reliable identification using meristic counts, morphometric proportions, body and fin pigment and geographic location ... While current information does not reliably and easily distinguish all species, it is possible that a deeper understanding of live specimen colour and genetic differences in combination with taxonomic information may provide better identification of species within *Gnatholepis*.'

Pleurosicya sp.

Material

South-east bay: USNM 442436 (1).

Remarks

The mtCOI barcode sequence of this single specimen clusters with those of specimens from the Marquesas identified as *Pleurosicya labiata* (Weber, 1913), a species that not been reported from the Hawaiian Islands (Mundy, 2005). Our specimen is too small to confirm its identification via morphology. We await collection of additional specimens of this taxon to confirm its identification.

Priolepis eugenius (Jordan & Evermann, 1903)

Material

Central bay: USNM 442463 (1); USNM 442465 (1).

Priolepis farcimen (Jordan & Evermann, 1903)



Fig. 7. *Omobranchus obliquus* (Garman, 1903), family Blenniidae. USNM 442345. Photo by D.E. Pitassy.

Material

South-east bay: USNM 442406 (1); USNM 442468 (1); USNM 442469 (1); USNM 442470 (1).

Psilogobius mainlandi Baldwin, 1972

Remarks

This species was described from Kāneʻohe Bay (Baldwin, 1972: 126).

Material

South-east bay: USNM 442466 (1); USNM 442464 (1).
Central bay: USNM 442337 (1); USNM 442339 (1); USNM 442341 (1).

Unspecified locality in Kāneʻohe Bay: USNM 442491 (1).

Family Kraemeriidae Whitley, 1935
Kraemia bryani Schultz, 1941

Remarks

Our single specimen was taken on the outer reef slope of Kāneʻohe Bay on subtidal sand. No tissue sample was taken.

Material

Central bay: USNM 442150 (1).

Order Blenniiformes Wiley & Johnson, 2010
Family Blenniidae Rafinesque, 1810
Blenniella gibbifrons (Quoy & Gaimard, 1824)

Material

Central bay: USNM 442164 (1); USNM 442425 (1); USNM 442421 (1); USNM 442422 (1); USNM 442431 (1); USNM 442432 (1).

Entomacrodus strasburgi Springer, 1967

Material

Central bay: USNM 442420 (1).

Omobranchus obliquus (Garman, 1903)
Figure 7.

Remarks

This species was classified as *Omobranchus rotundiceps obliquus* (Garman, 1903) by Springer & Gomon (1975) and Mundy (2005). We recognize this taxon as *Omobranchus obliquus* (Garman, 1903), following Randall (2007) and others. This species is known in Hawaii only from Kāneʻohe Bay where it was first collected in 1953; it is considered to be introduced (Randall, 2007). One specimen from the Central bay is illustrated in Figure 7.

Material

South-east bay: USNM 442453 (1); Central bay: USNM 442154 (2); USNM 442343 (1); USNM 442345 (1); USNM 442347 (1); USNM 442349 (1).

Parablennius thysanius (Jordan & Seale, 1907)

Remarks

This species was introduced into Hawaii, likely from the Philippines, via the shipping industry (Mundy, 2005).

Material

Central bay: USNM 442155 (19); USNM 442313 (1); USNM 442316 (1); USNM 442334 (1); USNM 442336 (1); USNM 442338 (1); USNM 442340 (1); USNM 442342 (1); USNM 442344 (1); USNM 442346 (1); USNM 442348 (1).

Order Perciformes Bleeker, 1863
Family Acanthuridae Bonaparte, 1835
Acanthurus sp.

Material

Central bay: USNM 442168 (7).

Acanthurus blochii Valenciennes, 1835

Material

South-east bay: USNM 442218 (1); USNM 442382 (1). Central bay: USNM 442167 (10); USNM 442306 (1); USNM 442310 (1); USNM 442323 (1); USNM 442325 (1); USNM 442326 (1); USNM 442329 (1).

Acanthurus guttatus Forster in Bloch & Schneider, 1801

Material

Central bay: USNM 442411 (1).

Acanthurus leucopareius (Jenkins, 1903)

Material

South-east bay: USNM 442459 (1). Central bay: USNM 442414 (1).

Acanthurus triostegus (Linnaeus, 1758)

Remarks

The Hawaiian Islands and Johnston Atoll populations of *A. triostegus* have been classified as the endemic subspecies *Acanthurus triostegus sandvicensis* Streets, 1877. Recent compilations of the Hawaiian biota either follow that classification (e.g. Mundy, 2005) or use the more broadly applied *A. triostegus* (e.g. Randall, 2007). We report on its mtCOI DNA barcode below.

Material

South-east bay: USNM 442219 (1); USNM 442256 (1); USNM 442391 (1). Central bay: USNM 442307 (1); USNM 442321 (1); USNM 441975 (2).

Acanthurus xanthopterus Valenciennes in Cuvier & Valenciennes, 1835

Material

South-east bay: USNM 441928 (2); USNM 442212 (1); USNM 442258 (1); USNM 442264 (1); USNM 442267 (1); USNM 442381 (1); USNM 442386 (1). Central bay: USNM 442304 (1).

Ctenochaetus strigosus (Bennett, 1828)



Fig. 8. *Chaetodon lunula* (Lacépède, 1802), family Chaetodontidae. USNM 442377. Photo by D.E. Pittassy.

Material

South-east bay: USNM 442217 (1); USNM 442376 (1); USNM 442378 (1). Central bay: USNM 441976 (5).

Naso lituratus (Forster in Bloch & Schneider, 1801)

Material

Central bay: USNM 442407 (1).

Naso unicornis (Forsskål, 1775)

Material

South-east bay: USNM 442255 (1); USNM 442257 (1); USNM 442259 (1). Central bay: USNM 442415 (1).

Zebrasoma flavescens (Bennett, 1828)

Material

South-east bay: USNM 442208 (1); USNM 442372 (1).

Zebrasoma veliferum (Bloch, 1795)

Material

South-east bay: USNM 442220 (1); USNM 442379 (1); USNM 442388 (1).

Family Apogonidae Günther, 1859
Foa brachygramma (Jenkins, 1903)

Material

South-east bay: USNM 442296 (1). Central bay: USNM 442428 (1); USNM 442299 (1); USNM 442331 (1); USNM 442333 (1); USNM 442335 (1). USNM 442157 (1).

Family Carangidae Rafinesque, 1815
Caranx ignobilis (Forsskål, 1775)

Material

South-east bay: USNM 442474 (1); USNM 442283 (1).

Caranx melampygus Cuvier in Cuvier & Valenciennes, 1833

Material

South-east bay: USNM 442254 (1); USNM 442481 (1).

Gnathanodon speciosus (Forsskål 1775)

Material

South-east bay: USNM 442424 (1).

Remarks

This specimen could not be identified with confidence using morphology alone. Sequence data for this specimen matches that of other sequences identified in BOLD as *G. speciosus*.

Scomberoides lysan (Forsskål, 1775)

Material

South-east bay: USNM 442260 (1); USNM 442261 (1); USNM 442297 (1). North-west bay: USNM 442472 (1).

Family Chaetodontidae Rafinesque, 1815
Chaetodon sp.

Material

Central bay: USNM 442301 (1).

Chaetodon auriga Forsskål, 1775

Material: South-east bay: USNM 442364 (1). Central bay: USNM 442324 (1).

Chaetodon lunula (Lacépède, 1802)
Figure 8

Remarks

Our specimen from the South-east bay is illustrated in **Figure 8**.

Material

South-east bay: USNM 442377 (1). Central bay: USNM 441977 (7); USNM 442300 (1); USNM 442302 (1); USNM 442303 (1); USNM 442314 (1); USNM 442317 (1).

Chaetodon lunulatus Quoy & Gaimard, 1825

Material

South-east bay: USNM 442209 (1); USNM 442389 (1); USNM 442404 (1). Central bay: USNM 442355 (1).

Chaetodon multicinctus Garrett, 1863

Material

South-east bay: USNM 442440 (1); USNM 442443 (1); USNM 442449 (1).

Chaetodon ornatissimus Cuvier in Cuvier & Valenciennes, 1831

Material

South-east bay: USNM 442457 (1).

Chaetodon quadrimaculatus Gray, 1831

Material

Central bay: USNM 442409 (1).

Chaetodon unimaculatus Bloch, 1787

Material

South-east bay: USNM 442437 (1).

Forcipiger flavissimus Jordan & McGregor in Jordan & Evermann, 1898

Material

South-east bay: USNM 442394 (1).

Family Cichlidae Bonaparte, 1835

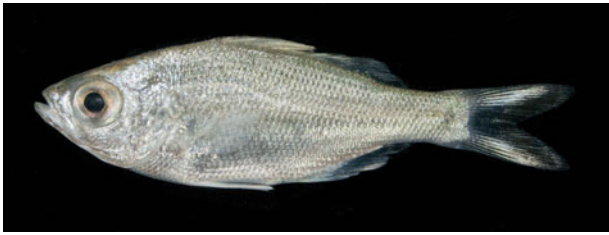


Fig. 9. *Kuhlia xenura* (Jordan & Gilbert, 1882), family Kuhlidae. USNM 442361. Photo by D.E. Pitassy.

Note: All species of cichlids in the Hawaiian Islands are introduced. Species in three genera – *Oreochromis*, *Sarotherodon* and *Tilapia* – have been recorded and many specimens likely represent hybrids (B. Mundy personal communication).

Sarotherodon melanotheron Rüppell, 1852

Material

South-east bay: USNM 441929 (1).

Tilapia sp.

Material

Central bay: USNM 442354 (1).

Family Cirrhitidae Macleay, 1841

Cirrhitus pinnulatus (Forster in Bloch & Schneider, 1801)

Material

South-east bay: USNM 442456 (1); USNM 442460 (1).

Family Creediidae Waite, 1899

Crystallodytes cookei Fowler, 1923

Material

South-east bay: USNM 442356 – 442360 (5). Central bay: USNM 442384 (1).

Family Kuhlidae Jordan & Evermann, 1896

Kuhlia xenura (Jordan & Gilbert, 1882)

[Figure 9](#)

Remarks

Randall & Randall (2001) reviewed the species of the genus *Kuhlia* from the Central Pacific and concluded that there are two species in Hawaii: the widespread *Kuhlia sandvicensis* (Steindachner, 1876) and *K. xenura*, a Hawaiian endemic, seen in [Figure 9](#). Some reports of *K. sandvicensis* from Kāneʻohe Bay (e.g. Tester & Takata, 1953) are of *K. xenura*, as noted by Randall & Randall (2001). This is the only species of *Kuhlia* recorded from the Bay by Greenfield (2003), the only species in the collection of fishes from Kāneʻohe Bay in the Bishop Museum, and the only species that we collected, with certainty, in 2017. Other reports of *K. sandvicensis* from the Bay (e.g. Watson & Leis, 1974; Coles *et al.*, 2002; [Appendix 1](#)) need to be confirmed. We report on its mtCOI DNA barcode, below.

Material

South-east bay: USNM 441981 (12); USNM 442285 (1); USNM 442287 (1); USNM 442289 (1); USNM 442291 (1); USNM 442293 (1); USNM 442294 (1); USNM 442295 (1). USNM 442400 (1); USNM 442479 (1); USNM 442402 (1); USNM 441934 (1). Central bay: USNM 442430 (1). North-west bay:

USNM 442361 (1); USNM 442148 (2).

Family Kyphosidae Jordan, 1887

Note: Identification of the species of *Kyphosus* follows Knudsen & Clements (2013).

Kyphosus hawaiiensis Sakai & Nakabo, 2004

Material

Central bay: USNM 442416 (1).

Kyphosus vaigiensis (Quoy & Gaimard, 1825)

Material

South-east bay: USNM 442396 (1); USNM 442399 (1).

Family Microcanthidae Bleeker, 1876

Microcanthus strigatus (Cuvier, 1831)

Material

Central bay: USNM 442318 (1).

Family Labridae Cuvier, 1816

Bodianus albotaeniatus (Valenciennes in Cuvier & Valenciennes, 1839)

Remarks

As the subspecies *Bodianus bilunulatus albotaeniatus* in Mundy (2005: 432).

Material

South-east bay: USNM 442385 (1).

Gomphosus varius Lacépède, 1801

Material

South-east bay: USNM 442392 (1); USNM 442393 (1).

Halichoeres ornatissimus (Garrett, 1863)

Material

South-east bay: USNM 442448 (1).

Novaculichthys taeniourus (Lacépède, 1801)

Remarks

We observed, but did not collect, a single individual on 10 May 2017 while snorkelling in the outer reef slope of the Bay near Kapapa Island.

Oxycheilinus unifasciatus (Streets, 1877)

Remarks

We sequenced the mtCOI DNA barcode of two specimens (USNM 442374 and USNM 442462) and compared them to DNA barcodes of specimens from French Polynesia and Futuna (see below).

Material

South-east bay: USNM 442374 (1); USNM 442462 (1).

Thalassoma ballieui (Vaillant & Sauvage, 1875)

Material

South-east bay: USNM 442366 (1).

Thalassoma duperrey (Quoy & Gaimard, 1824)



Fig. 10. *Polydactylus sexfilis* (Valenciennes, 1831), family Polynemidae. USNM 442250. Photo by D.E. Pitassy.

Material

South-east bay: USNM 442216 (1); USNM 442373 (1); USNM 442441 (1).

Family Lutjanidae Gill, 1861

Lutjanus fulvus (Forster in Bloch & Schneider, 1801)

Remarks

The three species of *Lutjanus* reported from Kāneʻohe Bay were introduced to Hawaii in the mid to late 1950s to enhance fisheries (Appendix 1; Mundy, 2005: 43). We collected specimens of one of these species in the south-east portion of the Bay.

Material

South-east bay: USNM 442213 (1); USNM 442244 (1); USNM 442246 (1).

Family Mullidae Rafinesque, 1815

Mulloidichthys flavolineatus (Lacépède, 1801)

Material

South-east bay: USNM 442214 (1); USNM 442365 (1); USNM 442375 (1); USNM 442405 (1); USNM 442380 (1); USNM 442390 (1); USNM 442395 (1); USNM 442477 (1); USNM 442484 (1).

Parupeneus multifasciatus (Quoy & Gaimard, 1825)

Material

South-east bay: USNM 442371 (1); USNM 442461 (1).

Parupeneus porphyreus (Jenkins, 1903)

Material

South-east bay: USNM 442476 (1).

Family Polynemidae Rafinesque, 1815

Polydactylus sexfilis (Valenciennes, 1831)

Figure 10

Remarks

This is the only species of polynemid that lives in the Hawaiian Islands. It has long been cultured and remains a sought-after food fish. Our four specimens were collected using a castnet just outside the wall of the Heʻeia fishpond; one is illustrated in Figure 10.

Material

South-east bay: USNM 442250 (1); USNM 442251 (1); USNM 442252 (1); USNM 442253 (1).

Family Pomacanthidae Jordan & Evermann, 1898

Centropyge potteri (Jordan & Metz, 1912)



Fig. 11. *Rhinecanthus rectangularus* (Bloch & Schneider, 1801), family Balistidae. USNM 442410. Photo by D.E. Pitassy.

Material

South-east bay: USNM 442445 (1).

Family Pomacentridae Bonaparte, 1831

Abudefduf sp.

Material

Central bay: USNM 442429 (1).

Abudefduf abdominalis (Quoy & Gaimard, 1825)

Material

South-east bay: USNM 442215 (1); USNM 442486 (1); USNM 442488 (1).

Abudefduf sordidus (Forsskål, 1775)

Material

South-east bay: USNM 441932 (2); USNM 442211 (1); USNM 442262 (1); USNM 442270 (1). North-west bay: USNM 442147 (4).

Abudefduf vaiensis (Quoy & Gaimard, 1825)

Material

South-east bay: USNM 441982 (7); USNM 442263 (1); USNM 442265 (1); USNM 442269 (1); USNM 442271 (1).

Remarks

The widespread Indo-Pacific *Abudefduf vaiensis* was first reported in Hawaiian waters in 1991 (Severns & Fiene-Severns, 1993; Randall, 2007). It is hypothesized to have been carried to the archipelago via rafting, perhaps on abandoned fishing nets or by other indirect human activities (Mundy, 2005). It has been reported to hybridize with the endemic *Abudefduf abdominalis* (B. Mundy personal communication; Coleman *et al.*, 2014).

Chromis sp.

Material

Central bay: USNM 442169 (3).

Chromis agilis Smith, 1960

Material

South-east bay: USNM 442447 (1).

Chromis hanui Randall & Swerdloff, 1973



Fig. 12. *Diodon hystrix* Linnaeus, 1758, family Diodontidae. USNM 442206. Photo by L.R. Parenti.

Material

South-east bay: USNM 442442 (1).

Dascyllus albisella Gill, 1862

Material

South-east bay: USNM 442398 (1); USNM 442369 (1).

Plectroglyphidodon imparipennis (Vaillant & Sauvage, 1875)

Material

North-west bay: USNM 442480 (1).

Stegastes marginatus (Jenkins, 1901)

Material

South-east bay: USNM 442451 (1); USNM 442454 (1)

Family Priacanthidae Günther, 1859
Heteropriacanthus carolinus (Cuvier, 1829)

Remarks

We follow the recent revision of the circumtropical *Heteropriacanthus cruentatus* by Fernandez-Silva & Ho (2017) and recognize our specimens as *H. carolinus*.

Material

Central bay: USNM 442408 (1).

Family Scaridae Rafinesque, 1810
Chlorurus spilurus (Valenciennes, 1840)

Remarks

Mundy (2005) reported this species from Hawaii as *Chlorurus sordidus* (Forsskål, 1775). Subsequently, specimens of the widespread *C. sordidus* have been recognized as *C. sordidus* in the Red Sea and Indian Ocean, and *C. spilurus* in the Pacific and Eastern Indian oceans (see Choat *et al.*, 2012).

Material

South-east bay: USNM 442268 (1); USNM 442276 (1); USNM 442367 (1); USNM 442401 (1); USNM 442487 (1); USNM 442489 (1); USNM 442490 (1).

Scarus psittacus Forsskål, 1775

Material

South-east bay: USNM 442274 (1).
Central bay: USNM 442328 (1); USNM 442332 (1).

Family Sphyracidae Rafinesque, 1815
Sphyracna barracuda (Edwards, 1771)

Material

South-east bay: USNM 442241 (1); USNM 442248 (1); USNM 442272 (1).

Family Zanclidae Bleeker, 1876
Zanclus cornutus (Linnaeus, 1758)

Material

South-east bay: USNM 442210 (1); USNM 442368 (1).

Order Tetraodontiformes Berg, 1940

Family Balistidae Rafinesque, 1810
Rhinecanthus rectangulus (Bloch & Schneider, 1801)

Figure 11

Remarks

This species is the state fish of Hawaii (see Hoover, 2016: 317). Its Hawaiian name is humu humu nuku nuku ā pua`a. Our two specimens were taken on spear. A specimen from the Central bay is illustrated in Figure 11.

Material

Central bay: USNM 442410 (1); South-east bay: USNM 442458 (1).

Sufflamen bursa (Bloch & Schneider, 1801)

Remarks

We collected specimens of this triggerfish while spearfishing.

Material

South-east bay: USNM 442438 (1); USNM 442444 (1).

Family Diodontidae Billberg, 1833
Diodon hystrix Linnaeus, 1758

Figure 12

Remarks

We found this specimen, illustrated in Figure 12, discarded on Laenani Beach in the central portion of the Bay; it had the remnants of a fishing hook in its mouth.

Material

Central bay: USNM 442206 (1).

Family Monacanthidae Nardo, 1843
Cantherhines sandwichiensis (Quoy & Gaimard, 1824)

Material

Central bay: USNM 442413 (1); USNM 442450 (1).

Family Ostraciidae Rafinesque, 1810
Ostracion meleagris Shaw in Shaw & Nodder, 1796

Remarks

We follow Randall (2007) and recognize this taxon at the species level. It is recognized at the subspecies level by Mundy (2005) who lists *Ostracion meleagris camurum* Jenkins, 1901 as a Johnston Atoll and Hawaiian Islands endemic. The other subspecies, *Ostracion meleagris meleagris* Shaw in Shaw & Nodder, 1796, ranges broadly throughout the Indo-Pacific, from east Africa to southern Japan, the Ogasawara Islands, Australia, Micronesia and French Polynesia (Mundy, 2005).

Material

South-east bay: USNM 442455 (1). Central bay: USNM 442418 (1).

Family Tetraodontidae Bonaparte, 1831
Arothron hispidus (Linnaeus, 1758)

Material

South-east bay: USNM 442222 (1); USNM 442223 (1). Central bay: USNM 442327 (1); USNM 442330 (1).

Canthigaster amboinensis (Bleeker, 1864)

Material

South-east bay: USNM 442446 (1). Central bay: USNM 442417 (1).

Canthigaster jactator (Jenkins, 1901)

Material

Central bay: USNM 442315 (1); USNM 442320 (1).

Discussion

The DNA barcode

The mitochondrial cytochrome oxidase-*c* subunit I (mtCOI) gene, the common DNA barcode region for animals (Hebert *et al.*, 2003), was sequenced from a tissue sample of at least one specimen of 94 of the species that we collected. Other species in our report were seen but not taken or were fixed without a tissue sample. These DNA barcode sequences were used to confirm species identification if they matched barcodes of other specimens identified as that species from French Polynesia or elsewhere in the Indo-Pacific.

We compared our data to barcode sequences from individuals collected principally in French Polynesia because the voucher specimens for that material are deposited in museum collections (e.g. Delrieu-Trottin *et al.*, 2015) and, therefore, may be used for morphological comparison to confirm identification. Sequence data that are not linked to museum vouchers are less reliable because identification of the taxon used to generate the data cannot be confirmed (e.g. Dillman *et al.*, 2014). Additionally, we used mtCOI sequences to verify our hypothesis that the populations of some species of fishes from Kāneʻohe Bay are genetically distinct from other populations within the Indo-Pacific. Documenting DNA barcodes in the current study also allows future monitoring of fish species composition at Kāneʻohe Bay by analysing environmental DNA (eDNA) in water samples (Ficetola *et al.*, 2008).

Here we discuss the results of DNA barcoding as case studies for six taxa. Data on barcoded specimens, including their USNM catalogue numbers, GenBank and BOLD database accession IDs, are in the Supplementary Material (Table S1).

Case 1: *Saurida*

We collected two species of *Saurida*, *S. gracilis* and *S. nebulosa*, that we recognized by morphology (as above). BOLD data for mtCOI, as summarized in a Neighbour-joining (NJ) tree, suggest there are at least three lineages within *S. gracilis* and two separate lineages of *S. nebulosa* as seen in Figure S1.

Saurida gracilis

We identify three lineages of *S. gracilis*: Lineage 1, Kāneʻohe Bay – This lineage includes all of our samples identified as *S. gracilis* (Table S1). There is less than 0.50% difference in mtCOI between

our samples and two other samples in this lineage from French Polynesia. We examined these French Polynesian specimens; they also key out to *S. gracilis*; Lineage 2, General Indo-Pacific – This lineage includes sequences from specimens from French Polynesia, the western Pacific and the western Indian Ocean. There is a 9.5–9.7% difference in mtCOI between these and our Kāneʻohe Bay lineage; and Lineage 3, SW Indian Ocean – This lineage includes samples from off the southern African coast and nearby islands. There is a 13.8–14.1% difference in mtCOI between these and our Kāneʻohe Bay lineage. We hypothesize that these lineages are part of a widespread *S. gracilis* species complex in need of revision. Further, the sequences from Lineage 3, SW Indian Ocean, are from GenBank; they need to be verified with vouchered specimens and tissue samples.

Saurida nebulosa

We identify two, distinct lineages of *S. nebulosa* within Kāneʻohe Bay: Lineage 1 includes two of our samples and sequences of specimens from Australia, Indonesia and Mauritius; Lineage 2 includes two more of our samples and sequences of specimens from French Polynesia. Variation within each lineage is less than 1%, whereas the two lineages differ by 4.5–4.9% mtCOI sequence divergence. We infer that these lineages are part of what may be an *S. nebulosa* species complex. Sequence divergence among the lineages is not as deep as that of lineages of *S. gracilis*. Yet, our specimens that key out to *S. nebulosa* are in two distinct lineages in the BOLD NJ tree, as in Figure S1. Further work is needed to test hypotheses of species limits of the Kāneʻohe Bay species of *Saurida*.

Case 2: *Sebastapistes coniora* Jenkins, 1903

Once regarded as endemic to the Hawaiian and Johnston islands, *Sebastapistes coniora* has been reported recently from New Caledonia and Wake Atoll (Fricke *et al.*, 2011). Randall (2007) considered that reports of this species living outside of Hawaiʻi and throughout Oceania could be of the morphologically similar *S. tinkhami*. We sequenced the mtCOI DNA barcode of one specimen of *S. coniora* from Kāneʻohe Bay and compared it with the barcodes of three specimens of *S. tinkhami* from French Polynesia. The mtCOI DNA barcodes of the three French Polynesian specimens, MNHN 2008-360, USNM 423383 and USNM 400555, differ from each other by just 0.2%. Our Kāneʻohe Bay specimen (USNM 442298) differs from these three by 3.1–3.5%. Our Hawaiian *S. coniora* are genetically distinct from the French Polynesian *S. tinkhami*, confirming the hypothesis that these are distinct species. Voucher specimens and tissue samples of specimens identified as *S. coniora* from New Caledonian and Wake Atoll should be examined to confirm their species identification.

Case 3: *Acanthurus triostegus* (Linnaeus, 1758)

A genetic analysis of populations of *A. triostegus* throughout its broad range suggested that populations from Hawaii (including Oʻahu) and the Marquesas, French Polynesia, are distinct from other Pacific populations (Planes & Fauvelot, 2002, Figure 2). The mtCOI DNA barcode of our Kāneʻohe Bay specimen is just 1.56–1.76% different from that of Gambier, Austral, and Manuaʻe (Scilly) Islands, French Polynesia, populations identified as *A. triostegus*, which supports the observation that there is little genetic difference among populations of this species in these areas.

Case 4: *Asterroteryx semipunctata* Rüppell, 1830

This goby is one of the most common species throughout Kāneʻohe Bay. It lives in a variety of shallow marine habitats and is relatively easy to collect and, therefore, is well-studied in the Bay (e.g. Privitera, 2002; Hagedorn *et al.*, 2018). The species is broadly distributed and ranges from the western Indian Ocean to the central Pacific. Its type locality is the Red Sea. We tested the hypothesis that Hawaiian populations of this broadly distributed Indo-Pacific species may be genetically distinct. Four specimens of *A. semipunctata* from the Gambier Islands, French Polynesia (USNM 401104, USNM 399599, USNM 399547, USNM 399551) have nearly identical barcodes, differing from each other only by 0.6% or less. Our specimen from Kāneʻohe Bay (USNM 442231) differs from these four by 6.3–7.1% sequence divergence. This difference between French Polynesian and Hawaiian populations suggests that this widespread species needs revision and may represent a species complex.

Case 5: *Kuhlia xenura* (Jordan & Gilbert, 1882)

There are two valid species of the genus *Kuhlia* in Hawaii, following Randall & Randall (2001): the widespread *Kuhlia sandvicensis* (Steindachner, 1876) and *K. xenura* (Jordan & Gilbert, 1882), a Hawaiian endemic. *Kuhlia xenura* is distinguished from *K. sandvicensis* by a larger eye, among other morphological characters. We sequenced the mtCOI barcodes of three specimens we identified as *K. xenura* from Kāneʻohe Bay and compared it with the barcodes of six specimens of *K. sandvicensis* from French Polynesia. Two of our specimens (USNM 442289, USNM 442361) differ from the French Polynesian specimens (MNHN 2008–686, MNHN 2008–687, USNM 424191, USNM 399546, USNM 399548, USNM 399602) by 6.2–6.4% mtCOI sequence divergence. A third specimen of *K. xenura* from Kāneʻohe Bay (USNM 442430) differed from the French Polynesian specimens by only 1.4–1.6%. This specimen has a relatively large eye as seen in Figure 9, a character of *K. xenura*, according to Randall & Randall (2001). We conclude that our specimens from Kāneʻohe Bay represent *K. xenura*, but that additional study may reveal potential hybridization between these two *Kuhlia* species in Hawaii.

Case 6: *Oxycheilinus unifasciatus* (Streets, 1877)

This species of *Oxycheilinus* has a distinctive white band that circumvents the body just anterior to the caudal peduncle. We sequenced the mtCOI barcode of two specimens we identified as *O. unifasciatus* from Kāneʻohe Bay and compared it with the barcodes of three specimens identified as *O. unifasciatus* from the Gambier and Austral islands, French Polynesia (USNM 404650, USNM 423436, USNM 423374) and two specimens from Futuna (USNM 446422, USNM 446380). The mtCOI sequences of the five Polynesian specimens differ from each other by 0.2–0.5%. Our Hawaiian specimens (USNM 442374, USNM 442462) differ from these by 2.3–2.8% sequence divergence. Our specimens of *Oxycheilinus unifasciatus* have a relatively large mouth that extends posteriorly beyond the anterior rim of the orbit and represent unrecognized morphological and genetic diversity.

Fish diversity of Kāneʻohe Bay

To develop a working list of the fish species that live in Kāneʻohe Bay, we compiled the taxa reported in the surveys of Watson & Leis (1974), Coles *et al.* (2002), Greenfield (2003) and the current study (Appendix 1). This list of some 388 taxa is not complete,

nor have all the species on it been confirmed to live in the Bay. Further we do not expect many of the taxa that Watson & Leis (1974) reported only as larvae and eggs to be found in the Bay as adults (Appendix 1). The identification and distribution of each species should be validated with a vouchered specimen and, ideally, a tissue sample.

Nearly all of our 109 species are represented by a formalin-fixed voucher specimen and one or more tissue samples, a colour photograph and collection data. Greenfield (2003) reported 202 species classified in 49 families; specimens of some 190 species were fixed in formalin and catalogued in the collections of the California Academy of Sciences (CAS), San Francisco. The formalin-fixed specimens collected by Watson & Leis (1974) representing some 80 listed taxa representing over 175 different types of eggs or larvae were ultimately distributed among various museum and university collections. Coles *et al.* (2002) developed their list of some 263 species with a combination of literature reports and museum collections. Watson & Leis (1974), Coles *et al.* (2002) and Greenfield (2003) did not collect tissue samples for genetic analysis as that was not yet the custom.

Different fish collecting methods yield different species. Only 10 species appear on all four lists: nine native species, synodontid *Saurida gracilis*; the atherinid *Atherinomorus insularum*; the gobiids *Asterroteryx semipunctata*, *Eviota epiphanes* and *Psilogobius mainlandi*; the apogonid *Foa brachygramma*; the kuhliid *Kuhlia xenura*; the pomacentrids *Abudefduf abdominalis* and *Stegastes marginatus*; and one introduced species, the blennioid *Omobranchus obliquus*. We did not obtain many of the small, cryptic fish species reported from Kāneʻohe Bay by Greenfield (2003) who collected using ichthyocides with dipnets on scuba. For example, Greenfield (2003) collected 22 species of gobiids, whereas we collected just 11 (Appendix 1). Moray eels, family Muraenidae, are particularly difficult to capture with our methods; we recorded just three species compared with the 13 of Greenfield (2003). Likewise, Watson & Leis (1974) reported just two of some nearly 40 species of eels known for their extensive leptocephalus larval phases. In contrast, our focused effort on the larger, more conspicuous reef fishes using spears yielded 11 species of acanthurids, whereas Greenfield (2003) collected just six acanthurids. Our study was also unique among the four in documenting the occurrence of the balistid *Rhinecanthus rectangulus*, the state fish of Hawaii, in the Bay.

Using plankton tows, Watson & Leis (1974) collected larvae and eggs over a period of one year. The cryptic gobioids *Schindleria pietschmani* and *S. praematura*, not reported in the three other studies, were abundant in their collections. Further, both Greenfield (2003) and our study did not report the Bay's endemic anchovy *Enchrasicholina purpurea*.

Also of interest is the report by Watson & Leis (1974) from the Sampan Channel of larvae or eggs of some 20 species in oceanic families including Gonostomatidae, Myctophidae, Stomiidae and Chlorophthalmidae (Appendix 1). Although the adults of these species are not expected to be found in the Bay, they may be important components of environmental DNA (eDNA) analyses. Collection of tissue samples along with voucher specimens is critical for future eDNA analyses of water and aquatic sediment samples of the Bay. Also, the eggs and larvae of these taxa may provide an important trophic component to other post-metamorphic fishes that visit, or reside in, Kāneʻohe Bay (Brandl *et al.*, 2019).

Conclusions

We collected 109 species of fishes in Kāneʻohe Bay during the 2017 MarineGEO survey. Nearly all the species we report are represented by one or more tissue samples in addition to a formalin-fixed voucher specimen, a colour photograph, plus

other data. We were successful in collecting the larger, more conspicuous reef fishes that live throughout the Bay, but were unable to collect many of the smaller, cryptic fishes. To fill in these gaps, we will continue to explore methods to record a higher diversity of fish species in the Bay and maintain voucher specimens and tissue samples.

The mtCOI DNA barcode provides evidence to confirm the identifications of fish species in Kāneʻohe Bay. It also provides evidence to differentiate these populations from those of the same nominal species in French Polynesia and elsewhere throughout the Indo-Pacific. Despite the observed genetic distances, we do not propose species validity/synonymy from barcode sequences alone because these data are insufficient to make such conclusions (see Ebach & Holdrege, 2005). Genetic lineages may represent valid species, but we do not recognize them as such without description of concordant morphological differences (e.g. Baldwin *et al.*, 2011). Even with these caveats, we find the mtCOI DNA barcode sequences to be a useful tool to assess diversity and to provide preliminary data for eventual environmental DNA (eDNA) surveys of Kāneʻohe Bay.

Supplementary material. The supplementary material for this article can be found at <https://doi.org/10.1017/S0025315420000417>.

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References

- Alda F, Reina RG, Doadrio I and Bermingham E (2013) Phylogeny and biogeography of the *Poecilia sphenops* species complex (Actinopterygii, Poeciliidae) in Central America. *Molecular Phylogenetics and Evolution* **66**, 1011–1026.
- Altschul SF, Gish W, Miller W, Myers EW and Lipman DJ (1990) Basic local alignment search tool. *Journal of Molecular Biology* **215**, 403–410.
- Arnold RJ and Pietsch TW (2012) Evolutionary history of frogfishes (Teleostei: Lophiiformes: Antennariidae): a molecular approach. *Molecular Phylogenetics and Evolution* **62**, 117–129.
- Bahr KD, Jokiel PL and Toonen RJ (2015) The unnatural history of Kāneʻohe Bay: coral reef resilience in the face of centuries of anthropogenic impacts. *PeerJ* **3**, e950.
- Baldwin WJ (1972) A new genus and new species of Hawaiian gobiid fish. *Pacific Science* **26**, 125–128.
- Baldwin CC, Mounts JH, Smith DG and Weigt LA (2009) Genetic identification and color descriptions of early life-history stages of Belizean *Phaeoptyx* and *Astrapogon* (Teleostei: Apogonidae) with comments on identification of adult *Phaeoptyx*. *Zootaxa* **2008**, 1–22.
- Baldwin CC, Castillo CI, Weigt LA and Victor BC (2011) Seven new species within western Atlantic *Starksia atlantica*, *S. lepicoelia* and *S. sluiteri* (Teleostei, Labrisomidae), with comments on congruence of DNA barcodes and species. *ZooKeys* **79**, 21–27.
- Benson DA, Cavanaugh M, Clark K, Karsch-Mizrachi I, Lipman DJ, Ostell J and Sayers EW (2017) GenBank. *Nucleic Acids Research* **45**, D37–D42.
- Bertin L (1935) Les types de Kaup dans la collection des leptocephales du Muséum. *Bulletin du Muséum national d'histoire naturelle (Séries 2)* **7**, 99–106.
- Brandl SJ, Tornabene L, Goatley CH, Casey JM, Morais RA, Côté IM, Baldwin CC, Parravicini V, Schiettekatte NM and Bellwood DR (2019) Demographic dynamics of the smallest marine vertebrates fuel coral reef ecosystem functioning. *Science* **364**, 1189–1192.
- Choat JH, Carpenter KE, Clements KD, Rocha LA, Russell B, Myers R, Lazuardi ME, Muljadi A, Pardede S and Rahardjo P (2012) *Chlorurus spirurus*. *The IUCN Red List of Threatened Species* 2012, e.T190727A17783061.
- Clarke TA (1971) The ecology of the scalloped hammerhead shark, *Sphyrna lewini*, in Hawaii. *Pacific Science* **25**, 133–144.
- Coleman RR, Gaither MR, Kimokeo B, Stanton FG, Bowen BW and Toonen RJ (2014) Large-scale introduction of the Indo-Pacific damselfish *Abudefduf vaigiensis* into Hawaiʻi promotes genetic swamping of the endemic congener *A. abdominalis*. *Molecular Ecology* **23**, 5552–5565.
- Coles SL, DeFelic RC and Eldredge LG (2002) Nonindigenous marine species in Kaneʻohe Bay, Oʻahu, Hawaiʻi. Bernice Pauahi Bishop Museum Hawaiʻi Biological Survey. Bishop Museum Technical Report no. 24, 353 pp.
- Delrieu-Trottin E, Williams JT, Bacchet P, Kulbicki M, Mourier J, Galzin R, de Loma TL, Mou-Tham G, Siu G and Planes S (2015) Shore fishes of the Marquesas Islands, an updated checklist with new records and new percentage of endemic species. *Check List (Luis Felipe Toledo)* **11**, 1758.
- Devaney DM, Kelly M, Lee PJ and Motteler LS (1982) *Kāneʻohe. A History of Change*. Honolulu: Bishop Museum Press, 217 pp.
- Dillman CB, Zhuang P, Zhang T, Zhang L-Z, Mugue N and Hilton EJ (2014) Forensic investigations into a GenBank anomaly: endangered taxa and the importance of voucher specimens in molecular studies. *Journal of Applied Ichthyology* **30**, 1300–1309.
- Durand J-D, Chen WJ, Shen, KN, Fu C and Borsa P (2012) Genus-level taxonomic changes implied by the mitochondrial phylogeny of grey mullets (Teleostei: Mugilidae). *Comptes Rendus Biologies* **335**, 687–697.
- Ebach MC and Holdrege C (2005) DNA barcoding is no substitute for taxonomy. *Nature* **434**, 697.
- Fernandez-Silva I and Ho H-C (2017) Revision of the circumtropical glassy fish *Heteropriacanthus cruentatus* (Perciformes: Priacanthidae), with resurrection of two species. *Zootaxa* **4273**, 341–361.
- Ficetola GF, Miaud C, Pompanon F and Taberlet P (2008) Species detection using environmental DNA from water samples. *Biology Letters* **4**, 423–425.
- Fricke R, Kulbicki M and Wantiez L (2011) Checklist of the fishes of New Caledonia, and their distribution in the Southwest Pacific Ocean (Pisces). *Stuttgarter Beiträge zur Naturkunde A, Neue Serie* **4**, 341–463.
- Fricke R, Eschmeyer WN and Van der Laan R (eds) (2019). *Eschmeyer's Catalog of Fishes: Genera, Species, References*. (<http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>). Electronic version accessed 18 Sept 2019.
- Gordon JA and Helfrich P (1970) *An Annotated Bibliography of Kaneohe Bay*. Honolulu: University of Hawaiʻi, Hawaiʻi Institute of Marine Biology, Technical Report No. 20, 260 pp.
- Greenfield DW (2003) A survey of the small reef fishes of Kāneʻohe Bay, Oʻahu, Hawaiian Islands. *Pacific Science* **57**, 45–76.
- Greenfield DW and Randall JE (1999) Two new *Eviota* species from the Hawaiian Islands (Teleostei: Gobiidae). *Copeia* **1999**, 439–446.
- Greenfield DW and Randall JE (2004) The marine gobies of the Hawaiian Islands. *Proceedings of the California Academy of Sciences* **55**, 498–549.
- Hagedorn MM, Daly JP, Carter VL, Cole KS, Jaafar Z, Lager CV and Parenti LR (2018) Cryopreservation of fish spermatogonial cells: the future of natural history collections. *Nature Scientific Reports* **8**, 6149.
- Hebert PD, Cywinska A, Ball SL and Dewaard JR (2003) Biological identifications through DNA barcodes. *Proceedings of the Royal Society of London. Series B: Biological Sciences* **270**, 313–321.

- Hoover JP** (2016) *The Ultimate Guide to Hawaiian Reef Fishes, Sea Turtles, Dolphins, Whales, and Seals*. Seventh printing. Honolulu: Mutual Publishing, 388 pp.
- Jokiel PL** (1991) *Jokiel's Illustrated Scientific Guide to Kāne'ōhe Bay, O'ahu*. Honolulu: Hawai'i Institute of Marine Biology, Technical Report, 65 pp.
- Katoh K and Standley DM** (2013) MAFFT Multiple sequence alignment software version 7: improvements in performance and usability. *Molecular Biology and Evolution* **30**, 772–780.
- Knudsen SW and Clements KD** (2013). Revision of the fish family Kyphosidae (Teleostei: Perciformes). *Zootaxa* **3751**, 1–101.
- Larson HK and Buckle DJ** (2012) A revision of the goby genus *Gnatholepis* Bleeker (Teleostei, Gobiidae, Gobiionellinae), with description of a new species. *Zootaxa* **3529**, 1–69.
- Last PR, Naylor GJP and Manjaji-Matsumoto BM** (2016a) A revised classification of the family Dasyatidae (Chondrichthyes: Myliobatiformes) based on new morphological and molecular insights. *Zootaxa* **4139**, 345–368.
- Last PR, White WT, de Carvalho MR, Séret B, Stehmann MFW and Naylor GJP** (eds) (2016b) *Rays of the World*. Victoria: CSIRO Publishing, 790 pp.
- Mundy BC** (2005) Checklist of the fishes of the Hawaiian Archipelago. *Bishop Museum Bulletin in Zoology* **6**, 704 pp.
- Planes S and Fauvelot C** (2002) Isolation by distance and vicariance drive genetic structure of a coral reef fish in the Pacific Ocean. *Evolution* **56**, 378–399.
- Privitera LA** (2002) Reproductive biology of the coral-reef goby, *Asterropteryx semipunctata*, in Kaneohe Bay, Hawaii. *Environmental Biology of Fishes* **65**, 289–310.
- Randall JE** (2007) *Reef and Shorefishes of the Hawaiian Islands*. Honolulu: University of Hawai'i Sea Grant College Program, 546 pp.
- Randall JE** (2010) *Shorefishes of Hawai'i*. Revised Edn. Honolulu: University of Hawai'i Press, 234 pp.
- Randall JE and Greenfield DW** (2007) Redescription of *Gnatholepis cauerensis* (Bleeker, 1853), with discussion of the validity of the species. *Zoologische Mededelingen Leiden* **81**, 303–308.
- Randall JE and Randall HA** (2001) Review of the fishes of the genus *Kuhlia* (Perciformes: Kuhliidae) of the Central Pacific. *Pacific Science* **55**, 227–256.
- Ratnasingham S and Hebert PD** (2007) BOLD: The Barcode of Life Data System (<http://www.barcodinglife.org>). *Molecular Ecology Notes* **7**, 355–364.
- Sakai K and Nakabo T** (2004) Two new species of *Kyphosus* (Kyphosidae) and a taxonomic review of *Kyphosus bigibbus* Lacepède from the Indo-Pacific. *Ichthyological Research* **51**, 20–32.
- Schemmel E, Kamikawa K, Shimoda T and Peyton KA** (2019) The life history of the invasive mullet, *Osteomugil engeli* (Bleeker, 1858) in Hawaiian estuaries. *Environmental Biology of Fishes* **102**, 553–568.
- Schloss PD, Westcott SL, Ryabin T, Hall JR, Hartmann M, Hollister EB, Lesniewski RA, Oakley BB, Parks DH, Robinson CJ and Sahl JW** (2009) Introducing mothur: open-source, platform-independent, community-supported software for describing and comparing microbial communities. *Applied and Environmental Microbiology* **75**, 7537–7541.
- Severns M and Fiene-Severns P** (1993) *Molokini Island - Hawaii's Premier Marine Preserve*. Wailuku: Ka Lima O Maui, 144 pp.
- Springer VG and Gomon MF** (1975) Revision of the blennioid fish genus *Omobranchus* with descriptions of three new species and notes on other species of the tribe Omobranchini. *Smithsonian Contributions to Zoology* **177**, 1–135.
- Tester AL and Takata M** (1953) *Contribution to the Biology of the Aholehole, a Potential Baitfish*. Final Report. Industrial Research Advisory Council Grant No. 29. HML [=HIMB] Contribution no 38, 54 pp.
- Thacker CE and Cole KS** (2002) Phylogeny and evolution of the gobioid genus *Coryphopterus*. *Bulletin of Marine Science* **70**, 837–850.
- Van der Laan R, Eschmeyer WN and Fricke R** (2014) Family-group names of recent fishes. *Zootaxa* **3882**, 1–230.
- Ward RD, Zemlak TS, Innes BH, Last PR and Hebert PDN** (2005) Barcoding Australia's fish species. *Philosophical Transactions of the Royal Society of London B* **360**, 1847–1857.
- Watson W and Leis JM** (1974) *Ichthyoplankton of Kaneohe Bay, Hawaii. A One-year Study of Fish Eggs and Larvae*. The University of Hawaii Sea Grant Program. Sea Grant Technical Report 75-01, 178 pp.
- Williams JT and Viviani J** (2016) *Pseudogramma polyacantha* complex (Serranidae, tribe Grammistini): DNA barcoding results lead to the discovery of three cryptic species, including two new species from French Polynesia. *Zootaxa* **4111**, 246–260.

Appendix 1. Working list of fishes in Kāneʻohe Bay with a comparison of previous studies

Species by Family	A	B	C	D	Taxonomic notes
Family Carcharinidae (2)					
<i>Carcharhinus amblyrhynchos</i>				●	
<i>Galeocerdo cuvier</i>				●	
Family Sphyrnidae (1)					
<i>Sphyrna lewini</i>	●			●	
Family Dasyatidae (1)					
<i>Bathytoshia lata</i>	●			●	
Family Elopidae (1)					
<i>Elops hawaiiensis</i>				●	
Anguilliformes (1)			●		Unidentified leptocephalus
Family Chlopsidae (1)					
<i>Kaupichthys hyoproridae</i>		●			
Family Congridae (3)					
<i>Ariosoma bowersi</i>	●				
<i>Conger marginatus</i>		●		●	As <i>C. cinereus marginatus</i> in B, as <i>C. cinereus</i> in D (see Randall, 2007)
<i>Conger oligoporus</i>		●		●	
Family Moringuidae (1)					
<i>Moringua ferruginea</i>		●			
Family Muraenidae (27)					
<i>Anarchias</i> sp. (2 or more)		●			
<i>Anarchias cantonensis</i>				●	
<i>Anarchias leucurus</i>				●	
<i>Echidna nebulosa</i>	●			●	
<i>Echidna polyzona</i>				●	
<i>Enchelycore pardalis</i>				●	
<i>Gymnomuraena zebra</i>		●		●	
<i>Gymnothorax buroensis</i>				●	
<i>Gymnothorax chilospilus</i>				●	
<i>Gymnothorax eurostus</i>	●	●		●	
<i>Gymnothorax flavimarginatus</i>		●		●	
<i>Gymnothorax gracilicauda</i>		●		●	
<i>Gymnothorax javanicus</i>				●	
<i>Gymnothorax kidako</i>				●	
<i>Gymnothorax melatremus</i>		●			
<i>Gymnothorax meleagris</i>		●		●	
<i>Gymnothorax pictus</i>				●	As <i>Gymnothorax hilonis</i> in D (see Randall, 2007)
<i>Gymnothorax rueppelliae</i>		●		●	
<i>Gymnothorax steindachneri</i>				●	
<i>Gymnothorax undulatus</i>	●	●		●	
<i>Scuticaria tigrina</i>				●	As <i>Uropterygius tigrinus</i> in D (see Randall, 2007)
<i>Uropterygius</i> sp.			●		
<i>Uropterygius fuscoguttatus</i>		●		●	
<i>Uropterygius inornatus</i>		●		●	

(Continued)

Appendix 1. (Continued.)

Species by Family	A	B	C	D	Taxonomic notes
<i>Uropterygius macrocephalus</i>		●			
<i>Uropterygius supraforatus</i>				●	
Family Ophichthidae (5)					
Ophichthidae				●	Unidentified
<i>Callechelys lutea</i>				●	
<i>Ichthyapus vulturis</i>		●			
<i>Leiuranus semicinctus</i>		●		●	
<i>Ophichthus fowleri</i>				●	As <i>O. erabo</i> in D (see Randall, 2007)
Family Clupeidae (3)					
<i>Etrumeus teres</i>			●	●	
<i>Herklotsichthys quadrimaculatus</i> ^a	●	●		●	
<i>Sardinella marquesensis</i> ^a				●	
Family Engraulidae (1)					
<i>Encrasicholina purpurea</i>			●	●	
Family Cyprinidae (1)					
<i>Carassius auratus</i> ^a				●	
Family Cobitidae (1)					
<i>Misgurnus anguillicaudatus</i> ^a				●	
Family Clariidae (1)					
<i>Clarias fuscus</i> ^a				●	
Family Evermannellidae (1)					
<i>Evermanella</i> sp. ^b			●		
Family Gonostomatidae (2)					
<i>Cyclothone</i> sp. ^b			●		
<i>Diplophos taenia</i> ^b			●		
Family Myctophidae (13)					
<i>Bolinichthys</i> sp. ^b			●		
<i>Ceratoscopelus townsendi</i> ^b			●		
<i>Diaphus</i> sp. ^b			●		
<i>Diogenichthys</i> sp. ^b			●		
<i>Hygophum proximum</i> ^b			●		
<i>Lampadena</i> sp. ^b			●		
<i>Lampadena luminosa</i> ^b			●		
<i>Lampadena urophaos</i> ^b			●		
<i>Lampanyctus</i> sp. ^b			●		
<i>Myctophum</i> sp. ^b			●		
<i>Taaningichthys minimus</i> ^b			●		
<i>Triphoturus</i> sp. ^b			●		
<i>Triphoturus nigrescens</i> ^b			●		
Family Phosichthyidae (1)					
<i>Vinciguerria nimbaria</i> ^b			●		
Family Stomiidae (1)					
<i>Bathophilus</i> sp. ^b			●		
Family Chlorophthalmidae (1)					
<i>Chlorophthalmus</i> sp. ^b			●		

(Continued)

Appendix 1. (Continued.)

Species by Family	A	B	C	D	Taxonomic notes
Family Synodontidae (10)					
<i>Saurida</i> sp.				●	
<i>Saurida flamma</i>		●			
<i>Saurida gracilis</i>	●	●	●	●	
<i>Saurida nebulosa</i>	●				
<i>Synodus binotatus</i>		●			
<i>Synodus dermatogenys</i>		●		●	
<i>Synodus</i> sp.			●		
<i>Synodus falcatus</i>				●	
<i>Synodus ulae</i>		●		●	
<i>Synodus variegatus</i>				●	
Family Bythitidae (2)					
<i>Grammonus waikiki</i>		●			
<i>Microbrotula rubra</i>				●	
Family Carapidae (1)					
<i>Onuxodon fowleri</i>		●			As cf. <i>Onuxodon fowleri</i> in B
Family Ophidiidae (1)					
<i>Brotula multibarbata</i>		●			
Family Mugilidae (3)					
<i>Mugil cephalus</i>	●			●	
<i>Neomyxus leuciscus</i>		●		●	
<i>Osteomugil engeli</i> ^a	●			●	As <i>Moolgarda engeli</i> in D
Family Atherinidae (1)					
<i>Atherinomorus insularum</i>	●	●	●	●	As <i>Pranesus insularum</i> in C (see Fricke et al., 2019)
Family Isonidae (1)					
<i>Iso hawaiiensis</i>			●		
Family Hemiramphidae (1)					
			●		Unidentified
Family Belonidae (3)					
<i>Platybelone argala platyura</i>		●			
<i>Tylosurus crocodilus</i>	●			●	
<i>Tylosurus</i> sp.			●		
Family Poeciliidae (7)					
<i>Gambusia affinis</i> ^a	●				
<i>Poecilia</i> sp. ^a	●				
<i>Poecilia latipinna</i> ^a				●	
<i>Poecilia mexicana</i> ^a				●	
<i>Poecilia reticulata</i> ^a				●	
<i>Poecilia vittata</i> ^a				●	
<i>Xiphophorus maculatus</i> ^a				●	
Family Holocentridae (9)					
<i>Myripristis</i> sp.				●	
<i>Myripristis amaena</i>		●		●	
<i>Myripristis berndti</i>		●		●	
<i>Myripristis kuntze</i>		●			
<i>Neoniphon sammara</i>	●	●		●	
<i>Plectrypops lima</i>		●		●	

(Continued)

Appendix 1. (Continued.)

Species by Family	A	B	C	D	Taxonomic notes
<i>Sargocentron diadema</i>		●		●	
<i>Sargocentron punctatissimum</i>		●		●	
<i>Sargocentron xantherythrum</i>		●			
Family Aulostomidae (1)					
<i>Aulostomus chinensis</i>	●	●		●	
Family Fistulariidae (1)					
<i>Fistularia commersonii</i>	●	●		●	
Family Syngnathidae (6)					
<i>Cosmocampus</i> sp.			●		
<i>Cosmocampus balli</i>			●		As <i>Syngnathus balli</i> in C (see Mundy, 2005)
<i>Doryrhamphus excisus</i>		●	●	●	As <i>Doryrhamphus melanopleura</i> in C; as <i>Doryrhamphus excisus excisus</i> in B (see Randall, 2007)
<i>Dunckerocampus baldwini</i>		●		●	
<i>Hippocampus fisheri</i>				●	
<i>Hippocampus kuda</i>	●		●		
Family Caracanthidae (1)					
<i>Caracanthus typicus</i>		●		●	As <i>Caracanthus maculatus</i> in D (see Mundy, 2005)
Family Scorpaenidae (17)					
Scorpaenidae				●	Unidentified
<i>Dendrochirus barberi</i>	●	●		●	
<i>Dendrochirus brachypterus</i>				●	
<i>Iracundus signifer</i>		●			
<i>Pterois sphex</i>		●	●	●	
<i>Scorpaenodes hirsutus</i>		●			
<i>Scorpaenodes kelloggi</i>		●		●	
<i>Scorpaenodes littoralis</i>		●			
<i>Scorpaenodes parvipinnis</i>		●			
<i>Scorpaenopsis brevifrons</i>		●		●	
<i>Scorpaenopsis cacopsis</i>	●	●		●	
<i>Scorpaenopsis diabolis</i>		●		●	
<i>Sebastipistes ballieui</i>		●		●	
<i>Sebastipistes coniora</i>	●	●		●	
<i>Sebastipistes fowleri</i>	●	●		●	
<i>Sebastipistes galactacma</i>		●			
<i>Taenianotus triacanthus</i>	●	●		●	
Family Eleotridae (2)					
<i>Eleotris fusca</i>				●	
<i>Eleotris sandwicensis</i>				●	
Family Gobiidae (30)					
<i>Asterropteryx semipunctata</i>	●	●	●	●	
<i>Bathygobius</i> sp.	●				
<i>Bathygobius coalitus</i>	●	●		●	
<i>Bathygobius cocosensis</i>	●	●	●	●	As <i>Bathygobius fuscus</i> , in part, in C and D (see Greenfield & Randall, 2004)
<i>Bathygobius cotticeps</i>		●	●	●	
<i>Bryaniops yongei</i>		●			
<i>Cabillus</i> sp.				●	

(Continued)

Appendix 1. (Continued.)

Species by Family	A	B	C	D	Taxonomic notes
<i>Cabillus caudimacula</i>		●			As <i>Cabillus</i> sp. (B Mundy personal communication)
<i>Coryphopterus</i> sp. or <i>Fusigobius</i> sp.		●		●	See Thacker & Cole (2002)
<i>Fusigobius duospilus</i>				●	As <i>Coryphopterus neophytus</i> in D. (See Thacker & Cole, 2002; Mundy, 2005)
<i>Eviota</i> sp.				●	
<i>Eviota epiphanes</i>	●	●	●	●	
<i>Eviota rubra</i>		●		●	
<i>Eviota susanae</i>	●	●		●	
<i>Gnatholepis anjerensis</i>	●	●		●	
<i>Gnatholepis cauerensis</i>		●			
<i>Lentipes concolor</i>				●	
<i>Mugilogobius cavifrons</i> ^a		●		●	
<i>Opuia nephodes</i>		●		●	As <i>Hazeus nephodes</i> in B
<i>Oxyurichthys lonchotus</i>		●	●	●	
<i>Pleurosicya</i> sp.	●	●			
<i>Priolepis aureoviridis</i>		●		●	
<i>Priolepis eugenius</i>	●	●		●	
<i>Priolepis farcimen</i>	●	●		●	
<i>Priolepis limbatosquamis</i>		●		●	
<i>Psilogobius mainlandi</i>	●	●	●	●	
<i>Sicyopterus stimpsoni</i>				●	
<i>Stenogobius hawaiiensis</i>				●	
<i>Trimma taylori</i>		●			
<i>Trimma unisquamis</i>		●		●	
Family Kraemeriidae (1)					
<i>Kraemeria bryani</i>	●	●			
Family Microdesmidae (1)					
<i>Gunnelliichthys</i> sp.			●		
Schindleriidae (2)					
<i>Schindleria pietschmanni</i>			●		
<i>Schindleria prematura</i>			●		
Family Blenniidae (17)					
<i>Blenniella gibbifrons</i>	●	●		●	
<i>Cirripectes obscurus</i>				●	
<i>Cirripectes quagga</i>		●		●	
<i>Cirripectes vanderbilti</i>		●		●	
<i>Cirripectes variolosus</i>				●	
<i>Cirripectes</i> sp.			●		
<i>Enchelyurus brunneolus</i>		●	●	●	Also as <i>Enchelyurus ater</i> in D, not a Hawaiian species (Mundy, 2005)
<i>Enneapterygius atriceps</i>				●	
<i>Entomacrodus marmoratus</i>		●		●	
<i>Entomacrodus strasburgi</i>	●	●		●	
<i>Exallias brevis</i>		●	●		
<i>Istiblennius zebra</i>		●	●	●	
<i>Omobranchus obliquus</i> ^a	●	●	●	●	As <i>Omobranchus rotundiceps obliquus</i> in B and D, as <i>Omobranchus elongatus</i> in C and D (see Randall, 2007)

(Continued)

Appendix 1. (Continued.)

Species by Family	A	B	C	D	Taxonomic notes
<i>Parablennius thysanius</i> ^a	●	●			
<i>Plagiotremus ewaensis</i>		●			
<i>Plagiotremus goslinei</i>		●			
<i>Plagiotremus</i> sp.			●		
Family Tripterygiidae (1)					
<i>Enneapterygius atriceps</i>		●	●		
Family Acanthuridae (20)					
Acanthuridae			●		Unidentified
<i>Acanthurus</i> sp.	●				
<i>Acanthurus achilles</i>				●	
<i>Acanthurus blochii</i>	●			●	
<i>Acanthurus dussumieri</i>				●	
<i>Acanthurus guttatus</i>	●				
<i>Acanthurus leucopareius</i>	●	●		●	
<i>Acanthurus nigricans</i>				●	
<i>Acanthurus nigrofuscus</i>		●		●	
<i>Acanthurus nigroris</i>		●		●	
<i>Acanthurus olivaceus</i>				●	
<i>Acanthurus triostegus</i>	●	●		●	
<i>Acanthurus xanthopterus</i>	●			●	
<i>Ctenochaetus hawaiiensis</i>				●	
<i>Ctenochaetus strigosus</i>	●	●		●	
<i>Naso brevirostris</i>				●	
<i>Naso lituratus</i>	●			●	
<i>Naso unicornis</i>	●			●	
<i>Zebrasoma flavescens</i>	●	●		●	
<i>Zebrasoma veliferum</i>	●			●	
Family Apogonidae (8)					
<i>Apogon deetsie</i>		●		●	
<i>Apogon erythrinus</i>		●		●	
<i>Apogonichthys perdix</i>		●		●	
<i>Foa brachygramma</i>	●	●	●	●	Also <i>Foa fo</i> in D, not a Hawaiian species (see Mundy, 2005)
<i>Ostorhinchus maculiferus</i>		●		●	As <i>Apogon maculiferus</i> in B and D (see Randall, 2007)
<i>Pristiapogon kallopterus</i>		●		●	As <i>Apogon kallopterus</i> in B and D (see Randall, 2007)
<i>Pristiapogon taeniopterus</i>		●		●	As <i>Apogon menesemus</i> in B and D (see Randall, 2007)
<i>Pseudamiops diaphanes</i>		●		●	
Family Callionymidae (3)					
<i>Callionymus decoratus</i>		●	●		
<i>Draculo pogognathus</i>		●	●		
<i>Synchiropus rosulentus</i>		●		●	
Family Carangidae (9)					
<i>Alectis ciliaris</i>				●	
<i>Atule mate</i>			●	●	
<i>Caranx ignobilis</i>	●			●	
<i>Caranx melampygus</i>	●			●	
<i>Gnathanodon speciosus</i>	●		●		

(Continued)

Appendix 1. (Continued.)

Species by Family	A	B	C	D	Taxonomic notes
<i>Seriola dumerili</i>				●	
<i>Seriola rivoliana</i>			●		
<i>Seriola</i> sp.			●		
<i>Scomberoides lysan</i>	●				
Family Chaetodontidae (14)					
<i>Chaetodon</i> sp.	●				
<i>Chaetodon auriga</i>	●	●		●	
<i>Chaetodon fremblii</i>		●		●	
<i>Chaetodon kleinii</i>		●			
<i>Chaetodon lineolatus</i>				●	
<i>Chaetodon lunula</i>	●	●		●	
<i>Chaetodon lunulatus</i>	●	●		●	Also as <i>Chaetodon trifasciatus</i> in D (see Mundy, 2005)
<i>Chaetodon miliaris</i>		●		●	
<i>Chaetodon multicinctus</i>	●	●		●	
<i>Chaetodon ornatissimus</i>	●			●	
<i>Chaetodon quadrimaculatus</i>	●			●	
<i>Chaetodon unimaculatus</i>	●	●		●	
<i>Forcipiger flavissimus</i>	●	●		●	
<i>Heniochus diphreutes</i>				●	
Family Cichlidae (3)					
<i>Oreochromis mossambicus</i> ^a				●	
<i>Sarotherodon melanotheron</i> ^a	●			●	
<i>Tilapia</i> sp. ^a	●				
Family Coryphaenidae (1)					
<i>Coryphaena hippurus</i>			●		
Family Serranidae (9)					
<i>Cephalopholis argus</i>		●		●	
<i>Epinephelus</i> sp.				●	
<i>Hyporthodus quernus</i>				●	As <i>Epinephelus quernus</i> in D
<i>Liopropoma collettei</i>		●			
<i>Plectranthias nanus</i>		●		●	
<i>Plectranthias winniensis</i>		●			
<i>Pseudogramma brederi</i>		●		●	As <i>Pseudogramma polyacanthum</i> in B; as <i>P. p. polyacanthum</i> and <i>P. p. hawaiiensis</i> in D (see Williams & Viviani, 2016)
<i>Suttonia</i> sp.				●	
<i>Suttonia lineata</i>		●			
Family Cirrhitidae (5)					
<i>Amblycirrhitus bimacula</i>		●			
<i>Cirrhitops fasciatus</i>		●			
<i>Cirrhitus pinnulatus</i>	●	●			
<i>Paracirrhites arcatus</i>		●			
<i>Paracirrhites forsteri</i>		●			
Pinguipedidae (1)					
<i>Parapercis schauinslandii</i>		●			
Family Creediidae (2)					
<i>Crystalloides cookei</i>	●	●			

(Continued)

Appendix 1. (Continued.)

Species by Family	A	B	C	D	Taxonomic notes
<i>Limnichthys nitidus</i>		●			
Family Kuhlidae (1)					
<i>Kuhlia xenura</i>	●	●	●	●	As <i>K. sandvicensis</i> in C and D (see comments in species accounts, above)
Family Kyphosidae (5)					
Kyphosid complex			●		
<i>Kyphosus cinerascens</i>			●	●	
<i>Kyphosus hawaiiensis</i>	●			●	As <i>Kyphosus bigibbus</i> in D (see Sakai & Nakabo, 2004)
<i>Kyphosus vaigiensis</i>	●				
<i>Sectator ocyurus</i>				●	
Family Microcanthidae (1)					
<i>Microcanthus strigatus</i>	●			●	
Family Cheilodactylidae (1)					
<i>Cheilodactylus vittatus</i>				●	
Family Labridae (28)					
<i>Anampses chrysocephalus</i>		●		●	
<i>Anampses cuvier</i>		●		●	
<i>Bodianus albotaeniatus</i>	●	●		●	As <i>B. bilunulatus</i> in B and D (see Randall, 2007)
<i>Cheilinus</i> sp.			●		
<i>Cheilio inermis</i>				●	
<i>Coris flavovittata</i>		●		●	
<i>Coris gaimard</i>		●			
<i>Coris venusta</i>		●		●	
<i>Cymolutes lecluse</i>			●		
<i>Gomphosus varius</i>	●	●		●	
<i>Halichoeres ornatissimus</i>	●	●		●	
<i>Labroides phthirophagus</i>		●		●	
<i>Macropharyngodon geoffroy</i>		●		●	
<i>Novaculichthys taeniourus</i>	●	●			
<i>Oxycheilinus bimaculatus</i>		●		●	
<i>Oxycheilinus unifasciatus</i>	●			●	
<i>Pseudocheilinus evanidus</i>		●		●	
<i>Pseudocheilinus octotaenia</i>		●		●	
<i>Pseudocheilinus tetrataenia</i>		●			
<i>Pseudujuloides cerasinus</i>		●			
<i>Stethojulis</i> sp.			●		
<i>Stethojulis balteata</i>		●		●	
<i>Thalassoma ballieui</i>	●	●		●	
<i>Thalassoma duperrey</i>	●	●		●	
<i>Thalassoma purpurum</i>				●	
<i>Thalassoma quinquevittatum</i>				●	
<i>Thalassoma trilobatum</i>		●		●	
<i>Wetmorella albofasciata</i>				●	
Family Lethrinidae (1)					
<i>Monotaxis grandoculis</i>		●			
Family Lutjanidae (4)					
<i>Lutjanus fulvus</i> ^a	●			●	

(Continued)

Appendix 1. (Continued.)

Species by Family	A	B	C	D	Taxonomic notes
<i>Lutjanus gibbus</i> ^a				●	
<i>Lutjanus kasmira</i> ^a				●	
<i>Pristipomoides filamentosus</i>				●	
Family Lobotidae (1)					
<i>Lobotes surinamensis</i>				●	
Family Nomeidae (2)					
<i>Cubiceps baxteri</i>			●		As <i>Cubiceps caeruleus</i> in C (see Mundy, 2005)
<i>Cubiceps pauciradiatus</i>			●		
Channidae (1)					
<i>Channa maculata</i> ^a				●	As <i>Ophicephalus striata</i> in D (see Mundy, 2005)
Family Mullidae (8)					
<i>Mulloidichthys flavolineatus</i>	●			●	
<i>Mulloidichthys vanicolensis</i>				●	
<i>Parupeneus cyclostomus</i>		●		●	
<i>Parupeneus insularis</i>				●	As <i>Parupeneus bifasciatus</i> in D (see Randall, 2007)
<i>Parupeneus multifasciatus</i>	●	●		●	
<i>Parupeneus pleurostigma</i>				●	
<i>Parupeneus porphyreus</i>	●			●	
<i>Upeneus arge</i>				●	
Family Polynemidae (1)					
<i>Polydactylus sexfilis</i>	●			●	
Family Pomacanthidae (4)					
<i>Apolemichthys arcuatus</i>		●		●	As <i>Desmoholacanthus arcuatus</i> in B and D (see Randall, 2007)
<i>Centropyge flavissima</i> ^a				●	
<i>Centropyge loriculus</i> ^a				●	
<i>Centropyge potteri</i>	●	●		●	
Family Pomacentridae (15)					
<i>Abudefduf</i> sp.	●		●		
<i>Abudefduf abdominalis</i>	●	●	●	●	
<i>Abudefduf sordidus</i>	●	●		●	
<i>Abudefduf vaigiensis</i>	●			●	
<i>Chromis</i> sp.	●				
<i>Chromis agilis</i>	●	●			
<i>Chromis hanui</i>	●	●		●	
<i>Chromis ovalis</i>		●		●	
<i>Chromis vanderbilti</i>		●			
<i>Chromis verater</i>		●		●	
<i>Dascyllus albisella</i>	●	●		●	
<i>Plectroglyphidodon imparipennis</i>	●	●		●	
<i>Plectroglyphidodon johnstonianus</i>		●		●	
<i>Plectroglyphidodon sindonis</i>		●		●	
<i>Stegastes marginatus</i>	●	●	●	●	As <i>S. fasciolatus</i> in B and D, as <i>Pomacentrus jenkinsi</i> in C (see Randall, 2007)
Family Priacanthidae (1)					
<i>Heteropriacanthus carolinus</i>	●	●		●	As <i>H. cruentatus</i> in B and D (see Fernandez-Silva & Ho, 2017)

(Continued)

Appendix 1. (Continued.)

Species by Family	A	B	C	D	Taxonomic notes
Family Scaridae (8)					
Scaridae			●		Unidentified
<i>Calotomus carolinus</i>				●	
<i>Chlorurus perspicillatus</i>				●	
<i>Chlorurus spilurus</i>	●	●		●	As <i>Scarus sordidus</i> in B and D (see Randall, 2007)
<i>Scarus</i> sp.				●	
<i>Scarus dubius</i>				●	
<i>Scarus psittacus</i>	●			●	
<i>Scarus rubroviolaceus</i>				●	
Family Gempylidae (1)					
<i>Gempylus serpens</i>			●		
Family Scombridae (4)					
<i>Acanthocybium soldandri</i>				●	
<i>Euthynnus affinis</i>			●	●	
<i>Katsuwonus pelamis</i>				●	
<i>Thunnus albacares</i>			●	●	
Family Sphyracidae (1)					
<i>Sphyracis barracuda</i>	●	●	●		
Family Zanclidae (1)					
<i>Zanclus cornutus</i>	●	●		●	
Family Antennariidae (8)					
Antennariidae			●		Unidentified
<i>Antennarius</i> sp.				●	
<i>Antennarius commerson</i>		●		●	
<i>Antennarius drombus</i>		●		●	
<i>Antennarius pictus</i>				●	
<i>Antennatus analis</i>		●			As <i>Antennarius analis</i> in B (see Arnold & Pietsch, 2012)
<i>Antennatus nummifer</i>		●		●	As <i>Antennarius nummifer</i> in B and D (see Arnold & Pietsch, 2012)
<i>Histrio histrio</i>		●		●	
Family Balistidae (3)					
<i>Rhinecanthus rectangulus</i>	●				
<i>Sufflamen bursa</i>	●	●		●	
<i>Sufflamen fraenatum</i>				●	
Family Diodontidae (3)					
<i>Diodon</i> sp.			●		
<i>Diodon holocanthus</i>				●	
<i>Diodon hystrix</i>	●			●	
Family Monacanthidae (5)					
<i>Cantherhines dumerilii</i>		●		●	
<i>Cantherhines sandwichiensis</i>	●	●			
<i>Cantherhines verecundus</i>				●	
<i>Pervagor aspricaudus</i>		●			
<i>Pervagor spilosoma</i>		●			
Family Ostraciidae (2)					
Ostraciidae			●		As Ostraciontidae in C
<i>Ostracion meleagris</i>	●	●			As <i>O. meleagris camurum</i> in B (see Randall, 2007)

(Continued)

Appendix 1. (Continued.)

Species by Family	A	B	C	D	Taxonomic notes
Family Tetraodontidae (7)					
<i>Arothron hispidus</i>	●	●		●	
<i>Arothron meleagris</i>			●		
<i>Canthigaster amboinensis</i>	●	●		●	
<i>Canthigaster coronata</i>		●			
<i>Canthigaster epilampra</i>		●			
<i>Canthigaster jactator</i>	●	●		●	
<i>Canthigaster rivulata</i>		●		●	
Family Molidae (1)					
<i>Ranzania laevis</i>			●		
Family Bothidae (3)					
<i>Bothus mancus</i>		●		●	
<i>Bothus pantherinus</i>		●		●	
<i>Engyprosopon hawaiiensis</i>		●			
Family Samaridae (2)					
<i>Samariscus</i> sp.				●	
<i>Samariscus triocellatus</i>		●		●	
Family Soleidae (3)					
<i>Aserragodes</i> sp.		●		●	
<i>Aserragodes borehami</i>		●		●	
<i>Aserragodes therese</i>		●		●	

Reports of presence (●); Column A: this study; column B: Greenfield (2003); column C: Watson & Leis (1974; eggs and larvae only); column D: Coles *et al.* (2002). The column of Taxonomic notes includes information on conflicting or contrasting taxonomy among the studies. See Species Accounts and Fricke *et al.* (2019) for further information on current species classification.

^aKnown or suspected exotic species.

^bOceanic species not expected to be collected as adults in Kāneʻohe Bay.