Tropical Eastern Pacific Records of the Prickly Shark, *Echinorhinus cookei* (Chondrichthyes: Echinorhinidae)[1]

Douglas J. Long,[2,3,5] *John E. McCosker*,[3] *Shmulik Blum*,[4] *and Avi Klapfer*[4]

Abstract: Most records of the prickly shark, *Echinorhinus cookei* Pietschmann, 1928, are from temperate and subtropical areas of the Pacific rim, with few records from the tropics. This seemingly disjunct distribution led some authors to consider *E. cookei* to have an antitropical distribution. Unreported museum specimens and underwater observations of *E. cookei* from Cocos Island, Costa Rica; the Galápagos Islands; and northern Peru confirm its occurrence in the tropical eastern Pacific and, combined with other published records from the eastern Pacific, establish a continuous, panhemispheric eastern Pacific distribution.

The genus *Echinorhinus* contains two species, the bramble shark, *E. brucus* (Bonnaterre, 1788), from the Atlantic, Mediterranean, western Indian Ocean, and Australia, New Zealand, and Japan, and the prickly shark, *E. cookei* Pietschmann, 1928, known from Hawai'i and the western and eastern Pacific Ocean (Compagno et al. 2005, Last and Stevens 2009). The species are easily differentiated by visual examination: *E. brucus* possesses few, relatively large, sparse denticles, some of which are fused into plates, and *E. cookei* has numerous, close-packed, relatively small and stellate denticles that are not fused into plates (Compagno 1984).

Echinorhinus cookei was described from an adult male (220.3 cm total length [TL]) caught off Kaua'i, Hawai'i (additional Hawaiian captures and observations in Chave and Mundy [1994] and Crow et al. [1996]); it has subsequently been collected or observed off Japan (Taniuchi and Yanagisawa 1983, Kobayashi 1986), Taiwan (Teng 1958), Palau (Saunders 1984), Tonga (Randall et al. 2003), New Caledonia (Fourmanoir 1979), New Zealand (Garrick 1960, Garrick and Moreland 1968), northeastern and southeastern Australia (Last and Stevens 2009), and possibly the Gilbert Islands (Whitley and Colefax 1938). In the northeastern Pacific it was first reported from southern California (Hubbs and Clark 1945) and Guadalupe Island, western Mexico (Collyer 1953), but misidentified as *E. brucus*. Later captures from the western coast of North America extended the range of *E. cookei* from a northernmost record off Astoria, Oregon (46° 11′ N, 124° 00′ W) (Pearcy et al. 1985), along the coast of central and southern California (Varoujean 1972, Crane and Heine 1992, Long 1994, Barry and Maher 2000), the Gulf of California (Mariano-Meléndez and Villavicencio-Garayzar 1998, Aguirre et al. 2002, Ruiz-Campos et al. 2010), the Pacific coast of Mexico off Nayarit (21° 01′ N, 105° 40′ W) (Chavez-Ramos and Castro-Aguirre 1974), and a southernmost record off El Salvador (12° 51′ 83″ N, 89° 36′ 18″ W) (Rojas et al. 2006). In the southeastern Pacific, *E. cookei* has been reported from a northern record off Huacho, Peru (11° 10′ S, 77° 50′ W) (Chirichigno 1963, misidentified as *E. brucus*), along the Chilean coast (Flores

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[2] Natural Sciences Department, Oakland Museum of California, 1000 Oak Street, Oakland, California 94607.

[3] California Academy of Sciences, 55 Music Concourse Drive, San Francisco, California 94118.

[4] Undersea Hunter Group, San Jose, Costa Rica.

[5] Corresponding author (e-mail: dlong@museumca.org).

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and Rojas 1979, Ruiz and Fernandez 1984, Meléndez and Meneses 1989, Meléndez et al. 1993), to a southernmost record in the Golfo de Arauco, Chile (33° 37′ S, 73° 20′ W) (Brito 2004), and also west of Chile from the Nazca Ridge (21° 30′ S, 81° 40′ W) (Golovan and Pakhorukov 1986, Parin 1991). This species has also been noted in fisheries checklists for other localities in the eastern Pacific (though all lack any specific location, depth, or specimen data), including continental Ecuador (Bearez 1996), Nicaragua (Sánchez 1997), Panama, Costa Rica, and Malpelo Island, Colombia (Compagno and Niem 1998, Robertson and Allen 2002). *Echinorhinus cookei* has been listed as a bycatch species in the coastal Colombian shrimp fishery (Puentes et al. 2007), although Mejía-Falla et al. (2007) noted the occurrence of this species in Pacific Columbian continental waters as "unconfirmed or dubious."

In light of the seemingly disjunct capture localities in largely temperate and subtropical marine areas, Hubbs (1952) suggested that *E. cookei* was a classic example of a shark with an antitropical distribution. Subsequent captures showed that *E. cookei* was more widespread in the Pacific basin than Hubbs realized, but the species was still largely absent from tropical waters of the eastern Pacific. Current published distributional maps for *E. cookei* also depict an apparently disjunct distribution between the Northern and Southern hemispheres, with equatorial waters seeming to be a barrier (Compagno 1984, Robertson and Allen 2002, Compagno et al. 2005, Last and Stevens 2009), but our data show this to be incorrect. We report on new records of *E. cookei* from the tropical eastern Pacific, as well as records from numerous other published reports that indicate that the northern and southern distributions of *E. cookei* do not represent disjunct antitropical populations but likely compose a continuous eastern Pacific population.

MATERIALS AND METHODS

Museum acronyms used in this study follow Eschmeyer (1998), and measurements follow Compagno (1984). All available locality, depth, and biological data that accompanied the museum specimens are presented. Material is housed in the ichthyological collections of the California Academy of Sciences (CAS), the Los Angeles County Museum of Natural History (LACM), the University of Costa Rica (UCR), and the United States National Museum of Natural History (USNM).

Underwater observations were made aboard the untethered manned submersibles *Johnson Sea-Link* (JSL) at the Galápagos Islands (McCosker et al. 1997) and the *DeepSee* (DS) at Cocos Island, Costa Rica (Cortes and Blum 2008). The *Johnson Sea-Link* is owned and operated by the Harbor Branch Oceanographic Institute (HBOI) of Fort Pierce, Florida; the *DeepSee* is operated by the Undersea Hunter organization of San Jose, Costa Rica. Both are outfitted with powerful exterior lighting and high-definition video and still cameras. Sharks were photographed and/or videotaped in situ, and the identifications were later reconfirmed by D.J.L. and J.E.M. Galápagos field observations are listed as JSL, followed by the dive number(s).

RESULTS

Museum Specimens

A total of eight specimens, including two from northern Peru and six from the Pacific coast of Costa Rica, is reported from four museum collections, and all represent previously unpublished localities for *E. cookei* (Table 1).

Underwater Observations

GALÁPAGOS ISLANDS (Figure 1, *bottom*): JSL dive 3952, immature, sex undetermined (approx. 130 cm TL), over a rocky bottom at 580 m, temperature 8.29°C, off Cabo Hammond (00° 27.99′ S, 91° 37.48′ W), Isla Fernandina, 14 Nov. 1995; JSL 3957, immature, sex undetermined (approx. 190 cm TL), over a rocky bottom at 449 m, 8.40°C, off Cabo Douglas (00° 17.53′ S, 91° 38.84′ W), Isla Fernandina, 16 Nov. 1995; JSL 3967, adult female (approx. 270 cm TL), over a rocky bottom at 514 m, 8.54°C, off Isla Darwin (01° 42.00′ N, 92° 00′ W), 21 Nov. 1995.

TABLE 1

List of Museum Specimens Cited in This Study

Museum No.	Sex	Length	Date Collected	Locality
LACM 33827-31	Male	67.4 cm	29 June 1973	Trawled off Puntarenas City, Golfo de Nicoya, Costa Rica
UCR 589-1	Male	95.0 cm	1972	Trawled off Puntarenas City, Golfo de Nicoya, Costa Rica
UCR 759-1 (1 of 2)	Male	32.5 cm	27 March 1973	Trawled at 274 m off Cabo Blanco, Peninsula de Nicoya, Costa Rica
UCR 759-1 (2 of 2)	Female	37.0 cm	27 March 1973	Trawled at 274 m off Cabo Blanco, Peninsula de Nicoya, Costa Rica
UCR 811-1	Male	78.5 cm	23 June 1974	Trawled at 311 m off Quepos, Costa Rica
UCR 1361-2	Male	53.0 cm	20 June 1980	Trawled at 329 m off Cabo Blanco, Peninsula de Nicoya, Costa Rica
USNM 201913	Female	152.4 cm	3 June 1966	Trawled by the R/V *Anton Brunn*, cruise16, station 627A at 311 m off Talara (5° 01′ S, 81° 25′ W), Peru
CAS 58049	Female	118.8 cm	3 June 1966	Trawled by the R/V *Anton Brunn*, cruise16, station 27A at 311 m off Talara (5° 01′ S, 81° 25′ W), Peru

Note: Measurements are of total length (in cm); depth is listed in meters. Refer to text for museum acronyms.

FIGURE 1. Photos of four different *Echinorhinus cookei* taken from manned submersibles. (*Top row*) Cocos Island, Costa Rica, ca. 305 m depth; (*bottom row*) (*left*) Isla Fernandina (dive 3957, 449 m depth), (*right*) Isla Darwin (dive 3967, 514 m depth), Galápagos Islands. See text for additional information.

TABLE 2

Summary of Known Localities and Depths of *Echinorhinus cookei* in the Eastern Pacific Ocean

Locality	Citation	Depth	No. of Specimens[a]
Oregon	Pearcy et al. (1985)	439 m	1 (136.5 cm)
Northern California	Varoujean (1972)	30–140 m	19 (109.5–280 cm)
	Crane and Heine (1992)	15–35 m	96+ (300–400 cm)
	Dawson and Starr (2009)	5–260 m	25 (170–270 cm)
Southern California	Varoujean (1972)	100–280 m	7 (174.4–188 cm)
	Barry and Maher (2000)	342 m	1 (175 cm)
	Long (1994)	57–275 m	7 (135.7–200 cm)
Guadalupe Island	Collyer (1953)	40 m	2 (267, 295 cm)
	Long (1994)	23 m	1 (280 cm)
Socorro Island	Mariano-Meléndez and Villavicencio-Garayazar (1998)	120–130 m	2 (295, 306 cm)
W. Baja California	Ruiz-Campos et al. (2010)	127–181 m	1 (81 cm)
Gulf of California	Chavez-Ramos and Castro-Aguirre (1974)	400–424 m	2 (68.5, 93.5 cm)
	Mariano-Meléndez and Villavicencio-Garayazar (1998)	144–160 m	4 (130–211 cm)
	Ruiz-Campos et al. (2010)	"near surface"	1 (294 cm)
Southwestern Mexico	Aguirre et al. (2002)	132 m	1 (37.7 cm)
El Salvador	Rojas et al. (2006)	180–357 m	2 (34.6, 52.0 cm)
Costa Rica	This report	274–329 m	6 (32.5–95 cm)
Cocos Island	This report	180–350 m	46 (200–400 cm)
Galápagos Islands	This report	449–514 m	3 (130–270 cm)
Peru	This report	311 m	2 (118.8, 152.4 cm)
Chile	Flores and Rojas (1979)	300–340 m	1 (145 cm)
	Ruiz and Fernandez (1984)	400 m	1 (135.5 cm)
	Meléndez and Meneses (1989)	400–524 m	2 (81.3, 135.5 cm)
	Meléndez et al. (1993)	160 m	1 (N/A)
	Brito (2004)	208 m	1 (107 cm)
Nazca Ridge	Golovan and Pakhorukov (1986)	300–340 m	2 (205.5, 235 cm)
	Parin (1991)	345–540 m	N/A
Hawai'i	Chave and Mundy (1994)	360–420 m	N/A
	Crow et al. (1996)	177–370 m	13 (183–304.8 cm)

[a] Measurements for total length (TL) in parentheses; those where number of specimens examined and/or measurements are not available are listed as N/A.

COCOS ISLAND, COSTA RICA (Figure 1, *top*): S.B. and A.K. have had 42 encounters with *E. cookei* since December 2005 while piloting the submersible *DeepSee* at Cocos Island. The sharks were observed over both soft and rocky sediments between 185 and 350 m, generally offshore between 05° 34.6′ N, 87° 03.6′ W and 05° 34.4′ N, 87° 03.9′ W. The majority of sharks were female (38 of 42) and mostly single individuals (40 of 42). During one encounter four females were seen together; during the other the gender of the two individuals could not be determined. Estimated lengths of the females ranged between 250 and 400 cm TL, and the males were estimated to be 250 cm TL. The skin of the males was less scarred than that of the females.

DISCUSSION

Antitropical distributions of marine species occur where separate populations in the Northern and Southern hemispheres are divided by warmer tropical waters. These can be real patterns of distribution where a vicariant event, usually a change in ocean temperature or currents, divides an original range into two isolated populations (Stepien and Rosen-

blatt 1996, Hillbish et al. 2000). However, some previously assumed antitropical populations are often the result of temperature preference where cold-adapted forms are found in much deeper waters than their shallower ranges in temperate areas (Randall 1981, Lindberg 1991). Earlier and seemingly disjunct distribution records of *E. cookei* led Hubbs (1952) to believe that the species had an antitropical distribution. The inference was that these panhemispheric populations existed in earlier times of cooler equatorial water, or that some *E. cookei* crossed the tropics during Pleistocene glacial periods, when equatorial waters were less extensive, by swimming into slightly deeper, cooler areas. Northern and southern populations were permanently separated as the tropics expanded during warmer interglacial periods into the disjunct populations seen today (Hubbs 1952).

Compagno (1984) described *Echinorhinus cookei* as a eurybathic species, ranging in depth from 11 to 415 m, but additional captures have extended the known depth range from as shallow as 5 m off California (Dawson and Starr 2009) to 524 m off Chile (Meléndez and Meneses 1989), 540 m on the Nazca Ridge (Parin 1991), between 550 and 650 m off Japan (Kobayashi 1986), and our maximum depth observations from the Galápagos at 514 m (Table 2). Although most shallow-water records for *E. cookei* are from higher latitudes and deeper-water records are from lower latitudes, the species shows a broad depth range in the eastern Pacific (Table 2). Distribution of this species in low latitudes appears to be limited to deeper, cooler isotherms between 5.5°C and 11°C (Chavez-Ramos and Castro-Aguirre 1974, Kobayashi 1986); in the tropics it generally occupies deeper (200+ m) waters (Formanoir 1979, Saunders 1984, Chave and Mundy 1994, Crow et al. 1996). By combining our data with previously published records, we conclude that *E. cookei* is not an antitropical species. Instead, *E. cookei* is a panhemispheric species in the eastern Pacific and probably a circum-Pacific species that will undoubtedly be captured elsewhere in the Pacific basin. Thus, what seem to be apparent patterns of antitropical distributions in some marine species might initially be artifacts based on limited initial data. At least in the case of *E. cookei*, the addition of a wealth of data from subsequent specimen captures and observations in tropical areas has elucidated a more genuine distributional pattern.

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