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Distribution of the pelagic stingray, *Dasyatis violacea* (Bonaparte, 1832), off California, Central America, and worldwide

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Abstract. The pelagic stingray, *Dasyatis violacea* (Bonaparte, 1832), is nearly worldwide in subtropical and tropical seas, and also at temperate latitudes. It is found in the top 100 m over deep water. This paper presents the pelagic stingray distribution off California from by-catch of the California drift gill-net fishery for swordfish during 1990–99 and research longline cruises for pelagic sharks in the southern California Bight. Field data of 28 specimens in the Scripps Institute of Oceanography collection suggested that females in the eastern Pacific population gives birth in warmer water in winter off the coast of Central America and then migrate to higher latitudes including southern California. A worldwide distribution map has been prepared, based on by-catch data from the longline fishery in the central north Pacific, the New Zealand and Australia Exclusive Economic Zone, and location reports of new captures in the literature and personal communications.

Introduction

The pelagic stingray, *Dasyatis violacea* (Bonaparte, 1832), was thought to occur only in the Mediterranean Sea and to be rare in most places (Tortonese 1956). More recent work showed that this species is nearly universal in subtropical and tropical seas, and also occurs at temperate latitudes (Wilson and Beckett 1970; Krefft and Stehmann 1973; Tortonese 1976; Nishida and Nakaya 1990; McEachran and Capapé 1994; Last and Stevens 1994). The pelagic stingray, in the family Dasyatidae, is different from most stingrays, which are demersal from the intertidal zone down to several hundred metres (Compagno 1987). It is a relatively small ray with a maximum disc width (DW) of 80 cm. It is generally caught in the top 100 m over deep water as by-catch on longlines for swordfish and tuna (e.g. Wilson and Beckett 1970; Last and Stevens 1994). Nakaya (1982) reported the only captures from a bottom trawl at 330–381 m near the Kyushu Palau Ridge. However, Bañón *et al.* (1997) suggested that the first record from the Galicia Bank north-east of the Iberian Peninsula was probably caught in the top 100 m when the bottom trawl at 800 m was hauled up.

The first record off southern California was in autumn 1959, after nine years of subnormal temperatures (Radovich 1961). Pelagic stingrays were observed as by-catch in the California drift gill-net fishery, which operated at 32–42°N (Hanan *et al.* 1993), and in the experimental drift longline fishery for sharks off southern California (O'Brien and Sunada 1994). A pelagic stingray was observed off California as far north as 41°N, 61 km west of Trinidad Head (R. Lea, personal communication).

Lo Bianco (1909), Ranzi (1932, 1933), and Ranzi and Zezza (1936) caught pregnant females with embryos in all stages of development during summer in the Bay of Naples and were able to determine that gestation was short (8 weeks) and that parturition was in August–September. Parturition occurred before the rays migrated to warmer water when the water in the Bay of Naples became too cold. Males matured at a smaller size (~37.5 cm DW) than did females (~ 50 cm DW, 3.50–3.75 kg) (Ranzi 1932; Tortonese 1976). The largest female was ~70 cm DW (~9 kg) (Ranzi 1932). Pelagic stingrays are still observed sporadically in the Bay of Naples (F. Bentivegna, personal communication)

Wilson and Beckett (1970) reported the distribution in the North Atlantic based on 75 specimens and proposed a northward movement to the Georges Bank and Grand Bank from the Gulf Stream as the surface water warms in summer. Their analysis included the largest recorded female specimen (80 cm DW; Bigelow and Schroeder 1965). Among all the summer captures, only two pregnant females were caught, which suggested that parturition might not be in summer but in winter, in the West Indies where the water is warmer.

Purpose/Materials

I determined the distribution of pelagic stingray off California from by-catch of the California drift gill-net fishery for swordfish from 1990 to 1999 (D. Peterson and L. Enriquez, personal communications) (Tables 1 and 2). Pelagic stingray by-catch was observed in the gill-net fishery from 1980 to 1990, but no detailed records were kept (Hanan *et al.* 1993; D. Holts, personal communication). By-catch numbers without location were available from observed drift longline vessels (O'Brien and Sunada 1994) (Table 1).

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Table 1. Pelagic stingray captures in Southern California 1959–99

CPUE: catch per 1000 hooks for all research cruises and fisheries using longline; catch per set for drift gill net. p.c., personal communication

Date	Location or no. of rays	CPUE	Comments	Source (remarks)
1959 Autumn	First record off S. California		After 9 years of subnormal temperatures	Radovich (1961)
1979 Sept.	San Diego trough		SIO 82-1	H. J. Walker (1995 p.c.)
1980 Dec.	off La Jolla		SIO 80-256	H. J. Walker (1995 p.c.)
1981–91	By-catch observed. Fishing 32°–42°N	>0.24[A]	CA drift gill-net fishery for sharks and swordfish	Hanan *et al.* (1993); D. Holt (2001 p.c.)
1983 June	off La Jolla		SIO 83-44	H. J. Walker (1995 p.c.)
1987 May	N. Coronado I.			H. J. Walker (1995 p.c.)
1988	265 (8.7% of catch)	~2	Experimental drift longline fishery for sharks	O'Brien and Sunada (1994)
1989	194 (9.1% of catch)	~3	Experimental drift longline fishery for sharks	O'Brien and Sunada (1994)
1990 July	off La Jolla		SIO 91-6	H. J. Walker (1995 p.c.)
1993 Apr., Sept.	8, 11	4,10	NOAA/NMFS shark abundance cruises	D. Holts (1997 p.c.)
1994 June, July, Oct.	0, 115, 0	0, 32, 0	NOAA/NMFS shark abundance cruises	Holts (1994); see No. 2 in Table 2
1995 June, July, Oct.	15, 31, 9	9, 6, ?	CA F&G cruises	Holts (1995); J. Neer (1995 p.c.)
1996 Aug.	74	12	NOAA/NMFS shark abundance cruises	Holts (1996)
1997 July, Aug.	2, 24	0.7, 4	NOAA/NMFS July (off Baja)	D. Holts (1997 p.c.)
1997 Oct.	6	12.1	MBA Opah R&D	Ezcurra (2001)
1998 July, Aug.	5, 27	17	MBA Opah R&D	V. Franklin (1998 p.c.)
1990–99	219, 32–45°N (see Fig. 1)	0.24	CA drift gill-net fishery for swordfish	D. Peterson and L. Enriquez (1999 p.c.); see No. 1 in Table 2

[A]By-catch was larger than in the California drift gill-net fishery for swordfish in 1990–99 (last item in this table) probably because mesh size was smaller.

Table 2. Pelagic stingray by-catch from a research cruise and fishery observer programmes

NOAA/NMFS, US National Oceanic and Atmospheric Administration/National Marine Fisheries Service; EEZ, Exclusive Economic Zone; T, temperature; CPUE, catch per unit effort; p.c., personal communication

Fishery	Location	Mean T (°C) (range)	Pelagic stingray by-catch and other details of fishery	Agency (Contact)
1. Drift gill net for swordfish	California and Oregon EEZ	17.7 (14.6–22.8)	219, 1990–99; 189 sets representing 20% coverage with 1–4 rays; catch per set 0.24; Estimated total by-catch 110 year^{-1}	NOAA/NMFS La Jolla (D. Peterson and L. Enriquez p.c.)
2. Longline for pelagic sharks (research)	Southern California Bight	20.3 (18.3–21.5)	115, 11–24 July 1994; 22 longline sets, 3649 hooks; depth of water 366–042 m (mean 710 m)	NOAA/NMFS La Jolla CA (D. Holts 1994)
3. Hawaii based longline fleet	Central North Pacific north of Hawaii		2737, Mar. 1994–Dec. 1998; Mean CPUE ~1 per 1000 hooks and set (max. CPUE ~37 per set); Estimated total by-catch ~19000 year^{-1}	NOAA/NMFS Honolulu HI (S. Pooley p.c.)
4. Longline for tuna	New Zealand EEZ	20.4 (13–24)	608, 1995–99; Maximum of 225 in 1998	New Zealand Ministry of Fisheries (from M. Francis)
5. Longline for tuna	Australian EEZ	18.3 (10–31)	1370, Jan. 1990–May 2000; 89% during May–September in colder water	Australian Fish. Management Authority (R. Stanley p.c.)

I determined the seasonal and size distribution of pelagic stingrays in the eastern Pacific from field data on 28 specimens in the Scripps Institute of Oceanography (SIO) collection (1953–90) (H. J. Walker, personal communication). These specimens were caught on research cruises between Central America and Baja California, and included a few rays caught incidentally near beaches in La Jolla California (Table 1). I included 65 rays caught on the NOAA/NMFS shark-abundance cruise in the Southern California Bight, 11–24 July 1994 (Tables 1 and 2; Holts 1994/5/6). I also included a neonate caught 90 miles off Tartar Shoals Mexico (LACM 31753–1) and a near-term embryo from an aborted litter on a tuna boat off El Salvador (CAS 47114).

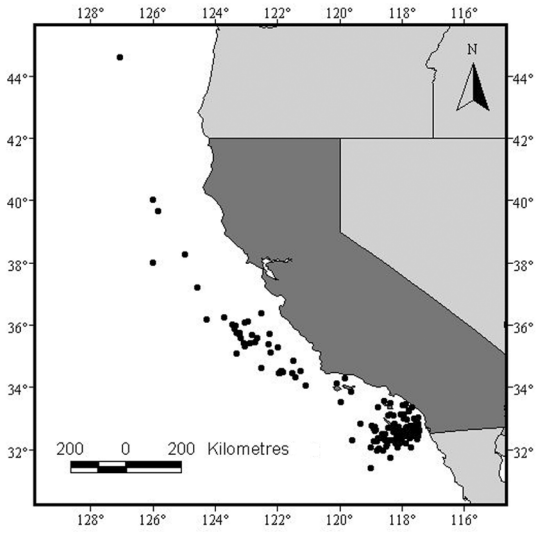

Fig. 1. Pelagic stingray by-catch in California drift gill-net fishery for swordfish, 1990–99.

I prepared an updated worldwide distribution map based on by-catch data from the longline fishery in the central-north Pacific, the New Zealand and Australia Exclusive Economic Zone (EEZ), and reports of new capture locations in the literature and from personal communications (Tables 2).

Results

The California drift gill-net fishery for swordfish recorded pelagic stingray by-catch not only off southern California but also off central and northern California, and Oregon (Fig. 1, Table 2). The stingray catches off southern, central (Point Conception 34°27′N to San Francisco 37°48′N), and northern California, and Oregon were 178, 36, 4 and 1, respectively, over the 10 years 1990–99. The surface water temperature was 14.6–22.8°C (mean 17.8°C, n = 84) for the sets off southern California and 16.0–17.9°C (mean 17.4°C, n = 12) for those off central California. No temperatures were available for sets off northern California. The fishery was operated during June–January and stingrays were caught during August–January with monthly by-catches of 9, 17, 48, 47, 66 and 32 for all areas combined.

During September–April, but predominantly November–March, pelagic stingrays were observed off Central America (Fig. 2*a*). About one-third of these rays were neonates <25 cm and included a near-term embryo observed in September (Fig. 2*b*). Pelagic stingrays were caught predominantly off Baja California and southern California from April to October and they were at least 40 cm, or about two years old. Females outnumbered males by 7:1 in one NOAA/NMFS cruise (n = 115) but no pregnant females were observed out of a total catch of 279 from 1993 to 1997 (Table 1). There were also no reports of pregnant females in the total catch of 459 rays reported by observers on vessels of the 1988–89 experimental drift longline fishery for sharks (Table 1).

The distribution of pelagic stingrays, including recent by-catch data from several fisheries in the north-central Pacific and from Australian and New Zealand waters and new records from several locations, is shown in Fig. 3. Pelagic stingrays occur worldwide in tropical, subtropical, and temperate seas. Rays were more numerous north of the Hawaiian chain (Fig. 3) than south of it (J. Arcenaux, personal communication). A pregnant ray was caught in the South Equatorial Current at 165°W in October 1994 (Anon. 1995) and is the only record of a pregnant female in the central Pacific.

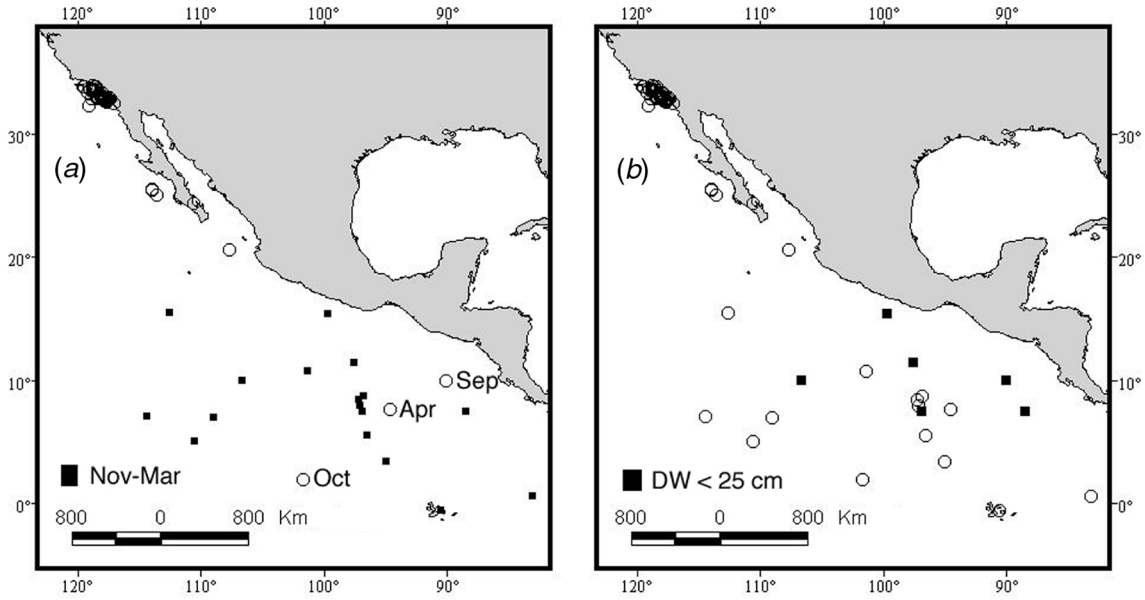

Fig. 2. Pelagic stingray distribution (n = 100) off Central America and southern California: *(A)* by season; *(B)* by size.

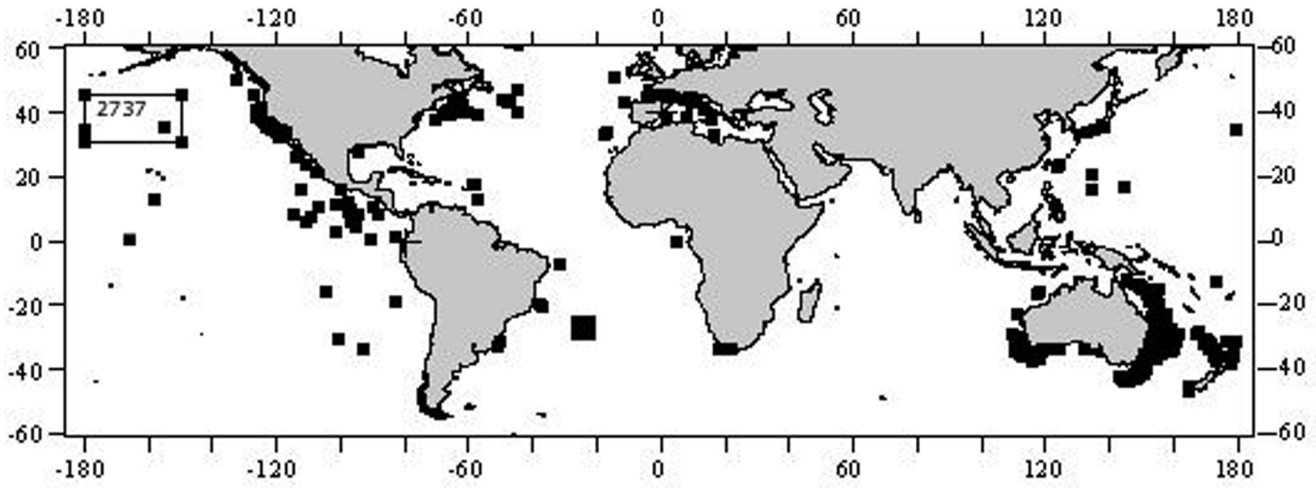

Fig. 3. Worldwide distribution of the pelagic stingray based on recent by-catch data from fisheries and new records[A]. The rectangle in the central Pacific shows the approximate location of the 2737 specimens caught in the longline fishery north of the Hawaiian Islands.
[A]From Ireland (A. Henderson, personal communication); Madeira, the Galicia Bank, Archachon Basin off Bordeaux and Gulf of Gascogne (Cazaux and Labourg 1971; Biscoito and Wirtz 1994; Bañón *et al.* 1997; Bañón 2000; Quero *et al.* 2000); Gibraltar and Greece (Ondrias 1971); Cantábrico waters off Santander (Iribar and Ibañez 1977); Archipelago of Madeira (Biscoito and Wirtz 1994); Tunisia (Capapé 1977); Gulf of Mexico (Branstetter and McEchran 1983); north-eastern Brazil (Menni *et al.* 1995); south of Trindade Island, Brazil (R. Mazzoleni, personal communication); Easter Island, Chile (Lamilla and Melendez 1989); La Paz Bay (Mariano and Villavicencio 1998); British Columbia (Peden and Jamieson 1988).

The pelagic stingray by-catch was variable in the swordfish fishery in the Ligurian Sea (off Genova, Italy) which operated during June–December. The total catch was estimated to be ~2000 in 1995, with up to 20 per boat, whereas the catch was smaller and much more variable in 1996 (F. Garibaldi, personal communication). Longline by-catch in January 2001, ~2000 km off the coast of central Brazil (≥5.5°S and ≥3.5°E of Trindade Island), comprised predominantly pregnant females (Fig. 3) (R. Mazzoleni, personal communication).

Discussion

Migration and parturition

The data suggest that females in the eastern Pacific population give birth in winter in warmer water off the coast of Central America before they migrate to higher latitudes nearer the coast including the Southern California Bight. No pregnant females were caught off southern California on our collection trips during April–October, 1995–97, and no pregnant females aborted on deck of vessels of the experimental drift longline fishery for shark during 1988–91 (O'Brien and Sunada 1994; K. Smirl, personal communication) or on vessels of the California drift gill-net swordfish fishery during 1981–2000 (Hanan *et al.* 1993; D. Peterson, personal communication). The pattern cannot be explained by seasonal variations in the fishery, observer coverage or mesh selectivity, and it contrasts with the Bay of Naples or off Brazil, where a large fraction of the catch consisted of pregnant females (Ranzi 1933; R. Mazzoleni, personal communication). A summer-caught female at San Diego Sea World had a litter in November, and one of six pups started feeding and survived after the water temperature was elevated to 25ºC (M. Shaw, personal communication).

Observations from the western and central Pacific also suggested that parturition occurs in November–March in warmer water near the equator. In the western Pacific, rays were collected on the Pacific coast of Kyushu and Shikoku, Japan, from May to November (May–June best, September–November next, July–August least; K. Nishida, personal communication), but no pregnant females were caught and no small specimens were observed. Many females caught in summer had litters later (November–March) at the Osaka Aquarium. No biological information was available from the large by-catch in the central Pacific north of Hawaii. The only specimen caught near the equator of the central Pacific in October 1994 was pregnant (Anon. 1994); this does not contradict parturition after migration into warmer equatorial waters in the central Pacific.

The migration pattern in the Mediterranean Sea appears to be different from that in the eastern Pacific. Parturition in the Bay of Naples takes place before the rays migrate to warmer water (Lo Bianco 1909; Ranzi 1933). Of 34 females captured in July–August 1932, two were virgins, one was not fecund, 30 (88%) were pregnant with eggs or embryos in all stages of development, and one was *post partum* (Ranzi 1933). The rays in the Bay of Naples migrated as the water became colder, although at the time it was suggested that they might move to the bottom to hibernate. Captive rays at

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